RESEARCH PAPER

Reference Centile Curves for Triceps Skinfold Thickness for Indian Children aged 5–17 years and Cut-offs for Predicting Risk of Childhood Hypertension: A Multi-Centric Study

ANURADHA KHADILKAR, RUBINA MANDLIK, SHASHI CHIPLONKAR, VAMAN KHADILKAR, VEENA EKBOTE AND VIVEK PATWARDHAN

From Jehangir Hospital and Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, Pune, Maharashtra, India. Correspondence to: Dr Anuradha Khadilkar, Department of Pediatrics, Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, 32 Sassoon Road, Pune 411 001, India. anuradhavkhadilkar@gmail.com
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Objective: To create age- and gender-specific Triceps Skinfold Thickness percentile curves for Indian children; and to determine cut-offs for predicting the risk of childhood hypertension.

Design: Cross-sectional.

Setting: Multicentric, school-based, 5 major Indian cities

Participants: 13375 children (7590 boys) aged 5-17 years

Procedure: Data on height, weight, blood pressure, triceps skinfold thickness (using Harpenden Skinfold caliper) were collected. Reference triceps skinfold thickness percentile curves were derived for boys and girls by LMS (lambda-mu-sigma) method. Receiver operating curve analyses were performed to determine the optimal cut-off of triceps skinfold thickness centile for predicting the risk of hypertension.

Results: Percentile curves for boys plateau around 13 years whereas for girls the curves increase steadily till the age of 17 years. Median triceps skinfold thickness increased by 7% to 9% till the age of 9 years in boys and girls. After 12 years, median triceps skinfold thickness decreased by 1% to 2% in boys but increased by 3% to 4% in girls. The optimal cut-off percentile yielding maximal sensitivity (68%) and specificity (74-78%) for predicting high blood pressure was the 70th triceps skinfold thickness percentile in both genders.

Conclusions: Percentile curves for triceps skinfold thickness developed in the present study would be useful in the assessment of adiposity and the risk of hypertension in Indian children.

Keywords: *Anthropometry, Adiposity, Blood pressure, Body mass index*.

Skinfold thickness is an important index for assessment of body fat composition in children [1]. Although high body mass index (BMI) in children may be an indicator of raised total body fat, it may be inaccurate [2]. Reports suggest that skinfold thickness is associated with adiposity even in non-obese children [3], leading to the assumption that it may be a better predictor of cardiovascular risk [2]. Thus, BMI followed by this measurement may help to correctly identify excess body fat in children [4].

Triceps skinfold thickness (TSFT) measurements are non-invasive and can function independently as predictors of childhood hypertension [5]. We have previously reported (on the same dataset) a positive association of TSFT with BP [6]. Furthermore, TSFT being easier to obtain as compared to skinfold measurements at other sites (removal of clothes not being a measurement requisite), making this technique useful in epidemiological settings. Reference centiles for TSFT for other populations [7,8] may not be applicable to Indian children due to racial differences.

The primary objective of this study was to develop reference centiles for TSFT representative of apparently healthy Indian children and adolescents aged 5-17 years. A secondary objective was to determine TSFT centile cut-offs to predict the risk of childhood hypertension.

METHODS

This study was part of a multi-centric study with the objective of defining gender- and age-wise waist percentiles for Indian children [9]. The study was performed in schools catering to children of higher socio-economic status in 5 major Indian cities (Delhi, Chennai, Pune, Kolkata and Raipur), one from each of the five zones [10] in India. Data were collected from July 2011 to January 2012. Detailed methodology has been previously detailed [6,9]. The study was approved by the Ethics Committee of the Hirabai Cowasji Jehangir Medical Research Institute.

Data were collected by the same team at each site; equipments were calibrated daily. The mean inter-observer and intra-observer coefficients of variation were

<1% for TSFT, height and BP measurements. BMI categories were defined as normal weight, overweight and obese as per adult equivalent values for Asians [11] and height-for-age (HAZ), weight-for-age (WAZ) and BMI-for-age (BAZ) z-scores were computed as deviations from the median [12]. TSFT was recorded using the Harpenden caliper, on the non-dominant upper arm [13]. Average of two readings for all parameters was used for analysis.

