Original Article

Assessment of nutritional status: Triceps and subscapular skin-fold thickness in Turkish children and adolescent

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ABSTRACT

Objectives: To determine the mean and percentile values and constitute the percentile curves of the triceps and subscapular skin-fold thickness (SFT) for obtaining a measure to be used in evaluating nutritional status of children and adolescents for age and gender to determine the threat of adiposity in Turkish children.

Methodology: This cross-sectional study was carried out between October 2006 and May 2007 with 6917 students selected among those with pre-defined socio-economic criteria and attending primary schools in Van city center. Based on these data, the subjects were distributed to age groups in 6-month intervals, beginning from the age of 7 up to the age of 17.

Results: Analysis of mean values of the thickness of triceps and subscapular SFT according to age in boy subjects demonstrated that these values generally increased with age up to thirteen years of age where peak values were observed, and the thickness decreased between 14 and 15 years of age, increasing again thereafter. A comparison of our data with the data reported from other countries revealed lower than median values of triceps and subscapular SFT in our study for both girls and boys regardless of the age group.

Conclusions: Subcutaneous fat accumulation is lower in Turkish children compared to those in other countries and no risk of obesity is imminent, at least in the region where this study was carried out.

KEY WORDS: Nutrition, Skin-fold thickness, Childhood.

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INTRODUCTION

Anthropometric measurements are important tools in determining nutritional status since they are indicative of protein and fat accumulation. Skin-fold thickness (SFT) is a practical and valuable method used in evaluating both the nutritional status and the body adiposity.[1-4] This method is used extensively in clinical practice and in field studies because of its simplicity, noninvasiveness, quickness of use as well as compatibility with methods that directly determine body fat mass.[1]

There are no measurements in Turkish school children and adolescents for assessment of their nutrition. Present study measured triceps and subscapular SFT in Turkish children of school age and percentile values for each age group and gender were also determined.

METHODOLOGY

This cross-sectional study was carried out between October 2006 and May 2007 with students selected among those with pre-defined socio-economic criteria and attending to primary schools in Van city center. Informed consents of the students and their parents as well as approval of Ministry of Education and Yuzuncu Yil University Ethics Committee were received prior to the initiation of the study. Students' anthropometric measurements were taken in th+eir schools in a closed area by pediatricians and well-trained students of the faculty of medicine. Students who refused to have their measurements taken were excluded from the study.

Measurements were taken with 0.1mm Lange Skinfold Caliper (Beta Technology Incorporated Cambridge, Maryland, USA). Caliper was calibrated every morning before measurements. Mean value of two measurements from the left side of the body was calculated for each child to ensure standardization across all students. Chronologic ages in decimals were calculated by the difference between the date of birth and date of measurements. Subjects were distributed to age groups in 6-month intervals, beginning from the age of seven up to the age of 17. Each age group included all ages in 12-month intervals based on the month and year of the birthday: e.g., age 8 included all ages from 8.0 to 8.99 year.

The population of ages 7-17 in the region has been reported as 132.000 and the universe of the study included 107 000 subject. The sample size was calculated with 95% confidence interval using the following equation based on the d=0.1 value taking a standard deviation value of 4.4 for a population meeting the inclusion criteria:

$$n = N.Z^2.J^2 / d^2 (N–1) + Z^2.J^{2.5}$$

Sample size was kept at large given the long period of the study. The LMS method was used for developing the percentile values. In this method, percentile values were developed for each age group based on the "specific Box-Cox power transformations' used in normalization of the data.[6] Intra-group descriptive statistics (e.g. 7.00–7.99) for each age group were studied using SPSS 13.0 (Chicago, IL, USA). "Pearson's correlation coefficient" was used to evaluate the linear relationship between SFT and age in terms of triceps and subscapular skin thicknesses for both genders. Student's t-test was used to determine absence of differences between girls and boys in terms of triceps and subscapular SFT.

RESULTS

Of the 6917 children and adolescents enrolled in the study, 3874 were girls (56%) and 3043 were boys (44%). Mean age was 11.2 ± 2.78 years for boys and 11.4 ± 2.57 years for girls. Means and standard deviations for triceps and subscapular SFT for girls and boys by age are summarized in Table-I. Triceps and subscapular SFT smoothed 3rd, 10th, 25th, 50th, 75th, 85th, 90th and 97th percentile values are presented in Table II-V.

