
Brief Report

Triceps Skinfold Thickness Centile Charts in Primary School Children in Shiraz, Iran

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Triceps skinfold thickness charts of a random sample of 2,234 healthy school children (1,161 boys and 1,073 girls) in Shiraz, Iran are presented. Triceps skinfold thickness increases by age and is higher in girls than boys, except for upper extreme centiles. Triceps skinfold thickness may be used with reasonable success to detect childhood obesity, which would be of great importance in public health promotion. It favors adequacy and simplicity in screening for adiposity. The charts presented here are likely to be applied to urban population of school-aged children in Iran, however, it should be updated periodically.

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Introduction

An indirect estimate of the proportion of adipose tissue in the body may be derived from the measurement of triceps skinfold thickness (TST). Evidence suggests that TST is an adequate index of body density, and thus of the percentage of total body fat.^{1,2} It measures the fat component of the body rather than attempting to estimate the fat by subtracting an estimate of fat-free weight from body weight, which estimates limb fat.³ The measurement of TST is simple and suitable for use in field surveys.² It is also relatively quick and inexpensive, so data can be collected on large number of subjects.¹ Determination of obesity is usually made by using population-based criteria, such as TST, established from a reference population. The 85th and 95th percentiles are frequently used to define obesity and super obesity operationally.⁴

One limited study was carried out in a northern city of Iran to report TST in high school girls.⁵ To

the best of our knowledge, no attempt has been made to provide a population-based reference data for Iran.

Therefore, this study determines TST as a measure of body fat distribution, and provides age-related and sex-specific reference curves and charts for primary school children in Shiraz, one of the five big cities of Iran, located in the southern part of the country.

Materials and Methods

Administratively, Shiraz is divided into four educational districts, each with distinct social, cultural, economic, and health characteristics. Since an adequate sampling frame of population was unavailable, a multistage random sampling was applied.⁶ A 10% sample of primary schools in each district was selected randomly. Within each randomly selected primary school, one out of each five healthy children from various grades aged 6.5 – 11.5 years was selected using systematic random sampling. Eventually, a total of 2,234 healthy students (1,161 males and 1,073 females) were selected in the academic year 2002 – 2003 to take part in this cross-sectional study. The students represented 2% of the primary school children in the city.

TST was measured as recommended by Cameron⁷ using a graded caliper. The measuring

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point was marked with the arm hanging straight, and not bent, and measurements were recorded in millimeters (mm). Fieldwork was carried out by auxologists who were trained thoroughly in measurement techniques before starting the study, but measurement error was not specifically quantified. The ages of the students were recorded meticulously.

The nonparametric method of Healy-Rasbash-Yang (HRY)⁸ was applied to calculate smoothed age-related centiles. The method works best with normal data. Therefore, an inverse transformation on TST was applied to normalize the data, and then HRY method was used to estimate the age-related TST smoothed centiles. Goodness of fit was assessed both graphically and numerically. The method has been implemented for the World Health Organization (WHO) in the GROSTAT computer package.

Results

Table 1 presents the number, mean, standard deviation (SD), and 95% confidence interval (CI) of TST (mm) by age and sex and the significance of differences. TST increases by age and is higher in girls than boys, except for the 95th centile. Chi-square test showed that the distribution of boys and girls was not statistically significant ($P>0.1$), implying homogeneity of their distributions.

Smoothed percentiles of TST (mm) by age and sex are provided in Table 2 at half yearly ages.

The fitted polynomials for the inverse of the TST measurements of school children are as follow:

Boys:

$$y_{pi} = [(45.53 - 6.35Zi + 0.44Zi^2 + 0.26Zi^3) + (-15.15 + 1.91Zi + 0.1Zi^2)age + (1.87 - 0.09Zi)age^2 + (-0.07)age^3]$$

Girls:

$$y_{pi} = [(-24.31 + 9.72Zi + 7.4Zi^2 + 1.71Zi^3) + (8.42 - 3.73Zi - 2.07Zi^2 - 0.13Zi^3)age + (-0.76 + 0.54Zi + 0.23Zi^2)age^2 + (0.03 - 0.02Zi - 0.01Zi^2)age^3]$$

Where y_{pi} is the p^{th} inverse TST centile for i^{th} subject and p corresponds to the p^{th} centile of normal equivalent deviation.

