

Original Article

Nutritional status of women in Bangladesh: comparison of energy intake and nutritional status of a low income rural group with a high income urban group

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This study evaluated the influence of socio-economic status on energy intake (EI), anthropometric characteristics and body composition (BC) of premenopausal Bangladeshi women in two socio-economic groups. This cross-sectional study measured height, weight, biceps and triceps skinfolds by standard procedures. A three-day dietary record was used to estimate EI. The biceps and triceps skinfolds were used to calculate total body fat (TBF), fat-free mass (FFM) and body fat percentage (BF%) according to Durnin and Womersley.³⁹ FAO/WHO/UNU¹⁵ equations were used to calculate basal metabolic rates (BMR). Two locations in Bangladesh were studied; the Dhaka city area and the west region of the subdistrict Nandail (Betagair Union) in the district of Mymensingh. Study subjects were premenopausal women ($N = 191$) aged 16–40 years. The high socio-economic group (group H, $N = 90$) consisted of women with high income and educational level. The low socio-economic group (group L, $N = 101$) consisted of rural, low income, illiterate women. Both groups contained three subgroups (non-pregnant, non-lactating = 1, pregnant = 2, lactating = 3). Socio-economic status had a significant effect on body weight, height, biceps and triceps skinfolds, BMI, TBF, FFM and BF% ($P < 0.001$). These variables were significantly higher ($P < 0.001$) in all subgroups of group H than in the corresponding subgroups of group L. The influence of physiological status on most of these variables was not significant. EI was, however, influenced by both socio-economic ($P < 0.001$) and physiological ($P < 0.05$) status. The mean EI was significantly lower ($P < 0.001$) in all subgroups of group L than in the corresponding subgroups of group H. The contributory sources were different in high and low income groups. In both groups, EI was lower than the recommended level. Based on the dietary and anthropometric results, we conclude that malnutrition is a common feature among low income rural women. This contradicts findings in western countries, where obesity is prevalent in low income groups.

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Key Words: anthropometry, body composition, energy intake, socio-economic groups, women, Bangladesh

Introduction

Nutrition is one of the most important factors influencing the quality of human life. Nutritional status is an important health indicator to assess a country's health status and morbidity pattern. In developing countries, women mature bearing obvious evidence of deprivation in childhood, namely stunting. Nutritional disorders are very frequent in women and involve a high risk of morbidity and mortality. Studies on nutritional status are very important in the women of childbearing age because of low to moderate prevalence of possible deficiencies.¹ The relationship between nutritional status and health of mothers and newborns is well documented.² Morbidity and mortality are inversely related to socio-economic status.³⁻⁵ In Bangladesh, natural calamities, such as devastating floods, prolonged droughts, destructive cyclones, often aggravate the nutritional deficiencies. These disasters cause high unemployment, elevated food prices, reduced food stock and a high scarcity of food, all of which have a marked impact on poor rural inhabitants and wage labourer

households. Moreover, during natural disasters, increased gender discrimination has been observed in previous studies, with a disproportionate increase in female mortality in severe food crises.⁶ A negative energy balance and chronic malnutrition have been reported in low income breast-feeding mothers in Bangladesh.^{7, 8}

Little published data exist on energy intake, anthropometry and body composition of premenopausal Bangladeshi women in high and low socio-economic groups. This study was therefore designed to evaluate the energy intake and body composition based on anthropometric variables of women of different physiological status in two socio-economic group.

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Subjects and methods

Selection of subjects

Recruited subjects included 191 women (aged 16–40 y) of two socio-economic groups (high socio-economic group = H group, $N = 90$; low socio-economic group = group L, $N = 101$) from the central and north-central parts of Bangladesh. The well-to-do families of the Dhaka city area were selected to represent high socio-economic status. This group consisted of women from highly educated, affluent families, such as those of the business world or high official households (government, non-government, private or self-owned businesses) living in buildings with modern facilities. Two locations in the newly developed part of Dhaka city (Malibag Chowdhurypara and Nakhhalpara) were chosen for this group. For women representing the low income group, three villages (Betagair, Choitonkhali and Charsrirampur) of Betagair Union (the west region of the subdistrict Nandail) in Mymensingh district were selected. A total of 101 out of 1320 low income households were randomly selected from these three villages. The villages are situated in a flood and drought-prone plain zone of the country, to the side of the shallow Kachamatia River a tributary of the Brahmaputra. The illiteracy, unsanitary conditions and inadequate health facilities are typical of the destitute people of Bangladesh. These women came from the households of daily labourers, beggars, landless individuals (owning less than 0.4 acres of cultivable land), landless farmers (usually cultivating land and giving 50% of proceeds to the owner) and farmers with small holdings (owning less than one acre of land). Subjects were divided into three categories: non-pregnant non-lactating = 1, pregnant = 2 and lactating = 3. The study was conducted from February to March and from April to May in 1995 for low income and high income women, respectively.