Triceps and subscapular SFT generally increased with age in girls and the correlation was statistically significant (r= 0.432). In boys, when mild decreases at the ages of fourteen and fifteen was excluded, subscapular SFT increased in an age-dependent manner as was the case for girls. While triceps SFT

Table-I: Mean and Standard Deviations of Triceps and Subscapular SFT (values by age and gender)

Age (year)	*Boys*					*Girls*				
	n (3043)	*Triceps SFT*		*Subscapular SFT*		*n (3874)*	*Triceps SFT*		*Subscapular SFT*	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
7	341	8.6	3.0	5.4	1.4	334	9.6	3.6	5.8	1.6
8	381	8.6	2.6	6.0	1.5	345	9.4	3.7	6.0	2.1
9	373	9.0	3.1	6.5	2.0	331	10.0	4.3	6.8	2.7
10	304	9.4	2.9	6.8	2.2	245	9.9	4.1	6.5	2.7
11	427	9.8	3.5	6.8	2.1	328	11.2	4.8	8.0	3.7
12	328	11.0	4.0	7.7	2.9	254	11.3	5.1	9.1	4.4
13	682	11.2	4.1	8.1	3.5	345	12.8	5.5	10.3	4.1
14	570	10.3	4.0	7.9	2.8	404	14.0	5.5	10.8	3.9
15	214	9.5	3.4	7.7	2.2	204	14.0	5.5	10.7	4.1
16	184	10.3	4.0	9.6	2.9	175	14.9	5.2	12.3	4.5
17	70	10.5	3.5	10.0	2.1	78	15.5	5.5	11.6	3.9

SFT: Skinfold thickness. Mean: 50. percentile value. SD: standard deviation.

Table-II: Percentiles Values of Triceps SFT for Boys.

Age (year)	*Triceps SFT for Boys*								
	5th	10th	25th	50th	75th	85th	90th	95th	97th
7	4.68	5.32	6.54	8.16	10.09	11.26	11.57	12.12	13.49
8	4.76	5.39	6.62	8.26	10.27	11.52	11.85	12.44	13.93
9	4.87	5.51	6.75	8.44	10.54	11.87	12.22	12.86	14.47
10	5.05	5.71	7.01	8.80	11.06	12.50	12.89	13.59	15.37
11	5.28	5.97	7.35	9.29	11.74	13.33	13.76	14.53	16.52
12	5.49	6.22	7.69	9.76	12.42	14.15	14.62	15.47	17.67
13	5.54	6.30	7.80	9.94	12.72	14.55	15.05	15.95	18.28
14	5.44	6.17	7.66	9.79	12.58	14.42	14.92	15.84	18.22
15	5.31	6.02	7.47	9.55	12.30	14.14	14.64	15.56	17.96
16	5.23	5.92	7.33	9.37	12.10	13.94	14.44	15.36	17.80
17	5.18	5.85	7.23	9.24	11.95	13.80	14.31	15.24	17.72

in boys increased with age until adolescence, showed a decrease in this period, and increased thereafter, but these values were higher than those measured before adolescence and lower than those measured during early adolescence. There was a significant difference between girls and boys in terms of triceps and subscapular SFT values (p=0.001). A highly significant, linear, positive correlation was noted between girls and boys in terms of triceps and subscapular SFT (r= 0.632, p=0.001; r = 0.525, p=0.001, respectively).

DISCUSSION

Nutrition during childhood and adolescence is an important point of interest thoroughly studied by investigators. Reduced subcutaneous adipose tissue is typically observed in children with chronic malnutrition.[7] Changes in subcutaneous adipose tissues are indicative of both the nutrition and the metabolism of children. SFT decreases during the catabolic process.

Obesity is another nutritional disorder with increasing significance worldwide. Besides being a critical condition itself, obesity is also important in causing type II diabetes mellitus, dyslipidemia, hypertension and coronary artery disease in adolescents and adults.[8,9] Number of methods have been applied for assessment of body fat ratio.[1,10-13] These methods were concluded to be expensive and not superior to anthropometric measurements. Furthermore, as some of these methods are invasive, others have the risk of radiation exposure.

