Meeting 24-h movement guidelines: Prevalence, correlates, and the relationships with overweight and obesity among Chinese children and adolescents

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Methods: Cross-sectional data from the 2017 Youth Study in China of 114,072 children and adolescents (mean age = 13.75 years, 49.18% boys) were used. Meeting 24-h movement guidelines (≥60 min of daily moderate-to-vigorous physical activity, ≤2 h of daily leisure screen time, 9–11 h and 8–10 h nightly sleep duration for 6–13-year-olds and 14–17-year-olds, respectively) and height and weight of all participants were assessed. The prevalence of meeting the 24-h movement guidelines and World Health Organization weight status categories were determined. Generalized linear models were used to determine the correlates of meeting the 24-h movement guidelines and the relationships of meeting the 24-h movement guidelines with overweight (OW) and obesity (OB).

Results: Only 5.12% of Chinese children and adolescents met the 24-h movement guidelines, and 22.44% were classified as OW/OB. Older children and adolescents were less likely to meet the 24-h movement guidelines. Parental education level and family income were positively related to meeting the 24-h movement guidelines. Children and adolescents meeting the 24-h movement guidelines showed lower odds ratios for OW/OB. Compared with participants not meeting the 24-h movement guidelines, boys in 4th–6th grades met none of the recommendations (OR = 1.22, 95%CI: 1.06–1.40), met the screen time recommendation only (OR = 1.13, 95%CI: 1.01–1.28), met the nightly sleep duration recommendation only (OR = 1.14, 95%CI: 1.03–1.28), and had significantly higher odds ratios for OW/OB. Similar trends were observed for girls in 4th–6th grades: meeting none of the guidelines (OR = 1.35, 95%CI: 1.14–1.59), meeting sleep duration guidelines only (OR = 1.23, 95%CI: 1.08–1.39), and meeting moderate-to-vigorous physical activity + nightly sleep duration guidelines (OR = 1.24, 95%CI: 1.01–1.54). For girls in 7th–9th grades, the following trend was observed: meeting none of the guidelines (OR = 1.30, 95%CI: 1.01–1.67).

Conclusion: Very few Chinese children and adolescents met the 24-h movement guidelines. Age (negatively correlated), parental education level, and family income (both positively correlated) were correlates of meeting the 24-h movement guidelines. Children and adolescents meeting the 24-h movement guidelines were more likely to have lower risks for OW/OB, especially in the youngest age group (Grades 4–6); and girls in the middle age group (Grades 7–9) were also more likely to have lower risks for OW/OB. Further research studies should explore additional correlates and determinants for meeting the 24-h movement guidelines. Also, future studies should use longitudinal or interventional designs to determine the relationships between meeting the 24-h movement guidelines and OW/OB and other health indicators, while taking sex and age differences into account.

Keywords: Body weight; China Youth Study; Moderate-to-vigorous physical activity; School-aged children; Screen time; Sleep duration

1. Background

Child and adolescent overweight (OW) and obesity (OB) have been a growing global health problem. Despite increasing
meeting guidelines for healthy 24-h movement behaviors. Two studies indicated that the prevalence of meeting the 24-h movement guidelines in Canadian children and adolescents ranged from 2.6%19 (using the Health Behavior School-aged Children Questionnaire) to 17.5%28 (using the Canadian Health Measures Survey). Lee et al.29 reported that only 3% of South Korean adolescents met the 24-h movement guidelines. This large variation in the prevalence of meeting the guidelines may be due to the use of different measures. Despite the higher accuracy of accelerometers in estimating 24-h movement behaviors, self-reported measures are an ideal measurement method for large-scale monitoring and surveillance owing to their lower testing burden and costs. To our knowledge, however, little is known about the prevalence of meeting the 24-h movement guidelines among young people in China.31

With regard to the correlates of meeting the 24-h movement guidelines, a limited number of studies have been conducted.14,15 Two studies suggested that parental support, residence, and outdoor time were the key correlates.15,16 However, such evidence pertaining to Asia is not available and is insufficient for fully understanding the pattern of movement behaviors in Chinese children and adolescents.32 Further studies are required in this field, especially studies that seek to identify sociodemographic correlates.20

