Physical Anthropology 213 - 227

Nutritional status of children as indicated by z-scores of the Hmars: A tribe of N.E. India

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Abstract

Introduction: In North-East India, many growth studies have been published for the populations of Assam and Meghalaya. However, no study, especially with regard to the nutritional status of the Hmars of Mizoram has been undertaken. So, more growth and nutritional studies are needed to carry out in populations of Northeast with a view to understanding the nutritional status of children.

Objective: To assess the nutritional status of children (based on z-scores) in relation to other demographic and socio-economic conditions of the study population.

Methods: The present study was based on anthropometric data from 507 children (boys =255 and girls =252) between 2 to 10 years from four rural villages. Three anthropometric indices were adopted for assessing the nutritional status of children.viz. weight-for-age, height-for-age and weight-for-height - which are considered as indicators of nutritional status. The data collected for the present study are quantified and analysed statistically, using SPSS Window software. The differences between two means were tested, using t-student test, while the differences between more than two means were determined, using one-way analysis of variance (ANOVA). Analysis of covariance was also carried out for testing the differences among means, allowing for the effects of other covariates. The differences between proportions were tested, using chi-square test. Multiple regression analysis was also carried out for understanding the effects of socio-economic factors on demographic parameters and growth patterns of children. Logistic regression analysis was used for analyzing the effects of maternal age, sex, income and education and on the three anthropometric indices – weight-for- age, height-for-age and weight-for-height.

Result: We observed higher prevalence of underweight and stunting in the higher age group (6-10 years) than in the lower age group (below 6 years) for both boys and girls. The present population is characterized by a high prevalence of underweight (28.40% for both sexes) and a very high prevalence of stunting (48.72% for both sexes) but with low prevalence of wasting (3.16%).

Conclusion: The low prevalence of wasting as indicated by weight-for-height is due to the fact that weight-for-height is independent of age, whereas indices of underweight and stunting are dependent of age. Weight-for-height is, therefore, a better indicator of nutritional status.

Keywords: Hmar children, weight-for-age, height-for-age, weight-for-height, nutritional status.

Introduction

Children's nutritional studies are many in different parts of the world, but among the present population, no such anthropological studies have been conducted so far. The Hmars are one of the major tribes of North East India and they are distributed in Churachandpur, Tipaimukh and Jiribam divisions of Manipur state. A good number of Hmars are also found in North Cachar hills (Assam), Meghalaya, Mizoram and Tripura. The present

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study deals with the Hmars of Aizawl district in Mizoram. The term "Hmar" is believed to have originated from the term "Hmarh" meaning "tying of one's hair in a knot on the nape of one's head". Physically, the Hmars are a strong and sturdy race and belong to the Mongoloid stock, with a flat broad nose and short stature, and well developed legs. The skin is usually yellow brownish in colour. The face is broad and flat and body is fairly well built with scanty body hairs. The men seldom have hair upon their faces. Allen et al. (1979). Agriculture is the mainstay occupation of the Hmar. Most of them are engaged in jhum cultivation. A number of monographs describe the socio-cultural life of these hill tribals (Songate 1957, 1976; Allen et al 1979). However, with regard to anthropometric data and especially nutritional status no work have been done so far. With this in mind, the present work was undertaken to study the anthropometric characteristics and nutritional status of the Hmars of Aizawl District, Mizoram.

In North-East India, many growth studies have been published for the populations of Assam (Das, 1969-71, 1972; Hazarika, 1974; Das 1973, 1974; Choudhury et al., 1992; Das and Choudhury, 1992; Begum and Choudhury, 1999; Choudhury and Begum, 2003). Some studies have been published for other populations of Northeast India (Gaur and Singh, 1995; Talwar and Singh, 1995; Khongsdier, 1996, 1999; Singh and Singh, 2000; Khongsdier and Mukherjee, 2003a, 2003b; Khongsdier et al., 2005). Recently, it has been shown that growth and nutritional status of the Khasi children was greatly influenced by economic condition and by the intermixture with other populations (Khongsdier and Mukherjee, 2003a, 2003b). However, no study, especially with regard to the nutritional status of the present population has been undertaken. So more growth and nutritional studies are needed to carry out in populations of Northeast with a view to understanding the nutritional status of children in relation to socioeconomic conditions.

