

Waist circumference and waist-to-height ratio in Han Chinese children living in Chongqing, south-west China

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Submitted 25 August 2009; Accepted 20 January 2010; First published online 18 March 2010

Abstract

Objective: To derive age- and sex-specific reference values for waist circumference (WC) and waist-to-height ratio (WHtR) for Han Chinese children and adolescents and to establish the prevalence of excess central adiposity in our study population. **Design:** Cross-sectional study of schoolchildren attending randomly selected primary and secondary schools in south-west China in October 2003 and April 2004. Anthropometry was measured using standard procedures. The LMS method was used to construct smoothed WC and WHtR percentile curves. Overweight and obesity were defined by the International Obesity Task Force (IOTF) criteria and the Working Group on Obesity in Children. Excess central adiposity fat was defined by previously published WC cut-points and a WHtR ≥ 0.5 .

Setting: Primary and secondary schools in Chongqing, south-west China.

Subjects: A total of 7326 (49.2% boys) Han Chinese students at 5–17 years old.

Results: On the basis of the IOTF criteria, 26.4% of boys were overweight or obese compared with 16.4% of girls ($P < 0.001$). WC cut-points identified 31% of boys and 28% of girls as having excess central adiposity, whereas using the WHtR criterion, 14.8% of boys and 5.6% of girls were identified. Young boys (5–12 years) had a significantly ($P < 0.001$) higher WHtR than girls.

Conclusions: We have constructed WC and WHtR percentile curves for Han Chinese children and adolescents living in Chongqing. Our measurements were based on a student population with a relatively high rate of overweight and obesity. These data will provide a point of reference for future studies measuring the prevalence of overweight and obesity in China.

Keywords
Central adiposity
Han Chinese
Waist circumference percentiles
Waist-to-height ratio

Over the past two decades the prevalence of childhood overweight and obesity has increased dramatically in large Chinese cities⁽¹⁾. In parallel, there has been an escalated incidence of the metabolic syndrome⁽²⁾, a clustering of cardiovascular risk factors including dyslipidaemia, hypertension and insulin resistance⁽³⁾. Excessive accumulation of adipose tissue in both central subcutaneous and visceral regions of children and adolescents has been associated with these metabolic abnormalities⁽⁴⁾. The recommended anthropometric measures that reflect central adiposity distribution in children include waist circumference (WC) and waist-to-height ratio (WHtR). Both measures are highly sensitive to upper body fat accumulation and predict adverse cardiovascular risk factors^(5,6).

Several studies have described ethnic differences in WC^(7–10) and there are recognised cut-points for WC for

both European and Asian adults⁽¹¹⁾. For children and adolescents, WC cut-points tend to be based on age- and sex-specific reference values. Age- and sex-related WC percentile values have been established in several countries including the United States, the United Kingdom and Australia^(7,10,12). WC percentile charts have been developed for children living in Hong Kong⁽¹³⁾ and Xinjiang Uygur Autonomous Region⁽¹⁴⁾, in north-west China. However, both percentile charts have limitations. The percentile charts for Hong Kong children do not differentiate between ethnicities and the Xinjiang autonomous region charts are based on limited numbers of children in each age group (median: seventy-nine; range: forty-seven to 131).

The WHtR has also been proposed as a measure of central adiposity and studies in adults and children have suggested a cut-point of 0.5 as a simple means of indicating

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whether the amount of central fat is excessive^(5,15). The WHtR cut-point has several advantages over WC cut-points as it is easy to calculate and it is not age and sex specific. WHtR has not been previously described in Han Chinese children.

Establishing normative ethnic-specific data are essential for early detection of excess central adiposity. The aim of the present study was to derive age- and sex-specific reference values for WC and WHtR in Han Chinese children and adolescents and to establish the prevalence of excess central adiposity in our study population.