Socio-economic and demographic data

A questionnaire exploring socio-economic situation, lifestyle and demographics was developed. Parity was defined as the total number of viable pregnancies, including offspring both alive and dead but excluding abortions. Two trained female field workers interviewed the subjects in their homes to obtain all of the information. Socio-economic status was based on family income level and was categorized as low and high. In Bangladesh, the income levels of these two groups differ greatly. In the patriarchal society, women are dependent on men, such as their husband, father, brother, children or other male relatives, for support. Family income is therefore mainly based on the income of the husband. The income of the subjects and other members of the families was, however, also included in total family income. Furthermore, information regarding income from agriculture, poultry and livestock, home gardening, small businesses, etc., was collected. The money invested into these sources of income and debt servicing were not considered. However, family income recorded did take into account both cash and kind. The women in the low income group had no adequate means of support and survived at uncertain income levels. They lived on the outskirts of the village in bamboo-thatched huts or corrugated iron sheet and

bamboo houses with no electric power supply. Many of the women in subgroup L1 were sterilized after having had three or four children, a procedure becoming increasingly common in rural Bangladesh.

Energy intake

Information regarding energy intake was collected over three days including one Friday, which was at that time a weekly holiday in Bangladesh. Subjects were asked to maintain their normal dietary practices. The dietary information was collected by the female field workers, who were familiar with the local languages and dialects, customs, culture and food practices of the subjects of both locations. They were residents of the city of Dhaka, but were originally from the district of Mymensingh.

To collect the dietary information, the field workers were present at the houses of the subjects in a given area during all meals. The amount of food was measured using measuring cups and glasses collected from the Institute of Nutrition and Food Science, University of Dhaka and which had previously been used in the Nutritional Surveys of Bangladesh 1981–1982. The subjects were requested to measure their food by themselves in front of the field workers using the standardized measures provided. In addition, subjects were instructed to report the food and beverages taken between meals and to describe the portions in terms of the measures provided. These were recorded by the field workers during following visits on the same day. The food was coded by food item and weight measured in grams using the Food Code List and the Food Quantities Manual, respectively of the Institute of Nutrition and Food Science, University of Dhaka. The average intake of energy over three days was calculated for each individual using the computerized version of the Bangladesh food composition database promoted by the Institute of Nutrition and Food Science, University of Dhaka.

Anthropometric measurements

As Bangladesh is a predominantly Muslim society, the practice of purdah (a covered-up style of dress) is common for women. Thus, the acceptability of the anthropometric measurements to the subjects had to be considered; height, weight and biceps and triceps skinfolds were chosen. Body weight was measured to the nearest 0.5 kg, wearing no shoes, with light clothing, on a portable weighing scale. Standing height was measured with a wall-mounted scale to the nearest 0.5 cm, with the head in the Frankfurt horizontal plane,⁹ while standing straight on a horizontal surface with the heels together, the shoulders relaxed, arms at the sides and without shoes. Height and weight were used to calculate Quetelet or Body Mass Index BMI [weight (kg)/height (m²)]. The classifications of BMI applied in this study were recommended by the World Health Organization.¹⁰ BMI values of <18.5 kg/m² and ≥25 kg/m² represented thinness and overweight, respectively. An acceptable weight was considered to fall within these two extremes. In the case of pregnant women, BMI of <19.8 kg/m² indicated an underweight individual, while BMI of 19.8–26 kg/m² was considered to be within the normal range.¹¹ We found it difficult to measure the thickness of suprailiac and

subscapular skinfolds as the subjects were Muslim and this would have hurt their religious integrity. A Harpenden caliper was used to measure skinfold thicknesses (SFT). The measurements were taken at two sites on all subjects, at the biceps and triceps. The SFT was measured to the nearest millimetre, except for low values (usually 5 mm or less) when it was taken to the nearest 0.5 mm. These measurements were taken on the left side of the body with the subjects standing in a relaxed condition. Both skinfolds were measured in triplicate and the average of the three measurements was used. The two SFT values were used to estimate body fat percentage (BF%), total body fat (TBF) and fat-free mass (FFM) of the subjects according to Durnin and Womersley³⁹:

Equation I

$$\text{TBF} = \left(\frac{4.95}{\text{Body density}} - 4.50 \right) \times \text{Bodyweight}$$

Body density = $c - m \times \log \text{skinfold}$

where c and m are regression equation constants ($c = 1.1398$ and $m = 0.0738$) for the estimation of body density from the logarithm of (biceps + triceps) skinfold thickness. FFM and BF % were estimated using the following equations:

Equation II

$$\text{BF}\% = \frac{\text{TBF(kg)}}{\text{Actual body weight}} \times 100$$

Equation III

$$\text{FFM} = \text{Body weight} - \text{TBF}$$

Anthropometry and body composition differ widely during pregnancy because of extra weight gain due to the foetus, placenta, amniotic fluid and maternal tissue. Most subjects in both groups were at the beginning of their second trimester of pregnancy. Only a few subjects (<10%) were in the late first trimester and none had reached the third trimester of pregnancy. These subjects were compared with the specific standard for second trimester of pregnancy.¹¹

Basal metabolic rate

The basal metabolic rate (BMR) was calculated from body weight of adult women using the equations of FAO/

WHO/UNU.¹⁵ This equation was used for non-pregnant, non-lactating (NPNL) subjects and for lactating (L) subjects. The BMR of pregnant subjects was predicted using a relevant multiplication factor.¹²

Statistical analysis

The statistical analyses were carried out using χ^2 test and two-way analysis of variance (ANOVA). *Post-hoc* analyses between the corresponding subgroups of the two socio-economic groups were made with two-sided *t*-test using Bonferroni correction.¹³ Results are expressed as mean \pm SD. Mann-Whitney *U*-test was used for skewed distribution of variables. Taking Bonferroni correction into account, the significance level was set at $P < 0.0167$ (when three subgroups were compared with their counterparts). The Pearson correlation coefficient was used to estimate the relationship between different variables. The analyses were carried out with Stata Statistical Software.¹⁴

Results

Socio-economic and demographic data

The mean monthly income of the families was USD 22 and 358 for subjects in groups L and H, respectively. The mean age and monthly family income of the subjects in subgroups of these two groups are presented in Table 1. Of the subjects 21% were between 16–20 years, 65% were 21–30 years and the remaining 14% were 31–40 years old. The reported mean age at menarche was 14 and 13 years, and the mean age at marriage was 15 and 19 years for groups L and H, respectively. The mean parity of the subjects in low and high socio-economic groups was 3.0 and 1.7, respectively. The difference was statistically significant ($P < 0.001$). Nearly 90% of the subjects were housewives who were engaged in household activities only. About 90% of the subjects in group L were illiterate, whereas all the individuals in group H were literate. Five levels of education were distinguishable (Table 2).

Food and energy intake

There was a large group variation in the intake of the food groups ($P < 0.005$) but the subgroup variation in each group was minimal. A significant difference ($P < 0.005$) was observed in daily food consumption between the corresponding subgroups of the two groups. The food composition of the diet was different in the subjects in groups L and H. Apart for cereals, the high income group had a significantly higher intake of all other food items studied. The diet composition and food records displayed

Table 1. Age, monthly family income and distribution of the subjects by socio-economic groups, standard deviation or SD is given in parentheses

Low income group					High income group				
Subgroups	<i>N</i>	%	Age (yrs)	*MFI (USD)	Subgroups	<i>N</i>	%	Age (yrs)	*MFI (USD)
L1	36	35.6	28 (5)	19 (4)	H1	30	33.3	29 (6)	373 (230)
L2	30	29.7	23 (5)	31 (18)	H2	30	33.3	27 (4)	374 (328)
L3	35	34.6	23 (4)	16 (4)	H3	30	33.3	26 (5)	393 (250)

% indicate percentage of total subject in group; * monthly family income.

a variety of food consumed by group H, but the diet of the subjects in group L lacked variety, being mostly based on staples (rice and wheat), with only a small amount of animal products (such as meat, fish, eggs), milk and dairy products, fruits and sugar compared with the diet of group H. Fruits and meat were absent in the diets of sub-group L1 and milk and milk products were absent in both sub-groups of L1 and L2. A summary of daily food consumption (g/day) by food groups in the subgroups of both groups has been described in Table 3.