Aim

The main purpose is to assess the nutritional status of children (based on z-scores) in relation to other demographic and socio-economic conditions of the study population.

Materials and methods

Study population

The present study was undertaken was based on anthropometric data from 507 children (boys=255 and girls =252) between 2 to 10 years from four villages namely Tinghmun, Zohmun, Sakawrdai and Ratu in Aizawl District, Mizoram. These four villages (20% of the listed villages) were selected according to simple random sampling by using random numbers given by Snedecor and Cochran (1967). According to this sampling method, the list of 20 villages and their population in Aizawl District was first prepared based on the information from the District Gazetteer (TRI, 1992). The table of random numbers given by Snedecor and Cochran (1967) was used for selecting the required number of sample villages to assess the nutritional status of Hmar children, a tribe of North East India.

Anthropometric measurements

The present study of physical group was based on a cross sectional sample of Hmar boys and girls aged between 2-10 years. Following are the anthropometric measurements taken on 255 boys and 252 children. Weight (Kg) was measured using a scale and the height vertex (cm) was measured by a Martin's anthropometer.

Besides the above measurements, following are the ratios/indices and/or estimates computed for the children of the present study.

1. Weight for height (%) wasting
2. Weight for age (%) underweight
3. Height for age (%) stunting

An attempt was made to follow as far as possible the standard techniques of taking the measurements as described in Lourie and Weiner (1981). For assessing the nutritional status of children, we have adopted three anthropometric indices – weight-for-age, height-for-age and weight-for-height - which are considered as the indicators of nutritional status. These indices were derived as a standard deviation (SD) or Z-score of a child's measurement to the median weight of the international standard or reference, i.e., the growth reference of the WHO/U.S. National Centre for Health Statistics (WHO, 1983, 1995). The Z-score of -2 is generally considered as the cut-off point for screening the individuals who are likely to be malnourished. The formula for SD or Z-score is as follows:

Z = (Child's measurement – Reference median) ÷ Reference SD

where,

Child's measurement = height or weight of a given child at age X

Reference median = mean or 50th percentile of the reference population at age X

Reference SD = standard deviation of the reference population at age X

Income groups: Data on household income were collected directly from the head of the household and they were cross-checked taking into consideration some aspects of socio-economic conditions like housing condition, types of occupation, land holding, and monthly expenditure. The interval estimation based on standard deviation of the per capita monthly income of household was adopted for classifying the three economic groups (Khongsdier, 1997), which is as follows:

Above $(\bar{X} + 4SD/\sqrt{N})$ = High income group (HIG)

$(\bar{X} - 4SD/\sqrt{N})$ to $(\bar{X} + 4SD/\sqrt{N})$ = Middle income group (MIG)

Below $(\bar{X} - 4SD/\sqrt{N})$ = Low income group (LIG)

Educational Level: The data on educational attainment of individuals in the present study were arbitrarily classified as follows: The category 'No education' includes those individuals who were unable to read and write and those who had no education but could read or write their names. The individuals who attended school up to standard V were grouped into Primary level of education. The individuals with education of standard VI and above are included in the category of Secondary level of education due to inadequacy of data.

Statistical analysis

The data collected for the present study are quantified and analysed statistically, using SPSS Window software. The data are presented in terms of means, standard deviation, standard error and proportions or percentages. The differences between two means were tested, using t-student test, while the differences between more than two means were determined, using one-way analysis of variance (ANOVA). Analysis of covariance was also carried out for testing the differences among means, allowing for the effects of other covariates. The differences between proportions were tested, using chi-square test. Multiple regression analysis was also carried out for understanding the effects of socio-economic factors on demographic parameters and growth patterns of children. Logistic regression analysis was used for analyzing the effects of maternal age, sex, income and education on the three anthropometric indices – weight-for- age, height-for-age and weight-for-height.

Results

The findings of the present study are supposed to reflect to certain extent the nutritional status of the Hmar population, because according to the World Health Organization (WHO), under-nutrition affects all sexes and ages and is one of the major risk factors for infections and diseases (WHO, 2000a). About 50% of the total annual deaths in children under 5 years of age are associated with under-nutrition in developing countries (Rice et al., 2000; WHO, 2000b).