Materials and methods

Participants

This is a school based, cross-sectional study that was conducted in the city of Chongqing, south-west China in October 2003 (primary schools) and in April 2004 (secondary schools). The total city population is approximately thirty-two million of which 4.4 million are primary- and secondary-school students (National Chinese Census 2006, personal communication (F.X.) with the Office of Primary and Middle School Health of Chongqing Education Committee). For the present study, 7326 (49.2% boys) Han Chinese students aged 5–17 years were recruited from fifteen primary schools and nine secondary schools from a potential of thirty-eight primary schools and eighteen secondary schools in Chongqing. School selection was undertaken by the Office of Primary and Middle School Health of Chongqing Education Committee and was based on randomly computer-generated numbering to represent both urban and city areas and to be representative of total school community. Two classes in each grade were selected in collaboration with the school principal based on timetables and operational needs. A written informed consent was obtained from ~99% of the participants or from their parents and the research protocol was approved by the Primary and Secondary School Physical Health Division of the Chongqing Education Committee.

Measurements

Anthropometric measurements included height, weight and WC. Height was measured without shoes to the nearest 0.5 cm by a standard stadiometer. Weight was measured to the nearest 0.5 kg on calibrated scales, wearing light clothing. WC was measured midway between the lowest rib and the superior border of the iliac crest with a non-elastic flexible tape and was recorded to the nearest centimetre. All anthropometric measurements were performed by trained health technicians. BMI was calculated as weight/height² (kg/m²) and WHtR by dividing the WC (cm) by height (cm). Overweight and obesity were defined by age- and sex-specific BMI cut-off points according to the International Obesity Task

Force (IOTF) criteria⁽¹⁶⁾ and Working Group on Obesity in Children (WGOC)⁽¹⁷⁾ for children aged 7 years and older. Excess central fat was defined by previously published WC standards based on ethnic Chinese living in Hong Kong^(18,19) and a WHtR ≥ 0.5 ⁽¹⁵⁾.

Statistical analysis

Data were analysed using the Statistical Package for the Social Sciences statistical software package version 15.0 for Windows (SPSS Inc., Chicago, IL, USA). After assessing the data distribution, sex differences in anthropometric data were assessed with the Student's *t* test. Association between age and WHtR was assessed using curve estimation. The χ^2 test was used as a measure of association between categorical variables. The LMS method⁽²⁰⁾ was used to construct smoothed percentile curves for WC using LMS ChartMaker Light⁽²¹⁾. The LMS method summarises the changing distribution by three curves representing the median (M), coefficient of variation (S) and skewness (L); the latter expressed as a Box–Cox power. Using penalised likelihood methods, the three curves are fitted as cubic splines by non-linear regression, and the extent of smoothing required is expressed in terms of smoothing parameters or equivalent degrees of freedom. Agreement between criteria for classifying overweight and obesity was assessed by the κ statistic.

Results

The anthropometric characteristics of the study population are shown in Table 1. Boys were generally taller than girls, except at 10 years of age when girls were on average 2.9 cm taller than boys ($P < 0.001$). Boys aged 6–10 years also had a significantly higher BMI ($P < 0.001$). However, after the age of 10 years sex difference in anthropometry were small. Overall, using IOTF criteria 26.4% of boys were overweight or obese compared with 16.4% of girls ($P < 0.001$) and using the WGOC criteria (for children ≥ 7 years) 29.7% of boys and 19.4% of girls ($P < 0.001$) were overweight or obese. The two classification criteria showed very good agreement ($\kappa = 0.88$, $P < 0.001$); 99.6% of children defined as overweight or obese using the IOTF criteria were also defined as overweight and obese using the WGOC criteria.

Smoothed WC and WHtR percentile curves for boys and girls are shown in Figs 1 and 2. The percentile values are shown in Tables 2 and 3 (WC and WHtR). WC increased with age in both sexes until 15 years and then plateaued. Boys had a higher WC than girls. The mean WHtR was also higher in boys than girls until the age of 12 years ($P < 0.001$). In adolescents, the only statistical difference that was observed between sexes was at 15 years when girls had a higher WHtR than boys, 0.43 compared with 0.42 ($P < 0.001$). In contrast to the association between age and WC, the association between age and WHtR was flatter. In boys this association was negative, age explaining 2.5% of the variance ($R^2 = -0.025$,

