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Are preschool children active enough in Shanghai—An accelerometer-based cross-sectional study

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Are preschool children active enough in Shanghai—An accelerometer-based cross-sectional study

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ABSTRACT

Objective: Engaging in physical activity (PA) play an important roles in promoting physical and mental health, but the PA data for Chinese preschool children are lacking. This study is aim to objectively assess the PA levels of preschool children in Shanghai, China and to evaluate their PA levels relative to age-specific recommendations.

Design, Setting and Participants: A cross-sectional study was conducted among preschool children in Shanghai city of China. There were a total of 303 preschool children (boys, 174; girls, 129) were recruited from eight kindergarten classes in the Yangpu and Baoshan Districts of Shanghai.

Main outcome measures: Daily PA was assessed using ActiGraph $GT3X^+$ accelerometers for seven consecutive days, children were required to have data from at least two weekdays and one weekend day, with a minimum daily wear time of 480 min to be included in the analysis.

Results: Preschool children in Shanghai accumulated, on average, 70.9 minutes (min) of moderate-to-vigorous PA (MVPA) and 168.0 min of total PA (TPA) per day (d). Boys engaged in more MVPA and TPA than girls (72.8 min/d *vs.* 68.3 min/d and 171.9 min/d *vs.* 162.9 min/d, respectively). Overall, 72.9% of the participants met the age-specific recommendations of MVPA, while 35.3% met TPA recommendations. **Conclusions:** Findings of this study warn of the insufficiency of PA in Shanghai preschool children, suggesting there is substantial room to improve their PA. **Key words**: accelerometry, physical activity, preschool children.

Strength and limitation of this study

- Objective measures of daily physical activity were obtained by accelerometers in a sample of preschool children from Shanghai, China.
- Daily physical activity levels in Shanghai preschool children were evaluated by both moderate to vigorous physical activity and activity at any intensity recommended guidelines.
- For feasibility, this study sample was not a random sample recruited from the population. tion.

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INTRODUCTION

Engaging in physical activity (PA) and minimizing sedentary time play important roles in promoting physical, psychological, and cognitive health.¹ Moreover, establishing robust PA habits in childhood has positive long-term effects on lifestyle that persist into adulthood,² including reducing the risk of chronic diseases, such as coronary artery disease, diabetes, stroke, and hypertension. ³⁴ Accordingly, US and Canadian PA guidelines for preschoolers suggest that, to achieve health benefits, children aged 3 to 6 years old should participate in at least 60 minutes (min) of moderate-to-vigorous PA (MVPA) or 180 min of activity at any intensity level per day (d), cumulatively.⁵⁶

Researchers and public health professionals are interested in establishing what percentage of preschool children meet the aforementioned PA recommendations. Accelerometers can be used as an objective tool to facilitate and improve the accuracy of PA monitoring, overcoming the limitations of self-reported data from children and the potential for recall bias in proxy reports from parents or teachers.⁷ Thus, accelerometers have become increasingly popular as a feasible strategy for capturing preschoolers' movement behavior accurately.⁸

Although there is a perception that preschool children are constantly active,⁹ accelerometer-based evidence does not support this presumption for all children. In a sample of 3–5-year-old Canadian children, only 13.7% of participants met the PA recommendation for at least 60 min per day of MVPA.¹⁰ In a similar study of Australian preschool aged children, 22% of the sample met this guideline.¹¹ Moreover,

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a meta-analysis of 29 reports encompassing 6,309 preschool children in Canada and Australia yielded an average daily MVPA of only 42.8 (95% CI: 28.9–56.8) min.¹² As of yet, accelerometer-based PA data for Chinese preschool children are lacking.

The aim of this study was to assess PA levels quantitatively in a sample of preschool aged children in Shanghai, China with accelerometers and to determine the proportion of children meeting the aforementioned age-specific PA recommendations.

MATERIALS AND METHODS

Participants

This cross-sectional study forms a baseline dataset for The Physical Activity and Cognitive Function Study (Trial registration: ChiCTR-OOC-15007439), in which a total of 346 preschool children (boys, 201; girls, 145) were recruited from eight kindergarten classes in the Yangpu and Baoshan Districts of Shanghai, China. The aims and procedures of this study were explained comprehensively to the parents/guardians of all potential participants, including the right to withdraw from the study at any time. Signed informed consent forms were obtained from the participants' parents/guardians. This study was approved by the Ethics Advisory Committee of Shanghai University of Sport.