Table I. Statistical constants of weight (kg) for boys and girls

Age (yrs)	Boys			Girls			t-value
	Mean	SD	Increment	Mean	SD	Increment	
2	11.00	1.07	-	10.13	0.81	-	2.58*
3	12.89	1.93	1.89	11.62	1.42	1.49	2.75*
4	13.90	1.72	1.00	13.89	1.34	2.27	0.02
5	15.35	2.11	1.65	15.39	2.61	1.50	0.06
6	17.21	2.83	1.85	16.19	2.94	0.80	1.45
7	18.77	2.43	1.57	18.38	2.41	2.20	0.69
8	21.06	4.03	2.29	20.79	2.02	2.41	0.29
9	22.79	2.91	1.73	22.00	3.41	1.21	0.99
10	25.38	3.63	2.59	24.82	3.69	2.82	0.56

*p < 0.05

Weight

Table I shows the means and standard deviations of the body weight for both boys and girls by age groups while the mean values are plotted against age in Figure I. The distance curve shows that there is a gradual increase in average weight for both boys and girls from 2 to 10 years of age. It is observed that boys are heavier than girls at many age groups, and the differences are significant at 2 and 3 years of age (2 years: t-value = 2.58, P < 0.05; 3 years: t-value = 2.75, P < 0.05).

Figure I

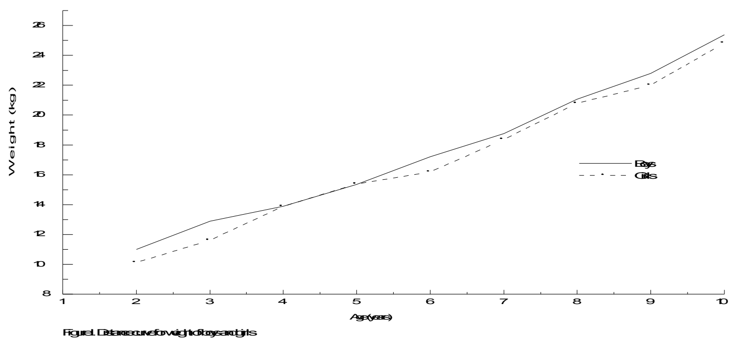
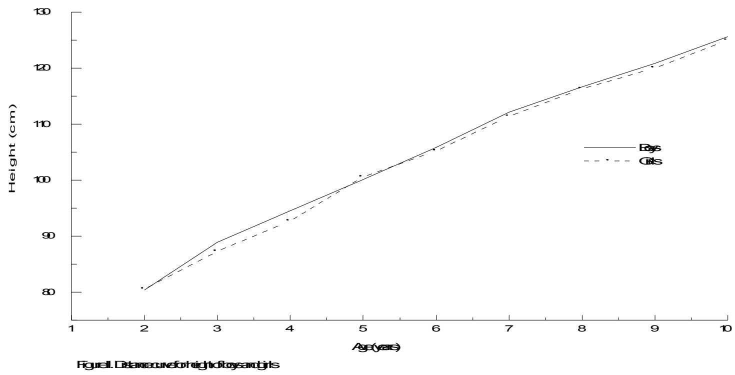


Table II. Statistical constants of height (cm) for boys and girls

Age (yrs)	Boys			Girls			t-value
	Mean	SD	Increment	Mean	SD	Increment	
2	80.37	2.46	-	80.55	4.76	-	0.13
3	88.92	4.84	8.55	87.30	5.76	6.75	1.12
4	94.53	5.36	5.61	92.70	4.35	5.40	1.40
5	100.11	5.59	5.58	100.58	5.00	7.88	0.32
6	105.85	4.79	5.74	105.24	6.40	4.66	0.44
7	112.13	4.49	6.28	111.42	5.07	6.18	0.62
8	116.68	5.77	4.55	116.29	3.98	4.87	0.27
9	120.84	5.54	4.17	120.05	3.83	3.76	0.62
10	125.61	5.34	4.77	124.96	5.61	4.91	0.43

Figure II



Weight-for-age

Weight-for-age, expressed as percentage or Z-score of individual weight to the median or 50th percentile of the international population references (i.e., WHO/NCHS growth references) is generally considered as one of the indicators of underweight. The means and standard deviations of the Z-score for weight-for-age are given in Table III. It is seen that the mean weight-for-age is lower in girls than in boys across age groups, except at 2 and 3 years of age and from 9 to 10 years of age when boys had higher Z-score for weight-for-age. The sex differences are not statistically significant except at 3 years of age ($t = 2.04$, $p < 0.05$).