Recent evidence has demonstrated that different combinations of MVPA, ST, and SLP (e.g., MVPA + ST, MVPA + SLP, or all of them) rather than 1 single behavior can lower the risks of OW/OB in children and adolescents.12,21,27,28 For example, Carson et al.27 found that the greater number of guidelines that children and adolescents meet, the lower the odds of their having a high body mass index (BMI) z-score, after controlling for age, sex, and level of parents’ education. Similar findings were also reported by Roman-Vinas et al.12 (who adjusted for sex, age, household education, and diet) and Laurson et al.15,34 (who adjusted for age, grade, and ethnicity). In sum, these studies, which all used objective measures to determine the BMI of participants, consistently showed that having sufficient MVPA, limited ST, and adequate SLP may be effective in preventing OW/OB. However, a study in Asia (Hong Kong, China) generated mixed results and showed that the combination of MVPA, ST, and SLP may not be associated with lower odds of OW/OB (adjusted for sex, age, and clustering school effects).21 These inconsistent findings point to the need for more evidence to clarify the relationships between movement behaviors and OW/OB, especially in Asia. The Behavioral Epidemiology Framework suggests that an essential element in determining whether behaviors should be targeted for intervention is determining the associations between the behaviors and health outcomes.35 However, the relationships reported in previous research have not been investigated in Chinese children and adolescents.32 Thus, studying the relationships as they pertain to Chinese children and adolescents can provide public health insights for OW/OB prevention in China.

Using the time-use epidemiology framework25 as a foundation, and to fill the gaps in the previous literature, the aims of this study were (1) to establish for the first time the prevalence of a national sample of Chinese children and adolescents
meeting the 24-h movement guidelines (in insolation or in combination); (2) to determine, in relation to Chinese children and adolescents, the correlates of meeting the 24-h movement guidelines; and (3) to examine the relationships between meeting the 24-h movement guidelines and OW/OB in Chinese children and adolescents.

2. Methods

2.1. Study design and participants

This study used a sample from a nationwide survey drawn from the 2017 Physical Activity and Fitness in China—The Youth Study (PAFCTYS). The overall study design for PAFCTYS can be found elsewhere. In brief, PAFCTYS is a nationally representative surveillance survey that assessed the physical fitness and health level of children and adolescents in China, with administrative support of the Ministry of Education. Using a multistage sampling design, a balanced representation of geography, economic development, and rural-urban diversity was achieved. Public schools in 31 administrative regions in the mainland of China were recruited. The sampling procedure involved sampling administrative cities and districts, towns, and local community districts that represented a mix of rural and urban areas. The smallest sampling units were primary schools (Grades 4–6), junior middle schools (Grades 7–9), and junior high schools (Grades 10–12). The student sampling took place in classes selected randomly from each grade in the selected schools. The Ministry of Education selected 4 regions in each province or administrative region, of which 1 urban and 1 rural area in each region were identified. In each area (urban or rural), 4 schools (2 primary, 1 junior middle, and 1 junior high schools) were selected. At the school level, 2 classes from each grade in the primary schools, and 1 class from each grade in the junior middle and junior high schools were randomly selected. Using the above procedure, a sex-balanced sample size of more than 30 students for each grade in the primary schools was achieved, and a sample size of more than 60 students was achieved for the junior middle and junior high schools.

Grades 1–3 were not included in this study because of the students’ limited cognitive ability to take part in the study survey. In total, 131,992 targeted students were recruited into the 2017 PAFCTYS. A total of 131,859 students (response rate = 99.90%) completed the questionnaire survey and physical assessments. They were recruited from 490 primary schools, 251 junior middle schools, and 245 junior high schools, from a total of 31 provinces, 4 direct-controlled municipalities, and 6 regions.

The study protocol was approved by the Institutional Review Board of Shanghai University of Sport in 2017, and permission to conduct the study was obtained from the teachers and principals at the participating schools. All the children and adolescents participating in the study and their parents or guardians were informed that participation was voluntary. Verbal informed consent was obtained from all parents or guardians, and positive assent was obtained verbally from all the children before data collection. Data were collected and analyzed anonymously.

