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Original article

Overweight, obesity, and screen-time viewing among Chinese school-aged children: National prevalence estimates from the 2016 Physical Activity and Fitness in China—The Youth Study

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Abstract

Purpose: This study presents the most recent estimates of prevalence of overweight, obesity, and screen-time viewing among Chinese school-aged children. Demographic differences in these estimates between sexes and resident locales were also examined.
Methods: Cross-sectional analyses of 116,615 Chinese school children 9 to 17 years of age who participated in the 2016 Physical Activity and Fitness in China—the Youth Study project. Outcomes were the prevalence of children's overweight (body mass index 85th ≤ BMI < 95th percentile) and obesity (BMI ≥95th percentile) (defined by the Working Group on Obesity in China) and not meeting screen-time viewing recommendations ("not meeting" was defined as more than 2 h per day of viewing activities after school). Analyses were conducted on the whole sample and by school grade cohorts (primary, junior middle, junior high schools), sex, and residence locales (urban, rural).
Results: Overall, 14.4% (95% confidence interval (CI): 13.8%–15.0%) of children and adolescents were overweight, 11.9% (95%CI: 11.0%–13.0%) were obese, and 36.8% (95%CI: 34.7%–38.9%) did not meet screen-time viewing recommendations. Across the 3-grade cohorts, boys were more likely to be obese than girls, and primary and junior middle school children living in urban areas were more likely to be obese than those living in rural areas. Primary and junior middle school boys were less likely to meet screen-time recommendations than girls, and junior high school children living in urban areas were less likely to meet screen-time recommendations than school children of the same grades living in rural areas.
Conclusion: In 2016, the prevalence of obesity among Chinese school children was about 12%, and about 37% of them did not meet screen-time viewing recommendations. The prevalence of obesity and sedentary behavior was generally higher among boys than among girls, and it was higher for children living in urban areas than for those living in rural areas.

Keywords: Physical inactivity; Sedentary behavior; Unhealthy lifestyle; Weight status

1. Introduction

Physical inactivity and obesity among children and youths have become a global public health concern because they negatively impact children's health, well-being, and growth.[1-3] China is among the countries where these health-related problems have become especially acute. Due to 3 decades of economic reform, China has undergone major demographic, environmental, and epidemiologic transitions leading to changing diets and a sedentary lifestyle. As a result, the country now faces a major challenge in the increase in non-communicable diseases such as diabetes and obesity. Studies of Chinese youth populations have shown a rising trend in sedentary behavior[4,5] and obesity prevalence[6-11] among school-aged children living in urban and rural areas. This situation is of high public health concern because it can lead to the development of chronic health risks during childhood and into adulthood.[12-15]

Compared to western countries, our knowledge regarding population-based weight status and screen-time viewing surveillance of school-aged children in China remains significantly limited. To date, most published studies have reported regional

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data,[4,7] and those from national surveys have provided data only up to 2010.[5,6,9] Therefore, from the perspective of public health, it is critical that up-to-date population-based surveillance data on school-aged children be gathered so that timely school- and community-based health promotion policies and interventions can be planned and developed to meet the specific goals of "Healthy China 2030."[16] Using the most recent data collected from the 2016 Physical Activity and Fitness in China—the Youth Study (PAFCTYS), the purposes of this study were to analyze the PAFCTYS data and present the prevalence estimates of weight status and screen-time viewing among Chinese school-aged children and to assess demographic differences in these outcome variables by sex and residence locale.

