Nutrient intake and growth of adolescents in southern Sri Lanka

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(Index words: Anthropometry, energy intake, iron intake, zinc intake)

Abstract

Objective Growth and dietary intake data are essential for formulation of nutritional policies and interventions for children.

Design 945 school children (11–16 years) were subjected to growth assessment and their nutrient intake was determined using the 24-hour dietary recall method on three consecutive days.

Results 21.3% of boys and 21.1% of girls were stunted (-2 SD below the median height-for-age). 141 (14.9%) children were both stunted and wasted (-2 SD below the median weight-for-age). Mean body mass index of girls was significantly higher ($p < 0.001$) than boys at all ages. The mean daily dietary intake of energy was 3.2 (± 2.4) MJ, protein 29.1 (± 2.1) g, fat 4.5 (± 1.1) g, iron 11.5 (± 1.0) mg, and zinc 0.8 (± 0.7) mg among boys. Among girls, energy intake was 4.2 (± 1.8) MJ, protein 29.0 (± 2.3) g, fat 4.4 (± 1.0) g, iron 11.4 (± 1.0) mg, and zinc 0.5 (± 0.6) mg. Fat comprised about 4.0% of the daily energy intake.

Conclusions High rate of growth deficiency and under-nutrition among adolescents mandates innovative nutritional intervention strategies. The observed mean intakes of nutrients in the sample showed a worrisome deviation from the recommendations of the dietary guidelines for Sri Lanka.

Introduction

Adequate growth and nutrition during adolescence implies adequacy of dietary intake and body stores of macro- and micronutrients with respect to the activity level of the individual. The coincident growth spurt combined with marginal nutrient intake [1] increases the risk of nutritional deficiencies in the adolescent age range defined as 10 to 19 years [2] by the WHO. There are inherent problems with regard to growth during this period, such as rapid changes in growth, variations in the rate of maturation and normal variations. The WHO in 1996 made provisional recommendations for the interpretation of anthropometric data during adolescence [3], and recommended the use of the National Centre for Health Statistics (NCHS) reference values for comparison.

Development of a database on the growth and nutritional status of adolescent schoolchildren is critical to the formulation of rational public health policies and

intervention strategies for this group. In Sri Lanka, the results of three demographic and health surveys show that there has been a steady decline in the rate of malnutrition over time [4] although, it continues to be a concern among children of 3–59 months of age. We hypothesized that the prevalence of stunting, an indicator of chronic undernutrition, has decreased substantially from 38% in 1973 [5], and that the current prevalence would be about 20%.

Materials and methods

The study was done in the Galle district in year 2003. A random sample of schoolchildren aged 12 to 16 years was drawn using a multistage cluster sampling technique. Schools were first stratified according to girls' schools, boys' schools and coeducational schools. Two coeducational schools and one girls' school were selected randomly. Individual classes in the schools were stratified and 43 classes were selected by random sampling. All students ($n = 1150$) from the selected classes were considered eligible for the study.

Approval was obtained from the Ethics Committee of the Faculty of Medicine, University of Ruhuna. After obtaining written permission from the Ministry of Education, the children and their parents were contacted through school principals and class-teachers and informed of the procedures involved in the study by letter. 945 children (82.2%) who had written consent from their parents were enrolled in the study.

The chronological age of the children was calculated to the nearest month. Height was obtained using a portable stadiometer with a precision of 0.1 cm. Weight was measured using a portable beam balance with non-detachable weights with a precision of 0.1 kg. Each child was measured in the school uniform, without shoes. Both instruments were checked for zero error before commencing each anthropometric session, and all the measurements were obtained over a period of two weeks. The date of first menstrual period was obtained from the girls.

Dietary intake was assessed by the 24-hour dietary recall method on 3 consecutive days. Intake of all foods, drinks and snacks during the previous day were recorded. Subjects were informed about the purpose of the study and asked to provide accurate information on food intake.

