

Original article

Prevalence of physical fitness in Chinese school-aged children: Findings from the 2016 Physical Activity and Fitness in China—The Youth Study

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Abstract

Purpose: This study was to present the 2016 prevalence estimates of Chinese school-aged children meeting physical fitness standards and to examine differences by sex and residence locales in children who did not meet fitness standards.

Methods: We conducted cross-sectional analyses of 171,991 children and adolescents (boy: 50.0%, Grades 1–12) who participated in the 2016 Physical Activity and Fitness in China—The Youth Study. The main outcomes were fitness measures, assessed by the 2014 revised Chinese National Student Physical Fitness Standard (CNSPFS), covering areas of aerobic capacity, upper body strength, flexibility, body mass index, abdominal strength, and trunk strength. Children's overall physical fitness performance was categorized, per CNSPFS standards, as excellent, good, pass, or no pass. Data on the prevalence of physical fitness categories and not meeting fitness standards (i.e., among children who received a “no pass” mark) were analyzed, through logistic regression, by sex (boy, girl) and residence locales (urban, rural) across 3 school grades (primary, junior middle, and junior high).

Results: In 2016, 5.95% of Chinese children and adolescents achieved an “excellent” mark, 25.80% received a “good” rating, 59.90% received a “pass”, and 8.35% received a “no pass”. Overall, boys were more likely to not pass the fitness standards compared with girls (adjusted odds ratio (aOR) = 1.710; 95% confidence interval (CI): 1.708–1.712) and children living in urban areas were more likely to not pass the standards than those living in rural areas (aOR = 1.298; 95%CI: 1.296–1.299). Consistent patterns of not meeting fitness standards were also found by sex and residence locales across all 3 school grades.

Conclusion: In the Chinese school-aged population, about 3 in 10 children achieved an “excellent” or “good” fitness standard in 2016, and about 8% of this population did not meet CNSPFS standards. Children living in urban areas were more likely to not meet minimum fitness performance levels, and boys in school were more likely to not meet minimum fitness performance levels than girls.

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Keywords: Cardiorespiratory endurance; Children; Fitness; Flexibility; Muscular strength; Physical activity

1. Introduction

Physical fitness, commonly consisting of cardiorespiratory endurance, muscle strength endurance, flexibility, and body composition, is an important health marker¹ and is a critical part of the overall physical and mental health and growth in school-aged children.² Physical fitness has been shown to be positively

associated with cognition,^{2,3} weight status,⁴ psychological well-being,⁵ academic achievement scores,^{2,6,7} and performance of real-world tasks.⁸ Low physical activity or fitness, in contrast, can lead to the development of cardiovascular disease risks and an increased prevalence of cardiovascular disease risk factors in childhood,⁹ which can, in turn, track into adulthood.¹

The public health importance of physical fitness in school-aged children suggests the need to include systematic physical fitness assessment in health monitoring and promotion for young populations. The importance of adopting this practice is even greater in China in light of the major social, demographic, and epidemiologic changes over the past 3 decades that have

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impacted the nutrition and behavioral lifestyles of many Chinese school children. Evidence from national fitness assessments of school children indicates a clear trend of decline in various indicators of physical fitness over a 20-year period, with increased levels of body mass index (BMI).¹⁰ A leveling-off of the early declining trend in fitness was reported in 2010 and 2014, but an increase in BMI continued.^{11,12} However, given the recent negative trends in low physical activity¹³⁻¹⁵ and rates of obesity^{16,17} among children and adolescents, the need for monitoring and tracking school children's physical fitness remains as a high public health priority. Filling this knowledge gap will also help support the development and implementation of childhood cardiovascular risk surveillance programs.

The 2016 Physical Activity and Fitness in China—The Youth Study (PAFCTYS) used the 2014 revised fitness standards to carry out a comprehensive assessment conducted by trained examiners. By analyzing the data from the PAFCTYS, the purposes of this study were to present the most recent prevalence estimates of Chinese school-aged children meeting physical fitness standards and to examine differences by sex and residence locale in children who did not meet the current fitness standards.

2. Methods

2.1. Study design and participants

The PAFCTYS is a cross-sectional study involving surveys of physical activity and assessment of physical fitness among Chinese school-aged children in 2016. The PAFCTYS applied a multistage stratified cluster sampling method to recruit a total of 195,047 children in Grades 1 through 12 from 1036 schools in 32 provinces, municipalities, and autonomous regions across the country. No power calculations were conducted on the sample size. Details of the study design and methodologies are described elsewhere.¹⁸ The study protocol was approved by the Institutional Review Board of Shanghai University of Sport. Informed consent was obtained from the all participating children's parents or guardians, and verbal agreement to participate was obtained from all the children prior to the survey.