Besides their use in analyzing whether nutritional status is satisfactory, anthropometric measurements are also frequently used for the evaluation of nutritional disorders since they are convenient and non-invasive methods. Skinfold thickness (SFT) measurement is another practical and valuable technique in evaluating both the nutritional status and body fat ratio.[2-4] It is a reliable indicator frequently used for evaluating nutritional and developmental status in childhood. Because it is painless, non-invasive and reproducible, SFT measurements may also be preferred in monitoring the nutritional status with chronic diseases in children.[14] Despite apparent variations between ethnicities and SFT disparities at

Table-III: Percentiles Values of Subscapular SFT for Boys.

Age (year)	*Subscapular SFT for Boys*								
	5th	10th	25th	50th	75th	85th	90th	95th	97th
7	3.71	3.96	4.45	5.14	6.03	6.63	7.10	7.90	8.52
8	3.91	4.18	4.72	5.48	6.52	7.23	7.80	8.81	9.60
9	4.09	4.38	4.97	5.82	7.00	7.84	8.53	9.80	10.83
10	4.24	4.55	6.13	7.47	8.45	9.27	10.81	12.10	12.10
11	4.36	4.70	5.40	6.44	7.95	9.06	10.00	11.77	13.27
12	4.44	4.82	5.60	6.76	8.43	9.65	10.67	12.58	14.17
13	4.51	4.93	5.80	7.09	8.90	10.19	11.23	13.14	14.66
14	4.60	5.07	6.04	7.44	9.33	10.63	11.66	13.47	14.85
15	4.92	5.27	6.32	7.81	9.76	11.05	12.05	13.74	14.99
16	4.92	5.50	6.64	8.21	10.20	11.48	12.44	14.03	15.18
17	5.11	5.74	6.98	8.63	10.65	11.91	12.84	15.24	15.41

Table-IV: Percentiles Values of Triceps SFT for Girls.

Age (year)	*Triceps SFT for Girls*								
	5th	10th	25th	50th	75th	85th	90th	95th	97th
7	4.80	5.59	7.12	9.15	11.56	13.03	13.42	14.11	15.81
8	4.19	5.05	6.72	8.96	11.64	13.28	13.71	14.47	16.35
9	4.05	4.96	6.75	9.17	12.08	13.85	14.31	15.13	17.17
10	4.21	5.16	7.05	9.62	12.73	14.64	15.14	16.02	18.24
11	4.52	5.53	7.54	10.27	13.60	15.64	16.18	17.14	19.53
12	4.90	5.98	8.11	11.03	14.57	16.76	17.33	18.36	20.91
13	5.31	6.46	8.74	11.83	15.59	17.89	18.50	19.58	22.27
14	5.71	6.93	9.34	12.60	16.53	18.94	19.57	20.70	23.49
15	6.09	7.37	9.89	13.29	17.36	19.85	20.50	21.66	24.53
16	6.45	7.79	10.40	13.91	18.10	20.65	21.31	22.50	25.43
17	6.78	8.17	10.87	14.47	18.76	21.36	22.04	23.25	26.24

different sites of the body, the US National Research Council Nutritional Anthropometry Committee lists triceps and subscapular SFT as a good index in determining obesity.[2] Bedogni et al.[15] have demonstrated high sensitivity for SFT in their excess adiposity screening in children. SFT directly measures subcutaneous fat tissue and reveals total lipidosis to a better extent. Studies on total body fat ratio using DXA have demonstrated a strong correlation between subcutaneous fat tissue and visceral lipidosis.[16] A study done with healthy adult subjects, investigated the reliability of SFT measurements by taking subcutaneous fatty tissue thickness values measured with ultrasonography (USG) as reference; SFT measurements could safely be used in investigations since a significant correlation was established between the measurements taken with these two methods.[17] Another study with children and adults has also reported a positive and significant relationship between anthropometric measurements and magnetic resonance imaging and computerized tomography.[18]

