Original Article

Associations between socioeconomic status and overweight among urban children aged 7-12 years in Chengdu, southwest China

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Background and Objectives: Income inequality in China has risen steadily over the past decades. This study explored the relationship between socioeconomic status (SES) and overweight among urban children aged 7-12 years in Chengdu, a comparatively prosperous metropolis city located in "the West China", the backward, less developed region of China. **Methods and Study Design:** A population-based cross-sectional study was conducted in 2013 among urban children aged 7-12 years old in Chengdu city. A total of 853 urban students were involved in this analysis, with measured heights, weights, and filled in self-administered questionnaires. Overweight, including obesity, was defined according to the Working Group on Obesity in China. SES indicators included family income, parental education and occupation class. **Results:** Urban girls living in high-income households were more likely to be overweight than those living in low-income households (OR 2.19, 95% confidence interval, 1.02-4.83). However, no significant associations were found among boys and there were also null significant associations between other SES indicators and overweight in children of either sex. **Conclusions:** Urban girls living in relatively affluent circumstances were at greatest risk for being overweight. This study implies that any future overweight prevention program in Chengdu city is needed to start at the family level beginning with individuals of a high socioeconomic background, especially in urban girls.

Key Words: children, overweight, obesity, socioeconomic status, China

INTRODUCTION

The overweight and obesity in children is a major public health concern worldwide. The prevalence increased 0.49% per year across all age/sex groups in nine countries between 1995 and 2008.[1] China is no exception, with the proportion of overweight and obese children increasing from 1.8% and 0.3% in 1981 to 11.4% and 7.9% in 2010, respectively.[2] Childhood obesity is associated with immediate and long-term health risk, in terms of an array of adverse physiological and psychological outcomes,[3] which in turn creates an enormous health and economic burden.[4] In this regard, it is essential to identify possible risk factors contributing to childhood obesity and to take action correspondingly for combating the epidemic.

The main causes of overweight are multifactorial and include both genetic and non-genetic factors.[5] Socioeconomic status (SES) is an important determinant of the shared family environment. SES indicators such as family income, parental education and occupation level were correlated with obesity, but the relationship varied with age, sex, ethnicity, the definition of SES and overweight/adiposity indicators.[6] Although China is a developing country, its rapid economic growth over the past few decades has led to alarming socioeconomic inequalities among districts.[7] Only a few of studies have examined the relationship between specific SES indicators and overweight/obesity of Chinese children, and with findings equivocal.[8-12] Although positive associations were found in economically developed metropolises like Hong Kong,[13] Taiwan[14] and Beijing,[9,15] most studies reported a mixture of inverse or no association throughout much of China.[10-12] At the same time, evidence is limited regarding the association of one SES indicator with overweight when evaluating together with other SES indicators. Keane et al. demonstrated that the inverse correlation between household income and obesity has been found in Irish children with univariate regression analysis. However, when maternal education and household class were included, the effect of household income on obesity disappeared.[16] Therefore, it is imperative to evaluate association of each SES indicator with overweight while controlling other SES indicators.[17]

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Chengdu is a comparatively prosperous metropolis located in "the West China", the backward, less developed region of China and its prevalence of overweight and obesity for children and adolescents aged 9-15 years in 2012 were reported to be 14.5% and 3.3%, respectively.[18] SES as a determinant of obesity for children among Chengdu city has received scant attention yet. Therefore, the aim of the present study was to explore the correlations between overweight and multiple SES indicators (family income, parental education class, and parental occupation class) among urban children aged 7-12 years in Chengdu city. Such information would be useful for prevention, management and treatment for overweight that are tailored to the needs of children in this population.[19]

METHODS

Study sample

A population-based cross-sectional study was conducted in spring 2013 by a team of trained graduate students leaded by the principal investigator, and subjects were recruited among elementary school children aged 7-12 years in Chengdu, a big city in southwest China. The cluster random sampling method was applied to obtain 2 schools from 35 elementary schools in total. Inclusion criteria for children being invited to this program included living in the local community and with the Han nationality, given that children living in rural community and with minority may differ in SES with their parents whom possibly had undergone special feeding regimes. Any child with evidence from history or physical examination of any known diseases associated with chronic illness such as diabetes mellitus, or hypertension was excluded. A total of 1047 students were recruited and 194 were excluded with missing information on anthropometric measurements or the self-administered questionnaires. Approval for the study was obtained from the Ethics Committee of West China School of Public Health (No. 4 West China Teaching Hospital) of Sichuan University (Approved date: 5 March 2012). All examinations were performed with the written consent of parents or guardians.