From the total sample, we analyzed the data from 171,991 children (88%) from 3 school grade categories in the Chinese education system: primary schools (Grades 1–6), junior middle schools (Grades 7–9), and junior high schools (Grades 10–12). These children participated in the grade- and sex-specific physical fitness assessment and provided complete anthropometric measurement data. A total of 23,056 children (12%, 8608 in primary schools, 3726 in junior middle schools, and 10,722 in junior high schools) were excluded from the original PAFCTYS data because some participants were unable to fully complete the physical fitness test battery or because assessments for some participating schools were cancelled on severe air pollution days.

2.2. Data collection

Measures of physical fitness were collected by trained regional research staff and assistants (test examiners) who were

recruited from 32 universities or colleges in China. These individuals completed an orientation and training course, conducted by the investigators, on fitness assessment using the Chinese National Student Physical Fitness Standard (CNSPFS) battery.¹⁹ Study outcome measurements were taken using standard protocols on school campuses during regular school hours. Prior to assessment, participating children were given detailed information and instructions on the fitness assessment and were provided with ample time to ask questions about it. Data collection was conducted in all schools concurrently from October to November, 2016.

2.3. Measures

Physical fitness was assessed using the revised 2014 version of the CNSPFS,¹⁹ which involves a total of 11 fitness indicators described below. Following the guidelines, test examiners conducted each test per a protocol determined *a priori*. Each fitness indicator score was weighted by a grade- and sex-specific percentage (see [Table S1](#) in the online supplement).

2.3.1. BMI

BMI was used as a surrogate of body composition. Children's height was measured to the nearest 0.1 cm in bare feet whereas body weight was measured to the nearest 0.1 kg. Both of these measures were assessed using a portable instrument (GMCS-IV; Jianmin, Beijing, China). From these values, BMI values were calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Anthropometric measures were obtained from the children in each of the 3 grade categories (i.e., primary, junior middle, and junior high schools).

2.3.2. Vital capacity (VC) of lung

In a quiet assessment setting, children's vital capacity (VC) was assessed via spirometry. VC is defined as the maximum volume of air (measured in milliliters) a child can expel from his or her lungs after a maximum inhalation. The test was repeated 3 times on each child, and his or her best performance from the 3 tests was recorded. The VC evaluation measure was obtained from the children of all 3 school grade categories.

2.3.3. 50 m sprint

To assess speed in this test, children were instructed to run in a straight line on a flat and clear surface as fast as possible for a 50 m distance. This test was performed once (as a single maximum sprint) for each child, and the time for the run was recorded, at the finish line, to the nearest 0.1 s. This measure was assessed for all participating children.

2.3.4. Sit and reach

As a flexibility indicator, children were instructed to perform a sit and reach test. In a seated position with both knees fully extended and feet placed firmly against a vertical support, children were asked to reach forward with their hands, along a measuring line, as far as possible. Two trials were given to each child, with the score recorded (measured to the nearest 0.1 cm) on the farthest distance reached in the 2 trials. This measure was assessed for all participating children.

2.3.5. Timed rope-skipping

As a measure of motor coordination, children were instructed to perform a rope-skipping task requiring that they take off and land on both feet. After determining appropriate size and length of rope for each child, the child was asked to jump continuously for 1 min, with the total number of jumps recorded. This measure was assessed only for primary school children (Grades 1–6).

2.3.6. Timed sit-ups

As a measure of abdominal muscle strength, children were instructed to perform a 1 min sit-up test. The protocol required that children lay in a supine position with the knees bent and feet flat on a floor mat (secured by the test examiner) with their hands placed on the back of the head and fingers crossed. During the performance, children were also instructed to elevate their trunk until the elbows made contact with the thighs and then return to the starting position by lowering their shoulder blades to the mat. Children were asked to perform as many sit-ups as possible during the 1 min test period. The test examiner counted and recorded the number of sit-ups. This measure was assessed for primary school children (Grades 3–6) and for junior middle and junior high school girls.

2.3.7. 50 m × 8 shuttle run

This test required the children to run back and forth 8 times along a straight track line between 2 poles set 50 m apart. Children were instructed to run at their maximum speed and, at the end of the track line, turn around at a pole in a counter-clockwise direction, and run back to the starting line. Each child performed a single trial, and his or her time was recorded to the nearest second. This measure was assessed only in primary school children (Grades 5 and 6).

2.3.8. Standing long jump

Children were instructed to stand with feet together behind a starting line marked on the ground and to vigorously push off with both feet and jump forward as far as possible. The jumping distance was measured from the take-off line to the nearest point of contact on the landing (back of the heels). Three attempts were allowed, with the longest distance jumped used as the measurement (in cm). This measure was obtained for junior middle and junior high school children.

