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Physical status, nutrient intake and dietary pattern of adolescent female factory workers in urban Bangladesh

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This cross-sectional study examined the physical status, nutrient intake and dietary pattern of adolescent female factory workers in urban Bangladesh. A total of 1211 postmenarchial girls aged 14-19y from seventeen readymade garment industries spread over the Dhaka City participated in the study. Body weight, height and skin fold thickness were measured for all subjects. The nutrient intake was assessed by 24-h recall method and 7-day food frequency questionnaire was used to investigate their dietary pattern on a sub-sample of 509 girls. Sixty five percent of the girls were short (height-for-age, <3rd percentile of NCHS reference values). Prevalence of short stature was higher in the older girls. Mean body weight was 38kg for the 14 year old girls, which gradually increased across the age groups to about 42 kg for the 18 and 19 year olds. About 17% of the girls were thin (BMI-for-age <5th percentile of NCHS reference values). Over all, about 23% were lean (TSFT-for-age<5th percentile of NCHS reference values). Food intake data revealed a deficit of 1.62 MJ/day in energy. Mean intake of protein, calcium, iron, vitamin A, thiamin, riboflavin, niacin and vitamin C were below the recommended dietary allowance. Most of the energy and nutrients came from cereal grains. Habitual pattern of food intake revealed poor intake of eggs, milk, meat, and green leafy vegetables. In conclusion, the data show a poor physical status of the adolescent female factory workers in Bangladesh. Simultaneous substantial deficits in energy and several nutrients in their diet stress the need for an appropriate intervention to improve their overall nutritional and physical status of these young females.

Key Words: adolescent girls, stunting, dietary pattern, factory workers, body size, Bangladesh.

Introduction

Adolescence is an important stage of physical growth and development in the lifespan. Unique changes that occur in an individual during this period are accompanied by progressive achievement of biological maturity. Growth occurs in skeleton, in the muscle, and in almost every system and organ of the body in adolescence except the brain and the head.[1] During adolescence, more than 20% total growth in stature and up to 45% of adult bone mass are achieved, and weight gained during the period contri-butes about 50% to adult weight.[2] Accelerated growth characteristic of adolescence places increased demand on energy, protein, and other nutrients. Tempo of growth during adolescence is slower in undernourished populations.[3] Protein deficiency has been shown to reduce growth during adolescence.[4] Iron has also been suggested to be essential for skeletal growth.[5] It has been shown to be a limiting factor for growth if intake is deficient.[6] Vitamin A has also been indicated to be important for growth, development, and maturation.[5-6] Increase in skeletal size and its mineral content enhances need for calcium, which is therefore greater during adolescence than in either childhood or young adulthood.[7]

Another significance of adolescence in human life cycle lies in its proximity to adulthood. For females, this is the period for preparation for motherhood. Thus, health and nutritional status of today's adolescent girls may have great impact on the quality of the next generations. A stunted adolescent girl is most likely to become a woman of short stature. Short stature is associated with increased risk of adverse reproductive outcomes. Risks for low birth weight,[8] cephalopelvic disproportion and caesarean section[9] are increased in short mothers. The risks are even higher if pregnancy occurs before physical growth and maturation have completed, which is common in the developing countries. In Bangladesh, almost one-fourth of the total population consists of adolescents. About 37% of the rural and 20% of urban girls aged 15-19 years are married.[10] Nearly half of the married women in Bangladesh have at least one child and another 14% have more than one child before the age of 19 years.[11] Further, maternal mortality rates for 15 to 19 year olds in Bangladesh are twice as high as that for 20 to 24 year olds.[12] In a society such as Bangladesh where the first pregnancy is likely to occur before adolescence is completed, physical growth, mental and sexual development of girls during adolescence

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may have critical effect on their capacity to carry successful pregnancies.

Despite all these important considerations, adolescent nutrition did not receive adequate attention in Bangladesh, and only recently few studies have been carried out in this population group. For example, Ahmed and colleagues investigated vitamin A and iron status among urban[13] and rural adolescent school girls,[14] and in adolescent female garment factory workers[15] and reported nutrient intake and growth of adolescent schoolgirls in the Dhaka City.[16] In Bangladesh, those who attend schools generally come from the well off families. On the other hand, poor people in general account for most of the undernutrition in the country. It is therefore also important to assess extent of malnutrition in the adolescent girls of this section of population. This study was carried out to investigate nutritional status, dietary intake and food habit of adolescent girls of a poor community of Bangladesh namely, the readymade garment factory workers in the Dhaka City.