Anthropometric measurements

An Ultrasonic Weight and Height Instrument (DHM-30, Dingheng Ltd., Zhengzhou, China) was used to measure children's weights and heights to the nearest 0.1 kg and 0.1 cm, respectively, with the subject barefoot, wearing light clothes and erecting with the feet together in a well-screened room. Scale reading was readjusted to zero before each measurement.

Definitions of overweight and obesity

Body mass index (BMI) is a widely used measure of adiposity that is calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Overweight and obesity were defined according to the sex- and age-specific body mass index (BMI; kg/m^2) cut-off points, proposed by the Working Group on Obesity in China (WGOC), based on sample data of 216,620 Chinese subjects aged 7–18 years from the Chinese National Survey on Students Constitution and Health, which reflect the body fat composition and musculoskeletal growth characteristics of an Asian population.[20] Overweight and obese group were combined because of the small number of children in the obese category.

Socioeconomic status

A structured questionnaire, designed in Chinese, to assess variables that may relate to weight status in children, which was pre-tested in the field and modified accordingly. SES indicators, family average annual income, parental education and occupation level, were assessed via parent reports on the self-administered questionnaires. Family average annual income in the past several years was assessed using three categories: (1) less than or equal to 15 thousand yuan (low level), (2) 15 to 35 thousand yuan (medium level), (3) more than 35 thousand yuan (high level). Parental education class was categorized into three groups: (1) less than elementary school (illiteracy or elementary school), (2) middle/secondary school (junior high school, senior high school, secondary school, or vocational school) (3) greater than high school (technical college, university, or graduate school). Parental occupation class was categorized into five groups: (1) farming, (2) business, (3) sales/service, (4) professional and technical work, (5) others (housewife or waiting for employment).[21]

Confounders

Confounders were selected based on previous studies on this topic and included gender, age, maternal weight, birth weight, schools and SES. Children's age was categorized into three groups, 7–8, 9–10, and 11–12 years old, respectively. Prior researches have shown that maternal BMI was related with a child's BMI,[8] which was calculated from height and weight reported by themselves. Maternal BMI was classified as underweight (<18.5 kg/m^2), normal weight (≥ 18.5 and <23.9 kg/m^2), overweight (≥ 24 and <27.9 kg/m^2) and obese (≥ 28 kg/m^2) according to the WGOC.[22] We assessed children's birth weight recalled by parents, which was classified as <2.5 kg, 2.5 to 4 kg, and ≥ 4 kg.[23] Schools was classified as school 1 and school 2.

Quality control

Quality control was conducted by training, pre-testing the processes and materials, field monitoring of data collection, logistics management and daily meetings of the study teams.

Analysis

Analysis was done by using SAS statistical software, version 9.3 (SAS Institute, Cary, NC, USA), for all data analyses. Data from boys and girls were analyzed separately as boys and girls exhibited different growth models[24] and socioeconomic gradient in overweight/obesity was different among boys and girls by decomposition analysis.[25] The variance inflation factor (VIF) was calculated to assess multicollinearity in the regression model. Categorical variables were presented as frequencies and percentages. Binary logistic regression was conducted to assess the relationship between SES factors and childhood overweight. In the basic models, the correlation analyses between each of the SES indicators and over-

weight were carried out first by crude odds ratios (OR) with 95% confidence interval (CI); Model 1 was adjusted for age, maternal BMI, birth weight and schools; Model 2 was further adjusted for all other SES indicators. Statistical significance was considered at $p< 0.05$ and all tests were two-sided.