2.2. Procedures

All selected students were informed about the research project prior to participation. A research assistant registered each verbal consent/assent, which was put into a subject file with a numeric identification code and subsequently entered into a computer database accessed exclusively by authorized project staff. Data collection took place at school between October and December of 2017. This period was selected so that physical fitness and health examinations could be conducted with administrative support from the Ministry of Education in China. Participants received detailed directions on how to answer the survey. Following a standardized survey-administration protocol, trained research assistants conducted a survey of physical activity and assessment of body weight and height during regular school time. Students first had body weight and height assessments. Then they independently completed the survey questionnaire either online (68%) or on a paper version (32%) in a classroom setting.

2.3. Measures

2.3.1. Demographics and socioeconomic status

Demographic information about the children and adolescents was collected via a student self-reported questionnaire, including gender (boy or girl), grade (4, 5, … 12), ethnicity (Han or others), and residence location (urban or rural).

Socioeconomic status (SES) information, including parental educational level (both parents: less than college or university, college or university or higher; in our study, the former was defined as low education level, while the latter was defined as high education level) and family income per person annually (Chinese currency (RMB): <9000, 9000–30,000, 30,001–100,000, >100,000), was collected via a parent-reported questionnaire based on the method developed by Cirino et al. (reliability coefficient = 0.78, validity coefficient = 0.30).

2.3.2. Movement behaviors

PA was measured by the reliable and valid item derived from the Health Behavior in School-aged Children survey questionnaire (reliability coefficient = 0.82). The following item was used: How many hours did you spend watching TV or movies in your leisure time on
weekdays and weekend days over the past week, respectively? (reliability coefficients: 0.74 and 0.72, respectively); (2) How many hours did you spend playing video games in your leisure time on weekdays and weekend days over the past week, respectively? (reliability coefficients: 0.54 and 0.69, respectively); and (3) How many hours did you spend in activities using electronic screen-based devices in leisure time on weekdays and weekend days over the past week, respectively? (reliability coefficients: 0.33 and 0.50, respectively); The responses to these questions could be: none, about 0.5 h, 1 h, 2 h, or 3 h or more. According to the Canadian 24-Hour Movement Guidelines, meeting the ST guideline requires daily ST ≤ 2 h per day.

SLP was measured by 1 item from the China Health and Nutrition Survey, which has accepted validation (reliability coefficient = 0.83). The item asked participants to report their usual nightly sleep duration (in hours) on a normal day. According to the Canadian 24-Hour Movement Guidelines, 9–11 h are recommended for 6–13-year-olds and 8–10 h are recommended for 14–17-year-olds. Participants who reported the recommended nightly sleep duration were regarded as meeting the SLP guidelines. Based on the above definitions, the combined prevalence(s) were defined as meeting two or all three of the guidelines (e.g., the prevalence of meeting the MVPA, ST, and SLP guidelines).

2.3.3. Weight status

Weight status was determined by BMI, calculated as the participants’ weight–height ratio. These measurements were conducted by well-trained research staff who followed a standardized protocol. Weight was measured to the nearest 0.1 kg with a balance-beam scale while the participants were wearing lightweight clothing. Height was measured to the nearest 0.1 cm with a portable stadiometer while the participants were barefoot. Both measures were assessed using a portable instrument (GMCS-IV; Jianmin, Beijing, China). BMI values were calculated (BMI = Weight (kg)/Height (cm)^2; kg/m^2). According to sex- and age-specific cut-offs for OW and OB established by the World Health Organization, participants were dichotomized into non-OW/OB or OW/OB.