2. Methods

2.1. Study design and participants

The data were drawn from the 2016 PAFCTYS,[17] which was a cross-sectional survey of physical activity and fitness among Chinese school-aged children. The PAFCTYS used a 3-stage cluster sampling method to recruit a nationally representative sample of children and adolescents from public schools in 22 Chinese provinces, 4 municipalities (Beijing, Shanghai, Tianjin, Chongqing), 5 autonomous regions (Inner Mongolia, Xinjiang, Guangxi, Ning xia, Tibet), and Xinjiang Production and Construction Corps (an independent division within Xinjiang Uyghur Autonomous Region) in the Mainland of China. The 3-stage sampling procedure involved sampling administrative cities and districts, towns, and local community districts that represented a mix of rural and urban areas, with the smallest sampling unit being local primary, junior middle, and junior high schools from which target children (Grades 4 through 12) were recruited. Children from Grades 1 through 3 were not included in this study because of concerns about their cognitive ability to complete the study survey. Details on the PAFCTYS design, methodologies, and research protocol are described elsewhere.[17]

The study protocol was approved by the Institutional Review Board of Shanghai University of Sport. Verbal consent was obtained before data collection from the children's parents or guardians, from all participating children, and from class teachers and school principals. Children were advised that their participation was completely voluntary and their identification would be protected.

2.2. Measures

Anthropometric measurements of weight and height were taken in the classroom by trained research staff. For primary school children in lower grades, the survey questions were read aloud and, if necessary, the children were assisted by staff in their responses. Data were ascertained between October and November 2016 from the children and their parents or guardians, who also completed a parent and guardian version of the survey that asked for family demographic information. Information on children's academic grades was collected via self-report and was verified by school records.

2.2.1. Weight status

Using a standardized protocol, children's body weight (kg) was measured to the nearest 0.1 kg, whereas height (cm) was measured to the nearest 0.1 cm in bare feet. Both of these measures were assessed using a portable instrument (i.e., GMCS-IV, Jianmin, Beijing, China). From these objectively assessed values, weight status categories among participants were determined by body mass index (BMI), calculated as body weight (kg) divided by height (m) squared (kg/m^2) using the criteria set by the Working Group on Obesity in China.[18] Categories included underweight (<5th percentile), normal weight (5th ≤ BMI < 85th percentile), overweight (85th ≤ BMI < 95th percentile), and obese (≥95th percentile).

2.2.2. Screen-time viewing

Children were asked to report the amount of leisure time they spent, both on weekdays and weekends, in watching TV or videos, using computers or tablets, and using electronic or mobile devices after school. This measure was assessed from responses to 3 questions: (1) "During the past week, on average how many hours per day did you sit and watch TV?"; (2) "During the past week, on average how many hours per day did you use mobile phones, tablets, and/or other electronic mobile devices outside of school?"; and (3) "During the past week, on average how many hours per day did you sit and use computers/laptops and other electronic devices to conduct the following activities including instant messaging, web browsing, checking emails, completing homework, *etc*.?" Possible responses to these questions were anchored on a 5-point scale corresponding to "*none*", "*about a half hour*", "*1 hour*", "*2 hours*", or "*3 hours or more*". A similar scale was used to measure screen-viewing activities on weekends. Following current guidelines,[19,20] children who reported 2 h or less per day were considered to have met the recommendations and those who spent more than 2 h/day were considered not to have met the recommendations.

2.2.3. Demographics

Information on the children's ages; sex; ethnicity (Han or minority); siblings; and child-rearing in the family was obtained from the children's survey. To determine population characteristics, information was collected from the parent or guardian survey on parental or guardian education, occupation, residential locality (urban or rural), and family income per person.

2.3. Statistical analysis

The data were analyzed using the Complex Samples option of SPSS (Version 22.0; IBM Corp., Armonk, NY, USA), which allows sampling weights and adjustments in the estimation of standard errors for statistical testing. To produce nationally representative estimates, sample weights were applied to account for the clustering effect of sampling by school. The overall data analyses proceeded in 2 steps. First, the prevalence of underweight, overweight, obesity, and adherence to screen-time viewing recommendations was calculated for the whole sample pooled from the 3 school grade cohorts (primary, junior

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middle, junior high schools) and for each grade cohort, stratified by sex (boy, girl) and residence locales (rural, urban). Second, we analyzed differences in sex and residence in the dependent variables of weight status (overweight, obese) and not meeting screen-time viewing recommendations in each grade cohort using multinomial logistic regression analysis for BMI groups (with normal weight as the reference) and logistic regression analysis for not meeting screen-time viewing recommendations. All analyses adjusted for family variables of number of children in the family, parental education, and family income per person. Adjusted estimates and their corresponding 95% confidence intervals (CIs), generated from the statistical models, were reported. Tests were considered statistically significant at an overall α level of 0.05.