Calculated energy intakes (EI) are presented in Fig. 1. Substantial variations between groups were observed. The mean daily EI of all subgroups of group L was significantly lower ($P < 0.001$) than that of subgroups of group H, which had a similar physiological status, and was far below recommended levels. The energy intake of subgroups (1, 2 and 3) of group H was found to cover 90%, 94% and 84% of Recommended Dietary Allowance (RDA), respectively.¹⁵ The daily dietary source of energy in group L was 10% from proteins, 7% from fats and 85% from carbohydrates compared with 12% from proteins, 23% from fats and 63% from carbohydrates in group H.

Anthropometric characteristics and body composition

Physical characteristics, such as height, weight, skinfolds and BMI were significantly lower ($P < 0.001$) in all subgroups of group L than in the corresponding subgroups of group H. Low BMI values ($\text{BMI} < 18.5 \text{ kg/m}^2$) were more prevalent and underweight percentage (71%) was significantly higher in group L than in group H (11%). More than 90% of subjects of subgroup L1 had a BMI lower

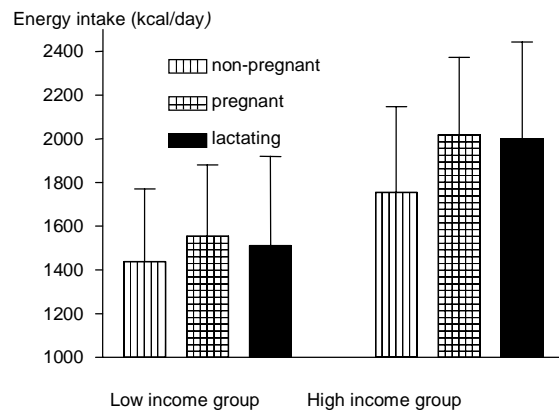


Figure 1. The mean daily intake of energy in subgroups of the two groups (bars showing the standard deviation).

than 18.5 kg/m^2 and none had a BMI above the normal range ($\text{BMI} \geq 25 \text{ kg/m}^2$). About 77% of pregnant subjects in the low income group and 13% in the high income group were classified as underweight.¹¹ In the pregnant subjects of the low income group, BMI values showed a higher prevalence of underweight even when pregnancy was ignored and normal classification of BMI was applied. Using these criteria, 36% of subjects in this subgroup had a $\text{BMI} < 18.5 \text{ kg/m}^2$. More than 66% of subjects in subgroup H2 were within the normal range of BMI for pregnant women, and 20% had a BMI higher than 26 kg/m^2 . In subgroup L3, about 80% of the subjects were underweight. The BMI values and distribution of subjects in different subgroups are presented in Table 4. The skinfold thickness differed significantly ($P < 0.001$) between corresponding subgroups of the two groups and

Table 2. Educational qualification of the subjects

Level of education	Group L	Group H	% of the total subjects
Illiterate	90	–	47.0
Can read and write	3	–	1.6
Attended primary school	4	2	3.1
Attended class VI-X	2	12	7.3
SSC* to HSC**	2	41	22.5
Graduation and above	–	35	18.3

*Secondary School Certificate; ** Higher Secondary Certificate.

Table 3. A summary of daily food consumption (g/day) by food groups in sub-groups of the two socio-economic groups, standard deviation or SD is given in parentheses