2.4. Statistical analysis

After cleaning invalid and abnormal values of all independent and dependent variables (Fig. 1), the final analytical sample size was 114,072. Descriptive analyses were performed to report the characteristics of the sample, the prevalence of meeting the recommendations (in isolation or in combination), and the prevalence of non-OW/OB and OW/OB. To produce nationally representative results, prevalence estimates (reported as percentages with 95% confidence interval (95%CI)) of the 2017 PAFCVTYS sample were weighted according to the Chinese school-aged population of children in the current school education system (i.e., primary, junior middle, and junior high schools). Because of the non-normal distribution of age and BMI in our sample, Mann-Whitney tests were performed to examine sex differences by age and BMI. Generalized linear models were used to examine the associations between the prevalence of meeting the recommendations (in isolation or in combination) and weight status. Models set the study sites as fixed effects and the school as random effects. There was a sex × age group interaction between the prevalence of meeting the various combinations of the 24-h movement guidelines and weight status. Thus, the models were presented by total samples, and then by sex and age group. The level of statistical significance was set at p < 0.05. Cohen d was calculated as a measure of effect size. All statistical analyses were executed using SPSS (Version 24.0; IBM Corp., Corp. Armonk, NY, USA).

3. Results

The descriptive characteristics of the samples in this study are shown in Table 1. The percentages for boys and girls were 49.18% and 50.82%, respectively. The mean age of the participants was 13.75 ± 2.61 years old (weighted: 13.16, 95%CI: 13.14–13.17), with statistical difference between sex groups (p < 0.001). The mean BMI was 19.93 ± 3.65 and was significantly different between sexes (p < 0.001, Cohen d = 0.06). The proportions of the sample across the 3 age groups were 34.83% (4th–6th graders; weighted: 42.85%, 95%CI: 42.55%–43.16%); 33.21% (7th–9th graders; weighted: 37.28%, 95%CI: 36.98%–37.57%); and 31.96% (10th–12th graders; weighted: 19.87%, 95%CI: 19.67%–20.07%), respectively. Most participants identified as Han ethnicity (86.37%; weighted: 86.19%, 95%CI: 85.98%–86.39%). There were no sex differences in age or ethnicity groups (both p > 0.05, both Cohen d = 0.01). The participants living in urban areas accounted for about 60% (weighted: 61.87%, 95%CI: 61.58%–62.16%) of the sample, and there was a sex difference in residence locations (p < 0.001, Cohen d = 0.02). The majority of participants’ parents had low education levels (81.38%, weighted: 80.92%, 95%CI: 80.68%–81.16%; no sex difference, p = 0.927, Cohen d = 0.01). More than 57% of
|                              | Overall (n = 114,072) | Boys (n = 56,103; 49.18%) | Girls (n = 57,969; 50.82%) | \( p \) | \( d \) |
|------------------------------|-----------------------|--------------------------|--------------------------|--------|--------|
| **Age (year)**               |                       |                          |                          |        |        |
| Unweighted                   | 13.75 ± 2.61          | 13.16                    | 13.14–13.17              |        |        |
| Weighted                     | 13.80 ± 2.61          | 13.20                    | 13.18–13.22              |        |        |
| 95%CI                        | 13.80 ± 2.61          | 13.20                    | 13.18–13.22              |        |        |
| **BMI (kg/m²)**              |                       |                          |                          |        |        |
| Unweighted                   | 19.93 ± 3.65          | 19.65                    | 19.62–19.67              |        |        |
| Weighted                     | 20.23 ± 3.89          | 19.95                    | 19.92–19.98              |        |        |
| 95%CI                        | 19.65 ± 3.38          | 19.35                    | 19.32–19.38              |        |        |
| **Age groups**               |                       |                          |                          |        |        |
| 4th–6th graders              | 39,736 (34.83)        | 42.85                    | 42.55–43.16              |        |        |
| 7th–9th graders              | 37,881 (33.21)        | 37.28                    | 36.98–37.57              |        |        |
| 10th–12th graders            | 36,455 (31.96)        | 19.87                    | 19.67–20.07              |        |        |
| **Ethnicity**                |                       |                          |                          |        |        |
| Han                          | 98,523 (86.37)        | 86.19                    | 85.98–86.39              |        |        |
| Others                       | 15,549 (13.63)        | 13.81                    | 13.61–14.02              |        |        |
| **Residence locations**      |                       |                          |                          |        |        |
| Urban                        | 69,102 (60.58)        | 61.87                    | 61.58–62.16              |        |        |
| Rural                        | 44,970 (39.42)        | 38.13                    | 37.84–38.42              |        |        |
| **Parental education**       |                       |                          |                          |        |        |
| Low education level          | 92,833 (81.38)        | 80.92                    | 80.68–81.16              |        |        |
| High education level         | 21,239 (18.62)        | 19.08                    | 18.84–19.32              |        |        |
| **Family composition**       |                       |                          |                          |        |        |
| Single child                 | 48,763 (42.75)        | 42.20                    | 41.91–42.50              |        |        |
| Two or more children         | 65,309 (57.25)        | 57.80                    | 57.50–58.09              |        |        |
| **Family income/person (RMB/year)** |                   |                          |                          |        |        |
| <9000                        | 36,733 (32.20)        | 31.76                    | 31.48–32.04              |        |        |
| 9001–30,000                  | 41,048 (35.99)        | 36.00                    | 35.71–36.29              |        |        |
| 30,001–100,000               | 28,302 (24.81)        | 24.97                    | 24.72–25.24              |        |        |
| >100,000                     | 7989 (7.00)           | 7.27                     | 7.12–7.43                |        |        |
| **Weight status**            |                       |                          |                          |        |        |
| Non-OV/OB                    | 88,471 (77.56)        | 76.21                    | 75.95–76.47              |        |        |
| OW/OB                        | 25,601 (22.44)        | 23.79                    | 23.53–24.05              |        |        |