Figure 1 compares TST centiles of boys and girls. Great variations in TST at selected centiles, especially by age and sex are apparent in this figure. Females had higher TST than males at all ages, except for the upper extreme centiles.

Discussion

We have provided TST reference charts for school children in Shiraz by age and sex for the first time. They may be applicable to urban populations of school- aged children in Iran.

The reference data presented here provide essential age-sex criteria based on a large, nationally representative sample for use both in classification of individuals and in evaluation of secular trends. TST, a sensitive and specific marker for excess adiposity,⁹ is certainly an important covariate in models relating antecedent conditions to disease outcomes.

TST can be used with reasonable success to detect childhood obesity.¹⁰ Our findings suggest that measurements of TST give acceptable results for obesity screening in boys and girls aged 6.5 – 11.5 yr, which would be of great importance in public health promotion. However, we suggest that such studies be carried out periodically across the country to validate the model and to increase the reliability. The mean of three measurements of TST can be used as an index for TST; therefore, it

Table 1. Summary of statistics for TST (mm) by age and sex in primary school children in Shiraz, Iran.

Age (year)	Boys				Girls				Sex (P value) Girls>Boys
	n	Mean	SD	95% CI	n	Mean	SD	95% CI	
6.5 – 7.49	211	7.2	3.8	(6.7,7.7)	172	7.1	3.7	(6.6,7.6)	0.426
7.5 – 8.49	211	7.8	4.9	(7.2,8.4)	203	8.4	4.1	(7.8,8.9)	0.044*
8.5 – 9.49	232	8.5	4.8	(7.9,9.1)	205	8.9	4.3	(8.3,9.5)	0.041*
9.5 – 10.49	242	8.9	5.0	(8.3,9.6)	235	9.9	5.0	(9.2,10.5)	0.018*
10.5 – 11.49	265	9.4	5.6	(8.8,10.1)	258	10.5	5.2	(9.9,11.1)	0.009*
Total	1161	8.4	4.9	(8.1,8.7)	1073	9.1	4.7	(8.8,9.4)	0.001*

n=number; SD=standard deviation; CI=confidence interval; *Significant.

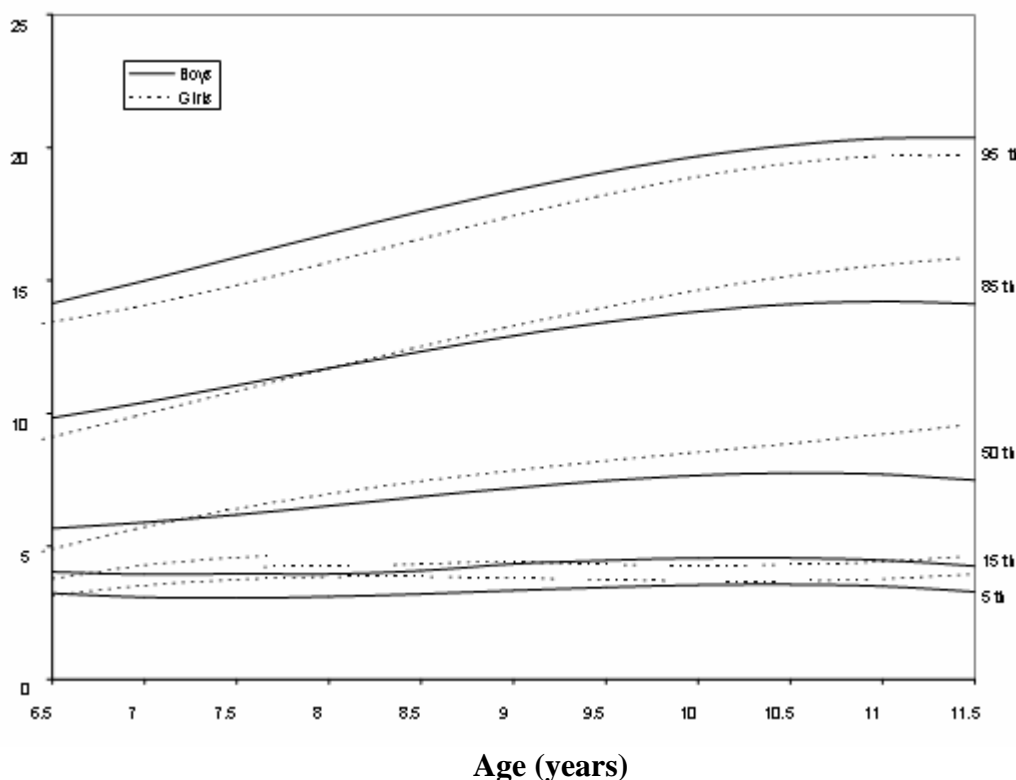
Table 2. Smoothed percentiles of TST (mm) for school children by age and sex in Shiraz, Iran.