Clinical assessments were carried out by pediatricians to confirm good health. BP was recorded as previously detailed [6]. SBP and/or DBP >90th percentile and < 95th percentile was considered as prehypertension. SBP and/or DBP ≥95th percentile was classified as hypertension [14].

Statistical Methods: All the statistical analyses were performed using SPSS software (version 16.0.2007, SPSS Inc., Chicago, IL). Pearson's correlation coefficient was computed gender-wise between TSFT, age, height, weight and BMI. All results were expressed as mean (SD) for comparability with other studies. Smoothed gender-specific reference plots showing 5th, 10th, 25th, 50th, 75th, 85th and 95th percentiles were derived using LMS method (LMSchartmaker Pro version 2.4, 2008; by Dr. Huiqi Pan and Dr. Tim Cole), which constructs reference percentiles adjusted for skewness [15]. Each variable of interest was summarized by three smooth curves plotted against age, representing the median (M), coefficient of variation (S) and skewness (L) of the measurement distribution [16]. Models were checked for goodness of fit using the detrended Q-Q plot, Q Tests and worm plots [17]. The LMS method was found to be appropriate to use for this data as the measure of skewness of the data was 1.1 with a standard error of 0.03.

With the help of the LMS chartmaker, we also determined the age- and gender-specific smoothed median triceps skinfold thickness for children who were overweight and obese according to the adult equivalent BMI cut-offs for Asians [8,11,18]. Receiver-operating characteristic (ROC) analysis was performed for identifying gender-wise risk of hypertension.

RESULTS

A total of 13388 children (7596 boys) from the selected schools were enrolled in the study.We excluded 13 outliers (5 children for height, 4 for BMI, and 4 for triceps). Anthropometric and blood pressure data on 13375 children (7590 boys) aged 5-17 years were analyzed for generating TSFT centiles. ***Table* I** describes the anthropometric characteristics of the included children. All the children were within reference range for anthropometric parameters, with the means of HAZ, WAZ and BAZ around 0. Using adult equivalent cut-offs for BMI [11, 13], 26% of children were found to be overweight and 14% were obese. 89.5% of the children had normal SBP and 85.9% had normal DBP.

TSFT was significantly (P<0.01) associated with age (r=0.18), weight (r=0.54), height (r=0.23) and BMI (r=0.77) in boys as well as in girls [age (r=0.4); weight (r=0.72), height (r=0.44) and BMI (r= 0.83)]. TSFT reference centile curves (5th, 10th, 25th, 50th, 75th, 85th and 95th) are presented for boys and girls in ***Fig*. 1*a*** and **1*b*,** respectively. Corresponding smoothed percentile values are given according to age and gender in ***Table* II** and **III**. The model was considered a good fit as per the shape of the worm plot; the Q statistic curves for L, M & S were within -2 and +2, and the detrended Q-Q plot indicated that the population was approximately normal. The smoothed percentile curves for boys plateaued around the age of 13 years whereas for girls the smoothed curves increased steadily till the age of 18 years (***Fig*. 1*a*** and **1*b***). Median TSFT increased by 7% to 9% till the age of 9 years in both genders. After the age of 12 years,

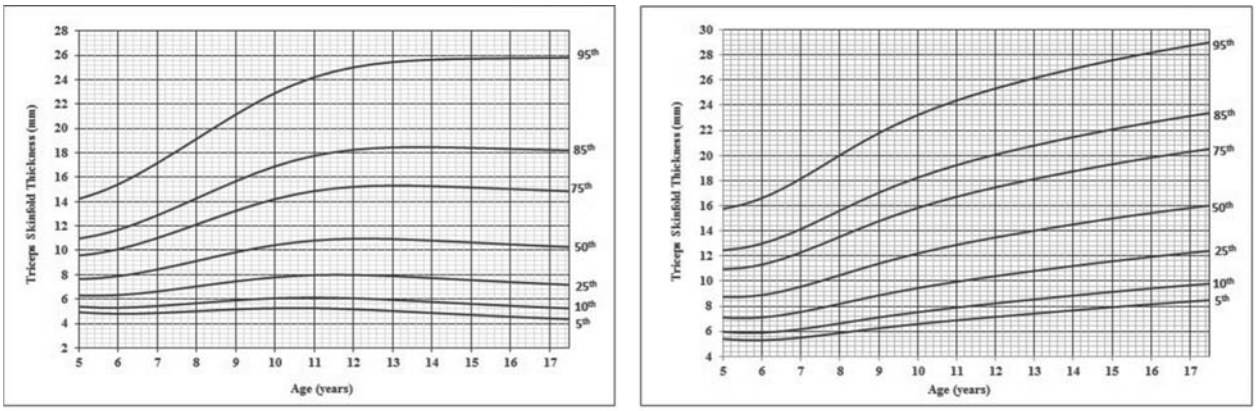

FIG. 1 *Smoothed percentile curves for triceps skinfold thickness in participants: (a) Boys, and (b) Girls.*