Notes: The weighted prevalence uses PAFCTYS sampling weights to be representative of the Chinese grade school population in 2017 (unweighted sample size = 114,072; weighted sample size = 102,739,979). \( d \) denotes effect size.

* High education level was defined as both parents’ educational levels being equal to or higher than college and university.

Abbreviations: 95%CI = 95% confidence interval; BMI = body mass index; MVPA = moderate-to-vigorous physical activity; OB = obesity; OW = overweight; PAFCTYS = Physical Activity and Fitness in China—The Youth Study; SLP = sleep duration; ST = screen time.
families (weighted: 57.80%, 95%CI: 57.50%–58.09%) had 2 or more children (p for sex difference < 0.001, Cohen d = 0.18). Only about 7% (weighted = 7.27%, 95%CI: 7.12%–7.43%) of families had an income > 100,000 RMB per person (p for sex difference < 0.001, Cohen d = 0.06). More than 22% (weighted: 23.79%, 95%CI: 23.53%–24.05%) of participants were classified as OW/OB (p for sex difference < 0.001, Cohen d = 0.27).

Table 2 presents the prevalence of participants meeting various combinations of the 24-h movement guidelines. The percentage meeting the 24-h movement guidelines was 5.12% (weighted: 6.04%, 95%CI: 5.89%–6.19%) (no sex difference, Cohen d = 0.01). The prevalence of meeting the MVPA, ST, and SLP guidelines was 11.80% (weighted: 12.89%, 95%CI: 12.68%–13.10%), 65.26% (weighted: 64.75%, 95%CI: 64.46%–65.03%) and 44.40% (weighted: 50.74%, 95%CI: 50.44%–51.04%), respectively. More boys reported meeting the MVPA and SLP guidelines than did girls (p < 0.001, Cohen d = 0.09 and 0.06, respectively). The prevalence of meeting some combination of the 24-h movement guidelines (e.g., MVPA + ST, MVPA + SLP, and ST + SLP) varied greatly, from 7.10% (weighted: 8.35%, 95%CI: 8.18%–8.53%) to 28.49% (weighted: 32.71%, 95%CI: 32.42%–33.00%). Boys had significantly higher prevalence of the combination of the MVPA + ST guidelines and MVPA + SLP guidelines than did girls (p < 0.001, Cohen d = 0.03 and 0.05, respectively).