Table III. Mean z-scores for weight-for-age of both boys and girls

Age (yrs)	Boys			Girls			t-value
	Number	Mean	SD	Number	Mean	SD	
2	15	-1.19	0.95	16	-1.42	0.69	0.78
3	28	-1.08	1.21	26	-1.69	0.96	2.04*
4	29	-1.47	0.90	27	-1.22	0.79	1.10
5	31	-1.57	1.00	23	-1.18	1.35	1.22
6	29	-1.49	1.22	42	-1.48	1.30	0.03
7	31	-1.55	0.92	42	-1.26	0.88	1.37
8	25	-1.37	1.30	24	-1.17	0.58	0.69
9	41	-1.41	0.77	24	-1.48	0.78	0.35
10	26	-1.26	0.79	28	-1.41	0.70	0.74

*p < 0.05

Table IV also shows the percentage distribution of undernourished children according to two arbitrary age groups. It is found that boys are about 1.47 times likely to be underweight as compared to girls (OR = 1.47, 95% CI = 0.89-2.43).

Besides sex variation in the distribution of low weight for age mentioned above, Table IV further shows that the frequencies of underweight (i.e., moderate plus severe forms) in boys for the age groups 2-5 and 6-10 years are 26.21% and 30.92%, respectively. While in the case of girls, these frequencies are 21.74% and 24.37%, respectively. Thus, it indicates that the prevalence of underweight is higher in the higher age groups for both boys and girls. In other words, the nutritional status with respect to weight-for-age seems to be better in the lower age groups as compared with the higher age groups. However, these differences in the distribution of undernourished individuals between age groups are not statistically significant in both boys.

Therefore, the present findings indicate that there are differences between the sexes and age groups with respect to the percentage distribution of underweight children, despite the absence of statistical significance. Girls seem to fair better than boys. Also, children in the lower age groups are better in weight-for-age as compared with those in the higher age groups.

Table IV. Nutritional status according to weight-for-age (based on NCHS references)

Nutritional status	Boys (N =255)		Girls (N = 252)	
	Number	Percent	Number	Per cent
2- 5 years				
Above normal (≤ + 2 Z score)	0	0.00	1	1.09
Normal (≤ -2 to +2 Z-score)	71	68.93	70	76.09
Moderate (-2 to -3 Z-score)	27	26.21	20	21.74
Severe (< -3 Z-score)	5	4.85	1	1.09
Total	103	100.00	92	100.00

χ^2 = 1.67, D.F. = 1, p > 0.05, OR (95% CI) = 1.57(0.82-2.99)				
6 to 10 years				
Above normal (≤ + 2 score)	1	0.66	1	0.63
Normal (≤ -2 to +2 Z-score)	102	67.10	117	73.12
Moderate (-2 to -3 Z-score)	47	30.92	39	24.37
Severe (< -3 Z-score)	2	1.32	3	1.88
Total	152	100.00	160	100.00
χ^2 = 1.35, D.F. = 1, p > 0.05, OR (95% CI) = 1.47 (0.89-2.43)				
2 to 10 years				
Above normal (≤ + 2 score)	1	0.39	2	0.79
Normal (≤ -2 to +2 Z-score)	173	67.84	187	74.21
Moderate (-2 to -3 Z-score)	74	29.02	59	23.41
Severe (< -3 Z-score)	7	2.75	4	1.59
Total	255	100.00	252	100.00
χ^2 = 2.85, D.F. = 1, p > 0.05, OR (95% CI) = 1.40 (0.95-2.07)				

χ^2 test for sex differences in the prevalence of underweight

OR = Odds ratio, CI = 95% confidential interval

Table V. Mean z-scores of height-for-age of both boys and girls

Age	Boys			Girls			
(yrs)	Number	Mean	SD	Number	Mean	SD	t-value
2	15	-1.64	0.77	16	-1.23	1.49	0.95
3	28	-1.58	1.27	26	-1.78	1.55	0.52
4	29	-1.97	1.26	27	-2.21	1.07	0.77
5	31	-2.14	1.22	23	-1.77	1.13	1.14
6	29	-2.11	0.99	42	-1.91	1.30	0.70
7	31	-1.88	0.88	42	-1.67	0.93	1.17
8	25	-1.92	1.08	24	-1.67	0.66	0.97
9	41	-2.00	0.98	24	-1.87	0.59	0.59
10	26	-1.89	0.88	28	-1.88	0.82	0.04

Height-for-age

Table V gives the means and standard deviations of Z-score for height-for-age. Height-for-age is considered as one of the best indicators of stunting or short stature of individuals due to under-nutrition.

