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Body composition and resting energy expenditure of adolescents in Yangon, Myanmar

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A cross-sectional descriptive study of body composition and resting energy expenditure (REE) of 312 adolescents (155 boys and 157 girls) was conducted in five state high schools in Yangon, Myanmar. The body composition was measured by anthropometry and resting energy expenditure was determined by indirect calorimetry method. Although statistically not significant, mean body mass index (BMI) of 12, 13 and 14 year-old girls was greater than that of age-matched boys (16.06 ± 2.98 vs 15.09 ± 2.56, 16.97 ± 2.60 vs 15.68 ± 2.30 and 17.18 ± 2.38 vs 16.77 ± 2.69 respectively). Mean lean body mass (LBM) of 12- year-old girls was greater than that of the boys (26.81 ± 5.32 kg vs 25.91 ± 5.18 kg) but 14- year-old boys has greater LBM than that of the girls (37.33 ± 11.75 kg vs 31.35 ± 4.61 kg). Mean body fat percentage of the girls was significantly ($p < 0.01$) greater than that of the boys in all age groups (21.08 ± 4.31% vs 13.14 ± 4.30%, 21.85 ± 3.77% vs 13.47 ± 9.11% and 22.37 ± 3.96% vs 13.50 ± 4.19% respectively). Mean resting energy expenditures (REE) of 12, 13 and 14 -year-old boys were 1193.90 ± 195.49 kcal/d, 1239.82 ± 180.60 kcal/d and 1438.35 ± 258.83 kcal/d respectively and those of the girls were 1164.09 ± 215.75 kcal/d, 1192.89 ± 159.13 kcal/d and 1212.61 ± 151.08 kcal/d respectively. These data will serve as a base-line data of current nutritional and metabolic status of adolescents in Yangon, Myanmar.

INTRODUCTION

For most public health purposes as well as for many clinical applications, total body weight is divided conceptually into two compartments, fat free mass and fat mass. The fat free mass as a percent of body weight in healthy people ranges from 65 to 85 percent. Some of the variations in healthy people are due to gender, age and ethnicity. The fat free mass is made of protein, water and minerals. Undernutrition and overnutrition alter body composition. Severely malnourished under-weight children are not just scaled down version of normal children but differ markedly in body composition. In Myanmar, the prevalence of under-weight in adolescents was 41.5 % among boys and 22.2 % among girls and the prevalence of stunting 37.6 % and 30.4 % respectively [1]. On the other hand, obesity in children, adolescents and adults has a major impact on health. It is a risk factor in the development of diabetes, renal disorders, vascular problems and early death. Obesity can limit activity, productivity and increase absenteeism from the work place. According to hospital statistics, nutrition and food related cardiovascular diseases were found to be 42 % in rural area and 57.9 % in urban area [2] and the prevalence of diabetes mellitus in Hlegu Township was 6.3 % [3]. Therefore, on top of the existing malnutrition problem, increasing incidence of cardiovascular diseases and diabetes resulting from

changing economy, industrialization and life style of the country worsen the scenario of the health problem related to energy imbalance. Body composition is a reliable tool for measuring the nutritional status.

According to the basic principle of thermo-dynamics, all dietary energy (calories eaten) is either utilized (expended) or is stored. In persons who are gaining or losing weight, energy stores are either increased (weight) or are used as energy source (weight loss). The difference between dietary energy and energy expended is equal to the total amount of energy stored. Thus, measure-ment of energy expenditure is very useful for determining how much energy has been stored and are indispensable for strategies to reduce the morbidity and mortality associated with undesirable body compo-sition. Additionally, energy expenditure measurements are useful for measuring food intake and energy needs in condition of pregnancy, lactation, growth and aging as well as for monitoring the effectiveness of nutritional education and behavioral modification programs.

