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BRIEF COMMUNICATION

# Triceps and subscapular skinfold thickness percentiles of a school-based sample of adolescents in Ho Chi Minh City, Vietnam

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## Abstract

Skinfold thickness is an indicator of body fat, allowing a more detailed description of obesity. In Vietnam, there are no published percentile values for triceps and subscapular skinfold measurements from population-based studies of adolescents. This study aims to establish percentile tables for triceps, subscapular, and triceps + subscapular skinfolds (TSF + SSSF) sum. We used data from a cross-sectional survey conducted in Ho Chi Minh City. BMI, triceps and subscapular skinfold measurements of 2660 students were obtained. The L (Box-Cox transformation), M (median), and S (coefficient of variation) parameters were used to generate exact percentiles. The proportion of overweight was higher in boys (18.4% vs. 8.2%, $p < 0.0001$). Triceps, subscapular skinfolds, and TSF + SSSF were significantly higher in girls than in boys ($p < 0.001$). Our results provide sex- and age-specific reference values for skinfold thickness that can be applied as a new complimentary assessment tool for Vietnamese adolescents.

## Introduction

Overweight and obesity are increasing among adolescents of Ho Chi Minh City (HCMC), Vietnam [1, 2]. Individuals with an accumulation of excess body fat are at greater risk of adverse health consequences.

Skinfold thickness measurements are widely used to assess body fat because the measurements are noninvasive, simple, and less expensive than laboratory-based techniques. The sum of the skinfold measurements significantly improves the prediction of body fatness beyond that obtained with BMI-for-age, which is a measure of excess weight, rather than excess body fat. The two most frequently taken skinfold measurements are at the triceps and subscapular sites. There are published percentile values for triceps (TSF) and subscapular skinfold (SSSF) measurements in school children from many countries [3–6]. However, there are no population-based studies that assess SF among adolescents in Vietnam. The aim of this study is to establish Vietnamese LMS (L (Box-Cox transformation), M (median), and S (coefficient of variation)) tables for triceps, subscapular, and triceps+subscapular skinfolds (TSF + SSSF) of children in HCMC, Vietnam.

## Methods

The study is a secondary data analysis of a previously reported cross-sectional study conducted in 2004 [7] with a representative sample of junior high school students aged 10–15 years from HCMC.

### Data collection

We measured weight and height and calculated body mass index (BMI), which was classified as overweight and obesity using age and sex-specific International Obesity Task Force BMI cut-offs [8].

Skinfold thickness was measured using Harpenden Caliper (England, UK) by trained physicians. We used the mean of two measurements taken at each site (Triceps and subscapular), as well as the sum of TSF and SSSF. We assessed pubertal development with a self-administered questionnaire using Tanner's stages. We recorded the date of the first menstruation for girls, and the date of attaining

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an adult voice for boys. Further details of pubertal stages based on the WHO definition [9] are reported elsewhere.

### Statistical analysis

Data were analyzed using independent *t* tests and Pearson's chi-squared tests to examine sex and age differences in anthropometric characteristics. Percentiles by sex and age categories were generated using the LMS method in Stata version 15.0. BMI-for-age *z*-scores were calculated using the US CDC 2000 growth reference with *zanthro* commands. BMI-LMS values are also presented. A significance level (α) of 5% was used.

## Results

Table 1 shows the descriptive statistics for the 2660 participants in this study. The proportion of males was 50.1%. The mean age was 12.92 years (SD = 1.2), and there were no significant differences in mean age by sex ($p = 0.643$). All anthropometric variables, except TSF, SSSF, and TSF + SSSF, were higher in boys ($p < 0.0001$). The proportion of overweight was higher in boys (18.4% vs. 8.2%, $p < 0.0001$).