TABLE 1 BASELINE CHARACTERISTICS OF THE PARTICIPANTS

Age (y)	*No.*	*Weight (kg)*	*Height (cm)*	*BMI (kg/m^2)*	*TSFT (mm)*	*SBP (mmHg)*	*DBP (mmHg)*
Boys							
5 +	417	19.5 (4.2)	112.4 (7.2)	15.3 (2.4)	8.3 (3.1)	88.2 (10.4)	60.8 (8.1)
6 +	747	21.7 (4.7)	117.8 (6)	15.5 (2.6)	8.9 (3.9)	91.4 (10.6)	62.4 (8.6)
7 +	638	25.2 (5.9)	124.2 (6.5)	16.3 (3)	9.6 (4.2)	96 (11.2)	64.9 (8.6)
8 +	722	28.2 (7.3)	129.3 (6.5)	16.6 (3.3)	10.4 (4.8)	98.4 (11.4)	67.6 (8)
9 +	708	31.5 (7.9)	134.6 (6.6)	17.3 (3.4)	11.5 (5.3)	101.6 (11.2)	68.9 (8.3)
10 +	573	36.2 (8.9)	140.4 (7.1)	18.2 (3.6)	13 (5.7)	104.6 (10.6)	69.5 (8.6)
11 +	733	40.1 (10)	145.4 (8)	18.9 (3.8)	12.9 (6)	106.7 (9.8)	71.2 (8)
12 +	720	44.1 (11.6)	151 (8.7)	19.2 (4.1)	13.3 (6.8)	107.6 (10.8)	72 (8.6)
13 +	741	48.9 (12.1)	157.4 (8.7)	19.6 (3.9)	12.2 (6.4)	109.2 (10.7)	72.6 (8.5)
14 +	540	54.9 (12.7)	164 (7.6)	20.3 (4.1)	12.4 (6.7)	113 (11)	73.3 (7.8)
15 +	509	59.3 (13.7)	167.8 (7.2)	21 (4.4)	11.4 (6.3)	115.4 (11.1)	75.5 (7.4)
16 +	389	60.8 (12.6)	169.4 (7)	21.2 (4)	11.4 (5.9)	116.2 (10.4)	76.2 (7)
17 +	153	64.8 (12.7	171.3 (6.5)	22 (4.1)	12.5 (6.4)	118.4 (8.2)	76.9 (7.8)
Girls							
5 +	391	19.3 (4)	111.3 (6.0)	15.5 (2.6)	9.4 (3.6)	89.8 (9.4)	61.5 (8.5)
6 +	545	21.3 (4.8)	116.9 (6.3)	15.6 (2.7)	9.8 (4)	92.4 (10.7)	63.1 (8.1)
7 +	491	24.4 (6.1)	123 (6.3)	16.1 (3.5)	10.6 (3.9)	95.3 (9.7)	65.4 (8)
8 +	558	27.8 (6.9)	128.8 (6.6)	16.6 (3.1)	12.1 (4.8)	99.7 (11.2)	67.2 (9)
9 +	540	30.4 (7.5)	133.5 (7.1)	17 (3.3)	12.9 (5)	100.7 (10.3)	67.8 (8.2)
10 +	418	35.5 (8.3)	140.4 (7.6)	17.9 (3.3)	13.8 (5.3)	103 (11.1)	68.9 (8.1)
11 +	523	40.5 (9.9)	146.9 (8.2)	18.7 (3.7)	14.8 (6)	106.9 (11)	71.1 (8.3)
12 +	518	43.6 (9.8)	151.5 (7.3)	19 (3.8)	14.3 (5.5)	108.5 (11.2)	71.7 (8.8)
13 +	560	48 (10.3)	154.6 (6.4)	20.1 (3.9)	15.1 (6.1)	110.1 (10.6)	73.6 (8.1)
14 +	445	50.3 (10.2)	155.9 (5.9)	20.7 (3.9)	15.7 (6.2)	111.3 (10.7)	73.5 (7.3)
15 +	389	52.8 (11.2)	156.7 (6)	21.5 (4.3)	16.5 (5.9)	111.1 (9.8)	74.3 (6.9)
16 +	294	52.7 (10.1)	157.4 (6.2)	21.2 (3.6)	16.6 (5.7)	111.9 (12.7)	74.8 (7.7)
17 +	113	53.9 (10.8)	157.4 (6.1)	21.7 (3.9)	17.3 (6.5)	113.6 (10)	75.1 (7.3)

