Original Article

# Prevalence of Overweight and Obesity in Chinese Preschoolers in Singapore

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## Abstract

**Introduction:** This study examines the prevalence of overweight and obesity in 6- to 72-month-old Chinese preschoolers in Singapore using 3 references. **Materials and Methods:** This was a population-based cross-sectional study of 3009 Chinese preschoolers aged 6 to 72 months from southwestern and western parts of Singapore. Overweight and obesity were defined by using the Center for Disease Control (CDC) (85th and 95th percentile, respectively), the International Obesity Task Force (IOTF) and the local National Health Group Polyclinics (NHGP), Singapore (90th and 97th percentile, respectively) references. **Results:** The prevalence of overweight and obesity in 24 to 72 months old Chinese children were 8.1% and 7.1% (the CDC reference), 7.6% and 3.9% (the IOTF reference) and 7.5% and 5.3% (the local reference [NHGP]) respectively. For preschoolers aged 6 to 72 months, the prevalence of overweight and obesity was 7.0% and 5.3%, respectively, using the local reference. An increasing trend in the prevalence of obesity with increasing age was seen in both genders, using the CDC and IOTF references ($P \leq 0.001$ and 0.001, respectively). The boys were more likely to be obese than the girls using the CDC reference (OR = 1.42, 95% CI, 1.02 to 1.97, $P$ = 0.03). **Conclusion:** Our study showed a lower prevalence of overweight and obesity among Chinese preschoolers in Singapore when compared to other countries like the United States, Italy, Chile using the CDC and/or IOTF references. The CDC reference overestimated whereas the IOTF reference underestimated the prevalence of overweight and obesity for our population when compared to using the local NHGP reference.

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Key words: CDC, Cross-sectional, IOTF, Population-based

## Introduction

The increasing prevalence of childhood overweight and obesity[1-3] and its associated adverse health outcomes have become an important health issue. Childhood obesity can persist into adulthood[4] and increases the risk of cardiovascular metabolic diseases,[5,6] giving rise to an increased healthcare burden. In Singapore, the prevalence of obesity for adults aged 18 to 69 years was 5.7%.[7] The prevalence of obesity for preschool children in Singapore has not been reported whereas the prevalence of obesity in preschool children in several other countries have been reported.[8-10] Therefore, the magnitude of childhood overweight and obesity in Singapore is still unclear, and

this has limited the comparison of obesity prevalence among local preschool children with other countries. This information can also provide impetus for the development of effective prevention strategies for the local childhood overweight and obesity trend.

Defining childhood obesity is not as straight forward as for the adults. Unlike adults, the body mass index (BMI) in a child changes with increasing age. The BMI decreases to a nadir at about the age of 4 to 6 years, and then gradually increases again, continuing to adulthood level at the end of adolescence.[11,12] Adult overweight and obesity are defined as BMI $25 \, kg/m^2$ and BMI $30 \, kg/m^2$ respectively. For children,

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the definitions of overweight and obesity are unclear and varied, as the cut-off values used are not defined by the epidemiological studies of cardiometabolic risk, but are arbitrarily chosen.[13]

The aim of this study was to determine and compare the prevalence of obesity in Singapore Chinese preschool children aged 6 to 72 months.

## Materials and Methods

### Study Design and Study Population

"STARS" (The STrabismus, Amblyopia and Refractive error in Singapore Chinese children) is a population-based study of Chinese children aged 6 to 72 months, residing in government apartments in southwestern and western parts of Singapore.[14,15] The detailed study design has been published in another study.[14,15]

A total of 5648 children were recruited and 3009 children (response rate = 72.3%) attended at one of 2 examination places (the Singapore National Eye Centre or the Jurong Medical Centre, Singapore). This study was conducted from May 2006 to November 2008, and ethics approval was obtained from the Institution Review Board (IRB) from Singapore National Eye Centre and Domain Specific Review Board (DSRB) from National Health Group.