In Table 2, girls had higher TSF, SSSF, and TSF + SSSF values at 12 years and older. Contrarily, boys 10-10.99 and 11–11.99 years had higher TSF, SSSF, and TSF + SSSF values from 50th percentile and above. For girls, 50th percentiles of TSF, SSSF, and TSF + SSSF ranged from 13.43 to 16.45 mm, 10.48 to 13.40 mm, and 24.38 to 29.46 mm, respectively. For boys, 50th percentiles of TSF, SSSF, and TSF + SSSF ranged from 8.26 to 14.95 mm, 8.40 to 11.94 mm, and 16.69 to 27.25 mm, respectively. Apart from 10 to 10.99 and 11 to 11.99 year age groups, girls had higher 50th percentiles of BMI, TSF, SSSF and sum of (TSF + SSSF). Median BMI for girls ranged from 17.15 to 18.82 (kg/m$^2$) and for boys was 18.10–19.05 (kg/m$^2$). Apart from 14 to 14.99 years, the median BMI for boys was higher across most age groups.

## Discussion

This is the first study to present age and sex-specific percentiles for TSF and SSSF skinfold thicknesses to detect overweight/obesity among Vietnamese children (10–16 years) in HCMC. Results suggest a higher prevalence of overweight and obesity among boys, which is similar to other Asian countries [10].

Our findings coincided with a gradual increase of skinfolds in girls, as observed in other countries [3, 5, 6]. However, in contrast to typical findings [5, 6], younger boys had higher skinfold thickness measurements than girls of the same age. As high skinfold thickness measurements can be seen in those

**Table 1** Descriptive characteristics of junior high school students in Ho Chi Minh City by sex.

| Characteristics | Total $n = 2660$ | Boys $n = 1332$ | Girls $n = 1328$ | $p$ value |
|---|---|---|---|---|
| Age (years) mean (SD) | 12.92 (1.2) | 12.91 (1.2) | 12.93 (1.2) | 0.643 |
| 10–10.99 years *n* (%) | 80 | 44 (55.0) | 36 (45.0) | |
| 11–11.99 years | 573 | 278 (49.3) | 295 (50.7) | |
| 12–12.99 years | 709 | 365 (51.5) | 344 (48.5) | |
| 13–13.99 years | 755 | 380 (50.3) | 375 (49.7) | |
| 14–14.99 years | 505 | 244 (48.3) | 261 (51.7) | $\chi^2 = 2.95$, 5 df, |
| 15+ years | 38 | 21 (55.3) | 17 (44.7) | $p = 0.708$ |
| Weight (kg) | 44.0 (10.2) | 45.12 (11.6) | 42.68 (8.4) | <0.0001 |
| Height (cm) | 152.3 (8.6) | 153.37 (10.1) | 151.30 (6.5) | <0.0001 |
| BMI (kg/m$^2$) | 18.80 (3.3) | 19.04 (3.5) | 18.57 (2.97) | <0.0001 |
| BMI (*z*-score) | −0.09 (1.2) | −0.01 (1.3) | −0.16 (1.0) | 0.0016 |
| BMI status (%)** | | | | <0.0001 |
| Normal weight* | 2244 | 1041 (78.1%) | 1203 (90.6%) | <0.0001 |
| Overweight* | 354 | 245 (18.4%) | 109 (8.2%) | <0.0001 |
| Obese* | 62 | 46 (3.5%) | 16 (1.2%) | <0.0001 |
| Waist circumference (cm) | 64.35 (8.5) | 65.99 (9.7) | 62.71 (6.8) | <0.0001 |
| TSF thickness (mm) | 14.16 (6.3) | 12.8 (6.5) | 15.52 (6.6) | <0.0001 |
| SSSF thickness (mm) | 12.57 (6.6) | 11.50 (6.9) | 13.65 (6.2) | <0.0001 |
| TSF + SSSF skinfolds (mm) | 26.73 (12.3) | 24.30 (12.9) | 29.17 (11.2) | <0.0001 |

Data are shown as mean (SD) or frequencies (%). Significant between-sex differences Independent samples *t* tests *or* **Pearson's $\chi^2$ tests or **z* statistics—two proportions tests.

*TSF* triceps skinfold, *SSSF* subscapular skinfold, *BMI* body Mass Index.