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Table 1. Anthropometric indices of children

Age	Mean (SD) of								
	Weight			Height			BMI ²		
	M	F	p-value ¹	M	F	p-value ¹	M	F	p-value ¹
12 (M 53, F 97)	28.1 (4.9)	30.1 (6.0)	0.02	138.6 (7.1)	140.8 (6.3)	0.03	14.6 (1.6)	15.1 (2.1)	0.05
13 (M 75, F 115)	31.9 (6.2)	35.0 (6.9)	0.01	144.5 (7.3)	146.6 (7.5)	0.02	15.2 (2.0)	16.2 (2.2)	0.01
14 (M 83, F 129)	37.0 (9.9)	39.1 (7.4)	0.05	151.4 (9.2)	151.3 (6.7)	0.27	15.9 (2.7)	17.0 (2.4)	0.01
15 (M 66, F 86)	41.7 (7.6)	40.8 (7.2)	0.23	157.4 (7.5)	152.2 (6.1)	<0.01	16.7 (2.3)	17.6 (2.5)	0.02
16 (M 84, F 156)	42.0 (6.9)	42.2 (6.7)	0.39	158.8 (8.3)	153.1 (5.6)	<0.01	16.6 (1.8)	18.0 (2.5)	<0.01
Over all (M 361, F 584)	36.7 (9.0)	37.9 (8.1)	0.02	150.9 (10.9)	149.3 (7.8)	0.01	15.9 (2.3)	16.9 (2.6)	<0.01

¹p-values based on independent sample student t-test comparing males and females

²BMI = weight (kg)/height (m)²

Dietary data collectors were trained to record the food intake on a standard format. Special attention was given to estimation of portion sizes using household measuring units. After completion, the food quantities were converted to nutrient intake using Food Composition Tables [6].

The survey data sheets that lacked information on any of the three days were excluded ($n=150$). Further, incomplete recall or unrealistic data, that could not be corrected reliably, were also rejected ($n=63$). Hence, dietary data have been reported on 732 study subjects (77.5% of those enrolled). The average energy and nutrient intake have been presented as a mean of the three-day intake.

Statistical analysis

The 1978 CDC/WHO growth reference curves were used from Epi-info version 3.0 (2003) for Windows to generate Z-scores of weight-for-age (wasting indicators) and height-for-age (stunting indicators). Percentile values of CDC 2000 for body mass index (BMI) of boys and girls (2–20 years of age) were used. A Z-score less than -2.0 SD from the reference median were used to detect wasting and stunting of children. The 85th and 5th percentiles were used as the cutoff points for overweight and thinness respectively. Data were analysed using SPSS version 10.0 (Chicago, USA). Chi-square test and student t-test were used to compare boys and girls.

Results

Of the 945 schoolchildren enrolled from Grades 7 to 11, there were 361 (38.2%) boys. Ages ranged from 12 to 16 years (Table 1). Girls aged 12–13 years were on average taller and heavier than boys. By 16 years, boys were similar in weight but taller than girls. Mean age at menarche was 13.9 ± 1.3 years.

Prevalence of undernutrition

The mean BMI was significantly higher among girls (15.1–16.9) than boys (14.6–15.9) in all age groups ($p<0.001$). The prevalence of thinness (BMI $\leq 5^{\text{th}}$ percentile) was 57.6% ($n=208$) and 35.7% ($n=220$) and

among boys and girls. There were no overweight children (BMI $\geq 85^{\text{th}}$ percentile) among 12–13 year old. 1.4% ($n=5$) boys and 1.9% ($n=11$) girls over 14 years were overweight (Table 2). Weight-for-age was lower in boys ($p<0.001$) but both sexes were equally to below height-for-age ($p=0.121$). Stunting, an indicator of previous or long-standing malnutrition, affected 21.5% ($n=203$) of children. 31.1% ($n=294$) of the children were wasted and 14.9% ($n=141$; 68 boys) were both wasted and stunted.

Dietary intake

Data from the dietary recall were tabulated in two age categories, 12–13 and 14–16 years (Table 3). The contribution of protein to the daily energy intake is not reported due to the low dietary protein intake; hence, only carbohydrates and fats were considered in calculating the mean daily energy intake. The mean daily dietary intakes among boys were 3.2 (± 2.4) MJ of energy, 29.1 (± 2.1) g of protein, 4.5 (± 1.1) g of fat, 11.5 (± 1.0) mg of iron and 0.8 (± 0.7) mg of zinc. Among girls, the mean daily dietary intakes were 4.2 (± 1.8) MJ of energy, 29.0 (± 2.3) g of protein, 4.4 (± 1.0) g of fat, 11.4 (± 1.0) mg of iron and 0.5 (± 0.6) mg of zinc. Fat comprised 3.2–3.6% of the daily energy supply in both age groups. Between the two age groups of boys and between the two groups of girls there were significant improvements ($p<0.001$ for all) with age in the daily dietary intakes of all nutrients except in zinc (Table 3).