The associations between demographics and the prevalence of meeting the 24-h movement guidelines are presented in Table 3. The odds ratios for meeting the 24-h movement guidelines among 4th–6th graders (odds ratio (OR) = 15.70, 95%CI: 13.89–17.74) and 7th–9th graders (OR = 4.10, 95%CI: 3.59–4.67) were significantly higher when compared to 10th–12th graders. Boys living in urban locations were more likely (OR = 1.11, 95%CI: 1.02–1.21) to meet the 24-h movement guidelines compared with either boys or girls living in rural locations. Participants whose parents had high education levels were 1.21 times more likely to meet the 24-h movement guidelines compared to participants whose parents had low education levels. These statistically significant trends were observed for both sexes (OR for boys = 1.25, 95%CI: 1.13–1.37; OR for girls = 1.23, 95%CI: 1.11–1.35). Participants in the higher family-income groups were more likely to meet the 24-h movement guidelines than participants in the lowest family-income group. A consistent gradient related to family income was observed among girls; however, only boys from families with the second highest (30,001–100,000) and the highest (> 100,000) family income categories were significantly more likely to meet the 24-h movement guidelines (OR for the second highest = 1.12, 95%CI: 1.00–1.25; OR for the highest = 1.46, 95%CI: 1.26–1.68). Ethnicity and family composition were not significantly correlated with the prevalence of meeting the 24-h movement guidelines.

Table 4 shows the associations between meeting different 24-h movement guidelines with OW/OB among the participants. After controlling for all the covariates (e.g., sex, grade, and parental education level), meeting none or fewer of the
guidelines showed higher ORs for OW/OB when compared with the group meeting the MVPA+ST+SLP guidelines. However, only meeting none (OR = 1.25, 95%CI: 1.16–1.34), ST (OR = 1.20, 95%CI: 1.12–1.28), SLP (OR = 1.15, 95%CI: 1.07–1.23), and MVPA+SLP (OR = 1.12, 95%CI: 1.01–1.25) guidelines exhibited higher statistically significant odds for OW/OB compared with those meeting the MVPA+ST+SLP guidelines (all \( p < 0.05 \)).

The summarized results for the OR for OW/OB participants meeting the different 24-h movement guidelines by sex and grade levels are shown in Table 5. A general pattern emerged, with lower odds of OW/OB participants’ meeting more 24-h movement guidelines, though most were not significant. The relationships appeared to be stronger in younger children and girls than in adolescents and boys.

### 4. Discussion

Using nationally representative data, this study aimed to investigate the prevalence among Chinese children and adolescents of meeting the 24-h movement guidelines, determine the sociodemographic correlates of the prevalence, and explore the relationships between meeting the integrated guidelines and OW/OB. We found that the prevalence of meeting the integrated guidelines was low, which was associated with age, parental education level, and family income. Meeting the 24-h movement guidelines was related to a lower OR of being OW/OB for boys in the 4th through 6th grades and girls in the 7th through 9th grades but not for the other age or sex groups (though a similar pattern was observed).