Food groups	L1	H1	L2	H2	L3	H3
Total cereals	356.2 (118.3)	264.1 (64.6)	380.0 (80.1)	323.6 (76.5)	392.2 (95.2)	301.7 (71.3)
*R&T	21.7 (20.0)	40.5 (22.6)	53.4 (32.7)	37.3 (30.6)	29.8 (18.8)	51.6 (39.7)
Potato	21.5 (20.0)	39.1 (22.9)	51.0 (30.2)	37.0 (30.6)	29.1 (18.8)	50.2 (40.0)
Pulses	4.6 (6.8)	26.3 (10.8)	15.3 (14.8)	29.8 (16.2)	7.7 (9.6)	31.9 (13.7)
**NLV	43.3 (24.2)	64.6 (43.1)	51.7 (33.9)	101.3 (44.5)	46.3 (25.8)	85.6 (47.3)
Fruits	–	84.5 (72.4)	30.3 (48.8)	129.7 (66.6)	1.5 (6.3)	92.2 (79.6)
Meat	–	41.1 (32.3)	2.0 (5.2)	31.7 (36.9)	3.0 (6.0)	38.1 (40.0)
Fish	15.4 (12.0)	37.2 (15.9)	19.2 (12.4)	46.9 (21.9)	14.4 (14.0)	49.5 (24.3)
Egg	0.9 (3.3)	26.9 (14.9)	4.8 (8.4)	23.5 (15.4)	0.2 (1.1)	31.3 (16.8)
Oil	4.0 (2.0)	33.8 (9.0)	7.7 (3.7)	28.5 (4.7)	5.4 (2.7)	32.0 (9.5)
Milk & dairy products	3.6 (14.7)	31.6 (53.7)	1.6 (5.3)	82.2 (60.8)	7.4 (22.2)	89.3 (99.1)

* Roots and tubers; ** Non-leafy vegetables; $P < 0.005$ between corresponding subgroups of the two groups; P -value calculated by Mann-Whitney U -test.

Table 4. Body Mass Index (BMI) values and distribution of subjects (%) in the investigated subgroups of the two socio-economic groups, mean value is given in parentheses

BMI (kg/m ²)	Subgroups of the group L			Subgroups of the group H		
	L1 (17.1)	L2 (19.4)	L3 (17.1)	H1 (22.9)	H2 (23.0)	H3 (21.8)
<16	25.0	–	25.7	3.3	–	3.3
16 – 17	22.2	10.0	31.4	–	–	3.3
17 – 18.5	44.4	26.6	22.8	6.6	6.6	6.6
18.5 – 25	8.3	60.0	20.0	66.6	70.0	73.4
>25	–	3.3	–	23.4	23.4	13.4

was significantly higher in all subgroups of group H as compared with subgroups of group L. Values of skinfolds thickness varied widely between subjects of the two groups (Table 5).

Body composition values are presented in Table 5. The results differed significantly ($P<0.001$) in BF%, TBF and FFM in the subgroups of group L compared with corresponding subgroups of group H. Interestingly, the mean TBF was much lower (<50%) in all subgroups of group L than in corresponding sub-groups of group H.

Basal metabolic rate

The calculated values of BMR (kcal/day) and EI:BMR ratios are presented in Table 5. The mean BMR was significantly lower ($P<0.001$) in all subgroups of group L than in subgroups of group H, which nonetheless had a similar physiological status. No significant differences were observed in EI:BMR ratios. The mean EI:BMR ratio was above 1.2 in all subgroups of both L and H groups, with the highest value (1.61) being observed in sub-group H3. A total of 47 out of 191 subjects (11 in L1, 10 in L2, 9 in L3, 10 in H1, 4 in H2 and 3 in H3) had an EI of less than 1.2 times their BMR.

Discussion

In this cross-sectional study, several possible associations between socio-economic situation and demographic characteristics were evaluated. Low income rural women showed a higher proportion of illiteracy, lower age at marriage and higher age at menarche. The mean age of non-pregnant, non-lactating women in both groups was higher than that of other women. This could be reflective of women of Bangladesh usually being in a constant state of pregnancy or lactation during the optimal reproductive years, an observation also made earlier.¹⁶ We found that more than 84% of high income women were housewives, although they were well educated. In this case, the similarity between the two groups most likely reflects the traditional culture of Bangladesh.

A socio-economic difference in dietary intake was observed in this study. Specific food intake and meal patterns between high and low income groups varied markedly in average contribution of energy from protein, fat and carbohydrate to total energy intake. This discrepancy in percentages of energy to total energy intake can probably be explained by the variation in dietary habits of Bangladeshi women in the two socio-economic groups.