Table 1 Anthropometric measures, prevalence of overweight and obesity, and excess central adiposity

| Age (years)† | n | Height (cm) | | Weight (kg) | | BMI (kg/m ²) | | Overweight | | Obese | | Excess central adiposity (WC)* | | Excess central adiposity (WHtR ≥ 0.5) | |
|--------------|------|-------------|------|-------------|------|--------------------------|-----|------------|------|-------|------|--------------------------------|------|---------------------------------------|------|
| | | Mean | SD | Mean | SD | Mean | SD | n | % | n | % | n | % | n | % |
| Boys | | | | | | | | | | | | | | | |
| 5 | 96 | 122.1 | 5.2 | 25.7 | 4.5 | 17.1 | 2.1 | 17 | 17.7 | 10 | 10.4 | ‡ | | 13 | 13.5 |
| 6 | 217 | 125.7 | 5.6 | 27.7 | 4.1 | 17.4 | 2.2 | 61 | 28.1 | 21 | 9.7 | 92 | 42.4 | 42 | 19.4 |
| 7 | 231 | 130.1 | 6.7 | 30.2 | 6.3 | 17.7 | 2.6 | 59 | 25.5 | 21 | 9.1 | 104 | 45.0 | 39 | 16.9 |
| 8 | 311 | 132.2 | 8.9 | 31.2 | 7.6 | 17.6 | 2.6 | 65 | 20.9 | 21 | 6.8 | 102 | 32.8 | 49 | 15.8 |
| 9 | 342 | 136.2 | 10.2 | 34.3 | 9.7 | 18.1 | 3.1 | 70 | 20.5 | 28 | 8.2 | 113 | 33.0 | 59 | 17.3 |
| 10 | 328 | 141.3 | 10.0 | 38.1 | 10.5 | 18.8 | 3.1 | 76 | 23.2 | 23 | 7.0 | 107 | 32.6 | 60 | 18.3 |
| 11 | 347 | 149.3 | 10.9 | 43.3 | 11.0 | 19.2 | 3.0 | 73 | 21.0 | 14 | 4.0 | 103 | 29.7 | 49 | 14.1 |
| 12 | 353 | 155.3 | 11.9 | 48.9 | 14.0 | 19.9 | 3.8 | 71 | 20.1 | 22 | 6.2 | 105 | 29.7 | 56 | 15.9 |
| 13 | 352 | 160.4 | 11.3 | 52.2 | 13.6 | 20.0 | 3.6 | 54 | 15.3 | 16 | 4.5 | 79 | 22.4 | 35 | 9.9 |
| 14 | 274 | 166.7 | 8.5 | 60.1 | 13.4 | 21.5 | 3.9 | 53 | 19.3 | 25 | 9.1 | 88 | 32.1 | 46 | 16.8 |
| 15 | 295 | 170.6 | 6.0 | 63.1 | 11.6 | 21.6 | 3.6 | 54 | 18.3 | 14 | 4.7 | 91 | 30.9 | 31 | 10.5 |
| 16 | 319 | 170.7 | 5.9 | 63.4 | 11.7 | 21.7 | 3.6 | 39 | 12.2 | 15 | 4.7 | 90 | 28.2 | 35 | 11.0 |
| 17 | 136 | 172.1 | 5.8 | 64.7 | 11.2 | 21.8 | 3.5 | 23 | 16.9 | 6 | 4.4 | 37 | 27.2 | 17 | 12.5 |
| Total | 3603 | 150.0 | 18.5 | 45.6 | 17.0 | 19.51 | 3.6 | 715 | 19.9 | 236 | 6.6 | 1112 | 30.9 | 531 | 14.7 |
| Girls | | | | | | | | | | | | | | | |
| 5 | 147 | 120.4 | 4.8 | 24.4 | 3.5 | 16.8 | 1.9 | 35 | 23.8 | 11 | 7.5 | ‡ | | 10 | 6.8 |
| 6 | 226 | 123.4 | 5.3 | 25.3 | 3.4 | 16.5 | 1.5 | 47 | 20.8 | 5 | 2.2 | 55 | 24.3 | 9 | 4.0 |
| 7 | 254 | 128.3 | 7.5 | 28.0 | 5.7 | 16.9 | 2.2 | 41 | 16.1 | 10 | 3.9 | 68 | 26.8 | 15 | 5.9 |
| 8 | 296 | 131.1 | 9.2 | 29.6 | 7.0 | 17.0 | 2.3 | 40 | 13.5 | 13 | 4.4 | 64 | 21.6 | 16 | 5.4 |
| 9 | 312 | 136.1 | 9.9 | 32.5 | 8.5 | 17.3 | 2.8 | 40 | 12.8 | 9 | 2.9 | 67 | 21.5 | 17 | 5.5 |
| 10 | 299 | 144.2 | 9.9 | 37.6 | 9.2 | 17.9 | 2.8 | 42 | 14.0 | 7 | 2.3 | 74 | 42.7 | 7 | 2.3 |
| 11 | 359 | 149.2 | 9.1 | 42.3 | 9.7 | 18.8 | 2.8 | 55 | 15.3 | 4 | 1.1 | 78 | 21.7 | 14 | 3.9 |
| 12 | 351 | 152.0 | 8.4 | 45.7 | 10.0 | 19.6 | 3.1 | 58 | 16.5 | 6 | 1.7 | 94 | 26.8 | 26 | 7.4 |
| 13 | 433 | 156.0 | 7.4 | 49.8 | 10.0 | 20.4 | 3.4 | 59 | 13.6 | 12 | 2.8 | 116 | 26.8 | 25 | 5.8 |
| 14 | 336 | 158.2 | 6.1 | 52.9 | 8.1 | 21.1 | 2.7 | 42 | 12.5 | 4 | 1.2 | 137 | 40.8 | 26 | 7.7 |
| 15 | 313 | 158.7 | 5.9 | 53.1 | 7.5 | 21.1 | 2.5 | 32 | 10.2 | 2 | 0.6 | 121 | 38.7 | 23 | 7.3 |
| 16 | 284 | 159.9 | 5.2 | 53.4 | 7.3 | 20.9 | 2.5 | 25 | 8.8 | 1 | 0.4 | 104 | 36.6 | 15 | 5.3 |
| 17 | 113 | 159.7 | 5.2 | 54.4 | 7.1 | 21.3 | 5.3 | 12 | 10.6 | 0 | 0.0 | 35 | 31.0 | 5 | 4.4 |
| Total | 3723 | 145.9 | 15.1 | 41.6 | 13.2 | 19.0 | 3.2 | 528 | 14.2 | 84 | 2.3 | 1013 | 27.2 | 208 | 5.6 |