Subjects and methods

Subject Selection

The study group comprised 1211 adolescent girls, aged 14-19 years, working in seventeen readymade garment factories spread over the Dhaka City. The factories were selected purposively. The objectives of the study were explained to the management of each factory selected and permission to carry out the study in their workers was sought. After obtaining their consent, a time was arranged to explain the purpose of the study to the workers and to obtain their verbal consent. List of the workers aged 14 to 19y old was provided by the factory administration. All postmenarchial workers in this age group in each factory were invited to participate. The response rate was over 90%. Girls suffering from fever, oedema, organ failure, or with clinical manifestations of chronic or infectious diseases were excluded from the study. The study was approved by the Ethical Review Committee of the Bangladesh Medical Research Council, Dhaka, Bangladesh. The study was conducted from March to July 1998 during screening for anaemia for an intervention aimed at investigating whether it was possible to reduce the frequency of anaemia through weekly supplementation of iron and folic acid in adolescent females.[17]

Questionnaire and collection of data

Questionnaires were developed to collect information on socio-economic conditions, personal characteristics, and dietary intake and food habit. The questionnaires were pre-tested before finalisation. The data were collected by face-to-face interviews on the factory premises. The factories were visited for collection of data on pre-set dates. Anthropometric and socio-economic data were collected from all subjects (N =1211). However, dietary data were collected on later dates from a sub-sample of 509 subjects on whom anthropometric measurements were done. The reason for using a sub-sample was that earlier investigation[18] and pilot study during pre-testing the questionnaire showed unvaried nature and poor quality of factory workers' diet. Secondly, collection of dietary data required withdrawing each subject for interview for a considerable length of time. Some factories found it difficult to accommodate in space and production management and agreed to allow withdrawing a randomly selected sub-sample for this purpose from the girls on whom anthropometric measurements were done.

Anthropometric measurements

Height and body weight of the subjects were taken in the morning using a combined height-weight scale (Detecto-Medic, Detecto Scales Inc. Missouri, USA) by standard methods, which have been validated.[16] Triceps skin fold thickness (TSFT) was measured on the subject's left arm with skin fold callipers (John Bull, British Indicators Limited, England) according to Jelliffe and Jelliffe.[19] A cut-off of less than 3rd percentile, using 6-month age bracket, of the NCHS reference values for height-for-age was used to identify stunting.[20] Body mass index (BMI) was computed by dividing body weight in kg by height in meter squared. Thinness or wasting was identified as BMI-for-age below the 5th percentile of the NCHS reference values.[21] TSFT below the 5th percentile of the NCHS reference were identified as lean.[21] Both BMI and TSFT measures were compared with reference values using 12-month age brackets.

Dietary information

Food consumption was assessed for working days only by 24-h recall method. Intake on the weekend was not recorded. To increase accuracy of estimate of portion size of food consumed, styrofoam and paper models of different foods, serving plates, cups, spoons and lunch boxes of different sizes were displayed. From the size and volume of food consumed obtained by this method, weight of each serving of different food items was calculated. The equivalent weight of raw food was calculated using a conversion table for Bangladeshi foods formulated at the Institute of Nutrition and Food Science (INFS).[22] A software based on Bangladeshi and Indian food composition tables developed by the INFS was used to compute nutrient intake from raw food weight.[23,24] A 7-day food frequency questionnaire on selected food items was used to obtain information about the habitual dietary pattern of the subjects.

Prediction of basal metabolic rate and calculation of energy expenditure

Basal metabolic rate ($MJ \cdot d^{-1}$) was predicted from body weight by the equation 0.056 × body weight (kg) + 2.898 for girls aged 14 to 17 years, and 0.062 × body weight (kg) + 2.036 for 18 and 19 year old girls.[25] Energy expenditure was calculated by simplified method based on activity pattern analysis recommended by James and Schofield.[26] Time allocated to each activity was obtained by interviewing the subjects. Energy cost of each activity was taken from James and Schofield.[26]

Statistical analysis

Statistical analysis was done by SPSS/version 10.0 statistical package.[27] Univariate analysis comprised simple frequency distribution of selected variables. Mean, standard deviation and median for all parameters were calculated. Means for various anthropometric indices of

different age groups were compared by analysis of variance. Prevalence of stunting, thinness (wasting) and leanness (low TSFT) by age group were compared by χ^2 test.