2.3.9. Pull-ups

As an upper-body strength test, children were instructed to perform a series of pull-ups. Assuming an upright position, with a light jump (a lift was given, if needed, by the test examiner), children grasped an overhead bar using an overhand grip (palms facing away from the body) with arms fully extended. Children were asked to use their arms to pull the body up until the chin cleared the top of the bar and then lower their body again to a position with the arms extended. The performance was repeated as many times as possible, with the total number of completed pull-ups recorded. This measure was assessed only for junior middle and junior high school boys.

2.3.10. 1000 m and 800 m run

This was a sex-specific test of endurance. The test involved running 1000 m for boys and 800 m for girls. Children were instructed to run at their fastest pace on a track line. Walking or slow jogging was allowed as an option for children who were unable to perform the test or had to stop for a rest during the assessment. Each child's performance time on this test was recorded to the nearest second. This measure was assessed for junior middle and junior high school children.

2.4. Statistical analysis

Data were entered centrally and verified by a trained group of research staff. Preliminary analyses were conducted to verify data discrepancies and check data distribution. Children's physical fitness scores from the 11 fitness indicators were first calculated using grade- and sex-specific weights defined by the 2014 revised CNSPFS, and weighted scores were subsequently categorized into the categories of excellent (defined as having scores of ≥ 90.0), good (scores 80.0–89.9), pass (scores 60.0–79.9), or no pass (scores < 60.0).

Taking the cluster sampling of the PAFCTYS design into account, the physical fitness data were weighted against clustering of schools and analyzed using the Complex Samples option in SPSS Version 23.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics on the specific indicators of physical fitness and prevalence estimates of meeting physical fitness standards were calculated by school grades (primary, junior middle, and junior high), sex (boy, girl), and residence locales (urban, rural). Because residence information was not available for children in Grades 1–3, 64,903 children were excluded in examining urban–rural differences. In addition, no direct comparisons on the physical fitness indicators were made across the 3 school grades due to the lack of consistency in the fitness measures.

To examine differences in meeting fitness standards among children, a dichotomized variable was made (no pass (scores < 60.0) vs. pass (scores ≥ 60.0)), and logistic regression analyses were used to analyze differences in sex and residence locales for the total sample. Subgroup analyses on not meeting fitness standards were also by sex and sex within residence locales across school grades (primary, junior middle, and junior high). All analyses controlled for children's chronologic age. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) on the prevalence estimates of not meeting fitness standards were calculated. The level of significance was set at an α level of < 0.05 . No adjustments were made for multiple comparisons.

3. Results

A total of 171,991 children (89,949 in primary schools, 43,996 in junior middle schools, 38,046 in junior high schools) aged 6–17 years (11.5 ± 3.4 years, mean \pm SD) participated in the national fitness assessment of the 2016 PAFCTYS. Descriptive information on sample sizes and participants' age, height, and weight, shown by school grade, sex, and residence locales, are presented in [Table 1](#).

Table 1
Demographic and anthropometric characteristics of participants by school grade, sex, and residence locale from the 2016 Physical Activity and Fitness in China—The Youth Study.

	Sample size (<i>n</i>)	Age (year) ^c	Height (cm) ^c	Weight (kg) ^c
Grade school^a				
Primary	89,949	8.8 ± 1.8	134.3 ± 11.6	31.7 ± 9.4
Junior middle	43,996	13.3 ± 1.1	159.2 ± 8.4	50.5 ± 11.0
Junior high	38,046	16.0 ± 0.9	165.6 ± 8.4	57.9 ± 10.9
Sex^a				
Boy				
Primary	45,152	8.8 ± 1.8	134.5 ± 11.3	32.4 ± 9.6
Junior middle	22,031	13.4 ± 1.1	162.0 ± 9.2	52.4 ± 12.4
Junior high	18,782	16.0 ± 0.9	171.4 ± 6.4	62.5 ± 11.5
Girl				
Primary	44,797	8.7 ± 1.8	134.0 ± 11.9	30.9 ± 9.1
Junior middle	21,965	13.3 ± 1.1	156.3 ± 6.2	48.5 ± 8.8
Junior high	19,264	16.0 ± 0.9	159.8 ± 5.7	53.4 ± 8.1
Residence locale^b				
Urban				
Primary	19,843	10.2 ± 1.0	144.3 ± 8.6	38.6 ± 9.7
Junior middle	16,974	13.2 ± 1.0	160.8 ± 8.2	52.6 ± 11.6
Junior high	15,618	16.0 ± 0.9	167.0 ± 8.3	59.9 ± 11.7
Urban boy				
Primary	9731	10.2 ± 1.0	144.2 ± 8.4	39.5 ± 10.1
Junior middle	8455	13.2 ± 1.0	164.0 ± 8.9	55.4 ± 13.0
Junior high	7798	16.0 ± 0.8	173.0 ± 6.1	65.2 ± 12.0
Urban girl				
Primary	10,112	10.2 ± 0.9	144.4 ± 8.7	37.7 ± 9.1
Junior middle	8519	13.1 ± 1.0	157.7 ± 6.0	49.9 ± 9.3
Junior high	7820	15.9 ± 0.9	161.1 ± 5.5	54.5 ± 8.4
Rural				
Primary	18,561	10.3 ± 1.0	141.5 ± 8.6	35.7 ± 8.7
Junior middle	20,186	13.4 ± 1.1	158.0 ± 8.2	48.9 ± 10.2
Junior high	15,906	16.0 ± 0.9	164.2 ± 8.2	56.2 ± 10.0
Rural boy				
Primary	9327	10.4 ± 1.0	141.3 ± 8.4	36.2 ± 9.0
Junior middle	9916	13.4 ± 1.1	160.8 ± 9.1	50.4 ± 11.5
Junior high	7626	16.0 ± 0.9	170.1 ± 6.2	60.2 ± 10.5
Rural girl				
Primary	9234	10.3 ± 1.0	141.8 ± 8.7	35.3 ± 8.3
Junior middle	10,270	13.3 ± 1.1	155.4 ± 6.1	47.5 ± 8.4
Junior high	8280	16.0 ± 0.9	158.8 ± 5.6	52.4 ± 7.7