In adults, triceps SFT values of above 23 mm in males and values above 30 mm in females indicate obesity.[19] As in all anthropometric values, SFT varies by age, stage of development and gender. Percentile values for age and gender were developed for children. According to these SFT percentile curves determined for a given population based on age and gender, children, or adolescents with values in the 85-90 percentile range are considered overweight and those with values above 95 are considered obese. Measurements below 25 in the SFT percentile curve suggest malnutrition.[20,21]

A comparison of our SFT data with those obtained in other countries showed that total mean triceps and subscapular SFT values of American children (5-18 years) were higher both in girls and in boys.[22] In boys, triceps and subscapular SFT was slightly lower compared to German children in both groups. There was a more marked decrease in the adolescent group in the subscapular measurements. SFT from both regions in girls in the German population was higher than our data.[23]

Table-V: Percentiles Values of Subscapular SFT for Girls.

Age (year)	*Subscapular SFT for Girls*								
	5th	10th	25th	50th	75th	85th	90th	95th	97th
7	3.71	4.05	4.71	5.60	6.70	7.40	7.92	8.79	9.41
8	3.53	3.89	4.61	5.62	6.95	7.83	8.50	9.66	10.51
9	3.54	3.94	4.73	5.89	7.46	8.54	9.40	10.89	12.03
10	3.64	4.07	4.95	6.24	8.05	9.31	10.32	12.11	13.50
11	3.95	4.44	5.45	6.95	9.03	10.49	11.65	13.71	15.31
12	4.42	5.00	6.18	7.93	10.32	11.97	13.26	15.51	17.22
13	4.91	5.60	6.98	8.99	11.66	13.44	14.82	17.17	18.91
14	5.31	6.09	7.66	9.89	12.74	14.60	16.01	18.34	20.03
15	5.58	6.46	8.21	10.61	13.59	15.47	16.86	19.13	20.73
16	5.80	6.79	8.71	11.28	14.36	16.24	17.62	19.81	21.34
17	5.98	7.08	9.18	11.90	15.07	16.96	18.32	20.44	21.90

SFT values reported from Asia were also higher than those obtained in our study whereas Triceps SFT values observed in Japanese girls were considerably high.[24] When our data from the 12-17 age groups was compared with Bahraini adolescents, mean triceps and subscapular SFT values were lower in girls and boys in all age groups. Similar decreases in mean triceps SFT values were observed in Bahraini boys of 15 years of age and in boys in the 14-15 age groups in our study. These values increased with age, without any decreases in the mean subscapular SFT values.[25] A comparison of our data and the mean triceps SFT values reported from a recent analysis of arm fat in Turkish children 6-18 years of age revealed that our results were lower in boys up to 11 years of age while our values were higher in the 11–13.9 and 14–17 age groups, whereas the difference was not statistically significant. The mean triceps data we obtained in our girl group was higher than reported in the above study in all age groups.[26]

In conclusion measuring skin fold thickness is useful for assessment of nutritional status in children & adolescents. Based on the results of our research, it was concluded that subcutaneous fat accumulation is lower in Turkish children compared to those in other countries & that no risk of obesity is imminent, at least in the region where this study was conducted.