3. Results

3.1. Study population

From a potential pool of 151,882 children across 1036 schools in China, the PAFCTYS recruited 125,281 participants (9–17 years old) from 991 schools. In the current study, we included 116,615 (93.1%) children who provided a complete and useable survey and anthropometric data on the study outcome measures. A total of 8666 children from the PAFCTYS were excluded due to missing or incomplete data on the measures related to the current study.

Sample sizes and weighted demographic characteristics for all 3 school grades of the study population are presented in Table 1. Participating children were primarily Han ethnicity (>80%) and were approximately equally distributed across sex (50.5% girls) and school grade cohorts (38,076 students in primary schools; 39,585 students in junior middle schools; 38,954 students in junior high schools). More than 50% of the junior middle and junior high school children reported living in rural areas compared to 52.7% of the primary school children living in urban areas.

Table 1
Demographic characteristics of Chinese school-aged children and adolescents 9–17 years old from the 2016 Physical Activity and Fitness in China—the Youth Study, (n (%) unless otherwise noted).

Variable	Primary school	Junior middle school	Junior high school
Sample size (n)	38,076	39,585	38,954
Age (year, mean ± SD)	10.28 ± 0.97	13.18 ± 1.16	15.94 ± 0.94
Girl	19,228 (50.5)	20,030 (50.6)	19,672 (50.5)
Ethnicity			
Han	31,679 (83.2)	33,568 (84.8)	32,527 (83.5)
Minority	6397 (16.8)	6017 (15.2)	6427 (16.5)
Family income/person (RMB)			
<9000	14,926 (39.2)	15,636 (39.5)	16,283 (41.8)
9000–30,000	13,593 (35.7)	14,290 (36.1)	13,439 (34.5)
>30,000–100,000	7539 (19.8)	7719 (19.5)	7479 (19.2)
>100,000	2018 (5.3)	1940 (4.9)	1753 (4.5)
Family composition			
Single child	14,164 (37.2)	15,082 (38.1)	16,633 (42.7)
Two or more	23,912 (62.8)	24,503 (61.9)	22,321 (57.3)
Residential setting			
Urban	20,066 (52.7)	18,249 (46.1)	18,308 (47.0)
Rural	18,010 (47.3)	21,336 (53.9)	20,646 (53.0)
Parent education			
Junior middle school or less	18,086 (47.5)	21,297 (53.8)	19,126 (49.1)
Junior high school or some college	12,603 (33.1)	12,113 (30.6)	13,751 (35.3)
Four-year college or more	7387 (19.4)	6175 (15.6)	6077 (15.6)
BMI (kg/m^2, mean ± SD)	18.10 ± 3.35	19.78 ± 3.41	21.04 ± 3.25

Abbreviation: BMI = body mass index.

3.2. Prevalence estimates

Table 2 shows the prevalence estimates of BMI and adherence to screen-time viewing across the 3 school grades, stratified by sex and residence locales of the participating children. In 2016, the overall prevalence of underweight, overweight and obesity among Chinese school-aged children 7–17 years old was 2.1% (95%CI: 1.8%–2.4%), 14.4% (95%CI: 13.8%–15.0%), and 11.9% (95%CI: 11.0%–13.0%), respectively (data not shown). With respect to the overall prevalence of screen-time viewing, 36.8% (95%CI: 34.7%–38.9%) of the school children surveyed exceeded the daily screen-time viewing recommendation of 2 h or less per day (data not shown).