**Results are expressed as mean (SD)*
BMI: Body mass index; TSFT: Triceps skin-fold thickness; SBP: Systolic blood pressure; DBP: Diastolic blood pressure.

median TSFT decreased by 1% to 2% in boys but showed increase by 3% to 4% in girls. Percentiles lower than 50th were more flat than the higher percentiles in boys. On the other hand, increasing trend was seen at lower as well as higher centiles in girls.

To judge the efficacy of TSFT centiles in identifying excess body fat and in turn risk of hypertension, ROC analysis was carried out. The optimal cut-off percentile yielding maximal sensitivity and specificity for predicting high BP was 70th TSFT percentile in boys and girls, the values for which are presented in ***Table* II** and **III**. Area under the curve (AUC) was 0.778 (95% CI: 0.753, 0.803) in boys with 68% sensitivity and 78% specificity. In girls, AUC was 0.749 [95% CI (0.713, 0.785)] with 68% sensitivity and 74% specificity.

Fig.* 2*a and **2*b*** illustrate the trajectory of the median TSFT curve for children classified overweight and obese according to BMI criteria. For boys, the median skinfold thickness for overweight boys was above the 75th percentile for TSFT, and the median TSFT for obese boys was above the 85th percentile for TSFT across age. For girls, the median skinfold thickness for overweight girls tracked the 75th percentile for skinfold thickness neatly while the median for obese girls was above the 85th percentile for skinfold thickness across age.

DISCUSSION

The present study provides age- and gender-specific reference percentiles of TSFT for Indian children and adolescents. Reports suggest that the ability of TSFT

TABLE II TRICEPS SKINFOLD THICKNESS (TSFT) PERCENTILES VALUES FOR BOYS WITH CUT-OFF VALUE OF 70TH PERCENTILE OF TSFT FOR HYPERTENSION RISK

Age	*5th*	*10th*	*25th*	*50th*	*70th*	*75th*	*85th*	*95th*
5	4.9	5.4	6.3	7.7	9.1	9.6	11.0	14.2
5.5	4.8	5.3	6.3	7.7	9.2	9.8	11.3	14.7
6	4.8	5.3	6.3	7.9	9.5	10.1	11.7	15.4
6.5	4.8	5.3	6.5	8.1	9.9	10.5	12.2	16.2
7	4.9	5.4	6.6	8.4	10.3	11.0	12.9	17.1
7.5	4.9	5.5	6.8	8.8	10.8	11.6	13.6	18.1
8	5.0	5.7	7.0	9.1	11.4	12.1	14.3	19.1
8.5	5.1	5.8	7.3	9.5	11.9	12.7	15.0	20.2
9	5.2	5.9	7.5	9.8	12.4	13.2	15.7	21.1
9.5	5.2	6.0	7.6	10.2	12.8	13.8	16.3	22.1
10	5.3	6.1	7.8	10.4	13.2	14.2	16.9	22.9
10.5	5.3	6.1	7.9	10.6	13.6	14.6	17.4	23.6
11	5.3	6.1	8.0	10.8	13.8	14.9	17.8	24.2
11.5	5.2	6.1	8.0	10.9	14.0	15.1	18.0	24.7
12	5.2	6.1	8.0	10.9	14.1	15.2	18.2	25.0
12.5	5.1	6.0	7.9	11.0	14.2	15.3	18.4	25.3
13	5.0	5.9	7.9	10.9	14.2	15.3	18.4	25.4
13.5	5.0	5.9	7.8	10.9	14.2	15.3	18.5	25.6
14	4.9	5.8	7.7	10.8	14.1	15.3	18.5	25.6
14.5	4.8	5.7	7.6	10.7	14.1	15.2	18.4	25.7
15	4.7	5.6	7.6	10.6	14.0	15.2	18.4	25.7
15.5	4.6	5.5	7.5	10.6	13.9	15.1	18.4	25.7
16	4.6	5.5	7.4	10.5	13.9	15.0	18.3	25.8
16.5	4.5	5.4	7.3	10.4	13.8	15.0	18.3	25.8
17	4.4	5.3	7.2	10.3	13.7	14.9	18.2	25.8
17.5	4.4	5.2	7.2	10.3	13.7	14.9	18.2	25.8