**Table 2** Smoothed age- and sex-specific percentile values of TSF, SSSF and sum of (TSF + SSSF) (mm) among a school-based sample of adolescents in Ho Chi Minh City, Vietnam.

| *n* | Mean | Age | L | S | $P_3$ | $P_5$ | $P_{10}$ | $P_{25}$ | (M) $P_{50}$ | $P_{75}$ | $P_{85}$ | $P_{90}$ | $P_{95}$ | $P_{97}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Girls N = 1328* | BMI | | | | | | | | | | | | | |
| 36 | 17.40 | 10–10.99 | −0.51 | 0.15 | 13.22 | 13.63 | 14.31 | 15.56 | 17.15 | 18.99 | 20.11 | 20.93 | 22.24 | 23.15 |
| 295 | 18.13 | 11–11.99 | −1.02 | 0.16 | 13.70 | 14.11 | 14.78 | 16.06 | 17.78 | 19.91 | 21.29 | 22.33 | 24.09 | 25.39 |
| 344 | 18.18 | 12–12.99 | −0.90 | 0.15 | 13.99 | 14.38 | 15.04 | 16.27 | 17.88 | 19.82 | 21.03 | 21.94 | 23.43 | 24.50 |
| 375 | 18.95 | 13–13.99 | −0.84 | 0.15 | 14.37 | 14.80 | 15.51 | 16.85 | 18.61 | 20.73 | 22.07 | 23.07 | 24.70 | 25.89 |
| 261 | 19.08 | 14–14.99 | −0.95 | 0.13 | 14.99 | 15.39 | 16.04 | 17.25 | 18.82 | 20.69 | 21.85 | 22.72 | 24.13 | 25.14 |
| 13 | 18.44 | 15–15.99 | 1.05 | 0.15 | 13.39 | 14.04 | 15.04 | 16.71 | 18.55 | 20.38 | 21.37 | 22.03 | 23.01 | 23.64 |
| Total | 18.56 | | −0.81 | 0.15 | 14.11 | 14.53 | 15.22 | 16.53 | 18.23 | 20.28 | 21.57 | 22.52 | 24.09 | 25.21 |
| *Boys N = 1332* | | | | | | | | | | | | | | |
| 44 | 18.95 | 10–10.99 | 0.02 | 0.17 | 13.51 | 14.07 | 14.98 | 16.64 | 18.68 | 20.97 | 22.31 | 23.27 | 24.76 | 25.77 |
| 278 | 19.39 | 11–11.99 | −0.06 | 0.19 | 13.49 | 14.08 | 15.04 | 16.82 | 19.05 | 21.59 | 23.10 | 24.19 | 25.90 | 27.09 |
| 365 | 18.54 | 12–12.99 | −1.25 | 0.18 | 13.73 | 14.14 | 14.84 | 16.21 | 18.10 | 20.57 | 22.25 | 23.57 | 25.89 | 27.70 |
| 380 | 19.21 | 13–13.99 | −0.91 | 0.17 | 14.08 | 14.54 | 15.31 | 16.78 | 18.76 | 21.25 | 22.86 | 24.09 | 26.17 | 27.71 |
| 244 | 19.17 | 14–14.99 | −1.31 | 0.16 | 14.50 | 14.91 | 15.60 | 16.94 | 18.78 | 21.15 | 22.74 | 23.98 | 26.15 | 27.82 |
| 18 | 18.70 | 15–15.99 | −2.40 | 0.15 | 15.04 | 15.37 | 15.92 | 17.02 | 18.61 | 20.85 | 22.51 | 23.94 | 26.77 | 29.38 |
| **Total** | 19.04 | | −0.88 | 0.18 | 13.9 | 14.37 | 15.13 | 16.61 | 18.59 | 21.07 | 22.67 | 23.9 | 25.96 | 27.49 |