3.3. Differences in sexes and residence locales

Across the 3 (primary, junior middle, junior high) school grade cohorts, there were significant differences in BMI percentile by sex and residence locales (Table 3), with the prevalence of obesity being higher among boys compared to girls in primary schools (odds ratio (OR) = 1.28, 95%CI: 1.07–1.53), junior middle schools (OR = 1.46, 95%CI: 1.30–1.63), and junior high schools (OR = 1.35, 95%CI: 1.13–1.63), after controlling for the number of children in the family, parental education, and family income per person. For overweight, junior middle school boys had a significantly lower prevalence of overweight (OR = 0.86, 95%CI: 0.75–0.98) compared to girls in the same school grades, and, in contrast, junior high school boys had significantly higher prevalence of overweight (OR = 1.19, 95%CI: 1.05–1.34) compared to girls in the same school grades.

In comparing urban and rural residence locales, the prevalence of obesity was significantly higher for primary and junior middle school children living in urban locales compared with the children in the same school grades living in rural locales (OR = 1.47, 95%CI: 1.09–1.99; OR = 1.49, 95%CI: 1.04–2.14, respectively). Primary and junior high school children living in urban areas had a significantly higher prevalence of overweight compared with children in the same grades living in rural areas (OR = 1.40, 95%CI: 1.17–1.68; OR = 1.31, 95%CI: 1.12–1.52, respectively).

Results related to screen-time viewing (Table 3) show that relative to girls, both primary and junior middle school boys were less likely to meet the screen-time viewing recommendations (OR = 1.37, 95%CI: 1.25–1.50; OR = 1.37, 95%CI: 1.26–1.49, respectively). Relative to children living in rural areas, junior high school children living in urban areas were

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Table 2
Prevalence of BMI and screen-time viewing in Chinese school-aged children and adolescents 9–17 years old from the 2012 Physical Activity and Fitness in China—the Youth Study (% (95%CI)).

	Primary school			Junior middle school			Junior high school		
	Total	Boy	Girl	Total	Boy	Girl	Total	Boy	Girl
BMI									
Urban									
<5th	2.4 (1.7–3.4)	2.4 (1.6–3.6)	2.4 (1.6–3.4)	1.6 (1.2–2.0)	2.3 (1.7–3.0)	0.9 (0.7–1.2)	1.6 (1.2–2.0)	1.4 (1.0–1.9)	1.8 (1.3–2.4)
85th–< 95th	15.4 (14.3–16.6)	16.7 (15.3–18.2)	14.2 (12.7–15.8)	15.2 (14.0–16.5)	14.8 (13.5–16.2)	15.6 (14.0–17.5)	16.8 (15.7–17.9)	18.7 (17.2–20.4)	14.9 (13.7–16.1)
≥95th	14.2 (12.3–16.3)	16.2 (14.0–18.6)	12.2 (10.3–14.5)	14.7 (12.4–17.3)	17.7 (14.8–21.0)	11.8 (9.8–14.1)	13.2 (11.5–15.1)	15.2 (13.1–17.5)	11.1 (9.2–13.4)
Rural									
<5th	2.9 (1.9–3.4)	3.3 (2.1–5.1)	2.6 (1.6–4.0)	2.6 (2.0–3.4)	3.7 (2.9–4.8)	1.5 (1.1–2.2)	1.7 (1.3–2.2)	1.8 (1.3–2.5)	1.5 (1.1–2.1)
85th–< 95th	11.6 (10.3–13.0)	10.8 (9.4–12.3)	12.3 (10.5–14.4)	12.4 (10.8–14.1)	10.1 (8.7–11.7)	14.7 (12.5–17.2)	13.3 (11.8–14.9)	12.0 (10.4–13.9)	14.6 (12.6–16.8)
≥95th	9.5 (7.6–11.8)	10.1 (8.1–12.6)	9.0 (6.6–12.0)	8.9 (6.6–11.8)	10.2 (7.6–13.4)	7.6 (5.6–10.3)	8.9 (7.3–10.9)	9.6 (7.2–12.7)	8.2 (6.8–10.0)
Adherence to screen–time viewing recommendations (≤2 h per day)									
Urban	66.8 (63.4–70.1)	64.8 (61.0–68.4)	68.9 (65.4–72.2)	59.5 (54.4–64.4)	57.4 (52.1–62.4)	61.6 (56.2–66.7)	61.8 (56.8–66.6)	60.7 (55.7–65.4)	63.0 (57.5–68.2)
Rural	65.0 (62.0–67.9)	59.5 (56.1–62.9)	70.3 (67.0–73.4)	60.5 (56.0–64.9)	55.5 (50.6–60.3)	65.5 (60.9–69.8)	69.0 (63.9–73.6)	68.0 (62.3–73.2)	69.9 (65.0–74.3)