^a Based on a sample size of 171,991 (boys = 85,965; girls = 86,026).

^b Based on a sample size of 107,088 with 52,435 children (boys = 25,984; girls = 26,451) living in urban areas and 54,653 children (boys = 26,869; girls = 27,784) living in rural areas.

^c Data presented as mean ± SD.

Complete fitness data were obtained for 89,949 primary school children on 5 indicators: BMI, VC, 50 m sprint, sit and reach, and timed rope-skipping. In addition, grade-specific measures were ascertained for timed sit-ups for 59,276 children in Grades 3–6 and for the 50 m × 8 shuttle run for 29,025 children in Grades 5–6. For junior middle and junior high school boys, fitness data were obtained for 40,813 boys for 7 fitness indicators: BMI, VC, 50 m sprint, sit and reach, standing long jump, pull-ups (sex-specific), and 1000 m run (sex-specific). Data were obtained for 41,229 girls for a similar set of 7 indicators: BMI, VC, 50 m sprint, sit and reach, standing long jump, timed sit-ups (sex-specific), and 800 m run (sex-specific).

The lack of consistent measures across school grades and sex reflect different fitness testing standards adopted in CNSPFS.¹⁷ Table 2 shows descriptive statistics on the 11 physical fitness indicators overall and separated by sex and residence locales across school grades.

3.1. Prevalence estimates

Prevalence estimates (data not shown) from the 2016 PAFCTYS show that, overall, more than 90% of Chinese school-aged children met the fitness testing standards, with 5.95% reaching an “excellent” performance mark, 25.80% reaching “good”, and 59.90% reaching “pass”. A total of 8.35% of the children were marked as “no pass” in their levels of fitness performance testing. Estimates by sex and residence locales across the 3 school grades in the study are shown in Table 3.

3.2. Differences by sex and sex within residence locale

Results from the whole sample (data not shown) show that relative to girls, boys (aOR = 1.710; 95%CI: 1.708–1.712) were more likely to not achieve the fitness performance standards, and that relative to children living in rural locales, children living in urban areas were more likely to not achieve the fitness standards (aOR = 1.298; 95%CI: 1.296–1.299). Estimates of not meeting fitness standards by sex and sex within residence locale across school grade are shown in Table 4. Largely consistent with the estimates generated from the total sample, results indicate that, relative to girls, boys in primary, junior middle, and junior high schools were more likely to not meet the fitness standards. Within the residence locale strata, with the exception of the insignificant estimate on primary school boys and girls living in rural areas ($p = 0.09$), boys living in urban areas across all 3 school grades were more likely to not meet the standards compared to girls.

4. Discussion

The 2016 PAFCTYS fitness assessment data, which use newly revised standards,¹⁹ show that a relatively small percentage of Chinese school-aged children achieved an “excellent” (5.95%) or “good” (25.80%) mark in their overall physical fitness performance. A significant number of children (59.90%) were marked as “pass”. Approximately 8% of the children assessed in 2016 received a “no pass” mark. Significant sex and urban–rural differences exist among children in meeting fitness standards, with more school boys not achieving fitness standards compared to girls, and children living in urban areas being less likely to achieve fitness standards than those living in rural areas in China.

With the exception of a few national reports issued between 2005 and 2014,^{10–12} there have been few recently published studies or reports in China on physical fitness among school-aged children. Using the PAFCTYS data, our report provides the most recent updates on the prevalence of Chinese children meeting physical fitness standards. Our findings indicate that the prevalence of meeting minimum fitness standards remains low. Most notably, only about 6% of the children in the

Table 2

Means and standard deviations on individual physical fitness indicators overall and separated by sex and residence locale across school grades from the 2016 Physical Activity and Fitness in China—The Youth Study.