| *Girls N = 1328* | TSF | | | | | | | | | | | | | |
| 36 | 14.01 | 10–10.99 | 0.18 | 0.31 | 7.35 | 7.97 | 8.99 | 10.95 | 13.51 | 16.54 | 18.39 | 19.74 | 21.88 | 23.37 |
| 295 | 14.42 | 11–11.99 | 0.01 | 0.38 | 6.55 | 7.17 | 8.24 | 10.39 | 13.43 | 17.36 | 19.92 | 21.86 | 25.09 | 27.43 |
| 344 | 14.82 | 12–12.99 | 0.05 | 0.37 | 6.84 | 7.49 | 8.60 | 10.81 | 13.90 | 17.81 | 20.32 | 22.22 | 25.32 | 27.55 |
| 375 | 16.44 | 13–13.99 | 0.37 | 0.36 | 7.27 | 8.13 | 9.57 | 12.31 | 15.88 | 20.04 | 22.52 | 24.32 | 27.13 | 29.06 |
| 261 | 16.46 | 14–14.99 | 0.36 | 0.33 | 7.82 | 8.65 | 10.02 | 12.62 | 15.96 | 19.82 | 22.11 | 23.77 | 26.34 | 28.11 |
| 13 | 15.74 | 15–15.99 | 1.18 | 0.31 | 6.18 | 7.58 | 9.65 | 12.96 | 16.45 | 19.83 | 21.59 | 22.78 | 24.51 | 25.63 |
| Total | 15.52 | | 0.23 | 0.37 | 6.97 | 7.72 | 8.98 | 11.45 | 14.77 | 18.79 | 21.27 | 23.1 | 26.01 | 28.06 |
| *Boys N = 1332* | | | | | | | | | | | | | | |
| 44 | 15.72 | 10–10.99 | 0.41 | 0.46 | 5.09 | 6.00 | 7.57 | 10.70 | 14.95 | 20.05 | 23.16 | 25.43 | 29.01 | 31.49 |
| 278 | 15.43 | 11–11.99 | 0.40 | 0.47 | 4.88 | 5.76 | 7.30 | 10.39 | 14.61 | 19.72 | 22.85 | 25.14 | 28.76 | 31.27 |
| 365 | 12.35 | 12–12.99 | −0.22 | 0.50 | 4.54 | 5.01 | 5.86 | 7.70 | 10.64 | 15.05 | 18.35 | 21.09 | 26.12 | 30.17 |
| 380 | 12.46 | 13–13.99 | −0.31 | 0.49 | 4.74 | 5.19 | 6.01 | 7.79 | 10.66 | 15.10 | 18.51 | 21.42 | 26.91 | 31.49 |
| 244 | 10.82 | 14–14.99 | −0.28 | 0.48 | 4.20 | 4.60 | 5.32 | 6.87 | 9.35 | 13.11 | 15.94 | 18.33 | 22.77 | 26.41 |
| 18 | 9.35 | 15–15.99 | −0.70 | 0.41 | 4.47 | 4.76 | 5.29 | 6.42 | 8.26 | 11.22 | 13.65 | 15.86 | 20.48 | 24.88 |
| **Total** | 12.81 | | −0.11 | 0.5 | 4.53 | 5.04 | 5.97 | 7.98 | 11.14 | 15.75 | 19.07 | 21.78 | 26.59 | 30.34 |
| *Girls N = 1328* | SSSF | | | | | | | | | | | | | |
| 36 | 11.43 | 10–10.99 | −0.10 | 0.40 | 5.05 | 5.52 | 6.34 | 8.02 | 10.48 | 13.80 | 16.05 | 17.80 | 20.80 | 23.03 |
| 295 | 12.45 | 11–11.99 | −0.49 | 0.43 | 5.53 | 5.95 | 6.69 | 8.30 | 10.85 | 14.78 | 17.83 | 20.47 | 25.57 | 29.97 |
| 344 | 13.02 | 12–12.99 | −0.40 | 0.39 | 6.18 | 6.64 | 7.45 | 9.14 | 11.71 | 15.42 | 18.13 | 20.37 | 24.43 | 27.72 |