Abbreviation: BMI = body mass index; CI = confidence interval.

Table 3
Multinomial logistic regression analysis of BMI percentile groups and logistic regression analysis of not meeting screen–time viewing recommendations from the 2016 Physical Activity and Fitness in China—the Youth Study (adjusted OR (95%CI)).

	Primary school	Junior middle school	Junior high school
BMI percentile[a]			
Sex			
Girl	Reference	Reference	Reference
Boy			
<5th	1.23 (0.99–1.53)	2.63 (2.10–3.29)	0.98 (0.79–1.21)
85th–< 95th	1.13 (0.99–1.30)	0.86 (0.75–0.98)	1.19 (1.05–1.34)
≥95th	1.28 (1.07–1.53)	1.46 (1.30–1.63)	1.35 (1.13–1.63)
Residence			
Rural	Reference	Reference	Reference
Urban			
<5th	1.04 (0.70–1.54)	0.70 (0.49–1.02)	1.09 (0.70–1.69)
85th–< 95th	1.40 (1.17–1.68)	1.22 (0.98–1.51)	1.31 (1.12–1.52)
≥95th	1.47 (1.09–1.99)	1.49 (1.04–2.14)	1.22 (0.93–1.59)
Not meeting screen-time viewing recommendations (>2 h per day)[b]			
Sex			
Girl	Reference	Reference	Reference
Boy	1.37 (1.25–1.50)	1.37 (1.26–1.49)	1.08 (0.99–1.18)
Residence			
Rural	Reference	Reference	Reference
Urban	1.00 (0.82–1.23)	1.26 (0.97–1.63)	1.34 (1.04–1.72)

[a] Multinomial logistic regressions of BMI group (underweight, overweight, and obese, with normal weight as the reference) on sex and residence locales. Each regression model adjusted for family variables of number of children in the family, parental education, and family income per person.

[b] Logistic regressions of screen-time viewing group (meeting recommendations for screen-time viewing (2 h per day or less is the reference), not meeting recommendations for screen-time viewing (>2 h per day)) on sex and residence locales. Each regression model is adjusted for family variables of number of children in the family, parental education, and family income per person.

Abbreviations: BMI = body mass index; CI = confidence interval; OR = odds ratio.

significantly less likely to meet the screen-time viewing recommendations (OR = 1.34, 95%CI: 1.04–1.72).

4. Discussion

Using data from the 2016 PAFCTYS, we found approximately 14% of the Chinese school-aged children and adolescents were overweight and about 12% were obese. While the prevalence of overweight among junior middle school boys was lower and the prevalence of overweight among primary and junior high school boys was significantly higher, obesity prevalence was consistently higher among all school-aged boys compared with girls. Urban–rural differences were noted, with primary school-aged children living in urban areas having a significantly higher prevalence of overweight and obesity compared with children living in rural areas. Similarly, among those living in urban areas, junior middle school children had a higher prevalence of obesity, and junior high school children had a higher prevalence of overweight compared with children in the same school grades living in rural areas.