Physical fitness indicator	Primary (<i>n</i> = 89,949)	Junior middle (<i>n</i> = 43,996)	Junior high (<i>n</i> = 38,046)
Total			
BMI (kg/m ²)	17.28 ± 2.96	19.82 ± 3.26	21.06 ± 3.11
VC (mL)	1677.94 ± 584.11	2742.85 ± 833.74	3385.59 ± 1020.35
50 m sprint (s)	10.46 ± 1.26	8.89 ± 1.04	8.49 ± 1.17
Sit and reach (cm)	9.36 ± 5.89	10.37 ± 7.19	13.51 ± 7.04
Timed rope-skipping (<i>n</i>) ^a	89 (60–117)	—	—
Timed sit-ups (<i>n</i>)	28.02 ± 10.84	29.25 ± 10.44	31.95 ± 10.37
50 m × 8 shuttle run (s)	116.01 ± 12.90	—	—
Standing long jump (cm)	—	175.20 ± 29.31	193.90 ± 35.24
Pull-ups (<i>n</i>) ^a	—	1 (0–4)	3 (1–6)
1000 m run (s)	—	284.59 ± 44.37	258.02 ± 30.65
800 m run (s)	—	251.28 ± 30.12	249.30 ± 27.07
Boy			
BMI (kg/m ²)	17.64 ± 3.13	19.84 ± 3.51	21.21 ± 3.39
VC (mL)	1766.46 ± 601.05	3082.64 ± 867.35	4042.40 ± 900.86
50 m sprint (s)	10.21 ± 1.24	8.30 ± 0.87	7.57 ± 0.61
Sit and reach (cm)	7.49 ± 5.69	7.94 ± 7.06	11.84 ± 7.23
Timed rope-skipping (<i>n</i>) ^a	83 (52–113)	—	—
Timed sit-ups (<i>n</i>)	30.03 ± 10.62	—	—
50 m × 8 shuttle run (s)	113.49 ± 13.30	—	—
Standing long jump (cm)	—	192.05 ± 27.25	222.06 ± 23.35
Pull-ups (<i>n</i>) ^a	—	1 (0–4)	3 (1–6)
1000 m run (s)	—	284.59 ± 44.37	258.02 ± 30.65
Girl			
BMI (kg/m ²)	16.92 ± 2.73	19.80 ± 2.99	20.92 ± 2.81
VC (mL)	1589.02 ± 552.48	2403.4 ± 638.31	2744.34 ± 657.94
50 m sprint (s)	10.71 ± 1.24	9.48 ± 0.84	9.39 ± 0.84
Sit and reach (cm)	11.23 ± 5.49	12.79 ± 6.48	15.15 ± 6.44
Timed rope-skipping (<i>n</i>) ^a	95 (68–121)	—	—
Timed sit-ups (<i>n</i>)	26.00 ± 10.69	29.25 ± 10.44	31.95 ± 10.37
50 m × 8 shuttle run (s)	118.53 ± 11.95	—	—
Standing long jump (cm)	—	158.36 ± 20.20	166.41 ± 19.81
800 m run (s)	—	251.28 ± 30.12	249.30 ± 27.07
Urban^b			
BMI (kg/m ²)	18.35 ± 3.26	20.27 ± 3.49	21.33 ± 3.32
VC (mL)	2051.79 ± 566.07	2836.71 ± 855.19	3494.04 ± 1029.60
50 m sprint (s)	9.77 ± 0.92	8.87 ± 1.05	8.44 ± 1.15
Sit and reach (cm)	9.06 ± 6.48	10.11 ± 7.43	13.05 ± 7.30
Timed rope-skipping (<i>n</i>) ^a	106 (80–131)	—	—
Timed sit-ups (<i>n</i>)	30.10 ± 10.93	30.75 ± 10.84	34.39 ± 10.41
50 m × 8 shuttle run (s)	117.06 ± 13.35	—	—
Standing long jump (cm)	—	173.76 ± 29.62	193.93 ± 35.28
Pull-ups (<i>n</i>) ^a	—	0 (0–3)	2 (0–5)
1000 m run (s)	—	287.76 ± 46.22	260.71 ± 31.97
800 m run (s)	—	254.83 ± 31.02	253.49 ± 28.05
Urban boy^b			
BMI (kg/m ²)	18.83 ± 3.46	20.48 ± 3.81	21.68 ± 3.59
VC (mL)	2153.29 ± 579.59	3208.41 ± 884.90	4162.71 ± 890.59
50 m sprint (s)	9.56 ± 0.91	8.29 ± 0.89	7.54 ± 0.61
Sit and reach (cm)	6.51 ± 6.00	7.20 ± 7.16	11.07 ± 7.37
Timed rope-skipping (<i>n</i>) ^a	101 (73–129)	—	—
Timed sit-ups (<i>n</i>)	31.82 ± 10.80	—	—
50 m × 8 shuttle run (s)	115.07 ± 14.16	—	—
Standing long jump (cm)	—	190.70 ± 28.13	221.54 ± 23.64
Pull-ups (<i>n</i>) ^a	—	0 (0–3)	2 (0–5)
1000 m run (s)	—	287.76 ± 46.22	260.71 ± 31.97
Urban girl^b			
BMI (kg/m ²)	17.88 ± 2.98	20.06 ± 3.13	20.99 ± 2.99
VC (mL)	1953.77 ± 534.71	2474.69 ± 644.49	2823.57 ± 655.63
50 m sprint (s)	9.97 ± 0.88	9.44 ± 0.86	9.33 ± 0.83