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REFERENCES

1. Must A, Dallal GE, Dietz WH. Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht2) and triceps skinfold thickness. Am J Clin Nutr 1991;53:839–846.
2. Tanner JM. Hause RHW. Revised standards for triceps and subscapular skinfolds. British Arch Dis Child 1975;50:142–145.
3. Durnin JV, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness. Measurements on 481 men and women aged from 16-72 years. Br J Nutr 1974;32:77–97.
4. Reilly JJ, Wilson J, Durnin JVGA. Determination of body composition from skinfold thickness: A validation study. Arch Dis Child 1995;73:305-310.
5. Yates F. Sampling methods for censuses and surveys. New York, Mac Millan Publishing, 1981.
6. Cole TJ, GreenP J. Smoothing reference centile curves: The LMS method and penalized likelihood. Stat Med 1992;11:1305–1319.
7. Curran JS, Barness LA. Malnutrition. In nutrition. In Nelson LB (editor): Nelson Textbook of Pediatrics. 16th international edition. Philadelphia, WB Saunders Elsevier, 2004: 169–172.
8. Sinha R, Fisch G, Teague B, Tamborlane WV, Banyas B, Allen K, et al. Prevalence of impaired glucose tolerance among children and adolescents with marked obesity. N Engl J Med 2002;346:802–810.
9. Gungor N, Thompson T, Sutton-Tyrrell K, Janosky J, Arslanian S. Early signs of cardiovascular disease in youth with obesity and type 2 diabetes. Diabetes Care 2005;28:1219–1221.
10. Taylor RW, Jones IE, Williams SM, Golding A. Body mass percentages measured by dual-energy X-ray absorbtiometry corresponding to recently recommended body mass index cutoffs for overweight and obesity in children and adolescent aged 3-18 y. Am J Clin Nutr 2002;76:1416-1421.
11. Duerenberg P, Kooy KVD, Leean R, Schouten FJM. Body impedance is largely dependent on the intra and extra cellular water distribution. Eur J Clin Nutr 1989;73:139–160.
12. Kooy KVD, Siedell JC. Techniques for the measurement of visceral fat. A practical guide. Int J Obes 1993;17:187–196.
13. Vijayaraghavan K. Anthropometry for assessment of nutritional status. Indian J Pediatr 1987;54(4):511–520.
14. Ekim M, Ikinciogullari A, Ulukol B. Evaluation of nutritional status and factors related to malnutrition in children on CAPD. Perit Dial Int 2001;21(4):395–400.
15. Bedogni G, Iughetti L, Ferrari M, Malavolti M, Poli M, Bernasconi S, et al. Sensitivity and specificity of body mass index and skinfold thickness in detecting excess adiposity in children aged 8-12 years. Ann Hum Biol 2003;30(2):132–139.
16. Ball GD, Huang TT, Cruz ML. Predicting abdominal adipose tissue in overweight Latino youth. Int J Pediatr Obes 2006;1(4):210-216.
17. Orphanidou C, McCargar L, Birmingham CL, Mathieson J, Goldner E. Accuracy of subcutaneous fat measurement: Comparison of skinfold calipers, ultrasound, and computed tomography. J Am Diet Assoc 1994;94:855-858.
18. Iacobellis G. Imaging of visceral adipose tissue: An emerging diagnostic tool and therapeutic target. Curr Drug Targets Cardiovasc Haematol Disord 2005;5(4):345–353.
19. Mayer J. Some aspects of the problem of regulation of food intake and obesity. Part l N Engl J Med 1996;274:610–616.
20. Dekkers JC, Podolsky RH, Treiber FA, Barbeau P, Gutin B, Snieder H. Development of general and central obesity from childhood into early adulthood in African American and European American males and females with a family history of cardiovascular disease. Am J Clin Nutr 2004;79:661–668.
21. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child over weight and obesity world wide. BMJ 2000;320(60):1240–1243.
22. Freedman DS, Wang J, Ogden CL, Thornton JC, Mei Z, Pierson RN, et al. The prediction of body fatness by BMI and skinfold thickness among children and adolescents. Ann Hum Biol 2007;34(2):183–194.
23. Boye KR, Dimitriou T, Manz F, Schoenau E, Neu C, Wudy S, et al. Anthropometric assessment of muscularity during growth: Estimating fat-free mass with 2 skinfold-thickness measurements is superior to measuring midupper arm muscle area in healthy prepubertal children. Am J Clin Nutr 2002;76:628–632.
24. Fukuyama S, Inaoka T, Matsumura Y, Yamauchi T, Natsuhara K, Kimura R, et al. Anthropometry of 5-19-year-old Tongan children with special interest in the high prevalence of obesity among adolescent girls. Ann Hum Biol 2005;32(6):714-723.
25. Al-Sendi AM, Shetty P, Musaiger AO. Anthropometric and body composition indicators of Bahraini adolescents. Ann Hum Biol 2003;30:367–379.
26. Cicek B, Ozturk A, Mazicioglu MM, Elmali F, Turp N, Kurtoglu S. The risk analysis of arm fat area in Turkish children and adolescents. Ann Hum Biol 2009;36(1):28-37.