WC, waist circumference; WHtR, waist-to-height ratio.

*Age- and sex-specific cut-points based on ethnic Chinese children living in Hong Kong^(18,19).

†Age is in whole years, e.g. 5 years = 5–5.99 years.

‡No cut-point available for 5-year-old children.

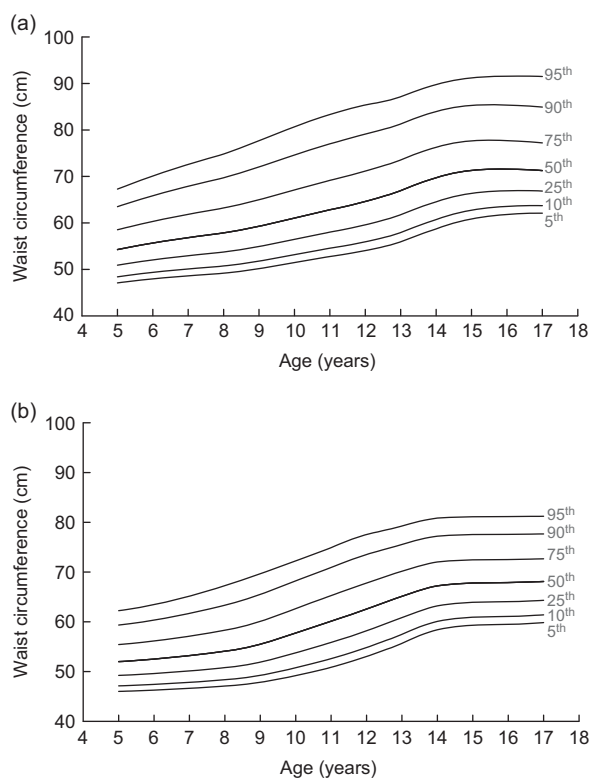


Fig. 1 Smoothed waist circumference curves for the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentile for (a) boys and (b) girls

$P < 0.001$). The relation between age and WHtR in girls was best described as quadratic ($R^2 = 0.021$, $P < 0.001$; Fig. 2).