| 375 | 14.54 | 13–13.99 | −0.33 | 0.40 | 6.67 | 7.20 | 8.13 | 10.09 | 13.06 | 17.32 | 20.40 | 22.92 | 27.45 | 31.06 |
| 261 | 14.82 | 14–14.99 | −0.31 | 0.39 | 6.92 | 7.47 | 8.42 | 10.41 | 13.40 | 17.64 | 20.65 | 23.09 | 27.45 | 30.86 |
| 13 | 13.30 | 15–15.99 | −0.21 | 0.39 | 6.16 | 6.68 | 7.58 | 9.45 | 12.21 | 16.00 | 18.63 | 20.72 | 24.33 | 27.10 |
| **Total** | 13.65 | | −0.33 | 0.41 | 6.13 | 6.63 | 7.51 | 9.36 | 12.19 | 16.29 | 19.26 | 21.71 | 26.13 | 29.67 |
| *Boys N = 1332* | | | | | | | | | | | | | | |
| 44 | 14.37 | 10–10.99 | −0.15 | 0.58 | 4.36 | 4.91 | 5.91 | 8.18 | 11.94 | 17.85 | 22.38 | 26.21 | 33.33 | 39.16 |
| 278 | 13.44 | 11–11.99 | −0.31 | 0.56 | 4.43 | 4.90 | 5.76 | 7.69 | 10.96 | 16.33 | 20.68 | 24.54 | 32.14 | 38.81 |
| 365 | 10.77 | 12–12.99 | −0.79 | 0.47 | 4.50 | 4.81 | 5.37 | 6.62 | 8.77 | 12.60 | 16.16 | 19.78 | 28.74 | 39.59 |
| 380 | 11.35 | 13–13.99 | −0.69 | 0.45 | 4.92 | 5.27 | 5.89 | 7.26 | 9.55 | 13.41 | 16.73 | 19.88 | 26.83 | 33.92 |
| 244 | 10.25 | 14–14.99 | −0.73 | 0.40 | 4.93 | 5.25 | 5.81 | 7.01 | 8.96 | 12.08 | 14.64 | 16.96 | 21.81 | 26.44 |
| 18 | 8.96 | 15–15.99 | −1.68 | 0.29 | 5.70 | 5.91 | 6.29 | 7.09 | 8.40 | 10.66 | 12.79 | 15.10 | 22.18 | 37.70 |
| **Total** | 11.49 | | −0.65 | 0.48 | 4.67 | 5.03 | 5.66 | 7.08 | 9.47 | 13.59 | 17.2 | 20.66 | 28.41 | 36.46 |
| *Girls N = 1328* | TSF + SSSF | | | | | | | | | | | | | |
| 36 | 25.43 | 10–10.99 | 0.18 | 0.33 | 12.59 | 13.74 | 15.67 | 19.41 | 24.38 | 30.35 | 34.02 | 36.72 | 41.02 | 44.03 |
| 295 | 26.87 | 11–11.99 | −0.30 | 0.39 | 12.64 | 13.63 | 15.37 | 18.98 | 24.39 | 31.98 | 37.35 | 41.68 | 49.34 | 55.32 |
| 344 | 27.84 | 12–12.99 | −0.19 | 0.36 | 13.62 | 14.70 | 16.55 | 20.32 | 25.76 | 33.03 | 37.92 | 41.75 | 48.26 | 53.15 |
| 375 | 30.98 | 13–13.99 | −0.03 | 0.36 | 14.92 | 16.20 | 18.41 | 22.82 | 29.01 | 36.95 | 42.11 | 46.03 | 52.53 | 57.26 |
| 261 | 31.28 | 14–14.99 | −0.02 | 0.34 | 15.50 | 16.79 | 19.00 | 23.38 | 29.46 | 37.16 | 42.10 | 45.85 | 52.00 | 56.44 |
| 13 | 29.05 | 15–15.99 | 0.32 | 0.34 | 13.86 | 15.29 | 17.68 | 22.23 | 28.14 | 35.03 | 39.16 | 42.15 | 46.83 | 50.05 |
| Total | 29.17 | | −0.1 | 0.37 | 13.83 | 15.01 | 17.04 | 21.17 | 27.07 | 34.81 | 39.95 | 43.91 | 50.57 | 55.49 |