TABLE III TRICEPS SKINFOLD THICKNESS (TSFT) PERCENTILES VALUES FOR GIRLS WITH CUT-OFF VALUE OF 70TH PERCENTILE OF TSFT FOR HYPERTENSION RISK

Age	*5th*	*10th*	*25th*	*50th*	*70th*	*75th*	*85th*	*95th*
5	5.4	6.0	7.1	8.7	10.4	10.9	12.5	15.8
5.5	5.3	5.9	7.0	8.7	10.5	11.1	12.6	16.1
6	5.3	5.9	7.1	8.9	10.7	11.3	13.0	16.6
6.5	5.4	6.0	7.3	9.2	11.1	11.7	13.5	17.3
7	5.5	6.2	7.5	9.6	11.6	12.3	14.1	18.2
7.5	5.7	6.4	7.9	10.0	12.2	12.9	14.9	19.1
8	5.9	6.6	8.2	10.5	12.8	13.5	15.6	20.0
8.5	6.1	6.9	8.5	10.9	13.4	14.2	16.3	20.9
9	6.2	7.1	8.9	11.4	13.9	14.8	17.0	21.8
9.5	6.4	7.3	9.2	11.8	14.5	15.3	17.7	22.5
10	6.6	7.5	9.4	12.2	14.9	15.8	18.2	23.2
10.5	6.7	7.7	9.7	12.6	15.4	16.3	18.8	23.8
11	6.9	7.9	9.9	12.9	15.8	16.7	19.2	24.4
11.5	7.0	8.1	10.2	13.2	16.1	17.1	19.7	24.9
12	7.2	8.2	10.4	13.5	16.5	17.5	20.1	25.3
12.5	7.3	8.4	10.6	13.8	16.8	17.8	20.4	25.8
13	7.4	8.5	10.8	14.0	17.1	18.1	20.8	26.2
13.5	7.5	8.7	11.0	14.3	17.4	18.4	21.1	26.5
14	7.7	8.8	11.2	14.5	17.7	18.7	21.5	26.9
14.5	7.8	9.0	11.4	14.8	18.0	19.0	21.8	27.3
15	7.9	9.1	11.6	15.0	18.3	19.3	22.1	27.6
15.5	8.0	9.3	11.8	15.2	18.5	19.6	22.4	27.9
16	8.2	9.4	11.9	15.4	18.8	19.8	22.6	28.2
16.5	8.3	9.5	12.1	15.6	19.0	20.1	22.9	28.5
17	8.4	9.7	12.3	15.8	19.2	20.3	23.1	28.7
17.5	8.5	9.8	12.4	16.0	19.4	20.5	23.4	29.0

percentiles to screen for adiposity is similar to that of BMI or waist circumference [19]. Around 15% children in this study had TSFT values above the 75th percentile even when their BMI was within normal range as judged by BMI adult equivalent cut-offs. This suggests that at lower BMI Indian children may have higher body fat percent [20].

In comparison with TSFT percentiles developed for Polish children using Harpenden caliper [7], it was observed that Indian children had similar TSFT values as compared to Polish children upto the 50th centile in boys and upto the 75th centile in girls, after which the TSFT values were higher in Indian children. This may partly be due to the tendency of Asians to have higher body fat than their Western counterparts at lower or similar BMI [21, 22]. TSFT centiles above 50th percentile in Indian boys in the present study were higher than the reference centiles of TSFT in Caucasian boys using Lange calipers whereas the TSFT centile values of girls were similar [8]. The percentage difference between the 50th and 95th percentile for TSFT by Harpenden caliper for Indian children (123.5% for boys, 86.8% for girls) in the current study was compared with Caucasian children as measured by Lange calipers (124.7% for boys, 89.5% for girls). The small magnitude of differences in TSFT centiles may be due to the difference in measurement technique.