Table 5. The differences in measured variables between corresponding subgroups of the two groups, values are expressed as mean \pm SD

Sub-groups	L1	H1	Pvalue	L2	H2	Pvalue	L3	H3	Pvalue
Height (cm)	148.9 (4.5)	155.3 (5.2)	<0.001	150.5 (5.4)	153.9 (6.2)	<0.05	148.6 (4.2)	153.8 (5.0)	<0.001
Weight (kg)	37.9 (4.3)	55.0 (8.8)	<0.001	43.9 (5.8)	54.4 (8.4)	<0.001	37.8 (4.2)	51.5 (8.2)	<0.001
Biceps skinfold	3.4 (0.9)	8.4 (3.7)	<0.001	3.9 (1.1)	7.3 (.8)	<0.001	3.2 (0.7)	7.3 (2.8)	<0.001
Triceps skinfold	7.0 (2.2)	17.5 (5.4)	<0.001	8.6 (2.7)	15.8 (5.3)	<0.001	6.7 (2.1)	15.9 (5.7)	<0.001
Optimum	49.6 (2.4)	53.2 (3.1)	<0.001	50.5 (3.0)	52.5 (3.6)	<0.05	49.2 (2.4)	52.3 (2.8)	<0.001
Total body fat	4.9 (1.5)	12.8 (3.9)	<0.001	6.5 (2.0)	12.0 (3.9)	<0.001	4.6 (1.5)	11.3 (3.8)	<0.001
Fat free mass	33.1 (3.2)	42.2 (5.6)	<0.001	37.4 (4.6)	42.5 (5.6)	<0.001	33.2 (3.1)	40.2 (4.5)	<0.001
Body fat (%)	12.6 (2.8)	22.9 (4.2)	<0.001	14.7 (3.4)	21.5 (3.9)	<0.001	12.0 (3.0)	21.6 (4.0)	<0.001
BMR*	1052 (63)	1304 (0.09)	<0.001	1141 (6.0)	1296 (124)	<0.001	1052 (61)	1253 (116)	<0.001
EI-BMR** ratio	1.36 (0.31)	1.35 (0.33)	<0.001	1.37 (0.30)	1.56 (0.30)	<0.001	1.43 (0.37)	1.61 (0.37)	<0.001

* Basal metabolic rate; ** Energy intake -basal metabolic rate; P-value calculated by a two-sided *t*-test after two-way analyses of variance.

The energy intake was higher in the high income group. This has been reported in other studies conducted in Bangladesh¹⁷⁻²⁰ but was lower in the low income subjects. Compared with other reported studies among the poor people of Bangladesh, our low income group had a higher intake of energy.²¹ Women of rural India with no physical activity in their leisure time have been reported to have similar energy intake levels.²² The observed energy intake in the sub-groups of the low income group agrees well with several earlier studies in women of developing countries.²³⁻²⁵ The mean energy intake in women of the high income group was in agreement with other reported studies of subjects of similar physiological status in developed countries such as in the UK,^{1, 26} the Netherlands,²⁷ and France,²⁸ but was somewhat higher than the energy intake of Southeast Asian (Cambodian, Laotian and Vietnamese) women living in the USA²⁹ and South Asian women living in the UK.¹

Energy intake in the high income group was somewhat lower than recommended levels. However, dietary assessment is usually affected by an underreporting bias. During the study period many of those in subgroups H1 and H3 reported that they were dieting. Whether the measured energy intake in the high income group approximated these subject's normal energy intakes could not be ascertained. In the low income group, by contrast, the energy intake measured could be considered to be at the absolute level because this study was carried out immediately after the major crop (rice) harvesting. A high energy intake level and improvement in nutritional status at the harvesting period have previously been reported in a study in Bangladesh.³⁰ However, it is difficult to draw any conclusions about the energy sufficiency of this group without considering their requirements. Energy insufficiency could be ascertained by examining trends in weight loss over time. The observed energy intake in the low income group might be explained by the low energy density of their diet. Daily food consumption (g/day) by food groups in the sub-groups of the both groups has been described in detail elsewhere.³¹

The higher percentages of low BMI and low body weight and height in the low income group highlights the inferior nutritional status of this group. Marriage and a constant state of pregnancy and lactation before physical maturation, accompanied by poor nourishment, make the women of this group vulnerable to many physical problems. These increase the risk of obstetric complications and mortality as well as stunting in height of the mother.³² Our results also support an association between the height and socio-economic status. Moreover, significant differences in BMI with socio-economic status were observed. However, the level of nutritional status observed in the low income group was similar to earlier studies in low income women in different regions of Bangladesh.^{7-8, 18, 33}