MATERIALS AND METHODS

Study design

Cross-sectional descriptive study

Subjects

Multistage sampling method was employed. From the sixteen states and divisions of Myanmar, Yangon, being the capital city of Myanmar, was purposively chosen. Initially, five townships in Yangon were randomly chosen. Then one high school from each township was again randomly selected. The selected schools were No.4 State High School, Ahlone Township, No.1 State High School, Insein Township, No.3 State High School, North Okkalapa Township, No.1 State High School, Mingala Taungnyunt Township and No.3 State High School, Thanlyin Township. Registered list of students was used as sampling frame. The eligible age range was from 12 to 14 years. The decimal year system was used. The age of the subject was obtained by subtracting the date of birth from the date of examination. The figure was corrected to two decimal places. The age group was the mid point of age range. To be able to describe a mean measure of a specific age and sex group in appropriate type 1 and type 2 errors, sample size was calculated based on hypothesized population para-meters. Mean and standard deviation of Body Mass Index (BMI) of 13 year-old males is used as a hypothesized value in the calculation. The calculated sample size was fifty male and fifty female students (a total of 100) at each age group. To obtain 100 adolescents from each age group, 10 male adolescents and 10 female adolescents were randomly selected from each school. Of them, 312 (155 males and 157 females) completed the study.

Anthropometric and body composition assessment

Body weight was measured with a bathroom scale weighing machine, calibrated with standardized weights. Subjects were weighed barefooted with a minimum of clothing. The weight was recorded to the nearest 0.1 kg.

Standing height was measured to the nearest 0.1 cm using a stadiometer. Subjects stood barefoot on a flat horizontal surface, their head held in the Frankfurt plane and with their heels, buttocks and shoulders touching the wall.

Body Mass Index (BMI) was calculated as weight / height^2 (kg/m^2).

Body composition was assessed by measurements of skin- fold thickness. Skin-fold thickness at sites of biceps, triceps, sub-scapular and supra iliac were measured on the left side of the body using a Harpenden caliper by a well-trained technician. Body fat percent was calculated by using the formula described by Durnin and Rahaman, 1967 [4].

Body fat % = (4.95 / **Y** – 4.5) x 100
Y = 1.1533 – 0.0643 **X** in boys and
Y = 1.1369 – 0.0598 **X** in girls.

(**Y** is body density and **X** is the log of the sum of skin-fold thickness at all four sites in millimeter)

Measurement of resting energy expenditure

It was measured in the morning 10 hours after fasting by respiratory gas analysis by using a mouth-piece system for breath collection. Expired gas was collected in Douglas Bag and volume was measured by Parkinson-Kowen Gas Meter and oxygen content of expired air was analyzed by Oxygen Analyzer (Miniox, USA). Energy expenditure was calculated by multiplying oxygen consumption with thermal equivalent. Measurement was done at room temperature between 20-25˚C and barometric pressure of 758 and 760 mmHg.

Statistical analysis

Descriptive presentation of mean values of resting energy expenditure (REE) and body composition was disaggregated by age group and sex. Comparison was made using Student's't' test for unpaired samples (two tailed). Differences were considered significant if $p<0.05$.

RESULTS AND DISCUSSION

Table 1 shows body fat percentage and resting energy expenditure of 12 years, 13 years and 14 years old boys and girls respectively. Mean body fat percentage of females was significantly greater than that of males ($p< 0.001$) in all age groups. Adolescence is characterized by a major sex difference in the rate of acquisition of lean weight. Boys show a rapid and sustained spurt in lean weight, whereas there is a modest acquisition of body fat in the early phase of puberty, followed by a decline. In contrast, girls have a smaller spurt in lean weight, but they acquired more body fat [5]. No significant differences were found in other parameters of body composition [Height, Weight, Lean Body Mass (LBM) and Body Mass Index (BMI)]. Although mean REE of males were seem to be greater than those of females in all age groups, the differences were statistically not significant.

Table 1. Body composition and resting energy expenditure of adolescents in Yangon, Myanmar

Age (yr)		Height (cm)	Weight (kg)	BMI	LBM (kg)	Fat %	REE (kcal/d)
12	Male (n=53)	140.9 ± 8.08	30.31 ± 6.99	15.09 ± 2.56	25.91 ± 5.18	13.14 ± 4.30	1193.9 ± 195.49
	Female (n=53)	144.84 ± 6.33	34.05 ± 8.54	16.06 ± 2.98	26.81 ± 5.32	21.08 ± 4.31	1164.09 ± 215.75
13	Male (n=52)	145.85 ± 8.89	33.71 ± 7.54	15.68 ± 2.30	30.02 ± 9.69	13.47 ± 4.02	1239.82 ± 180.60
	Female (n=50)	148.71 ± 6.58	37.78 ± 7.63	16.97 ± 2.60	30.47 ± 9.11	21.85 ±3.77	1192.89 ± 159.13
14	Male (n=50)	156.49 ±10.06	41.4 ± 9.79	16.77 ± 2.69	37.33 ± 11.35	13.5 ± 4.19	1438.35 ± 258.83
	Female (n=54)	153.39 ± 6.98	40.71 ± 7.62	17.18 ± 2.38	31.36 ± 4.61	22.37 ± 3.96	1212.61 ± 151.08