(continued on next page)

Table 2 (continued)

Physical fitness indicator	Primary (<i>n</i> = 89,949)	Junior middle (<i>n</i> = 43,996)	Junior high (<i>n</i> = 38,046)
Sit and reach (cm)	11.53 ± 5.95	12.95 ± 6.55	15.03 ± 6.65
Timed rope-skipping (<i>n</i>) ^a	110 (86–133)	—	—
Timed sit-ups (<i>n</i>)	28.43 ± 10.78	30.75 ± 10.84	34.39 ± 10.41
50 m × 8 shuttle run (s)	118.97 ± 12.23	—	—
Standing long jump (cm)	—	157.26 ± 20.22	166.25 ± 20.03
800 m run (s)	—	254.83 ± 31.02	253.49 ± 28.05
Rural ^b			
BMI (kg/m ²)	17.67 ± 3.00	19.44 ± 3.00	20.77 ± 2.91
VC (mL)	1932.45 ± 553.32	2664.03 ± 786.24	3297.97 ± 982.10
50 m sprint (s)	9.73 ± 0.90	8.91 ± 1.03	8.55 ± 1.18
Sit and reach (cm)	9.40 ± 5.87	10.87 ± 6.89	14.07 ± 6.72
Timed rope-skipping (<i>n</i>) ^a	105 (80–128)	—	—
Timed sit-ups (<i>n</i>)	28.05 ± 10.28	27.79 ± 9.84	30.19 ± 9.82
50 m × 8 shuttle run (s)	114.92 ± 12.01	—	—
Standing long jump (cm)	—	176.44 ± 28.53	193.75 ± 35.04
Pull-ups (<i>n</i>) ^a	—	2 (0–4)	4 (1–7)
1000 m run (s)	—	280.72 ± 41.88	256.09 ± 29.52
800 m run (s)	—	248.67 ± 29.01	246.59 ± 26.16
Rural boy ^b			
BMI (kg/m ²)	17.98 ± 3.16	19.28 ± 3.17	20.72 ± 3.14
VC (mL)	2045.68 ± 565.81	2989.43 ± 820.59	3956.21 ± 874.28
50 m sprint (s)	9.45 ± 0.87	8.29 ± 0.83	7.58 ± 0.61
Sit and reach (cm)	7.77 ± 5.69	8.69 ± 6.80	12.76 ± 6.99
Timed rope-skipping (<i>n</i>) ^a	99 (72–121)	—	—
Timed sit-ups (<i>n</i>)	30.49 ± 9.97	—	—
50 m × 8 shuttle run (s)	111.70 ± 11.96	—	—
Standing long jump (cm)	—	193.77 ± 25.99	223.04 ± 22.90
Pull-ups (<i>n</i>) ^a	—	2 (0–4)	4 (1–7)
1000 m run (s)	—	280.72 ± 41.88	256.09 ± 29.52
Rural girl ^b			
BMI (kg/m ²)	17.36 ± 2.79	19.59 ± 2.82	20.82 ± 2.68
VC (mL)	1819.20 ± 516.27	2354.60 ± 607.66	2701.15 ± 630.02
50 m sprint (s)	10.02 ± 0.84	9.50 ± 0.83	9.43 ± 0.84
Sit and reach (cm)	11.02 ± 5.59	12.94 ± 6.32	15.25 ± 6.24
Timed rope-skipping (<i>n</i>) ^a	110 (88–132)	—	—
Timed sit-ups (<i>n</i>)	25.62 ± 10.01	27.79 ± 9.84	30.19 ± 9.82
50 m × 8 shuttle run (s)	118.12 ± 11.18	—	—
Standing long jump (cm)	—	159.95 ± 19.69	167.19 ± 19.56
800 m run (s)	—	248.67 ± 29.01	246.59 ± 26.16

^a Expressed as median along with interquartile range as it was not normally distributed.

^b Based on a sample size of 107,088 (primary = 38,404; junior middle = 37,160; junior high = 31,524), with 52,435 children (boys = 25,984; girls = 26,451) living in urban areas and 54,653 children (boys = 26,869; girls = 27,784) living in rural areas.