Age (year)	Centiles										
	3	5	10	15	25	50	75	85	90	95	97
Boys											
6.5	2.9	3.2	3.6	4.0	4.3	5.6	7.9	9.8	11.3	14.1	16.2
7.0	2.7	3.0	3.5	3.9	4.4	5.8	8.4	10.4	12.0	14.9	17.2
7.5	2.7	3.0	3.5	3.9	4.5	6.1	8.9	11.0	12.7	15.8	18.2
8.0	2.7	3.1	3.6	3.9	4.7	6.5	9.4	11.6	13.5	16.7	19.2
8.5	2.8	3.2	3.7	4.1	4.9	6.8	9.9	12.3	14.2	17.5	20.1
9.0	2.9	3.3	3.9	4.3	5.1	7.1	10.4	12.9	14.8	18.3	21.0
9.5	3.0	3.4	4.1	4.5	5.3	7.4	10.8	13.4	15.4	19.0	21.8
10.0	3.1	3.5	4.0	4.5	5.4	7.6	11.2	13.8	15.9	19.6	22.4
10.5	3.1	3.5	4.1	4.6	5.4	7.7	11.3	14.1	16.2	20.0	22.2
11.0	3.1	3.4	4.0	4.5	5.3	7.7	11.4	14.2	16.4	20.3	23.2
11.5	2.9	3.2	3.8	4.3	5.1	7.4	11.2	14.1	16.3	20.3	23.3
Girls											
6.5	2.9	3.1	3.3	3.8	5.9	5.2	7.5	9.4	11.0	13.8	15.9
7.0	3.3	3.5	3.8	4.3	4.6	6.0	8.4	10.3	11.7	14.4	16.3
7.5	3.5	3.7	4.1	4.6	5.1	6.7	9.3	11.1	12.6	15.1	17.0
8.0	3.6	3.8	4.3	4.7	5.4	7.3	10.1	12.0	13.5	16.0	17.8
8.5	3.6	3.8	4.3	4.7	5.6	7.8	10.8	12.8	14.3	16.9	18.6
9.0	3.5	3.7	4.3	4.8	5.8	8.2	11.5	13.6	15.2	17.7	20.3
9.5	3.5	3.6	4.3	4.7	5.9	8.5	12.1	14.3	15.9	17.7	20.3
10.0	3.4	3.6	4.2	4.7	6.0	8.9	12.6	14.2	16.6	19.2	21.0
10.5	3.5	3.7	4.3	4.7	6.1	9.2	13.1	15.5	17.2	19.7	21.4
11.0	3.5	3.7	4.4	4.8	6.3	9.5	13.6	15.9	17.6	20.0	21.6
11.5	3.7	3.9	4.6	5.0	6.6	9.9	13.9	16.2	17.8	20.0	21.5

is an adequate yet simple index for screening adiposity, which also enjoys inexpensiveness.

A comparison of TST measurements of our

participants with their American peers reveals that, firstly there is a rather steady increase in TST for boys and girls, and secondly, girls have higher TST

**Figure 1.** Comparison of TST in boys and girls by age charts in school children in Shiraz, Iran.

readings than boys. However, American girls generally have skinfolds approximately 25% thicker than boys³, while in our study this was 5 – 12% (average 8%) more than boys. This may be attributed to the fact that obesity is less common in primary school children in Iran than the USA.¹¹ In addition, the rate of increase in TST would be more rapid in girls after nine years of age, which may be due to earlier puberty in girls than boys.

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