It is obvious that girls are by and large better than boys in respect of height-for-age especially after 4 years of age.

Table VI shows the nutritional status of both boys and girls according to height-for-age, following the cut-off levels proposed by Visweswara Rao (1996). It is seen that the proportions of boys with normal, moderate, and severe forms of growth retardation are 47.06%, 40.78% and 12.16%, respectively. In the case of girls, these frequencies are found to be 55.16%, 30.56% and 13.89%, respectively. Thus, it indicates that the overall prevalence of under-nutrition (moderate plus severe forms) for all age groups is higher in boys (52.94%) than in girls (44.44%), and it is statistically significant ($\chi^2 = 3.67$, D.F. = 1, $p < 0.05$). The estimated OR is found to be 1.45 (95% CI = 1.02-2.06), which is also significant at 5% level.

Table VI. Nutritional status according to height-for-age (based on NCHS references)

Nutritional status	Boys (N =255)		Girls (N = 252)	
	Number	Percent	Number	Per cent
2-5 years				
Above normal (≤ + 2 score)	0	0.00	0	0.00
Normal (≤ -2 to +2 Z-score)	53	51.46	53	57.61
Moderate (-2 to -3 Z-score)	36	34.95	21	22.83
Severe (< -3 Z-score)	14	13.59	18	19.56
Total	103	100.00	92	100.00
$\chi^2 = 0.74$, D.F. = 1, $p > 0.05$, OR (95% CI) = 1.26 (0.71-2.22)				
6 to 10 years				
Above normal (≤ + 2 score)	0	0.00	1	0.63
Normal (≤ -2 to +2 Z-score)	66	44.08	86	53.75
Moderate (-2 to -3 Z-score)	69	44.74	56	35.00
Severe (<-3 Z-score)	17	11.18	17	10.63
Total	152	100.00	160	100.00
$\chi^2 = 3.74$, D.F. = 1, $p < 0.05$; OR (95% CI) = 1.61(1.03-2.54)				
2 to 10 years				
Above normal (≤ + 2 score)	0	0.00	1	0.40
Normal (≤ -2 to +2 Z-score)	120	47.06	139	55.16
Moderate (-2 to -3 Z-score)	104	40.78	77	30.56
Severe (<-3 Z-score)	31	12.16	35	13.89
Total	255	100.00	252	100.00
$\chi^2 = 3.67$, D.F. = 1, $p < 0.05$, OR (95% CI) = 1.45 (1.02-2.06)*				

χ^2 test for sex differences in the prevalence of stunting

OR = Odds ratio, CI = 95% confidential interval

*p < 0.05

Table VI further shows the percentage distribution of growth retardation in boys and girls according to two age groups arbitrarily classified as in the case of weight-for-age.

In the second age group (i.e., 6-10 years), Table VI shows that about 44.74% and 11.18% of boys suffered from moderate and severe forms of stunting, respectively. In the case of girls, the frequencies of moderate and severe forms of stunting are about 35% and 10.63%, respectively. Accordingly, like the case of the first age group, the frequency of low height-for-age is higher in boys than in girls, and it is statistically significant ($\chi^2 = 3.74$, D.F. = 1, $p < 0.05$). The estimated OR shows that the prevalence of low height-for- age in boys are about 1.6 times higher than girls in this age group (95% CI = 1.03-2.54, $p < 0.05$). Thus, it indicates that the sex difference in height-for-age is more marked in the higher age groups. It is found that about 48.54% and 55.92% boys are stunted in the age groups 2-5 and 6-10 years, respectively. As for girls, these frequencies are about 42.39% and 45.63%, respectively.

Weight-for-height

Weight-for-height is generally considered as the best indicator of body fat mass, or wasting and thinness due to chronic energy deficiency. Table VII indicates that there are no significant differences between boys and girls, except at 4 years of age when girls had higher mean values than boys ($t = 2.29$, $p < 0.05$).