**Table 2** (continued)

| *n* | Mean | Age | L | S | $P_3$ | $P_5$ | $P_{10}$ | $P_{25}$ | (M) $P_{50}$ | $P_{75}$ | $P_{85}$ | $P_{90}$ | $P_{95}$ | $P_{97}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Boys N = 1332* | | | | | | | | | | | | | | |
| 44 | 30.08 | 10–10.99 | 0.17 | 0.51 | 9.65 | 11.10 | 13.70 | 19.16 | 27.25 | 38.00 | 45.10 | 50.54 | 59.55 | 66.09 |
| 278 | 28.87 | 11–11.99 | 0.03 | 0.51 | 9.72 | 11.00 | 13.28 | 18.17 | 25.61 | 35.96 | 43.07 | 48.67 | 58.23 | 65.39 |
| 365 | 23.12 | 12–12.99 | −0.56 | 0.47 | 9.41 | 10.15 | 11.49 | 14.45 | 19.40 | 27.61 | 34.51 | 40.87 | 54.27 | 67.09 |
| 380 | 23.81 | 13–13.99 | −0.57 | 0.46 | 10.08 | 10.86 | 12.24 | 15.28 | 20.28 | 28.43 | 35.13 | 41.22 | 53.79 | 65.51 |
| 244 | 21.08 | 14–14.99 | −0.53 | 0.42 | 9.44 | 10.14 | 11.39 | 14.08 | 18.38 | 25.08 | 30.34 | 34.94 | 43.97 | 51.91 |
| 18 | 18.31 | 15–15.99 | −1.27 | 0.34 | 10.47 | 10.96 | 11.81 | 13.66 | 16.69 | 21.85 | 26.53 | 31.32 | 43.78 | 61.03 |
| **Total** | 24.30 | | −0.43 | 0.48 | 9.63 | 10.46 | 11.95 | 15.23 | 20.61 | 29.2 | 36.07 | 42.14 | 54.15 | 64.75 |

*M* median, *P* percentile, *L* Box–Cox transformation, *S* coefficient of variation.

*BMI* body mass index, *TSF* triceps skinfold, *SSSF* subscapular skinfold.

at pre-mature stage due to the pubertal peak and the percentage of pre-mature boys (who were less than 12 years old) in our study was higher than that of girls (57.5% compared with 18.7%) thus higher values of skinfold thickness measurements in boys than in girls could be understandable.

Median TSF and SSSF values were similar to a Chinese study [3]; however, they were much lower than a Colombian study [5]. Although these countries are considered as upper-middle-income, differences among those studies may be due to heterogeneity in ethnic distribution, statistical methodology or even software used to analyze data (LMS Chart Maker Pro vs. Stata).

The strengths of our study include the representative sample of adolescents aged 10–15 years in HCMC from the original study [7]. Also, our results establish reference TSF and SSSF values using the LMS method from a large, population-based sample of HCMC school children.

The limitations include the lack of national representation of Vietnamese adolescents, although, HCMC is the largest urban area in Vietnam consisting of ~10–12% of the country's population. This diversity supports the application of our results to the whole population. Also, the data was collected in 2004. But since then, Vietnam has undergone a nutrition transition and rapid socioeconomic development leading to an increase in overweight and obesity among adolescents. However, a 2013 study [2] showed the prevalence of overweight and obesity among adolescents in HCMC remained high and with a similar pattern (higher in males than in females) to 2004. These recent findings highlight the continued need to address dietary habits and physical activity among urban youth in Vietnam.

## Conclusions

Our results provide sex- and age-specific reference values for skinfold thickness from a sample of Vietnamese adolescents in HCMC. Since relationships with health outcomes and/or disease markers were not examined, the data should be considered as a reference for future studies and not a growth standard.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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