Results

Characteristics of the participants

The largest group of the participants was 16 year olds, with 23% of the total. Next largest groups were 17 and 15 year olds, accounting for 22 and 19%, respectively. The 19 year old girls comprised the smallest age group (6%). The remaining were 14 and 18 year olds, accounting for 14 and 16% of the subjects, respectively. The girls came from the poorest section of the Bangladeshi population. Nearly 81% were illiterate, 17% were high school drop-outs and the remaining 2% went to the higher secondary level. Mean monthly income was Taka 1093 (SD $\pm$ 376) (Taka 58=1 US$). Monthly income of about 20% subjects was below poverty line for individual income.[28] An overwhelming majority (81%) lived in temporary houses built of steel sheets and bamboo in slums, while the others (19%) lived in permanent structures built of brick and cement.

Table 1. Trends in stature (height) and prevalence of stunting (height-for-age) of the female adolescent factory workers in urban Bangladesh, by age

Age (year)	*N*	Height (cm)		<3rd percentile* %
		Mean	SD	
14	168	147.1	4.4	61.5
15	225	148.3	5.0	59.3
16	281	148.9	5.0	60.9
17	263	149.1	4.8	74.1
18	197	149.7	5.4	66.5
19	75	149.9	4.8	69.3
All subjects	1211	148.8	5.0	65.0

N, number of subjects. SD, Standard deviation. * Using the NCHS reference value[20]

Anthropometric characteristics

Mean height by age group is presented in Table 1. Mean height increased significantly with age (*P*=0.000), except for 19 year old girls. Progressively smaller gain in height with increase in age was evident. The overall prevalence of stunting was 65%, and it ranged from 59 to 74% (height-for-age <3rd percentile of NCHS reference values[20]). Higher prevalence of stunting was observed in the girls older than 16 years (*P*=0.001). Mean body weight and BMI increased with age (*P*=0.000), except for the 19 year old girls (Table 2). About 17% of the subjects were thin (BMI-for-age <5th percentile of the NCHS reference[21]). As an indicator of total body fat, triceps skin fold thickness (TSFT) was measured (Table 3). TSFT was highly correlated with BMI (*r*=0.66; *P*=0.000). Mean TSFT increased with age except for 19-year old girls. Nearly 23% of the subjects were lean or had low subcutaneous fat (TSFT - for -age <5th percentile of NCHS reference[21]) (Table 3). Prevalence of leanness increased with age except for 15-year old girls (*P*=0.01).

Predicted basal metabolic rate, energy expenditure, energy and nutrient intake

Mean predicted basal metabolic rate was 5.02 (SD 0.35) MJ/day. Energy and nutrient intakes of the participants are shown in Table 4. Mean energy and nutrient intakes by age groups were similar (data not shown). Energy expenditure computed from the predicted basal metabolic rate and activity pattern analysis was 7.1 (SD 0.48) MJ/day. Mean energy intake was 5.48 (SD 1.46) MJ/day. There was a mean deficit of 1.62 MJ/day in energy intake. Energy intake of nearly 82% of the participants was less than energy expenditure. Major fraction of energy was obtained from carbohydrates, amounting to 74 % of total, proteins contributed about 10 % and fats contributed 16% of total energy intake. Mean intake of protein was 31.7g/day. Protein Intakes of all subjects were below the RDA. Total fat intake of 45% failed to meet daily requirement. Mean intakes of all micronutrients that are presented in Table 4 were below the RDA. Further, 91% of participants had calcium (RDA for 14-15 years: 600 mg/day; and 16-19 years: 500 mg/day), 97% had iron (RDA for 14-15 years: 28 mg/day; and 16-19 years: 30 mg/day), 82% had vitamin A (RDA 600 µg/day), 78% had thiamin (RDA 1.0 mg/day), 99% had riboflavin (RDA 1.2 mg/day), 64% had niacin (RDA 14 mg/day) and 83% had vitamin C (RDA 40 mg/day) intakes less than RDA. Table 5 shows food sources of nutrients. Cereals supplied about 89% of carbohydrate, 56% protein, 5% fat, 12% calcium, and 34% iron. Other sources of proteins were pulses (9%) fish (7%), and dairy and poultry (21%). Major suppliers of calcium were dairy and poultry (45%) and dark green leafy vegetables (DGLV, 24%). Cereals (34.4%) and DGLV (39%) provided large fraction of iron. Main supplier of preformed vitamin A (71%) was fish. The remaining 29% of this nutrient was obtained from dairy products. For carotenes, DGLV were the major sources (68%), while fruits accounted for only 16% of intake. Substantial amounts of vitamin C (27%) was provided by roots and tubers, next only to fruits, which accounted for 33% of total intake of this nutrient.