RESULTS

Participant characteristics by gender group

VIF was calculated, with the results from 1.01 to 1.57, which is less than the diagnostic criteria of 10. The distribution of demographic and socioeconomic characteristics of the subjects were shown (Table 1). Of the 853 enrolled participants, 406 (47.6%) were boys and 447 (52.4%) were girls. The mean age of the subjects was 9.6±1.6 years old, with an age ranging 7 from 12 years old. The prevalence rates of combined overweight and obesity reached 22.2% in boys, 14.8% in girls, respectively, and the prevalence was significantly higher in boys than girls ($p<0.05$). Approximately 15% of maternal BMI fell into the overweight/obesity category. Approximately 10% of children's birth weight were 4 kg or more. About 53% of children were from the school 1. As for economic and educational status, 27.1% of participants lived in a household with an annual income of more than 35 thousand yuan, and 7.4% and 3.8% of participants had a mother and father with less than primary school education, respectively. The majority of parents were engaged in sales, service, professional or business occupations.

Associations of SES indicators with overweight/obesity in participants

Table 2 showed the ORs and 95% CIs of being overweight for boys. Unadjusted logistic regression model

Table 1. Participant characteristics by gender group

Variable	Total (n=853) n (%)	Boys (n=406) n (%)	Girls (n=447) n (%)
Age (years old)			
7-8	324 (38.0)	153 (37.7)	171 (38.3)
9-10	321 (37.6)	162 (39.9)	159 (35.5)
11-12	208 (24.4)	91 (22.4)	117 (26.2)
BMI†			
Underweight and normal weight	697 (81.7)	316 (77.8)	381 (85.2)
Overweight/obesity	156 (18.3)	90 (22.2)	66 (14.8)
Maternal BMI‡			
Underweight	78 (9.1)	40 (9.9)	38 (8.5)
Normal weight	642 (75.3)	299 (73.6)	343 (76.7)
Overweight/obesity	133 (15.6)	67 (16.5)	66 (14.8)
Birth weight (kg)§			
<2.5	30 (3.5)	9 (2.2)	21 (4.7)
2.5-4	740 (86.8)	347 (85.6)	393 (87.9)
≥4	83 (9.7)	50 (12.3)	33 (7.4)
Family average annual income (thousand)			
≤15	295 (34.6)	146 (36.0)	149 (33.3)
15-35	327 (38.3)	143 (35.2)	184 (41.2)
≥35	231 (27.1)	117 (28.8)	114 (25.5)
Maternal education			
≤Primary school	63 (7.4)	36 (8.9)	27 (6.0)
Middle/ secondary school	571 (67.0)	275 (67.7)	296 (66.4)
≥College education	219 (25.7)	95 (23.4)	124 (27.7)
Paternal education			
≤Primary school	32 (3.8)	15 (3.7)	17 (2.0)
Middle/ secondary school	522 (61.2)	252 (62.1)	270 (31.7)
≥College education	299 (35.0)	139 (34.2)	160 (18.8)
Maternal occupation			
Farming	22 (2.6)	13 (3.2)	9 (2.0)
Business	154 (17.0)	61 (15.0)	84 (18.8)
Sales/service	303 (35.5)	149 (36.7)	154 (34.4)
Professional and technical work	221 (25.9)	101 (24.9)	120 (26.8)
Others	162 (19.0)	82 (20.2)	80 (17.9)
Paternal occupation			
Farming	18 (2.1)	10 (2.5)	8 (1.8)
Business	185 (22.0)	85 (20.9)	100 (22.3)
Sales/service	366 (42.9)	177 (43.6)	189 (42.3)
Professional and technical work	209 (24.5)	93 (22.9)	116 (26.0)
Others	75 (8.8)	41 (10.1)	34 (7.6)
Schools			
School 1	454 (53.2)	221 (54.4)	233 (52.1)
School 2	389 (46.8)	185 (45.6)	214 (47.9)

†BMI: body mass index, is defined by Working Group on Obesity in China (WGOC).
‡Maternal BMI was classified as underweight (<18.5 kg/m^2), normal weight (≥18.5 and <23.9 kg/m^2), overweight (≥24 and <27.9 kg/m^2) and obese (≥28 kg/m^2) according to the WGOC.
§Children's birth weight was classified as <2.5 kg, 2.5 to 4 kg, and ≥4 kg.