Table VII Mean z-scores of weight-for-height of both boys and girls

Age (yrs)	Boys			Girls			t-value
	Number	Mean	SD	Number	Mean	SD	
2	15	0.05	1.06	16	-0.56	1.24	1.47
3	28	-0.10	1.16	26	-0.56	0.95	1.59
4	29	-0.34	1.19	27	0.32	0.94	2.29*
5	31	-0.30	1.38	23	-0.07	1.81	0.53
6	29	-0.17	1.26	42	-0.49	1.08	1.15
7	31	-0.35	1.17	42	-0.22	1.03	0.50
8	25	-0.02	1.33	24	0.23	0.90	0.77
9	41	0.11	0.98	24	0.03	1.22	0.29
10	26	0.30	0.84	28	0.25	1.10	0.19

*p < 0.05

The nutritional status of both boys and girls according to weight-for-height Z-score relative to the NCHS growth references is given in Table VIII. Considering all age groups, the prevalence of wasting (below – 2 Z-score) is more or less similar in both boys (3.92%) and girls (3.17%). In the age group 2-5 years, the estimated OR adjusted for age shows that the prevalence of low weight-for-height in boys are about 1.55 times higher than girls (95% CI = 0.36-6.67, $p > 0.05$). It is found that the prevalence of wasting is slightly higher in boys (2.91%) than in girls (2.17%), despite the absence of statistical difference ($\chi^2 = 2.37$, D.F. = 1, $p > 0.05$). On the other hand, the prevalence of wasting is higher in girls (3.12%) than in boys (1.97%) in the age group 6-10 years, although it is not statistically significant ($\chi^2 = 0.40$, D.F. = 1, $p > 0.05$). Nevertheless, it indicates that there are not significant differences between boys and girls with respect to weight-for-height except at 4 years of age when girls had higher values of Z-score for weight-for-height. There are also no sex differences with respect to the prevalence of wasting as measured by weight-for-height.

Table VIII. Nutritional status according to weight-for-height (based on NCHS references)

Nutritional status	Boys (N =255)		Girls (N = 252)	
	Number	Percent	Number	Per cent
2 - 5 years				
Above normal (≤ + 2 score)	3	2.91	2	1.09
Normal (≤ -2 to +2 Z-score)	95	68.93	87	94.56
Moderate (-2 to -3 Z-score)	3	2.91	2	2.17
Severe (< -3 Z-score)	2	1.94	1	1.09
Total	103	100.00	92	100.00
χ^2 = 2.37, D.F. = 1, p > 0.05, OR (95% CI) = 1.55 (0.36-6.67)				
6 to 10 years				
Above normal (≤ + 2 score)	7	4.61	6	3.75
Normal (≤ -2 to +2 Z-score)	142	93.42	152	95.00
Moderate (-2 to -3 Z-score)	3	1.97	5	3.12
Severe (< -3 Z-score)	0	0.00	0	0.00
Total	152	100.00	160	100.00
χ^2 = 0.40, D.F. = 1, p > 0.05 OR (95% CI) = 0.72 (0.17-3.13)				
2 to 10 years				
Above normal (≤ + 2 score)	10	3.92	8	3.17
Normal (≤ -2 to +2 Z-score)	237	92.94	239	94.84
Moderate (-2 to -3 Z-score)	6	2.35	7	2.78
Severe (< -3 Z-score)	2	0.78	1	0.40
Total	255	100.00	252	100.00
χ^2 = 0.001, D.F. = 2, p > 0.05, OR (95% CI) = 0.99 (0.37-2.70)				