### Anthropometric Measurements

Two trained members of the research team were assigned for anthropometric measurements. Weight was measured in kilograms (kg) to the nearest one decimal point, and height was measured in centimeters (cm) to nearest one decimal point. Each child was measured with light clothing without shoes, heavy objects inside the pockets or hair accessories. For children who were more than 24 months old, a stadiometre (Seca model 220, Hamburg, Germany) was used to measure the standing height and weight. Children were asked to stand in the middle of the scale with both arms relaxed and hanging down by the side of the body with both feet slightly apart. When measuring height, children were asked to stand straight and look ahead. For children who were less than 24 months old or unable or unwilling to stand on the scale, the child was measured in the parent's arms. The child's weight was obtained by subtracting the combined weight of parent and child and the weight of parent alone. The length was obtained by using the Kiddmetre (Raven equipment Ltd, Castlemead, UK) which is a recumbent length board for infant with a fixed head board and movable footboard. The Body mass index (BMI) was calculated using weight in kilograms divided by height in meters squared ($kg/m^2$).

### Definition of Obesity

We compare the prevalence of overweight and obesity by (i) the age and gender specific BMI-for-age percentiles by (i) the Center for Disease Control (CDC),[16] (ii) the International Obesity Task Force (IOTF),[17] and (iii) our proposed cut-offs, using the local age and gender specific National Health Group Polyclinics (NHGP) reference.[18]

Although the CDC uses the terms "overweight and obese" ($\geq$95th percentile) and "at-risk-for-overweight" (85th to <95th percentile),[16] the National Heart, Lung, and Blood Institute defined overweight in adolescents as 85th to <95th percentile.[19] Thus, we used the terms "overweight" instead of "at-risk-for-overweight" and "obesity" instead of "overweight" to make a comparison with the other 2 different cut-offs (the IOTF and the local age and gender specific NHGP BMI references). The IOTF attempted to develop biological meaningful cut-offs by extrapolating risk from adult experience to children, using the BMI data from children of 6 countries and then produced percentile lines that intersect the adult cut-off points of a BMI of 25 $kg/m^2$ and 30 $kg/m^2$ at the age of 18 years.[17]

Our local (NHGP) reference include 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentile curves for children aged 6 to 72 months.[18] We proposed 90th and 97th percentile as "overweight" and "obesity" in our local (NHGP) reference. Some countries such as France also use the same definition based on their population BMI for age chart.[20] This definition may be closer to the IOTF cut-off lines which defines overweight as approximately 91% or greater and obesity as approximately 99% or greater.[21]

### Statistical Analysis

Age and gender specific prevalence rates were computed with confidence intervals. The $\chi^2$-trend test was used to assess trends in the prevalence of overweight and obesity. The mean values were compared using t-tests. Statistical significance was set at 0.05 and SPSS (version 17.0, SPSS Inc., Chicago, USA) software was used to compute all the analyses.

## Results

There were no statistically significant differences in the percentages of participants and non-participants across age groups ($P = 0.98$) and gender ($P = 0.67$). Of the total 3009 participants, 2964 children aged 6 to 72 months were included in the analysis due to missing information for 43 children and 2 extreme values of BMI above 90 $kg/m^2$.

Table 1 shows the height, weight and BMI of the participants in our study. There were similar participation percentages of boys (52.2%) and girls (47.8%). The boys were generally heavier, taller and had higher BMI compared to girls.

Table 1. Height, Weight and Body Mass Index (BMI) of participating Chinese Preschool Children in Singapore by Gender

| Characteristics | All n (%) | Boys n (%) | Girls n (%) | P value* |
|---|---|---|---|---|
| Gender | 2964 (100.0) | 1548 (52.2) | 1416 (47.8) | |
| Weight (kg) | | | | <0.001 |
| Mean (SD) | 14.8 (4.3) | 15.2 (4.3) | 14.5 (4.2) | |
| Height (cm) | | | | 0.01 |
| Mean (SD) | 96.0 (13.2) | 96.6 (13.1) | 95.4 (13.2) | |
| Body Mass Index (BMI) (kg/m$^2$) | | | | <0.001 |
| Mean (SD) | 15.9 (2.0) | 16.0 (1.9) | 15.7 (2.0) | |
| Age groups (months) | | | | 0.07 |
| 6.0 – 11.9 | 181 (6.1) | 85 (5.5) | 96 (6.8) | |
| 12.0 – 23.9 | 527 (17.8) | 304 (19.6) | 223 (15.7) | |
| 24.0 – 35.9 | 509 (17.2) | 257 (16.6) | 252 (17.8) | |
| 36.0 – 47.9 | 571 (19.3) | 291 (18.8) | 280 (19.8) | |
| 48.0 – 59.9 | 601 (20.3) | 321 (20.7) | 280 (19.8) | |
| 60.0 – 72.0 | 575 (19.4) | 290 (18.7) | 285 (20.1) | |

*P value based on chi-square (categorical) and independent sample t-test (continuous).