Gaining a thorough understanding of prevalence of meeting the 24-h movement guidelines is beneficial in promoting movement behavior in young people. The current study demonstrated that 5.12% (weighted: 6.04%) of Chinese children and adolescents met the 24-h movement guidelines. This is the first study to investigate the prevalence of meeting the 24-h movement guidelines in a nationally representative sample of Chinese children and adolescents. The prevalence found in this study is consistent with level of prevalence found among youth in the USA (5%). Although the level of prevalence of meeting the 24-h movement guidelines in our study was higher than that among children and adolescents in Hong Kong, China (1%), South Korea (3.2%), and Canada (<3%), it...
Table 5
|                | OR  | 95%CI   | OR  | 95%CI   | OR  | 95%CI   |
|----------------|-----|---------|-----|---------|-----|---------|
| **Boys**       |     |         |     |         |     |         |
| None           | 1.22| 1.06–1.40| 1.10| 0.91–1.33| 1.19| 0.80–1.75|
| MVPA           | 1.23| 0.94–1.61| 0.91| 0.68–1.21| 1.08| 0.68–1.74|
| ST             | 1.13| 1.01–1.28| 1.06| 0.88–1.28| 1.21| 0.82–1.78|
| SLP            | 1.14| 1.03–1.28| 0.96| 0.79–1.16| 1.10| 0.72–1.67|
| MVPA+ST        | 0.97| 0.78–1.21| 0.87| 0.68–1.10| 1.06| 0.70–1.62|
| MVPA+SLP       | 1.14| 0.97–1.34| 0.84| 0.62–1.13| 0.59| 0.27–1.26|
| ST+SLP         | 1.06| 0.96–1.17| 0.96| 0.79–1.16| 0.98| 0.65–1.47|
| MVPA+ST+SLP    | 1   | 1       | 1   | 1       |     |         |
| **Girls**      |     |         |     |         |     |         |
| None           | 1.35| 1.14–1.59| 1.30| 1.01–1.67| 2.36| 0.95–5.85|
| MVPA           | 1.24| 0.85–1.81| 1.32| 0.88–1.97| 1.68| 0.58–4.82|
| ST             | 1.13| 0.98–1.30| 1.16| 0.90–1.48| 2.33| 0.94–5.75|
| SLP            | 1.23| 1.08–1.39| 1.17| 0.90–1.52| 2.14| 0.84–5.45|
| MVPA+ST        | 1.02| 0.80–1.31| 1.00| 0.73–1.37| 2.04| 0.80–5.20|
| MVPA+SLP       | 1.24| 1.01–1.54| 1.32| 0.85–2.04| 1.98| 0.44–8.81|
| ST+SLP         | 1.01| 0.90–1.13| 1.14| 0.88–1.47| 1.78| 0.71–4.49|
| MVPA+ST+SLP    | 1   | 1       | 1   | 1       |     |         |

Notes: All models were adjusted for parental education level, ethnicity, residence location, family composition, and family income. Reference group: MVPA+ST+SLP. Abbreviations: 95%CI = 95% confidence interval; MVPA = moderate-to-vigorous physical activity; OR = odds ratio; SLP = sleep duration; ST = screen time.

is lower than the prevalence found in other previously published studies using international and national samples. These variations may be attributed to differences in measurements. For example, some studies used accelerometers to estimate the prevalence, while others used self-reported questionnaires. Considering the cumulative health benefits associated with the prevalence of meeting the guidelines, Compelling evidence has shown that there are age-related declines in MVPA, increases in ST, and lower SLP duration in children and adolescents. To secure improved education, the increased academic pressure that comes with increasing age often results in more time spent studying, which perhaps displaces PA opportunities and SLP. Furthermore, older Chinese children and adolescents typically have mobile smart devices, which increases the probability of sedentary screen-based behaviors. These 2 factors may have contributed to our findings that very few Chinese children and adolescents met the 24-h movement guidelines. Parental education level and family income can be considered strong indicators of SES and have been shown to be significantly correlated with children’s and adolescents’ MVPA, ST, and SLP. The underlying mechanism may be that parents in higher SES categories have better awareness of their children’s health behaviors and help them pursue healthy lifestyles. They may also be able to provide better financial support, which helps to facilitate healthful PA and sport opportunities. However, family SES is hard to modify. Therefore, reinforcing the importance of equitable access to interventions for children and adolescents from different SES levels is necessary. Although our study provides some preliminary evidence for understanding time use in a 24-h time-frame by Chinese children and adolescents, additional studies that explore the association between 24-h movement behaviors and multidimensional factors are encouraged.
SLP) and health. Therefore, if researchers use 24-h movement guidelines, they can better examine the relationship between integrated behaviors within a 24-h cycle and health outcomes, and the implications of their findings for promoting young people’s health will be increased. The relationships between meeting the 24-h movement guidelines and OW and OB have been reported in previous studies. A systematic review by Saunders and colleagues indicated that the combination of sufficient MVPA, limited ST, and adequate SLP may result in lower odds of being OW/OB. Our study supports their findings, which are also supported by other empirical evidence. We found that MVPA may not be an effective predictor of OW and OB, which is inconsistent with other studies that suggest that MVPA is a strong predictor of these conditions. Possible reasons for this inconsistency may lie in the fact that different measures of PA were used. However, our finding that those not meeting the 24-h movement guidelines had the highest OR for OW/ OB compared with those who met the guidelines is consistent with the findings of Roman-Vitas et al. and Laurson et al. Our finding reinforces the importance of combining MVPA, ST, and SLP in the prevention of OW/OB in Chinese children and adolescents rather than promoting a single behavior (MVPA, ST, or SLP) in isolation. Our study supports the time-use epidemiological framework, in which combinations of sufficient MVPA, limited ST, and appropriate SLP lead to improved health conditions in young people. Because our study design does not establish a true cause-and-effect relationship, future studies should address this research issue.