The age- and sex-specific WC cut-points based on ethnic Chinese living in Hong Kong were approximately equivalent to the 70th percentile of our population; 31.7% of boys and 28.3% of girls were identified as having excess central adiposity (Table 1). Using these WC cut-points, excess central adiposity was particularly prevalent in 6- and 7-year-old boys (43.8%) and 14- to 17-year-old girls (36.8%). In comparison the WHtR cut-point of 0.5 identified 14.8% of boys and 10.8% of girls as having excess central adiposity (Table 1). The highest WHtR was observed (0.71) in a 14-year-old boy who had a BMI of 37.4 kg/m^2 , 2.3% of children (3.1% boys, 1.1% girls) had a WHtR > 0.55 and 0.7% (1.1% boys, 0.3% girls) had a WHtR > 0.6 .

Discussion

We constructed WC and WHtR percentiles for Han Chinese children, aged 5 to 17 years, living in the city of Chongqing in 2003 and 2004. Our WC percentiles are similar to those published on Han Chinese children living in Xingjiang Uygur Autonomous Region⁽¹⁴⁾ but higher than those published on children living in Hong Kong in

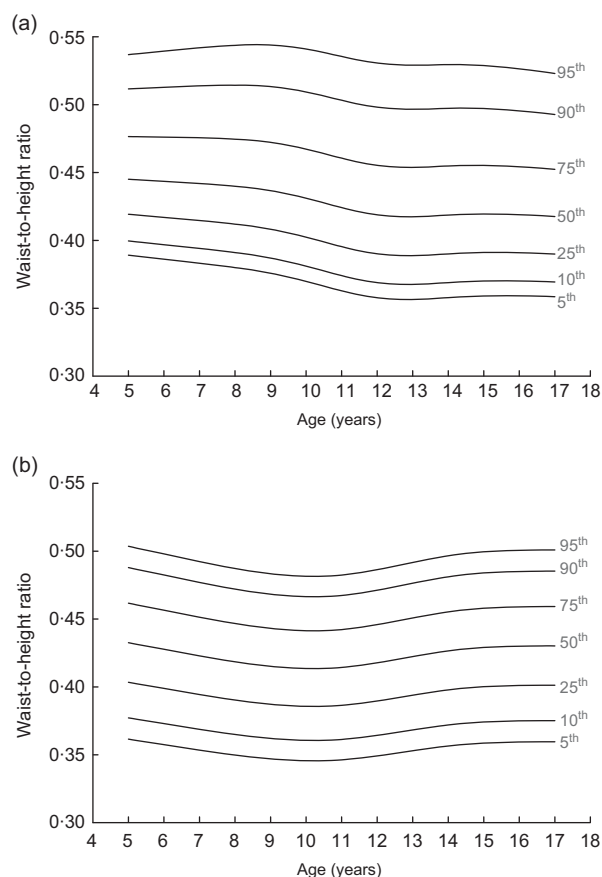


Fig. 2 Smoothed waist-to-height ratio curves for the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentile for (a) boys and (b) girls

2005 and 2006 (Table 4)⁽¹³⁾. At the 90th percentile the differences ranged from 2.4 to 7.2 cm in boys and from 1.8 to 6.9 cm in girls and were greater in both sexes during early adolescence (13–15 years) compared with younger children (6–9 years).

The difference in WC between Han Chinese living in China and children living in Hong Kong can be explained, in part, by the different rates of overweight and obesity as defined by the IOTF criteria. In our cohort, 26% of boys and 16% of girls were overweight or obese compared with 21% and 14% of boys and girls in the Hong Kong cohort. Similar rates of overweight and obesity to ours have been reported in Han adolescents (12–14 years old) living in Beijing; 24% of boys and 18% of girls were overweight or obese⁽²⁾. These rates are considerably higher than the 2002 Chinese national figures of 6% for children aged 7–17 years⁽²²⁾. The disparity between different rates of overweight and obesity in rural China and large cities has been well documented⁽²²⁾. The WC percentile data in our study population are likely to represent the current trend in overweight and obesity in Chinese cities.