Although statistical analysis could not be done, the mean height and weight of adolescents in the present study were found to be greater than those of Myanmar adolescents in the previous studies for respective ages (Table 2).

Table 2. Height for age and weight for age data of adolescents in Myanmar by different investigators.

Data sources	12 years		13 years		14 years	
	Male	Female	Male	Female	Male	Female
Height (cm) for age (yr)						
Ko Ko (1957-1958)	133.86	134.4	139.19	140.97	149.6	145.00
NASP/ DMR (1982-1986)	134.96	137.57	139.47	143.43	145.82	147.82
Present study (2004)	140.94	144.84	145.85	148.71	156.49	153.39
Weight (kg) for age (yr)						
Ko Ko (1957-1958)	27.77	28.23	29.86	35.41	33.64	35.73
NASP/ DMR (1982-1986)	27.45	29.66	30.09	33.74	34.17	37.13
Present study (2004)	30.31	34.05	33.71	37.78	41.4	40.71

When comparison was done on percentages of stunted (<-2SD of NCHS standard of height for age) and severely stunted growth (<-3SD of NCHS standard of height for age) of adolescents between the present study and those of five countries (Indonesia, India, Vietnam, Ghana and Tanzania), the proportion of stunted growth adolescents in the present study was found to be low. However, when under weight (<-2SD of NCHS standard of weight for age) and severely underweight (<-3SD of NCHS standard of weight for age) adolescents were compared, the proportion of underweight adolescents was not much different (Table 3).

Table 3. Comparison of percentages of stunted growth and underweight adolescents in the present study with those of the adolescents from five countries' study (Indonesia, India, Vietnam, Tanzania and Ghana)

Age (Years)	Five countries' study	Present study (2004)					
	7 – 17	12		13		14	
		M	F	M	F	M	F
Height(cm) for age(yr) %							
- 2SD of NCHS standard	48 –56	28.3	7.55	19.23	18	12	20.37
- 3SD of NCHS standard	15 –22	1.89	3.77	5.77	6	4	-
Weight (kg) for age(yr) %							
- 2SD of NCHS standard	34 –62	35.9	20.75	36.54	14	26	16.67
- 3SD of NCHS standard	2 – 11	-	-	1.92	-	6	3.70

M = Male , F = Female

When the REE of the adolescents in the study were compared with predicted basal metabolic rate (BMR) based on weight for age, the values were more or less similar but when comparison was done with BMR of adolescent of respective ages described by WHO based NCHS standard of height for the age and weight for the age, the REE of the adolescents in the study were found to be low (Table 4). Mean body weight of the adolescents in the study was found to be between 15th and 20th percentile of NCHS standard for respective age groups. Since body weight is the most useful index of BMR for practical purposes [6], the low body weight might be the reason for low resting energy expenditure of adolescents in the present study.

Table 4. Comparison of measured resting energy expenditure of adolescents to calculated basal metabolic rate based on body weight and basal metabolic rate described by WHO for respective age groups.

Age (Year)	Sex	Present Study (2004)		WHO (1985)
		REE(kcal/d) (measured)	BMR (kcal/d) (predicted)	BMR (kcal/d)
12	M	1193.9 ± 195.49	1146.37 ± 119.26	1300
	F	1164.09 ± 215.75	1162. 75 ± 103.62	1220
13	M	1239.82 ± 180.60	1200.46 ± 121.19	1370
	F	1192.89 ± 159.13	1206.67 ± 93.33	1280
14	M	1438.35 ± 258.83	1312.46 ± 149.82	1465
	F	1212.61 ± 151.08	1242.62 ± 93.02	1340

M = Male , F = Female

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