Biceps and triceps skinfold thicknesses were significantly lower in all subgroups of the low income group, indicating lower subcutaneous fat deposition. Triceps skinfolds of high income subjects were comparable with previous findings of fat patterning and distribution among Asian women from four subethnic groups.³⁴ In addition, biceps and triceps skinfold thicknesses in this group were

similar to those of Chinese women and young Nigerian women^{35,36} but were higher than those of Nepalese women.³⁷ Another study reported that New Zealand, European and Polynesian women had much higher biceps and triceps skinfolds than the women in our study.³⁸ However, skinfold thickness values differ widely, and variations in the distribution of subcutaneous fat occur with age, sex and race.³⁹

As no equation is available to predict total body fat percentage for Bangladeshi women, the population-specific equations developed for European women were used. The mean values estimated for the two groups of Bangladeshi women were very low compared with that for the analogous age group from which the first equation was derived. In view of the lower energy intake compared with European women, the lower body fat percentage among women of Bangladesh is not surprising. The body fat percentages in group H women were comparable with those obtained for Indian, Beninese Ethiopian women⁴⁰ and Nigerian secondary school students,³⁵ but TBF% was lower in group L subjects than in the low income working women of India.²² Several studies have observed that Asian women have a tendency towards a central pattern of fat distribution. Bermingham *et al.*,⁴¹ for instance, reported higher levels of central fat in Vietnamese women than in Australian women, despite the former having low BMI.⁴¹ Folsom *et al.*,⁴² noted the central pattern of fat distribution among lean Chinese women who also had a relatively low BMI. Because of ethical limitations the supriliac and subscapular skinfold thicknesses were not included. If these skinfolds thicknesses had been used, the TBF% of women in the two groups might have been different.

The BMR values in subgroups of group H were similar to the average BMR value for adult women aged 18-30 years estimated with FAO/WHO/UNU¹⁵ equations. All subgroups of the low income group had lower BMR values than this estimated BMR. It is not clear how appropriate the FAO/WHO/UNU equations are to the Asian populations. These FAO/WHO/UNU equations have been demonstrated to overestimate the BMR for Asian women living in the tropics and at low altitudes.⁴³ Lower BMR in subjects living in tropical countries is most likely due to a combination of factors such as climate, diet, ethnic background and body configuration.⁴⁴ Seasonal variation in BMR has also been reported by other investigators.^{40,45} The FAO/WHO/UNU¹⁵ equations are derived from European populations. These subjects probably had higher percentages of body fat than the subjects of the present study. Locally derived equations would provide more accurate results because Bangladeshi women in the low income group are short and underweight.

According to FAO/WHO/UNU¹⁵, the minimum energy expenditure of an individual is 1.4 times the BMR when not engaged in any occupational or discretionary activities. If the habitual energy intake of an individual is found to be less than 1.4 times the BMR, underestimation is likely,⁴⁶ indicating either under-reporting of normal dietary intake or reduction of energy intake during the period the dietary record was kept. Energy intake of less than 1.2 times the BMR is usually excluded because it

could not be representative of habitual intake.³⁵ In our study, energy intake was found to be much lower with 17 women in group H and 30 in group L having an average energy intake of less than 1.2 times the BMR. The explanation for this lower energy intake in both groups is complicated. However, we believe that energy intake of the women in the high income group is not typical of their habitual intake. Energy intake was probably under-reported in this group. With regard to the low income women, it is more difficult to comment because prevalence of underweight was very high in this group. The findings in the low income group were contradictory to those of previous studies in western countries.^{27, 47, 48}

In conclusion, the higher prevalence of short stature in subjects of the low socio-economic group indicates nutritional deficiencies in the past. Nutritional problems were predominantly present in women of the low income group, and the high prevalence of both low BMI and low energy intake emphasize the vulnerability of this group to malnutrition. The study defined several differences in the nutritional states of the two main groups which have a potential influence on the well-being of the subjects as well as their offspring. Intervention programmes of the Public Health Department in developing countries should target these women at risk and attempt to eliminate these differences for the sake of future generations.

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