The cut-off of 70th percentile of TSFT in our study for predicting hypertension is similar to the cut-off for waist circumference percentile suggested by us for screening for metabolic syndrome risk for both genders [9]. While we have reported cut-offs for TSFT for

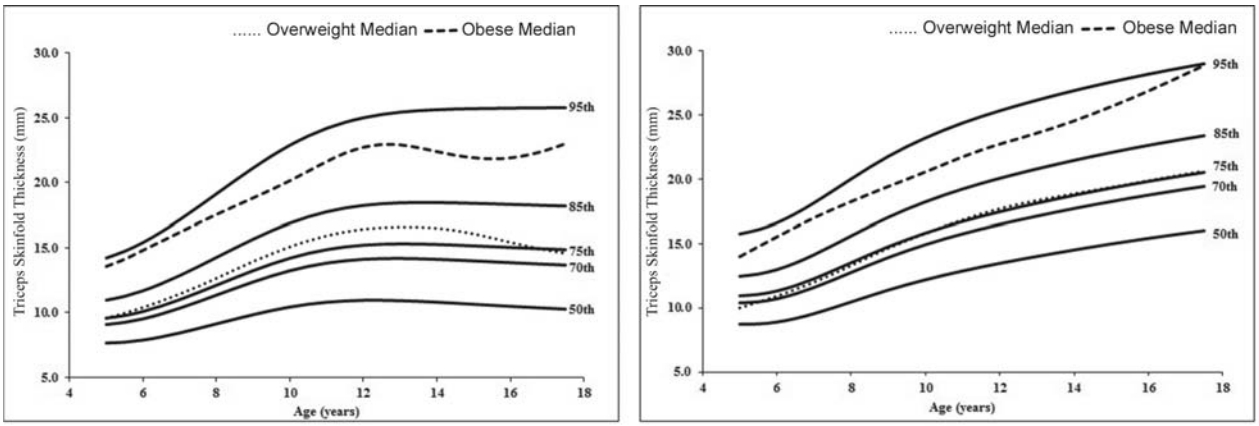

FIG. 2 *Triceps skinfold thickness percentiles with median TSFT percentile for overweight and obese participants (a) boys and (b)girls.*

predicting risk for childhood hypertension in an earlier publication [6], these cut-offs were based on Western data due to absence of Indian reference data. The present cut-offs, based on Indian reference data, are lower than those earlier reported and may be used effectively to screen Indian children with a risk for hypertension.

One of the limitations of the study is the comparability of Harpenden calipers with other instruments for measuring TSFT. Therefore, similar methods of measuring TSFT need to be employed for using these centiles. Another limitation is that TSFT is prone to measurement errors by technicians and it is imperative that trained personnel measure TSFT. Additionally, while our rates of false positivity are comparable to those reported earlier [23], one of the reasons for the low specificity may be that triceps skinfold thickness is an indicator of presence of excess fat and is not a measure of total body fat.

In summary, our study provides smoothed TSFT percentiles for Indian children and adolescents using a multicentric nationwide data. These percentiles would be useful in field studies for screening adiposity and risk of hypertension.

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Contributors: AVK: conceptualized and designed the study, coordinated and supervised data collection at the sites, carried out the initial analyses, reviewed and revised the manuscript; RM: data analyses and drafted the initial manuscript; SAC: conceptualized and designed the study, carried out the analyses, reviewed and revised the manuscript; VVK: conceptualized and designed the study, critically reviewed the manuscript; VHE: conceptualized and designed the study, coordinated and supervised data collection at the sites; VGP: carried out data management and analyses. All authors approved the final version of manuscript.

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Competing interests: None stated.