Ethnicity is also a potential confounder in explaining the difference in WC and WHtR percentiles. It is estimated

Table 2 Waist circumference (cm) percentiles for boys and girls

| Age (years)* | <i>n</i> | 5th | 10th | 25th | 50th | 75th | 90th | 95th |
|--------------|----------|------|------|------|------|------|------|------|
| Boys | | | | | | | | |
| 5 | 96 | 47.1 | 48.4 | 50.9 | 54.3 | 58.5 | 63.5 | 67.3 |
| 6 | 217 | 48.0 | 49.4 | 52.0 | 55.7 | 60.3 | 65.8 | 70.1 |
| 7 | 231 | 48.7 | 50.1 | 53.0 | 56.9 | 61.9 | 67.9 | 72.6 |
| 8 | 311 | 49.2 | 50.8 | 53.8 | 57.9 | 63.2 | 69.7 | 74.8 |
| 9 | 342 | 50.2 | 51.8 | 54.9 | 59.3 | 65.0 | 72.0 | 77.7 |
| 10 | 328 | 51.5 | 53.2 | 56.5 | 61.0 | 67.1 | 74.6 | 80.7 |
| 11 | 347 | 52.8 | 54.6 | 58.0 | 62.8 | 69.2 | 77.0 | 83.3 |
| 12 | 353 | 54.1 | 56.0 | 59.6 | 64.6 | 71.2 | 79.1 | 85.4 |
| 13 | 352 | 55.9 | 57.9 | 61.7 | 66.9 | 73.5 | 81.2 | 87.1 |
| 14 | 274 | 58.7 | 60.7 | 64.5 | 69.7 | 76.3 | 84.0 | 89.8 |
| 15 | 295 | 60.9 | 62.8 | 66.4 | 71.3 | 77.7 | 85.3 | 91.2 |
| 16 | 319 | 61.8 | 63.6 | 66.9 | 71.6 | 77.7 | 85.4 | 91.6 |
| 17 | 136 | 62.1 | 63.7 | 66.9 | 71.3 | 77.2 | 84.9 | 91.5 |
| Girls | | | | | | | | |
| 5 | 147 | 46.2 | 47.3 | 49.3 | 51.9 | 55.1 | 58.8 | 61.5 |
| 6 | 226 | 46.2 | 47.4 | 49.6 | 52.5 | 56.1 | 60.2 | 63.3 |
| 7 | 254 | 46.5 | 47.8 | 50.1 | 53.3 | 57.3 | 62.0 | 65.6 |
| 8 | 296 | 47.0 | 48.3 | 50.8 | 54.3 | 58.6 | 63.8 | 67.8 |
| 9 | 312 | 47.9 | 49.3 | 52.0 | 55.7 | 60.3 | 65.8 | 69.9 |
| 10 | 299 | 49.2 | 50.8 | 53.8 | 57.7 | 62.6 | 68.1 | 72.1 |
| 11 | 359 | 51.1 | 52.8 | 55.9 | 60.1 | 65.1 | 70.6 | 74.6 |
| 12 | 351 | 53.3 | 55.1 | 58.4 | 62.6 | 67.7 | 73.3 | 77.1 |
| 13 | 433 | 55.7 | 57.5 | 60.8 | 65.1 | 70.2 | 75.7 | 79.4 |
| 14 | 336 | 57.9 | 59.7 | 62.9 | 67.1 | 72.1 | 77.5 | 81.2 |
| 15 | 313 | 59.2 | 60.8 | 63.9 | 67.9 | 72.7 | 78.0 | 81.6 |
| 16 | 284 | 59.5 | 61.1 | 64.0 | 67.8 | 72.4 | 77.3 | 80.8 |
| 17 | 113 | 59.7 | 61.2 | 63.9 | 67.5 | 71.8 | 76.4 | 79.8 |

*Age is in whole years, e.g. 5 years = 5–5.99 years.