Dietary intake and growth

Body mass index (BMI) was positively correlated with energy (Spearman rho 0.31; $p<0.01$), protein (0.35; $p<0.01$), fat (0.08; $p=0.01$), and iron (0.30; $p<0.01$) intake. Height-for-age Z-score has shown a negative correlation with intake of energy (-0.17 ; $p<0.01$), protein (-0.17 ; $p<0.01$) and iron (-0.14 ; $p<0.01$). Dietary zinc intake was negatively correlated with BMI Z-score (-0.06 ; $p=0.04$). Stunting (HAZ < -2.00) has shown a positive correlation with intake of energy (0.01; $p=0.02$), iron (0.01; $p=0.02$) and zinc (0.06; $p=0.05$) in these children. However, wasting (WAZ < -2.00) did not appear to be significantly correlated with dietary intake.

Table 2. Weight-for-age (WAZ) and height-for-age (HAZ) Z-scores and nutritional status of children by age and gender

Age	N	Weight-for-age Z-score ¹ Mean (SD)	p-value	Height-for-age Z-score ¹ Mean (SD)	p-value	Nutritional status (%)		Obesity ⁴ (%)	
						Wasted ²	Stunted ³	<5 th centile	>85 th centile
12 years									
Male	53	-1.58 (0.75)	0.084	-1.23 (0.90)	0.278	35.8	20.8	69.8	—
Female	97	-1.40 (0.85)		-1.08 (0.95)		28.9	16.5	57.7	—
13 years									
Male	75	-1.66 (0.85)	0.001	-1.37 (1.09)	0.164	37.3	25.3	61.3	—
Female	115	-1.20 (0.88)		-1.07 (1.01)		20.9	19.1	40.0	—
14 years									
Male	83	-1.55 (1.10)	0.024	-1.07 (1.10)	0.281	32.5	19.2	61.4	3.6
Female	129	-1.21 (0.93)		-1.16 (2.00)		17.1	19.4	31.8	3.1
15 years									
Male	66	-1.43 (0.95)	0.426	-0.99 (0.99)	0.002	30.3	13.6	48.5	3.0
Female	85	-1.51 (0.74)		-1.42 (0.86)		27.1	23.5	31.8	2.4
16 years									
Male	84	-1.95 (0.81)	0.002	-1.14 (1.31)	0.214	54.7	26.2	50	—
Female	156	-1.70 (0.80)		-1.55 (0.88)		36.5	25.6	32.1	1.9
Over all									
Male	361	-1.64 (0.92)	0.001	-1.18 (1.08)	0.121	38.8	21.3	57.6	1.4
Female	584	-1.42 (0.87)		-1.26 (0.96)		26.4	21.1	37.7	1.9

¹Results were derived from Epi-info version 3.0 of the 1978 CDC/WHO growth reference curves²Percentage of subjects having a weight-for-age Z-score ≥ -2.0 SDs³Percentage of subjects having a height-for-age Z-score ≥ -2.0 SDs of the National Center for Health Statistics median⁴CDC 2000 body mass index (BMI) centiles of boys and girls (2–20 years of age) were used to obtain percentiles of BMI