Table 2. Associations of SES indicators with overweight/obesity in boys aged 7 to 12 years (n=406)

Variable	Unadjusted model OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)
Maternal BMI			
Underweight and normal weight	1.00		
Overweight/obesity	2.12 (1.19, 3.73)*		
Birth weight (kg)			
<4	1.00		
≥4	1.21 (0.48, 1.78)		
Schools			
School 1	1.00		
School 2	1.41 (0.88, 2.26)		
Family average annual income (thousand)			
≤15	1.00	1.00	1.00
15-35	1.07 (0.61, 1.86)	1.20 (0.68, 2.12)	1.15 (0.63, 2.10)
≥35	0.97 (0.53, 1.74)	1.03 (0.56, 1.89)	0.91 (0.48, 1.74)
Maternal education			
≤Primary school	1.00	1.00	1.00
Middle/ secondary school	0.73 (0.34, 1.73)	0.69 (0.31, 1.68)	0.82 (0.30, 2.51)
≥College education	1.19 (0.51, 2.98)	1.14 (0.46, 2.98)	1.17 (0.34, 4.34)
Paternal education			
≤Primary school	1.00	1.00	1.00
Middle/ secondary school	0.47 (0.16, 1.57)	0.46 (0.15, 1.62)	0.48 (0.11, 2.04)
≥College education	0.73 (0.24, 2.46)	0.70 (0.22, 2.52)	0.63 (0.13, 3.00)
Maternal occupation			
Farming	1.00	1.00	1.00
Business	0.90 (0.23, 4.45)	1.04 (0.26, 5.28)	1.32 (0.25, 8.92)
Sales/service	0.84 (0.24, 3.92)	0.91 (0.24, 4.47)	1.42 (0.28, 8.99)
Professional and technical work	1.16 (0.32, 5.44)	1.30 (0.34, 6.50)	1.50 (0.28, 10.00)
Others	0.94 (0.25, 4.50)	1.03 (0.27, 5.14)	1.54 (0.32, 9.35)
Paternal occupation			
Farming	1.00	1.00	1.00
Business	0.72 (0.18, 3.57)	0.84 (0.20, 4.32)	0.70 (0.12, 4.56)
Sales/service	0.60 (0.16, 2.87)	0.76 (0.19, 3.80)	0.55 (0.10, 3.42)
Professional and technical work	0.81 (0.21, 3.99)	1.03 (0.25, 5.30)	0.55 (0.09, 3.67)
Others	0.48 (0.10, 2.64)	0.69 (0.14, 3.95)	0.42 (0.07, 2.83)

BMI: body mass index; CI: confidence interval; OR: odds ratio; SES: socioeconomic status.
Model 1: adjusted for age, maternal BMI, birth weight and schools.
Model 2: as model 1 and additionally adjusted for all other SES indicators. (Namely, family average annual income: as model 1 and additionally adjusted for maternal education, paternal education, maternal occupation and paternal occupation; Maternal education: as model 1 and additionally adjusted for family average annual income, paternal education, maternal occupation and paternal occupation; Paternal education: as model 1 and additionally adjusted for family average annual income, maternal education, maternal occupation and paternal occupation; Maternal occupation: as model 1 and additionally adjusted for maternal education, paternal education and paternal occupation; Paternal occupation: as model 1 and additionally adjusted for family average annual income, maternal education, maternal occupation and paternal education).
*$p<0.05$.

was used to evaluate the effects of selected sociodemographic characteristics on the likelihood of overweight for boys. Family average annual income, maternal education, paternal education, maternal occupation and paternal occupation were not significant predictors of children's overweight status. Additionally, ORs remained no statistical significance after adjustment for confounders.