Usual dietary pattern, expressed by consumption frequency per week, of the participants are shown in Table 6. Mean frequency of consumption was for eggs 2.4, milk 1.4, meat 1.4, fish 4.7, DGLV 2.6, sweet pumpkin 1.4 and fruits 8.1. A substantial proportion of the girls did not take milk (46%) and meat (29%); while 70% had fish at least 4 times a week. Big fish and small fish (species weighing under 10g) were taken equally often by them. A considerable proportion of girls did not take eggs (20%) and DGLV (22%); while 23% took eggs and 36% took DGLV at least 4 times in the week. Forty percent did not eat sweet pumpkin at all, a major source of provitamin A. Over 95% did not take liver at all in the week; liver is rich source of iron and preformed vitamin A. Only fruits were taken at least 4 times in the week by a large proportion (77%) of the girls.

Discussion

Malnutrition continues to be a serious public health problem in Bangladesh. Successive national nutrition surveys reported high prevalence of malnutrition in the country.[29,30] Although inadequate quantity and poor quality of food remain the main reasons, several other factors have been found to be responsible for perpetuation of malnutrition in a community. In many instances undernutrition stems from pre-pregnancy nutritional status of the mothers. Traditional studies on malnutrition in Bangladesh focused on the vulnerable groups of the population. There is a growing consensus in recent times that addressing only the vulnerable groups is not enough to tackle the problem of malnutrition and achieving a sustainable healthy population in the long run. Adolescent nutrition may be an important link in nutrition throughout lifespan. Any programme for a long-term effect on health of a population should have a focus on adolescent girls. However, information about nutritional status of the adolescent girls in Bangladesh is scant. Few reports that are available focused on schoolgirls. The works on the schoolgirls do not reflect the state of the adolescent girls of the lower socioeconomic stratum, who are affected most by under-nutrition. This work sought to investigate nutritional status of adolescent girls of a poor population group working in the garment factories of Bangladesh.

Height may be considered most representative characteristic of overall growth and development.[31] Increase in mean height with age showed that girls were still growing. However, very small difference in height between 18 and 19 year old girls indicate that linear growth had almost come to an end by 19 years of age. Comparison of height with the reference gives a measure of achievement in growth. If height-for-age below the 3rd percentile of the NCHS reference[21] is taken as criterion for classification, 65% of the girls are stunted. Proportion of stunting was higher in the older girls. Compared with adolescent schoolgirls in Bangladesh, prevalence of stunting was much higher in this population. On average, about 10% of the urban adolescent school girls[16] and 28% of rural adolescent school girls were judged to be stunted on the same scale for comparison.[14] Height to be gained after menarche is small in comparison with that of the premenarchial period. The girls came from families of low economic level. The observed loss in linear growth therefore had occurred mostly in the earlier stages of growth. However, higher prevalence of stunting in the older girls suggests that the process still continued in their late adolescence.

Body weight, proportion and composition are sensitive to more recent state of food intake as much as they reflect past nutritional experience. Body mass index-for-age was compared with the NCHS reference values.[21] Individuals with body mass index-for-age below 5th percentile were considered thin. About 17% of all subjects were found thin by this criterion. Prevalence of thinness increased from 11% in the 14-year old girls to 20% in the 19 year old in this study. On the contrary, thinness was found to be more common in younger age groups than in the older groups of urban schoolgirls.[16] The trend of leanness (low TSFT) across the age groups was apparently similar to that of thinness, increasing from 18% in the 14-year old girls to 29% in the 19-year old girls. However, prevalence of leanness was higher than prevalence of thinness. A