In our study, the relationship between meeting the 24-h movement guidelines and OW/OB varied by age and sex. This finding is in line with previous research. Sex and age differences in biological growth are responsible for different trajectories of weight status among young people. In our study, we found that among children and adolescents in Grades 7–12, there generally was no significant relationship between meeting the 24-h movement guidelines and OW/OB, irrespective of sex, a finding that is not supported by previous studies. Some potential explanations for this inconsistency are useful. First, measurement errors caused by the use of self-reported questionnaires may result in inaccurate measures of movement behaviors, which may skew the link between movement behaviors and OW/OB. Second, evidence has been presented that questions the independent link between ST and SLP and OW/OB in a young population. This implies that ST and SLP may not be determinants of OW/OB. Yet another explanation may be diet. It has been found that childhood and adolescent OW/OB is related to nutrition and diet, especially in developing countries (e.g., China). Diet can cause excessive energy intake, thus contributing to OW/OB. Therefore, it is possible that despite meeting the 24-h movement guidelines, children and adolescents who have unhealthful diets can be at increased risk for OW/OB. These findings may be useful in informing sex- and age-tailored weight interventions.

The strengths of our study include the following. First, we used a large survey sample, which could lead to a wider generalization of the findings for China. Second, our study was the first to examine the association between movement behaviors and weight status in Chinese children and adolescents, and, thus, can inform the design of effective interventions, prevention strategies, and policies. Third, we included additional sociodemographic factors related to meeting the 24-h movement guidelines, which could help researchers to better understand the patterns of movement behaviors. Some limitations, however, should also be mentioned. First, the cross-sectional design of this study precludes conclusions regarding causality between behaviors and weight status. Second, a self-reported questionnaire was used to collect data; therefore, measurement errors could have occurred. Third, our study considered only a few confounders influencing children’s and adolescents’ weight status; some other significant cofounders (e.g., diet and nutrition) were not included.

5. Conclusion and clinical implications

The prevalence of meeting the 24-h movement guidelines among Chinese children and adolescents was relatively low. Unhealthful lifestyles were associated with increasing age, lower parental education level, and lower family income. Meeting the 24-h movement guidelines was related to lower ORs for OW/OB. This relationship was obvious among boys in Grades 4–6 and among girls in Grades 7–9. Future studies should use improved study designs (e.g., longitudinal designs) to determine the correlates/determinants of meeting the 24-h movement guidelines among Chinese children and adolescents. To better understand the relationship between meeting the 24-h movement guidelines and OW/ OB, interventional studies should control for more confounders (e.g., diet and nutrition) while considering sex and age differences.

From a clinical perspective, our study suggests that promoting positive 24-h movement behaviors is needed urgently among Chinese children and adolescents because positive behaviors may, in turn, improve their future health outcomes. Older children and adolescents, especially those with lower parental education levels and lower family incomes, should be targeted as a priority. To address the health issue of OW/OB among children and adolescents, increasing MVPA, limiting screen time and improving sleep duration concurrently may be an effective approach, with sex- and age-specific strategies being encouraged.

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Authors’ contributions

STC, YL, JTH, YT, and PC conceptualized, designed this study, analyzed the data, interpreted the data, and drafted the manuscript; MST provided intellectual guidance in improving the manuscript; ZBC, JZ, ZZ, XW, LW, and YC assisted in revising the manuscript. 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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