Table 2 shows the prevalence of overweight and obesity in children aged 24 to 72 months by age groups and gender according to the 3 references. The prevalence of overweight and obesity in Chinese children aged 24 to 72 months, using the CDC reference, was higher (8.1% and 7.1%, respectively) than the IOTF reference (7.6% and 3.9%, respectively) and the local (NHGP) reference (7.5% and 5.3%, respectively). For children aged 6 to 72 months, the prevalence of overweight and obesity was 7.0% (95% CI, 6.1 to 7.9) and 5.3% (95% CI, 4.5 to 6.1), respectively, using the local (NHGP) reference. Based on the CDC and IOTF references, the prevalence of obesity increased with increasing age for both genders, although the age effect on overweight could only be seen for girls in the prevalence analysis performed by age groups and gender (data not shown). However, there was no trend of prevalence of overweight and obesity with increasing age for both genders, using the local (NHGP) reference.

Figure 1 compares the prevalence of overweight and obesity in Chinese preschool children aged 24 to 72 months in Singapore using the 3 references. In this analysis, we excluded children aged <24 months as the CDC and IOTF references only start from 24 months onwards. Based on the CDC reference, the boys were more likely to be obese than the girls (OR = 1.42, 95% CI, 1.02 to 1.97, P = 0.03). The other 2 references did not show statistically significant differences in the prevalence of overweight and obesity between genders [P = 0.10 and P = 0.13, using the IOTF reference and P = 0.39 and P = 0.94, using the local (NHGP) reference, respectively].

## Discussion

The prevalence of overweight and obesity in Chinese preschool children aged 24 to 72 months in Singapore were 8.1% and 7.1% (the CDC reference), 7.6% and 3.9% (the IOTF reference) and 7.5% and 5.3% [the local (NHGP) reference], respectively. Using the local (NHGP) reference which included the range of 0 to 23 months of age, the prevalence of overweight and obesity were 7.0% and 5.3%, respectively, in our preschool children aged 6 to 72 months old. Our study showed that the prevalence of overweight and obesity in Singapore Chinese preschool children were lower when compared to other countries like the United States, Chile, Italy, Jordan and Canada using the same reference for each individual study.[10,22-26]

In our study, the prevalence of overweight and obesity, using the CDC reference, was the highest compared to that of the IOTF and local (NHGP) references. Other studies, comparing different references, also showed a higher prevalence of obesity using the CDC reference, compared to the IOTF reference.[10,26,27] This is likely due to the lower percentile lines (95th and 85th) used for defining obesity and overweight, compared to the IOTF definition (99th and 91st). Therefore, using the appropriate reference to determine the prevalence of obesity is important for epidemiological studies. The WHO expert consultation, held in Singapore (2002), also emphasized on establishing appropriate BMI cut-off point for Asian populations because of different body compositions among different ethnic groups.[28] Our study provides prevalence estimations based on CDC, IOTF and local references, which can be used for comparisons across the local population. Our proposed cut-offs for overweight

Table 2. Frequency Distribution and Prevalence of Overweight and Obesity in Chinese Preschool children Aged 6 to 72 months in Singapore by Age Groups and Gender*