χ^2 test for sex differences in the prevalence of wasting

OR = Odds ratio, CI = 95% confidential interval

*p < 0.05

Summary on nutritional status

Boys are likely to have a higher prevalence of underweight when compared with girls across age groups. In addition, children in the lower age groups are better in weight-for-age as compared with those in the higher age groups. Like in the case of weight-for-age, it reveals that the mean Z-scores for height-for-age are higher in girls than in boys, especially after 4 years of age. The overall prevalence of stunting (moderate plus severe forms) for all age groups is higher in boys (52.94%) than in girls (44.44%), and it is statistically significant (χ^2 = 3.67, D.F. = 1, p < 0.05). The estimated OR is found to be 1.45 (95% CI = 1.02-2.06), which is also significant at 5% level. In addition, the sex difference in stunting according to height-for-age index is more marked in the higher age groups. It is found that about 48.54% and 56.58% of boys are stunted in the age groups 2-5 and 6-10 years, respectively. As for girls, these frequencies are about 42.39% and 45.63%, respectively, although it is not statistically significant. With respect to weight-for-height, there are no significant differences between boys and girls, except at 4 years of age when girls had higher mean values than boys (t = 2.29, P < 0.05). Overall, it seems that the present population is characterized by a high prevalence of underweight (28.40% for both sexes) and a very high prevalence of stunting (48.72% for both sexes) but with low prevalence of wasting (3.16%), according to the classificatory criteria proposed by Gorstein et al., (1994), which are given in Table IX.

*Table IX. Criteria for assessing severity of under-nutrition in a population**

Indicator	Prevalence (%)			
	Low	Moderate	High	Very high
Underweight	< 10	10.0 – 19.9	20.0 - 29.9	≥ 30.0
Stunting	< 20	20.0 – 29.9	30.0 - 39.9	≥ 40.0
Wasting	< 5	5.0 – 9.9	10.0 – 14.9	≥ 15.0

** As proposed by Gorstein et al., (1994)*

Risk Factors of Underweight, Stunting and Wasting

Table X shows the risk factors of underweight, stunting and wasting in terms of odds ratios derived from logistic regression models after adjusting certain variables. Four logistic regression models were used for presenting the risk factors of underweight. In the first model, age was taken into consideration by dividing the children into two age groups, viz., 2-5 and 6-10 years, for computing the odds ratio with 95% confidence interval (CI) from the regression models after adjusting for sex, income and maternal education. It is found that older children aged 6-10 years had about 1.15 times greater in risk of being underweight as compared to younger children aged 2-5 years of age. However, this risk is not statistically significant ($p = 0.508$).

The second model is concerned with the sex difference after adjusting for age, income level and maternal education. It is seen from the table that boys had about 1.48 (95% CI: 1.01-2.30, $p < 0.05$) greater risk of underweight as compared with girls. This is somewhat in contrast to the general observation that underweight in Southeast Asia is higher in girls than in boys.

In the third model of logistic regression, we have taken into consideration the three income groups after adjusting for age, sex and maternal education. It is found that children in the low and middle income groups had greater risk of underweight when compared to those in the high income group. Children in the low-income group had about 2.58 (95% CI: 1.32-5.05, $p < 0.006$) times greater in risks of being underweight as compared to those in the high income group. Similarly, children in the middle income group had about 2.41 (95% CI: 1.41-5.24, $p < 0.027$) times greater in risks of being underweight as compared to those in the high income group. This is clear that household income is very important factor for regulating body weight of children.

It can be observed from the table that boys had about 1.64 (1.09-2.23) times greater in risks of stunting as compared to girls. Thus, like in the case of underweight, stunting is likely to be more prevalent in boys than in girls.

With respect to economic condition, it is found that children in the low and middle income groups had greater risk of stunting when compared to those in the high income group, i.e., the prevalence of stunting is similar to that of underweight with respect to economic condition. Children in the low-income group had about 2.64 (95% CI: 1.52-4.56, $p < 0.001$) times greater in risks of stunting as compared to those in the high-income group. In comparison with those in the high-income group, children in the middle-income group had also about 2.18 (95% CI: 1.13-4.19, $p < 0.022$) times greater in risks of stunting after adjusting for age, sex, and mother's education. Thus, household income is likely to be an important in determining stunting in the present population. Like in the case of underweight, the effects of maternal education are not clearly perceptible in the present population.

Table X: Risk factors for underweight, stunting and wasting adjusted by logistic regression analysis