Table 2. Trends in body mass index (BMI) and prevalence of thinness (BMI-for-age) of the adolescent female factory workers in urban Bangladesh, by age

Age (year)	*N*	Body weight kg		BMI kg/m^2		<5th percentile* %
		Mean	SD	Mean	SD	
14	168	38.0	4.1	17.5	1.6	11.2
15	225	39.2	4.6	17.8	2.0	15.9
16	281	40.1	4.5	18.1	1.9	19.9
17	263	40.9	5.0	18.4	2.1	19.8
18	197	42.0	5.5	18.8	2.1	12.8
19	75	41.9	5.1	18.7	2.1	20.0
All subjects	1211	40.3	5.0	18.2	2.0	16.8

N, Number of subjects. SD, Standard deviation; * Using the NCHS reference value[21]

Table 3. Prevalence of leanness (low triceps skin fold thickness, TSFT) of the adolescent female factory workers in urban Bangladesh, by age

Age (year)	*N*	TSFT mm		<5th percentile*
		Mean	SD	
14	168	10.1	3.0	17.9
15	225	10.6	3.1	16.4
16	281	11.0	3.3	24.2
17	262	11.1	3.4	25.2
18	197	11.2	3.5	25.4
19	75	10.8	3.9	29.3
All subjects	1208	10.8	3.3	22.6

N, Number of subjects. SD, Standard deviation; * Using the NCHS reference value[21]

Table 4. Energy and nutrient intake of the adolescent female factory workers in urban Bangladesh, and the proportion of the girls who fell into different categories based upon the extent to which the dietary intake satisfied the RDA

	Mean	SD	Median	Percent of RDA[†¶]			
				<50%	50-74%	75-99%	≥100%
				%	%	%	%
Energy (MJ/day)	5.48	1.46	5.21	8.5	44.7	28.4	18.4
Carbohydrates (g)	244	77.4	228.9	n.a.	n.a.	n.a.	n.a.
Proteins (g/day)	31.7	10.6	31.2	52.9	42.4	4.7	0.0
Fats (g/day)	23.2	5.6	22.6	1.8	2.8	40.7	54.8
Calcium (mg/day)	212.0	205.6	128.6	75.8	9.4	6.4	8.4
Iron (mg/day)	7.9	7.1	5.5	88.6	5.8	2.3	3.3
Vitamin A (μg, RE/day)[‡]	308.9	432.9	140.9	69.7	8.0	4.0	18.3
Thiamin (mg/day)	0.8	0.2	0.8	9.8	37.9	30.3	22.0
Riboflavin (mg/day)	0.4	0.3	0.3	85.1	10.0	3.7	1.2
Niacin (mg/day)	12.7	4.1	12.1	7.1	26.5	30.3	36.1
Vitamin C (mg/day)	32.9	46.9	20.0	50.9	20.6	11.8	16.7

[¶]Energy intake was compared with energy expenditure computed by activity pattern analysis. [†]RDA, recommended dietary allowance for the Indian people made by the Indian Council of Medical Research.[24] [‡]Calculated using factors recommended by IVACG.[38]
RE=retinol equivalent.n.a. Recommended intake level not available

Table 5. Food Sources of various nutrients of the adolescent female factory workers in urban Bangladesh

Nutrient	Contributory food group[†]							
	Cereals	Roots and tubers	Pulses	DGLV	Other vegetables	Fruits	Fish	Dairy and poultry
Carbohydrates	89.2	5.0	2.6	0.6	0.8	1.1	0.0	0.4
Proteins	56.1	2.8	8.7	2.3	1.8	0.4	6.7	21.2
Fats[‡]	4.9	2.3	0.7	0.3	1.4	0.4	9.1	13.5
Calcium	12.1	2.7	3.7	23.9	6.7	0.9	4.5	45.5
Iron	34.4	4.5	6.0	38.9	4.7	1.7	3.9	5.6
Vitamin A	0.0	0.0	0.0	0.0	0.0	0.0	70.6	29.4
Carotenes	0.0	0.3	0.6	67.9	13.6	15.6	1.0	0.0
Vitamin C	0.0	27.3	0.0	6.5	22.2	33.3	0.0	10.6

[†]Percentage of total intake contributed by each food group. [‡]Remaining 67.2 percent was supplied by cooking fats. DGLV: dark green leafy vegetables.

relatively higher prevalence of leanness observed in the study may be at least in part due to increased mobilization of stored fat in response to deficit in energy they had been experiencing recently. Increased prevalence of stunting and thinness in the older girls suggest an overall pace of growth relative to the reference even slower than that was in the earlier stages of life. There were no differences in energy and nutrient intakes between the age groups. However, there were increased relative inadequacies of energy and nutrients in older girls. To maintain growth even at the earlier pace, the older girls actually needed to increase their food intake.