| | N | Overweight (%) | | | | | | Obesity (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CDC (85th to <95th percentile) | | IOTF (corresponding to a BMI of 25 kg/m² at age of 18) | | NHGP (90th to <97th percentile) | | CDC (≥95th percentile) | | IOTF (corresponding to a BMI of 30 kg/m² at age of 18) | | NHGP (≥97th percentile) | |
| | | n | % (95%CI) | n | % (95%CI) | n | % (95%CI) | n | % (95%CI) | n | % (95%CI) | n | % (95%CI) |
| Overall (boys and girls) | | 183 | 8.1 (7.0–9.2) | 171 | 7.6 (6.5–8.7) | 207 | 7.5 (6.4–8.6) | 159 | 7.1 (6.0–8.1) | 88 | 3.9 (3.1–4.7) | 158 | 5.3 (4.4–6.3) |
| Age Group | | | | | | | | | | | | | |
| 24.0–35.9 | 509 | 33 | 6.5 (4.3–8.6) | 32 | 6.3 (4.2–8.4) | 42 | 8.3 (5.9–10.7) | 10 | 2.0 (0.8–3.2) | 8 | 1.6 (0.5–2.7) | 29 | 5.7 (3.7–7.7) |
| 36.0–47.9 | 571 | 46 | 8.1 (5.8–10.3) | 43 | 7.5 (5.4–9.7) | 51 | 8.9 (6.6–11.3) | 41 | 7.2 (5.1–9.3) | 19 | 3.3 (1.9–4.8) | 33 | 5.8 (3.9–7.7) |
| 48.0–59.9 | 601 | 46 | 7.7 (5.5–9.8) | 39 | 6.5 (4.5–8.5) | 35 | 5.8 (4.0–7.7) | 48 | 8.0 (5.8–10.2) | 26 | 4.3 (2.7–6.0) | 30 | 5.0 (3.3–6.7) |
| 60.0–72 | 575 | 58 | 10.1 (7.6–12.6) | 57 | 9.9 (7.5–12.4) | 41 | 7.1 (5.0–9.2) | 60 | 10.4 (7.9–12.9) | 35 | 6.1 (4.1–8.1) | 28 | 4.9 (3.1–6.6) |
| P (trend) | | 0.05 | | 0.05 | | 0.20 | | <0.001† | | <0.001† | | 0.45 | |
| Gender | | | | | | | | | | | | | |
| Boys | | 84 | 7.3 (5.8–8.7) | 79 | 6.8 (5.4–8.3) | 91 | 7.9 (6.3–9.4) | 96 | 8.3 (6.7–9.9) | 53 | 4.6 (3.4–5.8) | 68 | 5.9 (4.5–7.2) |
| Girls | | 99 | 9.0 (7.3–10.7) | 92 | 8.4 (6.7–10.0) | 78 | 7.1 (5.6–8.6) | 63 | 5.7 (4.4–7.1) | 35 | 3.2 (2.2–4.2) | 52 | 4.7 (3.5–6.0) |
| P value | | 0.10 | | 0.10 | | 0.39 | | 0.03† | | 0.13 | | 0.94 | |

*According to the ''CDC, IOTF and local (NHGP)'' references.
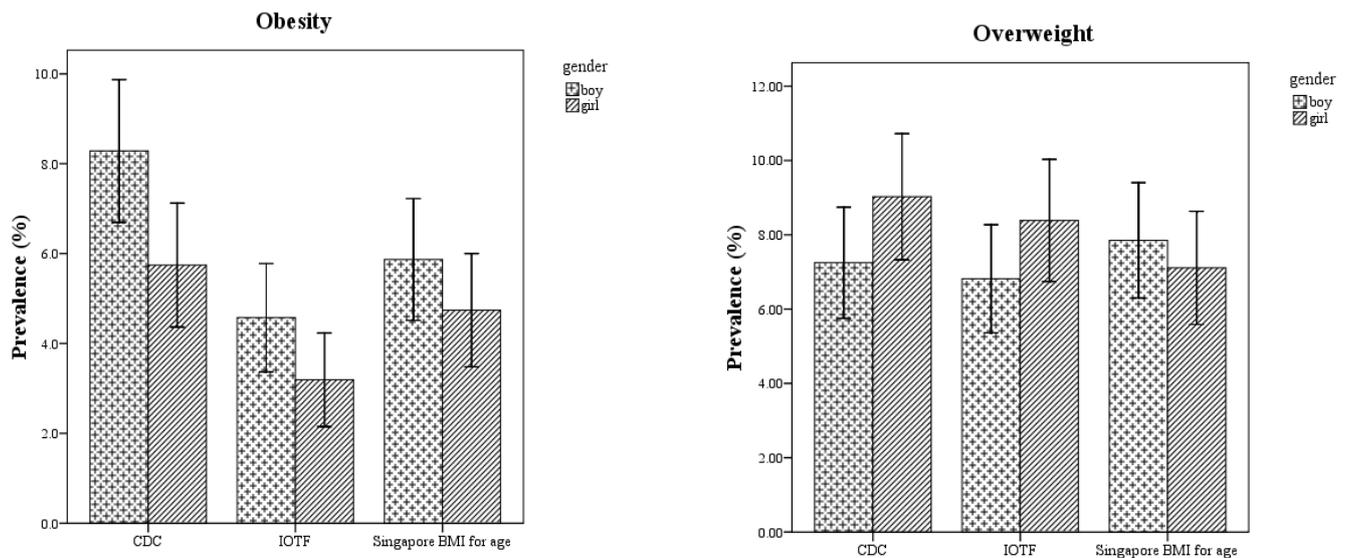† Statistically significant (P ≤0.05)