Table 3 Waist-to-height ratio percentiles for boys and girls

| Age (years)* | <i>n</i> | 5th | 10th | 25th | 50th | 75th | 90th | 95th |
|--------------|----------|------|------|------|------|------|------|------|
| Boys | | | | | | | | |
| 5 | 96 | 0.39 | 0.40 | 0.42 | 0.45 | 0.48 | 0.51 | 0.54 |
| 6 | 217 | 0.39 | 0.40 | 0.42 | 0.44 | 0.48 | 0.51 | 0.54 |
| 7 | 231 | 0.38 | 0.39 | 0.41 | 0.44 | 0.48 | 0.51 | 0.54 |
| 8 | 311 | 0.38 | 0.39 | 0.41 | 0.44 | 0.47 | 0.51 | 0.54 |
| 9 | 342 | 0.38 | 0.39 | 0.41 | 0.44 | 0.47 | 0.51 | 0.54 |
| 10 | 328 | 0.37 | 0.38 | 0.40 | 0.43 | 0.47 | 0.51 | 0.54 |
| 11 | 347 | 0.36 | 0.37 | 0.40 | 0.42 | 0.46 | 0.50 | 0.54 |
| 12 | 353 | 0.36 | 0.37 | 0.39 | 0.42 | 0.46 | 0.50 | 0.53 |
| 13 | 352 | 0.36 | 0.37 | 0.39 | 0.42 | 0.45 | 0.50 | 0.53 |
| 14 | 274 | 0.36 | 0.37 | 0.39 | 0.42 | 0.45 | 0.50 | 0.53 |
| 15 | 295 | 0.36 | 0.37 | 0.39 | 0.42 | 0.46 | 0.50 | 0.53 |
| 16 | 319 | 0.36 | 0.37 | 0.39 | 0.42 | 0.45 | 0.50 | 0.53 |
| 17 | 136 | 0.36 | 0.37 | 0.39 | 0.42 | 0.45 | 0.49 | 0.52 |
| Girls | | | | | | | | |
| 5 | 147 | 0.36 | 0.38 | 0.40 | 0.43 | 0.46 | 0.49 | 0.50 |
| 6 | 226 | 0.36 | 0.37 | 0.40 | 0.43 | 0.46 | 0.48 | 0.50 |
| 7 | 254 | 0.35 | 0.37 | 0.39 | 0.42 | 0.45 | 0.48 | 0.49 |
| 8 | 296 | 0.35 | 0.37 | 0.39 | 0.42 | 0.45 | 0.47 | 0.49 |
| 9 | 312 | 0.35 | 0.36 | 0.39 | 0.42 | 0.44 | 0.47 | 0.48 |
| 10 | 299 | 0.35 | 0.36 | 0.39 | 0.41 | 0.44 | 0.47 | 0.48 |
| 11 | 359 | 0.35 | 0.36 | 0.39 | 0.41 | 0.44 | 0.47 | 0.48 |
| 12 | 351 | 0.35 | 0.36 | 0.39 | 0.42 | 0.45 | 0.47 | 0.49 |
| 13 | 433 | 0.35 | 0.37 | 0.39 | 0.42 | 0.45 | 0.48 | 0.49 |
| 14 | 336 | 0.36 | 0.37 | 0.40 | 0.43 | 0.46 | 0.48 | 0.50 |
| 15 | 313 | 0.36 | 0.37 | 0.40 | 0.43 | 0.46 | 0.48 | 0.50 |
| 16 | 284 | 0.36 | 0.37 | 0.40 | 0.43 | 0.46 | 0.49 | 0.50 |
| 17 | 113 | 0.36 | 0.38 | 0.40 | 0.43 | 0.46 | 0.49 | 0.50 |

*Age is in whole years. e.g. 5 years = 5–5.99 years.

that ~95% of Hong Kong residents are ethnic Chinese, with no differentiation between Chinese ethnicities⁽²³⁾. Anthropometric differences in children of different Chinese ethnicities have been demonstrated⁽¹⁴⁾. Measurement error or sample bias is unlikely; both studies used the same technique to measure WC and the participants in both studies are representative of the population studied.

Similar to findings in a study on Australian children⁽²⁴⁾, WC identified a greater number of children and adolescents as having excess central adiposity compared with being classified as overweight or obese using BMI criteria. These results are concerning and have public health implications. Excessive accumulation of central adipose tissue has been associated with cardiovascular risk factors^(4,5). Of particular concern was the high proportion (44%) of young boys with increased WC. While the explanation for the difference between younger and older children is not clear, we speculate that it may represent the advancing wave of the obesity epidemic for boys in China.

We also described the association between age and WHtR in Han children and adolescents. In some populations WHtR has been shown to more readily identify adolescents with adverse cardiovascular risk factors compared with WC and BMI^(6,25–27). The WHtR is also easy to calculate and is considered to be independent of age and sex. However, in our study population we observed a clinical and statistically significant sex difference in WHtR in young children (5–11 years). A similar trend was observed in children living in Hong Kong⁽²⁸⁾.