Food intake data revealed an unvaried composition of diet of the subjects. Their diets based predominantly on cereals. In addition to providing most of the energy, cereal grains also supplied 56% of protein, 34% iron, and 12% calcium. About 28% of protein was provided by foods from animal sources and only 9% came from pulses.

Dairy and poultry provided 29% preformed vitamin A, 45% calcium and 21% protein. DGLV supplied 68% carotene, 24% calcium, and 39% iron. About 16% carotene came from fruits. A similar pattern of food intake was observed in the rickshaw pullers of Bangladesh.[32] Predominantly cereal based diet is probably common for the low-income people in this region. A number of studies in Indian manual workers also reported predominance of cereals in diet and deficit in energy.[33-35]

This study shows that intake of various nutrients of a large majority of the subjects are lower than RDA. For example, the intake of vitamin A for over 80% of the subjects failed to meet the RDA. Most of vitamin A was consumed as its precursor carotenes from vegetable sources. Moreover, 71% of preformed vitamin A was obtained from fish, mostly freshwater species, which contain vitamin A_2 that has 40% activity of A_1 found in

Table 6. Weekly pattern of consumption of food items by the adolescent female factory workers in urban Bangladesh, expressed as the percentage of girls consuming with different frequencies.

Food item	Frequency of consumption/week		
	0	1 - 3	≥ 4
	%	%	%
Eggs	20.4	56.7	22.9
Milk	46.2	43.9	9.9
Meat	29.3	66.0	4.5
Liver	95.9	4.1	0.0
Fish, all types	4.1	25.6	70.3
Large fish	17.9	55.1	27.0
Small fish	16.7	58.6	24.7
DGLV	22.3	41.9	35.9
Sweet pumpkin	40.0	51.8	8.2
Fruits	4.3	18.8	76.9

DGLV: Dark green leafy vegetables

the marine fish.[36] Vegetables supplied about 82% of carotenes, while only 16% was obtained from fruits. Recent findings suggest that bioavailability of carotenes from vegetables may be even lower than previously thought.[37] Recently recommended[38] factors for conversion of carotenes were used in this study. Like vitamin A, most of the iron was also provided by plant sources. Iron intake for 97% of the girls failed to meet the recommended intake. Only 9% of iron came from animal sources, thus accounting for a very small fraction of total intake. Bioavailability of non-haeme iron present in plant sources could be improved by adequate intake of vitamin C. Intake of only 17% of the girls was up to the requirement. The girls in this study still had some potential for growth and maturation was not complete. Calcium is important to sustain growth and maturation of the skeletal system. Mean intake of calcium was much lower than RDA and only 8% of the girls met the RDA.

The habitual dietary pattern of the girls also suggests low intake of micronutrients. Intake pattern of selected food items was investigated using 7-day food frequency questionnaire. Substantial proportion of girls did not consume milk (46%), meat (29%) and liver (96%). About 23% consumed eggs at least 4 times a week, while another 20% did not consume any eggs in the week preceding the interview. Consumption of small fish is emphasized for poor people. Overall habit of consumption of small fish was not good. Small fish are usually eaten whole and thus can contribute significant amounts of vitamins and minerals, particularly vitamin A and calcium. DGLV are the main sources of vitamin A precursors in the Bangladeshi diet. In addition to supplying vitamins, DGLV also supply significant amounts of iron. Only 36% consumed DGLV regularly, and 22% never consumed them. Sweet pumpkin, a rich source of provitamin A, was not consumed by 40% of the girls in the previous week. Fruits were most popular with the girls - 77% consumed them at least 4 times in a week. However, contribution of vitamin C by the fruits was lower due to small portion sizes.