Fig. 1. Prevalence of overweight and obesity in Chinese Preschool Children Aged 24 to 72 months in Singapore by the CDC, IOTF and Local (NHGP) References. CDC: Center for Disease Control; IOTF: International Obesity Task Force; NHGP: National Health Group Polyclinics. The two clustered bar charts depict the prevalence of overweight and obesity by the CDC, IOTF and local NHGP references with 95% confidence intervals, represented by error bars.

and obesity from the local NHGP reference is similar to that of France. In France, the 97th percentile is proposed as a cut-off for obesity in children which is close to 30 kg/m² using the IOTF definition.[20,29]

Based on the CDC reference, the study from the United States[22] showed 18.0% of prevalence of obesity in 3-year-old children from 20 cities in the United States. The limitation of that study was that it was nationally representative only for fragile families (unmarried parents and low income families with a higher risk of breaking up compared to the traditional families). The Chilean study[23] also used the CDC reference and showed 16.4% of the prevalence of obesity in children aged 2 to 5 years. This showed a slight lower prevalence of obesity than in the United States. The Chilean study had a large sample size, but children surveyed were from low and middle income families and thus was not representative of the Chilean population.

The study from Italy,[10] using both CDC and IOTF references, allowed for international comparison. The Italian study showed 16.0% (the CDC reference) and 8.0% (the IOTF reference) for the prevalence of obesity. The study also showed that the prevalence of obesity in children aged 2 to 6 years in Italy had a similar prevalence of obesity to the United States but a higher prevalence than that in Germany and Great Britain.

The lower prevalence in our study compared to most non-Asian countries may just not be due to differences in physical attributes, and also differences in lifestyles, and nutrient intake.

The Chinese study,[9] conducted in children aged 3.5 to 6.4 years children from northern and southern rural and urban areas, showed the overall overweight/obesity prevalence of 7.4% which was lower than that of our study for children aged 24 to 72 months old (11.5%). Although it was a population-based study in selected areas of China, it is not representative for all children in China. The higher prevalence of overweight and obesity in our study may be explained by the level of urbanisation. The study areas (northern rural and southern rural and urban areas) of the Chinese study might be less urbanised compared to Singapore and differences in lifestyles might be present between our study and the Chinese study.

The World Health Organization reported that girls were more likely to be slightly obese than boys in both developed and developing countries.[3] However, similar prevalence of obesity between genders were also seen in other studies.[26,30] In our study, the boys were more obese than the girls while there were no gender differences in the prevalence of overweight. This might be explained by different upbringing patterns across different countries which may also affect the eating habits of children.[31] Therefore, gender differences in the prevalence of overweight and obesity were seen across these countries.

We observed an increasing trend of obesity with increasing age, using the CDC and IOTF references, and the prevalence of overweight and obesity were the highest in the age group of 60 to 72 months. This coincided with adiposity rebound of approximately 6 years of age.[12] In this second period of rapid growth in body fat, both the size and number of adipocytes increase,[32,33] and it might be the reason for the highest prevalence of overweight and obesity in this age

group of 60 to 72 months. As earlier and greater adiposity rebound predicts higher risk of obesity at later years, this is a worrying trend.

This study is the first population-based study of preschoolers in Singapore, evaluating the prevalence of obesity in the young age group of 6 to 72 months. The strength of this study is that it was a population-based study with a large sample size of 3009. A fairly high response rate of 72.3% from the large study area of southwestern and western parts of Singapore also minimised any selection bias.

The main limitation of our study is using BMI to estimate body fatness. Although it is a common, inexpensive and practical method of measuring obesity, it cannot distinguish between body fatness and muscularity. Therefore, the accuracy and preciseness in determining body fat, using BMI, cannot be as accurate and precise as using dual energy X-ray absorptiometry (DEXA) or deuterium dilution technique.

## Conclusion

The prevalence of overweight and obesity by the CDC reference are 8.1% and 7.1% and that by the IOTF reference are 7.6% and 3.9% in Singapore Chinese children aged 24 to 72 months. Although this prevalence is still lower than that in most countries, preventive and health educational programmes should be considered as ways to control the prevalence of overweight and obesity in these preschool children and subsequently reducing their risks of cardiovascular metabolic diseases in Singapore.

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