Table 3 described the ORs and 95% CIs of being overweight for girls. Unadjusted logistic regression model and model 1 (adjustment for age, maternal BMI, birth weight and schools) showed that parental occupation was a predictor of urban girl's overweight status, while when further adjusted for other SES, this association was disappeared. Unadjusted logistic regression model and model 1 revealed that family average annual income and parental education level were not significant predictors of girl's overweight status. When the analysis was further adjusting for other SES indicators, results showed that urban girls living in high-income households were more likely to be overweight than those living in low-income households (OR 2.19, 95% CI, 1.02-4.83).

DISCUSSION

This study showed that urban girls living in relatively affluent circumstances were at greatest risk for being overweight. However, this study did not found any significant association among boys and there were also no significant associations between other SES indicators and overweight in children of either sex.

Generally speaking, the trend of the association of SES and overweight was contrary to that of developed countries[26,27] and consistent with the conclusions of developing countries.[28,29] But the association of childhood overweight/obesity and specific SES indicator was inconclusive. Refer to SES indicators and the prevalence of overweight among children, we firstly focused on family income. Our study found a positive association between family income and being overweight among urban girls,

Table 3. Associations of SES indicators with overweight/obesity in girls aged 7 to 12 years (n=447)

Variable	Unadjusted model OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)
Maternal BMI			
Underweight and normal weight	1.00		
Overweight/obesity	1.70 (0.86-3.22)		
Birth weight (kg)			
<4	1.00		
≥4	1.18 (0.47, 2.37)		
Schools			
School 1	1.00		
School 2	0.77 (0.45, 1.31)		
Family average annual income (thousand)			
≤15	1.00	1.00	1.00
15-35	1.39 (0.74, 2.70)	1.41 (0.74, 2.75)	1.58 (0.79, 3.18)
≥35	1.75 (0.88, 3.54)	1.85 (0.92, 3.76)	2.19 (1.02, 4.83)*
Maternal education			
≤Primary school	1.00	1.00	1.00
Middle/ secondary school	1.32 (0.44, 5.74)	1.53 (0.49, 6.75)	1.46 (0.44, 6.75)
≥College education	1.63 (0.51, 7.30)	2.15 (0.63, 10.05)	1.62 (0.38, 8.75)
Paternal education			
≤Primary school	1.00	1.00	1.00
Middle/ secondary school	0.50 (0.17, 1.85)	0.57 (0.18, 2.14)	0.65 (0.18, 2.80)
≥College education	0.63 (0.20, 2.37)	0.77 (0.24, 3.01)	0.89 (0.21, 4.31)
Maternal occupation			
Farming	1.00	1.00	1.00
Business	0.19 (0.04, 0.86)*	0.20 (0.04, 0.92)*	0.43 (0.05, 4.81)
Sales/service	0.20 (0.05, 0.85)*	0.22 (0.05, 0.96)*	0.50 (0.06, 5.33)
Professional and technical work	0.27 (0.07, 1.15)	0.32 (0.07, 1.46)	0.66 (0.08, 7.43)
Others	0.16 (0.04, 0.74)*	0.17 (0.04, 0.83)*	0.38 (0.04, 4.07)
Paternal occupation			
Farming	1.00	1.00	1.00
Business	0.16 (0.04, 0.76)*	0.15 (0.03, 0.74)*	0.21 (0.02, 2.04)
Sales/service	0.17 (0.04, 0.74)*	0.16 (0.04, 0.75)*	0.24 (0.02, 2.27)
Professional and technical work	0.15 (0.03, 0.69)*	0.15 (0.03, 0.73)*	0.14 (0.01, 1.40)
Others	0.21 (0.04, 1.13)	0.22 (0.39, 1.22)	0.29 (0.02, 3.14)

BMI: body mass index; CI: confidence interval; OR: odds ratio; SES: socioeconomic status.
Model 1: adjusted for age, maternal BMI, birth weight and schools.
Model 2: as model 1 and additionally adjusted for all other SES indicators. (Namely, family average annual income: as model 1 and additionally adjusted for maternal education, paternal education, maternal occupation and paternal occupation; Maternal education: as model 1 and additionally adjusted for family average annual income, paternal education, maternal occupation and paternal occupation; Paternal education: as model 1 and additionally adjusted for family average annual income, maternal education, maternal occupation and paternal occupation; Maternal occupation: as model 1 and additionally adjusted for maternal education, paternal education and paternal occupation; Paternal occupation: as model 1 and additionally adjusted for family average annual income, maternal education, maternal occupation and paternal education.)
*$p<0.05$.