Parameters	Underweight				Stunting			Wasting		
	N	Prevalence (%)	OR (95% CI)	p-level	Prevalence (%)	OR (95% CI)	p-level	Prevalence (%)	OR (95% CI)	p-level
Age groups (Years)										
2-5	195	53 (27.18)	-		89 (45.64)	-	-	8 (4.10)	-	-
6-10	312	91 (29.17)	1.15 (0.77-1.72)	0.508	156 (50.00)	1.26 (0.86-1.80)	0.243	8 (2.56)	0.62 (0.23-1.70)	0.352
Sex										
Girls	252	63 (25.00)	-		110 (43.65)	-	-	8 (3.14)	-	-
Boys	255	81 (31.76)	1.48 (1.01-2.30)**	0.052	135 (52.94)	1.64 (1.09-2.23)**	0.015	8 (3.17)	0.92 (0.34-2.52)	
Income group										
High	78	12 (15.38)	-	-	23 (29.49)	-	-	2 (2.56)	-	-
Middle	87	26 (29.89)	2.41 (1.11-5.24)**	0.027	42 (48.27)	2.18 (1.13-4.19)**	0.022	4 (4.60)	2.11 (0.37-12.09)	0.404
Low	342	106 (30.99)	2.58 (1.32-5.05)**	0.006	180 (52.63)	2.64 (1.52-4.56)**	0.001	10 (2.92)	1.34 (0.28-6.41)	0.714
Maternal education										
Primary	249	66 (26.51)	-	-	108 (43.37)	-	-	10 (4.02)	-	-
Secondary	139	45 (32.37)	1.22 (0.76-1.97)	0.403	72 (51.80)	1.30 (0.84-2.02)	0.240	5 (3.60)	0.84 (0.27-2.67)	0.768
No education	119	33 (27.73)	0.96 (0.56-1.66)	0.893	65 (54.62)	1.46 (0.89-2.38)	0.131	1 (0.84)	0.18 (0.02-1.58)	0.122

Discussions

The present findings indicate that boys have a higher prevalence of underweight when compared with girls across age groups. In addition, children in the lower age groups are better in weight-for-age compared with those in the higher age groups. Similarly, the mean Z-scores for height-for-age are higher in girls than in boys, especially after 4 years of age. The overall prevalence of stunting (moderate plus severe forms) for all age groups is significantly higher in boys (52.94%) than in girls (44.44%) with the estimated OR of 1.45 (95% CI = 1.02-2.06). In addition, the sex difference in the prevalence of stunting according to height-for-age index is more marked in the higher age groups. It is found that about 48.54% and 56.58% of boys are stunted in the age groups 2-5 and 6-10 years, respectively. With respect to weight-for-height, there are no significant differences between boys and girls, except at 4 years of age when girls had higher mean values than boys. Overall, according to the classificatory criteria proposed by Gorstein et al. (1994), the present population is characterized by a high prevalence of underweight (28.40% for both sexes) and a very high prevalence of stunting (48.72% for both sexes).

Although our study is inconsistent with those reported for under-five children in South Asia (Miller, 1997; Choudhury et al., 2000; Nubé and van den Boom, 2003; Shaikh et al., 2003), it may have certain implications for the role of cultural diversity in health and nutritional disparity in India. The excess under-nutrition among boys in the present study does seem to be indicative of the absence of female discrimination in the Hmar society. However, it does not mean for us to generalise that there was an absence of excess female under-nutrition in other Indian patrilineal societies. Considering our study and other studies, it is likely that anti-female bias in India varies from one population to another or from one culture area to another, which might not be detected statistically at the national level (Marcoux, 2002).

Socio-economic Condition and Under-nutrition

Under-nutrition affects all sexes and ages. What makes the situation more serious is that children under 5 years of age are the most vulnerable victims. Under-nutrition predisposes an individual to infection and vice versa. It is one of the major risk factors for infections and diseases (WHO, 2000a). About 50% of the total annual deaths in children under 5 years of age are associated with under-nutrition in developing countries (Rice et al., 2000; WHO, 2000b). Under-nutrition is attributable not only to poor access to food but also to other poor environmental conditions, such as poor housing and hygienic conditions, unsafe drinking water, heavy workloads, lack of preventive and control measures of locally endemic diseases and infections (Khongsdier, 2002). These poor environmental conditions are the common characteristics of population groups belonging to the lower socio-economic strata of the society, especially in developing countries (de Onis et al., 2000). In other words, the major cause of under-nutrition is poverty compounded by other poor environmental conditions that predispose an individual to morbidity and mortality. There is considerable evidence that children in the lower socio-economic groups especially in developing countries are often the victims of malnutrition and its associated morbidity and mortality (WHO, 2000a). In the present study, we have also observed that the prevalence of underweight and stunting is significantly higher in children with low economic condition. The important implication of the present study is that nutritional status is an indicator of not only the health inequality but also the social inequality in Hmar population and perhaps in many populations in developing countries.

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