The estimates of overweight and obesity from the 2016 PAFCTYS are consistent with recent regional and national estimates on the prevalence of and trends in obesity among

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Chinese school-aged children.[6,7,21] In general, findings from this report support the observation of the continually rising trend in obesity among children (7–18 years of age), with high rates reported among school boys and those living in urban areas.[6,7] The estimate on obesity from the 2016 PAFCTYS data is lower than childhood obesity in the United States (16.9% from 2009–2010 data)[22] but comparable with estimates reported in Canada (11.7% from 2004 data) and Mexico (11.5% from 2006 data).[23]

In the 2016 PAFCTYS, the prevalence of adherence to screen-time viewing recommendations by the children was 63.2%. However, over a third of the children (36.8%) in the survey did not meet the screen-time recommendations. This is generally consistent with the findings reported from previous Chinese cross-sectional and trend studies,[4,5,24] but the percentage of those not adhering to the recommendations in China is lower than the percentages reported for populations of school-aged children in the United States.[25,26] In China, primary and junior middle school boys were less likely to meet the recommendations compared with the girls in the same school grades. Among the 3 school grades across the urban–rural settings, only junior high school adolescents living in urban areas were less likely to meet the recommendations. Similar demographic (sex, urban–rural) differences have also been reported in other studies.[4,5,21]

Obesity prevalence among preschool children, school-aged children, and adults in China has been rising over the past 2 decades.[21,27,28] Among school-aged children, national estimates show that obesity increased rapidly from 0.2% in 1985 to 8.1% in 2010,[6,21] with especially rapid increases in the prevalence of obesity and screen-time viewing occurring among boys. Despite national efforts and strategic plans to increase physical activity among Chinese children,[16] prevalence estimates on both obesity and screen-time viewing from the 2016 PAFCTYS estimates indicate that the trend is not leveling off and suggest the need to step up efforts to increase physical activity and reduce sedentary time and obesity.

A strength of the 2016 PAFCTYS is that it had good minority representation of the Chinese population. While the Han ethnicity comprises 92% of the total population in China, the 2016 PAFCTYS recruited more than 15% ethnic minorities, thereby increasing the representativeness of the study population. Another strength that enhances the representativeness of the study population is the inclusion of schools sampled from all provinces, municipalities, and autonomous regions in the Mainland of China.

The 2016 PAFCTYS, however, has a few major limitations. First, both overweight and obesity in the study are defined by BMI, which is based on weight adjusted for height. Therefore, as a surrogate measure, it may not represent an accurate measure of body fat percentage. Relatedly, our BMI measure is culturally defined based on Chinese definitions, which may not allow it to be directly compared with population estimates based on different definitions of overweight and obesity (e.g., U.S. Centers for Disease Control and Prevention growth charts[29] or the definitions of the World Health Organization[30,31]). Due to the large scale of the survey conducted, our screen-time viewing measure was collected via children's self-reports, which may be subject to recall bias and result in underestimates of the prevalence of screen-time viewing. Last but not least, children in Grades 1 through 3 in primary schools were excluded, which may limit the generalizability of the prevalence estimates to primary school-aged children.

In conclusion, taking into account previous survey estimates in China, weight status and sedentary time data from the 2016 PAFCTYS show a continued trend of increasing prevalence of overweight, obesity, and screen-time viewing among Chinese school-aged children. Future investigations are needed to understand individual- and school-level correlates of these risk factors. Longitudinal studies are also warranted to monitor the trends and changes in these health-risk measures over time.

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Authors' contributions

YC conceptualized and drafted the initial manuscript and coordinated data collection; XZ conceptualized, drafted the initial manuscript, and carried out the statistical analyses; XW conceptualized and drafted the initial manuscript, carried out the statistical analyses, and supervised data collection. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

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