Table 4 Waist circumference (cm) corresponding to the 90th percentile from three different populations

| Age (years) | Han living in Chongqing | Han living in Xingjiang Uyger Autonomous Region ⁽¹⁴⁾ | Ethnic Chinese living in Hong Kong ⁽¹³⁾ |
|--------------|-------------------------|---|--|
| Boys | | | |
| 5 | 63.5 | | |
| 6 | 65.8 | | 63.4 |
| 7 | 67.9 | 65.5 | 65.0 |
| 8 | 69.7 | 67.4 | 66.6 |
| 9 | 72.0 | 70.2 | 68.5 |
| 10 | 74.6 | 73.1 | 70.6 |
| 11 | 77.0 | 75.8 | 72.5 |
| 12 | 79.1 | 78.3 | 74.0 |
| 13 | 81.2 | 80.4 | 75.3 |
| 14 | 84.0 | 82.3 | 76.8 |
| 15 | 85.3 | 83.9 | 78.3 |
| 16 | 85.4 | 85.5 | 79.6 |
| 17 | 84.9 | 87.0 | 80.7 |
| Girls | | | |
| 5 | 58.8 | | |
| 6 | 60.2 | | 58.4 |
| 7 | 62.0 | 60.7 | 60.0 |
| 8 | 63.8 | 62.1 | 61.6 |
| 9 | 65.8 | 63.8 | 63.4 |
| 10 | 68.1 | 66.0 | 65.1 |
| 11 | 70.6 | 68.5 | 66.9 |
| 12 | 73.3 | 71.4 | 68.4 |
| 13 | 75.7 | 74.4 | 69.7 |
| 14 | 77.5 | 76.7 | 70.6 |
| 15 | 78.0 | 77.9 | 71.3 |
| 16 | 77.3 | 78.0 | 71.8 |
| 17 | 76.4 | 77.3 | 72.2 |

WHtR sex differences are likely to be a result of the differences in overall adiposity; 30% of boys aged 5–11 years were overweight or obese compared with 19% for girls.

To date, no cut-points for WHtR have been validated against metabolic outcomes for Han Chinese children and adolescents. In the absence of metabolic markers we defined excess central adiposity as a WHtR ≥ 0.5 . Fewer children were identified as having excess central adiposity using a WHtR ≥ 0.5 compared with WC cut-points, 10.2% and 30.0%, respectively. Almost all students (99.5%) with a WHtR ≥ 0.5 were identified as having excess central adiposity defined by WC cut-points. We speculate that a WHtR cut-point of 0.5 may identify those children at greatest metabolic risk. However, a limitation of our study is that metabolic markers were not measured and further studies are required to further investigate the use of both the WC cut-points and WHtR in predicting cardiovascular risk in Han Chinese children.

In conclusion, we have constructed WC and WHtR percentile curves for Han Chinese children and adolescents aged 5–17 years living in Chongqing. Our measurements were based on a student population with a relatively high rate of overweight and obesity. Using IOTF criteria ~ 1 in 4 boys and 1 in 6 girls were overweight or obese. These data will provide a point of reference for future studies measuring the prevalence of overweight and obesity in China.

Acknowledgements

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. The authors thank members of Students' Health and Fitness Department of Chongqing Education Committee for supporting this study. The authors would also thank the trained health technicians from the School Students Health Examination Centre in Chongqing YuZhong district and ShaPingBa district for measuring the children. S.P.G. is supported by a NHMRC Australian Clinical Research Fellowship no. 457225. F.X. participated in all aspects of the study, including design, ethics submission, recruiting, data analysis and interpretation, and preparation of the paper. S.P.G. and C.T.C. participated in the concept, data analysis and interpretation, and preparation of the paper. C.B. assisted with data analysis, interpretation and preparation of the paper. Y.Z., C.-L.L., Q.W. and D.-G.W. supervised the study implementation including recruitment, anthropometric measurements and reviewed the paper. Y.-H.L. and S.-Q.L. participated in recruitment, anthropometric measurements and data management. There is no conflict of evidence to disclose.

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