The weakness of 24 h recall method is its vulnerability to over and under reporting. A single 24 h recall record of food consumed is not therefore suitable for assessing usual food and nutrient intakes of individuals. However, it can be used to assess average intakes of food and nutrients of population groups,[39,40] and quality of data can be improved by good preparation for the work.[41] One advantage in this study was that the study subjects were members of a single occupational group from a fairly homogeneous socio-economic class, they spent most of their time in the factory and their daily routines were similar. Their lunch could be observed since they assembled to take food in a specified place during lunch break. Range of food items consumed by them was relatively limited. Uncommon responses could be identified and were verified by further interrogation.

This study estimated average food and nutrient intakes of the subjects for six workdays and examined how the intakes compared with the daily average intake they are expected to maintain. Question remains about intakes on the weekly holidays. It was observed during the study that many factories suspended weekly holidays to clear production backlog. There might be some variation in the weekend diets of those who could take the day off. However, it was unlikely that it would be large enough to substantially change the daily average intake calculated from working days' intake in this poor population.

Subsistence on inadequate diet implies use of body reserve of nutrients and development of deficiency as body reserves approach exhaustion. Consistent with the dietary intake observed in this study, high prevalence of iron and vitamin A deficiencies[15] and significant deterioration of serum indicators of these two nutrients in a span of three months[17] were observed in this population. This work shows an apparent deficit of 1.62MJ in energy intake of this population. However, it is important to bear in mind the interpretive limitation of the observed deficit. This arises in part from the shortcomings of the simplified method for estimation of energy expenditure used in this study. The equations incorporated about 15 percent variations in BMR between two individuals of the same age, body weight and sex to estimate mean BMR. Furthermore, the subjects in this study were under-nourished. Although the exact magnitude is disputed, it has been widely accepted that BMR falls in under-nutrition.[42-44] Other biological response to shortage in energy is loss of body weight. The deficit observed in this study implies that the subjects are in process of losing body weight.

Although older girls had higher mean body weights, trends in body mass index and TSFT across the ages may give an impression that the girls are achieving a balance between energy intake and expenditure at the expense of stored energy and some metabolically active body protein. This inconsistency may be due to their complex behavioural adaptation to circumstances. Most of the workers are migrant workers of rural origin.[45] They take frequent short and long term leaves, and return to rural residence. High rate of daily absence is common in the readymade garment factories in Bangladesh.[46] Unlike other occupational groups, they also continue for a short period with job and then quit, which is indicated by a steep drop in the number of workers aged 18 and 19 years. For a cross-sectional study on a mobile population like this, average energy intake of a single day indicates the situation of the whole population at a point in time. However, it may be inadequate to relate trends in anthropometric measures with energy intake.

Physical status of the girls suggests functional impairment both concurrent and in future life. One relevant issue is their work capacity and productivity. Work capacity is related to body weight and to some extent stature.[47-49] Not surprisingly, with an under-nourished and underfed work force, readymade garment factories in Bangladesh are not production efficient. Expansion of this industry in Bangladesh owes greatly to the quota privilege granted to the Bangladeshi products by the Developed countries.

Majority of the young female readymade garment factory workers come from rural farming households. Energy and nutrient intake by them is much lower than their rural counterparts.[29] Income management practices showed that most of them spend a part of their meagre earnings for fancy objects and/or save for future,[45,46] while unlike in rural residences, money is to be spent on housing, and all the food items have to be purchased. Thus health and nutrition is compromised by other benefits of cash earning. It is unlikely that loss in physical growth and development incurred by poor nutrition in this stage of life will be later recovered, even if they leave their jobs. Many of the girls are likely to start child bearing within a short period of time before any recovery can take place. Maternal nutritional status is an important determinant of birth weight and health of her offspring.[50,51] A significant fraction of babies born to these girls may therefore have low birth weight if measures towards improvement of their nutritional status are not taken.

The present study reveals a need for a comprehensive intervention programme to improve the overall nutritional status of this segment of the population. Ahmed *et al.,*[17] showed benefit of weekly iron, folic acid and vitamin A supplementation in this population. This study shows that the diets of a large majority of the girls was deficient in many micronutrients. Multiple mineral vitamin supplementation to correct the problem could be done for little cost. Providing free or price-subsidized food during work hours would be a further step towards improving their nutritional status. Return in enhanced productivity, and long-term social benefit of their improved health from giving a good meal would outweigh cost of taking such beneficial steps.

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