Abbreviations: “—” = not evaluated; BMI = body mass index; VC = vital capacity.

PAFCTYS achieved an “excellent” fitness status, which points to the major public health challenge materializing from the nation’s *Healthy China 2030* goal of achieving 25% “excellent” performance in physical fitness among Chinese youth.²⁰

The low prevalence of “excellent” performance corresponds to the continued and chronic trend of physical inactivity or sedentary behaviors among Chinese children, leading to an epidemic of obesity^{11,14,21} and low, unchanged levels of physical activity among Chinese school-aged children.^{13,18} An early report on physical fitness showed a 2-decade decline in children’s fitness,⁹ and another study, the 2010 National Physical Fitness and Health Surveillance, showed a low level of physical activity, with about 77% of primary and junior middle school children failing to meet the recommendations.²² Estimates from the 2016 PAFCTYS provide additional evidence suggesting that the nation’s overall physical fitness level

among school children remains low, with more than 8% of the population failing to pass the current fitness standards. The results from this study and other studies on physical activity, physical inactivity, and obesity speak collectively to the urgent need for school-based public health interventions to improve the current status of physical health among Chinese children.

4.1. Strengths and weaknesses

This study has some notable strengths. First, we used the most up-to-date fitness assessment requirements and standards,¹⁹ which are specifically tailored toward children in different school grades. Therefore, the estimates presented provide the most comprehensive and recent data available and may help serve as a milestone for future annual assessment efforts and baseline estimates for tracking and evaluating

Table 3
Prevalence of meeting physical fitness standards (“excellent”, “good”, “pass”, or “no pass”) overall and separated by sex and residence locale across school grades, from the 2016 Physical Activity and Fitness in China—The Youth Study (%).

	Primary	Junior middle	Junior high
Total^a			
Excellent	7.89	3.65	2.00
Good	28.46	22.85	20.01
Pass	56.87	62.05	68.67
No pass	6.78	11.45	9.32
Boy			
Excellent	8.26	3.69	2.13
Good	25.92	17.80	17.10
Pass	57.71	62.76	70.64
No pass	8.11	15.75	10.13
Girl			
Excellent	7.51	3.60	1.87
Good	31.00	27.89	22.85
Pass	56.04	61.36	66.75
No pass	5.45	7.15	8.53
Residence locale^b			
Urban			
Excellent	8.05	3.94	1.99
Good	28.77	22.74	19.74
Pass	57.33	59.81	68.11
No pass	5.85	13.51	10.16
Urban boy			
Excellent	9.07	3.76	1.93
Good	26.55	16.59	15.14
Pass	57.31	60.78	71.06
No pass	7.07	18.87	11.87
Urban girl			
Excellent	7.06	4.12	2.06
Good	30.91	28.73	24.35
Pass	57.35	58.86	65.15
No pass	4.68	8.29	8.44
Rural			
Excellent	5.15	3.32	2.13
Good	27.77	23.79	20.79
Pass	61.68	63.54	68.90
No pass	5.40	9.35	8.18
Rural boy			
Excellent	6.39	3.42	2.41
Good	28.83	18.98	19.15
Pass	59.39	65.36	70.24
No pass	5.39	12.24	8.20
Rural girl			
Excellent	3.91	3.21	1.88
Good	26.72	28.38	22.28
Pass	63.97	61.81	67.68
No pass	5.40	6.60	8.16

^a Based on an analytic sample size of 171,991 children (boys = 85,965; girls = 86,026).

^b Based on a sample size of 107,088, with 52,435 children (boys = 25,984; girls = 26,451) living in urban areas and 54,653 children (boys = 26,869; girls = 27,784) living in rural areas.

changes over time. Second, unlike previous large-scale national fitness assessments,¹⁰⁻¹² the PAFCTYS employed a rigorous methodology, which included the use of established assessment protocols, quality control of data collection, and measures that were taken by trained fitness test examiners (rather than by physical education teachers, as has been routinely done in other

Table 4
Odds of not meeting Chinese fitness standards among Chinese school-aged children by sex and sex within residence locale across school grade.

	aOR (95%CI) ^c		
	Primary	Junior middle	Junior high
Sex^a			
Boy	1.547 (1.545–1.550)	2.513 (2.508–2.518)	1.203 (1.200–1.206)
Girl	1 (reference)	1 (reference)	1 (reference)
Residence locale^b			
Urban			
Boy	1.588 (1.582–1.593)	2.715 (2.708–2.723)	1.449 (1.444–1.455)
Girl	1 (reference)	1 (reference)	1 (reference)
Rural			
Boy	1.003 (1.000–1.007)	2.021 (2.015–2.027)	1.009 (1.004–1.013)
Girl	1 (reference)	1 (reference)	1 (reference)

^a Based on an analytic sample size of 171,991 children (boys = 85,965; girls = 86,026).