Table 3. Daily macro- and micro-nutrient intake of children age and gender

	Mean (SD) nutrient intake among						p-value boys ²	p-value girls ³
	12–13 years			14–16 years				
	Boys (n=88)	Girls (n=182)	p-value ¹	Boys (n=147)	Girls (n=315)	p-value ¹		
Energy (MJ)	4.58 (0.28)	4.5 (0.29)	0.02	5.20 (0.54)	5.18 (0.48)	0.35	0.01	0.01
Protein (g)	27.0 (1.0)	26.9 (1.0)	0.19	30.3 (2.0)	30.2 (2.0)	0.34	0.01	0.01
Fat (g)	4.3 (0.9)	4.3 (0.9)	0.31	4.6 (1.0)	4.5 (1.0)	0.12	0.01	0.01
Iron (mg)	10.8 (0.6)	10.7 (0.7)	0.03	11.9 (0.9)	11.9 (0.9)	0.40	0.01	0.01
Zinc (mg)	0.77 (0.6)	0.47 (0.6)	0.01	0.75 (0.7)	0.53 (0.6)	0.01	0.40	0.15

¹Difference between boys and girls in the same age group²Difference between 12–13 and 14–16 years old boys³Difference between pre-menarcheal (n=196) and post-menarcheal girls (n=301)

Discussion and conclusions

This report is part of a comprehensive study on micro-nutrient malnutrition among adolescents in Sri Lanka. The weights and heights of the schoolchildren in this study are consistent with Tanner's velocity curves, in which girls begin their adolescent growth spurt earlier than boys. Kandiah and Wikramanayake [7] observed children between 5–18 years of age from the higher socio-economic strata and found that at all three quartiles (the 25th, 50th and the 75th centiles), for both sexes, the weight-for-age of the NCHS population is significantly higher than that of Sri Lankan children. They found no difference between the two populations when the 25th and the 50th centiles

for height-for-age are considered, but the 75th centiles were marginally different with the NCHS values being slightly higher. In our study 203 (77 boys) (21.5%) children were below -2.0 SD of the NCHS median height-for-age and 294 (140 boys) (31.5%) children were wasted (< -2.0 SD of the NCHS weight-for-age). This was much less than the 38% observed in the 1973 survey [5] as we expected. The National Family Health Survey (1998–99) of India reported that 38% wasted and 36% stunting among adolescents in urban areas [8].

Dietary inadequacy in girls is best reflected in changes in the average age of menarche in developing countries, as nutrition is an important factor in pubertal

maturation. In our study, the mean age at menarche (13.9 ± 1.3 years) is higher than that reported previously (13.54 ± 1.8 years) [9], and (13.0 ± 1.2 years) [10] in Sri Lankan girls. These studies did not report the nutritional status of the participants. Poor nutrition may delay menarche by up to 2 years [11]. In a longitudinal study in India [12], a significant difference in the mean age at menarche between the most stunted (14.1 years) and the least stunted (13.7 years) was reported.

The mean energy intake of the subjects was about 50% of the recommended daily dietary intake (RDDI) [13] for Sri Lankan adolescents. Results obtained on the nutrient intake of the our study are similar to those reported in the dietary surveys carried out in India [14,15]. The low energy intake we observed could be because we gathered information only on week days, and most children (62%) attended school without taking breakfast. Since children were the only informants, it is possible that they under-reported dietary intake at home as there is a likelihood to underestimate key ingredients as they do not prepare food even though they remember the dishes consumed. Horwath [16] reported that 13% of the young female University students studied followed a weight reduction diet while recording the food intake and, suggested that at any time a proportion of the subjects is voluntarily restricting their intake, providing records that reflect low caloric intake.

The energy distribution among individual meals in Asian populations has not been widely studied. In Sweden, recommendations have been developed for adolescents: breakfast 20–25% of daily energy intake, lunch and dinner 25–35% and the remainder as two or three snacks between meals [17].

Inadequate food/nutrient intake as a major contributory factor of malnutrition has been identified. Analysis for difference in dietary intake among those who were undernourished/stunted and those normal revealed low intake for most nutrients in the undernourished/stunted group with significant differences in the energy intake ($p=0.035$). Poor nutrition may have thus contributed to the deficit found in weight and height leading to wasted and stunting among these children.

In conclusion, there was less stunting than wasting. Height, weight, and BMI measurements in males were significantly lower than that of females indicating a higher proportion of under-nutrition among males. Based on the current dietary recommendations the intake of energy, protein and micronutrients among adolescent schoolchildren appear inadequate. These results provide important information on planning nutritional interventions for adolescents at national level, as it may affect the learning abilities, mental alertness and cognitive powers of the schoolchildren.

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