REFERENCES

1. Reilly JJ, Wilson J, Durnin JV. Determination of body composition from skinfold thickness: a validation study. Arch Dis Child. 1995;73:305-10.
2. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. Risk factors and adult body mass index among overweight children: the Bogalusa Heart Study. Pediatrics. 2009;123:750-7.
3. Freedman DS, Wang J, Ogden CL, Thornton JC, Mei Z, Pierson RN, *et al*. The prediction of body fatness by BMI and skinfold thicknesses among children and adolescents. Ann Hum Biol. 2007;34:183-94.
4. Himes JH, Dietz WH. Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. The Expert Committee on Clinical Guidelines for Overweight in Adolescent Preventive Services. Am J Clin Nutr. 1994;59:307-16.
5. Moser DC, Giuliano Ide C, Titski AC, Gaya AR, Coelho-e-Silva MJ, Leite N. Anthropometric measures and blood pressure in school children. J Pediatr (Rio J). 2013;89:243-9.
6. Kajale NA, Khadilkar AV, Chiplonkar SA, Khadilkar VV. Body fat indices for identifying risk of hypertension in Indian children. Indian Pediatr. 2014;51:555-60.
7. Jaworski M, Ku³aga Z, P³udowski P, Grajda A, Gurzkowska B, Napieralska E, *et al*.; OLAF Study Group. Population-based centile curves for triceps, subscapular, and abdominal skinfold thicknesses in Polish children and adolescents – the OLAF study. Eur J Pediatr. 2012;171:1215-21.
8. Addo OY, Himes JH. Reference curves for triceps and subscapular skinfold thicknesses in US children and adolescents. Am J Clin Nutr. 2010;91:635-42.
9. Khadilkar A, Ekbote V, Chiplonkar S, Khadilkar V,

WHAT IS ALREADY KNOWN?

- Triceps skinfold thickness (TSFT) measurements are useful in assessment of adiposity in children and can function as stand-alone predictors of childhood hypertension.

WHAT THIS STUDY ADDS?

- Age-and gender-specific smoothed reference percentiles curves of TSFT for Indian children and adolescents are provided.
- A cut-off of 70th percentile of TSFT is suggested to predict pediatric hypertension.

Kajale N, Kulkarni S, *et al*. Waist circumference percentiles in 2-18 year old Indian children. J Pediatr. 2014;164:1358-62.
10. Indian Academy of Pediatrics Growth Charts Committee, Khadilkar V, Yadav S, Agrawal KK, Tamboli S, Banerjee M, Cherian A, *et al*. Revised IAP growth charts for height, weight and body mass index for 5- to 18-year-old Indian Children. Indian Pediatr.2015.52:47-55.
11. Khadilkar VV, Khadilkar AV, Borade AB, Chiplonkar SA. Body mass index cut-offs for screening for childhood overweight and obesity in Indian children. Indian Pediatr. 2012;49:29-34.
12. Khadilkar VV, Khadilkar AV, Cole TJ, Sayyad MG. Cross-sectional growth curves for height, weight and body mass index for affluent Indian children, 2007. Indian Pediatr. 2009;46:477-89.
13. National Health and Nutrition Examination Survey. Anthropometry Procedures Manual (revised January 2004); 35. Available from: *http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/BM.pdf*. Accessed October 28, 2014.
14. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics. 2004;114:555-76.
15. van 't Hof MA, Wit JM, Roede MJ. A method to construct age references for skewed skinfold data, using Box-Cox transformations to normality. Hum Biol. 1985;57:131-9.
16. Cole TJ, Green PJ. Smoothing reference centile curves: the LMS method and penalized likelihood. Stat Med. 1992;11:1305-19.
17. van Buuren S, Fredriks M. Worm plot: a simple diagnostic device for modelling growth reference curves. Stat Med. 2001;20:1259-77.
18. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ. 2000;320:1240-3.
19. Krebs NF, Himes JH, Jacobson D, Nicklas TA, Guilday P, Styne D. Assessment of child and adolescent overweight and obesity. Pediatrics. 2007;120:S193-228.
20. Pandit D, Chiplonkar S, Khadilkar A, Khadilkar V, Ekbote V. Body fat percentages by dual-energy *X*-ray absorptiometry corresponding to body mass index cutoffs for overweight and obesity in Indian Children. Clin Med Pediatr. 2009;3:55-61.
21. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004;363:157-63.
22. Yajnik CS, Yudkin JS. The Y-Y paradox. Lancet. 2004;363:163.
23. Sardinha LB, Going SB, Teixeira PJ, Lohman TG. Receiver operating characteristic analysis of body mass index, triceps skinfold thickness and arm girth for obesity screening in children and adolescents. Am J Clin Nutr. 1999;70:1090-5.