^b Based on a sample size of 107,088 with 52,435 children (boys = 25,984; girls = 26,451) living in urban areas and 54,653 children (boys = 26,869; girls = 27,784) in rural areas.

^c Rounded to 3 decimal places for precision.

Abbreviations: aOR = adjusted odds ratio; CI = confidence interval.

national surveys). Finally, the PAFCTYS provided wide national coverage of cities and regions (including Xinjiang Production and Construction Corps, an independent division within Xinjiang Uighur Autonomous Region), increasing the representativeness of the Chinese school student population and the generalizability of the findings.

There are some major limitations of the study that should be noted. First, as was the case in previous reports,¹⁰⁻¹² data collected from the 2016 PAFCTYS only provided a snapshot of fitness performance levels among Chinese school-aged children. Future efforts are needed to measure and track trends in children’s fitness levels across time. Second, due to the lack of a standardized test protocol and differences in test measures, it is impossible to make a meaningful comparison between the PAFCTYS prevalence data and other domestic^{4,10-12} and international studies.²³ Relatedly, the use of grade- and sex-specific fitness test standards may have been confounded with children’s chronologic age. Therefore, the current estimates should be interpreted with this caution in mind. Third, the lack of survey information from children in Grades 1–3 may have significantly reduced the generalizability of the study findings. Last but not least, narrow CIs were found around aOR estimates. While these may indicate accuracy and precision in the estimates, it is also plausible that the sample weights used in this study may have resulted in low variance in the fitness data. Because the PAFCTYS used a multistage sampling scheme, the sampling weights applied to account for cluster sampling may not have fully taken into account all aspects of the sampling design to adjust for probabilities of sample selection, differential sampling, and nonresponse that are required to produce nationally representative estimates. This is an issue that needs to be addressed in future sampling designs in order to draw valid conclusions about population fitness from sample data.

4.2. Future directions for the field

Major efforts are needed to improve fitness standards, strengthen assessment methodologies, and expand knowledge of fitness testing. First, future research needs to refine and standardize sex- and grade-specific fitness test items. This effort will allow direct comparisons across various assessments. Second, criterion-related validation studies are needed to provide validity evidence of current fitness standards. There is also a concomitant need to develop stringent measurement protocols and weighting procedures for assessing body composition, aerobic fitness, and musculoskeletal fitness and to establish training requirements and certification programs for test examiners and administrators. Third, with continuing efforts and plans for collecting annual fitness surveillance data, there is a need to examine temporal changes in fitness and its relationship to change in health and physical activity among school children. Finally, a more finely grained analysis of children's fitness levels by various demographics (e.g., age, family socioeconomic status, school PA resources, regions of residence) is needed to help identify subgroups of children at health risk, which may aid the development of prevention and intervention efforts.

4.3. Public health implications

The findings in this study that an extremely low proportion of Chinese children met the CNSPFS "excellent" fitness standard and 8% of them failed to pass the fitness standard in 2016 highlight the significance of the low level of fitness among the nation's school children. To put these numbers in a broad perspective, it means that, among 166 million Chinese school-aged children in 2016,²⁴ only about 10 million of them achieved an "excellent" fitness mark and more than 13 million were unable to meet the currently established fitness performance standards. These estimates speak to the major public health challenge that school educators and policy-makers face in achieving the nation's target goal of having 25% of school-age children meet the "excellent" fitness standard by 2030.²⁰ Thus, as the nation works toward its health goal of improving children's physical fitness, the estimates presented herein suggest the need to accelerate the public health effort in developing and implementing school physical education policies that will improve the level of Chinese school children's health and fitness. The findings also suggest that schools should develop and provide physical activity interventions that will create opportunities for children, especially boys and children attending urban schools, to engage in physical activity and participate in fitness-enhancing programs both in school environments and non-school (i.e., sports facility, neighborhood, community) environments.

5. Conclusion

Overall, approximately 6% of Chinese school-aged children achieved an excellent fitness standard in 2016, and about 8% of them did not meet CNSPFS standards. School boys and children living urban areas were more likely to not meet

minimum fitness performance levels. Corroborating the evidence from previous reports, the overall fitness levels among Chinese children remain low, and thus it is important to continue surveillance and develop school- and community-based policies and interventions aimed at increasing physical activity and improving the fitness of school-aged children in the Mainland of China.

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Authors' contributions

ZZ performed data analysis and drafted the article; YY and ZK were involved in the conceptualization of the paper and participated in coordinating the fitness portion of the PAFCTYS project; YZ and JZ conceived of the current study, supervised all aspects of its implementation, data interpretation, and drafted the article. 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.

Appendix: Supplementary material

Supplementary data to this article can be found online at [doi:10.1016/j.jshs.2017.09.003](https://doi.org/10.1016/j.jshs.2017.09.003)

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