and showed no relation among urban boys. However, a study carried out in rural northeast China for 5-18 years old children reported an inverse result.[8] Meanwhile, null and positive associations were revealed among children of each sex from China Health and Nutrition Surveys in 1993[30] and 2006,[12] respectively. In addition, although Yen found that obesity in Taiwanese males was associated with low paternal education,[31] this study showed no association between parental education and the prevalence of overweight among children of either sex. Finally, no significant difference was seen between parental occupation and the prevalence of overweight in the present study, while a positive relation was observed in children from eastern China by Guiju Sun's group.[32]

There are several possible explanations for these inconsistencies. Firstly, there were variations in classifications of the SES variables in different studies.[8,10] For example, family income was divided into three groups (<2000, 2000-5000, ≥5000 yuan per month) in some studies[8] and categorized into tertiles in others,[12] partly accounting for the conflicting findings. Secondly, given insufficient potential confounding factors for adjustment in many studies,[12,30] at least some of the findings observed previously may attribute to confounders. Thirdly, the demographic factors (populations, region, race, etc.) and economic development with large heterogeneity might yield controversial results.[9,12] For instance, the wide-ranging differences in human growth between eastern and western China partially made it fail to conclude consistent results.[33] Furthermore, binary logistic model with different reference possibly made it difficult to reach a unanimous conclusion when exploring the effects of SES variables on the prevalence of overweight.[8,30] Finally, the diverse criterion of defining overweight and obesity made some results lack of comparability.[8,12] Further studies are needed to examine and explain the discrepancy.

The mechanisms underlying the associations between SES and being overweight among urban girls have yet to be established. The theoretical framework proposed by Sobal[34] acknowledges that economic status may affect

their children's access to resources by lifestyle choices and behaviors, area of residence and food affordability, which involves in the development of overweight. More importantly, dietary behaviors, physical activity and sedentary lifestyle are independent predictors of overweight.[35] Even though evidence was limited regarding dietary patterns that contribute to excessive calorie intake, Shi et al reported that daily consumption of soft drink and juice were found to be more common in the high SES group of Chinese girls.[36] Furthermore, similar to other findings,[37] our previous research demonstrated that girls from high family income have been found to spend more time on using computer than those from low family income.[21] Meanwhile, a study conducted in Guangzhou city of China found that girls from low SES did more housework than those from high SES,[38] which provided some evidence on supporting our conclusion. High consumption of high-energy food, screen-based sedentary behaviors and less time on housework among high family income group of girls may account for its high prevalence of overweight. It would however be worthwhile to design a study that would probe such issues as dietary and physical activity patterns.

Several limitations of this study should be noted. First of all, some of the children and parents did not complete the questionnaire fully, even though we minimized vacancies for variables by quality control. Therefore, the final sample size was smaller than the original one. In addition, we cannot explore the socioeconomic determinants of childhood overweight and obesity separately due to limited sample size for each group, especially in obesity. Finally, our results were based on a cross-sectional design, which introduced uncertainties regarding the sequence of cause and effect of the observed associations.

Despite these limitations, the strong points of this study were evaluating five SES indicators, adjusting for other SES indicators when analyzing one indicator, and exploring the relation between SES and overweight by gender, which provided some important insights into the overweight problems of children. This research implies that any future overweight prevention program in Chengdu city is needed to start at the family level beginning with individuals of a high socioeconomic background, especially in urban girls.

Conclusions

According to the present results, urban girls of high family income from Chengdu city of China have suffered high rates of overweight. However, the effect of more accurate indicator of SES or a composite index of SES on obesity in school age children include the rural ones needs further exploration, which would help policymakers confront the pediatric obesity epidemic effectively in the specific context of different SES class in Chengdu city.

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AUTHOR DISCLOSURES

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