Measures and procedures

PA was assessed with $GT3X^+$ accelerometers (ActiGraph, Pensacola, FL), worn on the right hip attached to an elastic adjustable belt for seven consecutive days.

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Parents or guardians agreed to have their children wear the accelerometers during all waking, including water-based activities such as bathing and swimming. They were instructed on the proper way to wear and remove the accelerometers, and asked to encourage their children to wear them as much as possible during their school hours. The accelerometers were collected at the end of a 7-d study period, and the accelerometer data were transferred to a computer via ActiLife version 6.11.6 software. Non-wear time was determined by the Choi algorithm;¹³ children were required to have data from at least two weekdays and one weekend day, with a minimum daily wear time of 480 min to be included in the analysis. Based on these criteria, 43 participants were excluded from the final analysis.

Body mass index (BMI) was calculated with the formula weight/height² (kg/m²). Based on his or her BMI, each child was categorized as normal, overweight, or obese based on the International Obesity Task Force scale.¹⁴

Interpretation of accelerometer data

Data were collected in 1-second epochs, because short epochs have been recommended for capturing movement behavior in this age group.¹⁵ Raw output was expressed as counts per minute (CPM), and cut-off count levels previously developed for preschool children by Pate and colleagues were used to analyze MVPA time.⁷ We classified PA into three levels: light (LPA), 101–1679 CPMs; moderate (MPA), 1680– 3367 CPMs; and vigorous (VPA), \geq 3368 CPMs. Total physical activity (TPA) was calculated as the sum of LPA, MPA, and VPA time periods. TPA values were

compared to the established recommendations of $\geq 60 \text{ min of MVPA or } \geq 180 \text{ min of}$ PA at any intensity to evaluate the proportion of participants meeting these recommendations.

Data analysis

The data are reported as means \pm standard deviations (SDs) for normally distributed variables or as medians with interquartile ranges (IQRs) for non-normally distributed variables. Independent *t* tests, Mann-Whitney *U* tests, and chi-square tests were used to assess gender differences in characteristics for normally distributed, nonnormally distributed, and categorical variables, respectively. When necessary, PA data were normalized by a log or square root methods prior to analysis. Differences in PA by gender and day were determined with independent *t* tests, and differences in PA by BMI category were determined by one-way analysis of variance (ANOVA) with Bonferroni *post hoc* tests. Analyses were performed in SPSS version 22.0 (IBM Inc., Armonk, NY). A two-sided *P* value $\leq .05$ was considered statistically significant.

RESULTS

Characteristics of participants

The descriptive characteristics of the 303 participants included in the present cohort analysis are shown in **Table 1.** Weight, BMI, and the proportion of overweight/obese children were significantly higher in boys than in girls.

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The amount of different intensities of PA

On average, the number of valid accelerometer days among participants was 6.3 days (95%CI = 6.2–6.4 d), and the mean duration of wear time across all valid days was 748.7 min/d (95%CI = 740.3–756.7 min/d). The absolute and relative time spent engaged in CPM and each PA intensity level are presented in **Table 2**. On average, participants in this study accumulated 168.0 min/d of TPA, and spent 13.0% (~97.2 min) of their daily waking time engaged in LPA and 9.5% (~70.9 min) of their days was spent engaged in MVPA. In general, boys were more active than girls, and participants engaged in more PA on weekend days than on week days. No significant difference in PA was identified with respect to BMI category.

Meeting the current PA recommendations

Almost three quarters of the participants spent at least 60 min/d engaged in MVPA across all valid days, while only a little more than a third accumulated at least 180 min/d of PA at any intensity. Boys met the PA recommendations more frequently than girls (**Table 3**).

DISCUSSION

In this accelerometer-based cross-sectional study of preschool children in Shanghai, we found that, on average, boys accumulated 72.8 min/d of MVPA and 171.9 min/d of TPA, while girls accumulated 68.3 min/d of MVPA and 162.9 min/d of TPA. At least 27% of the participants did not meet the established PA guidelines.

Strengths and limitations

To the best of our knowledge, this is the first study to evaluate PA in Chinese preschool children with accelerometers, which eliminating the recall bias associated with other PA measurements. Additionally, our PA data were evaluated relative to both MVPA and TPA recommended guidelines.

This study had two noteworthy limitations. First, for sampling feasibility, all participants were recruited from Northeast Shanghai. Thus, it remains to be determined whether similar findings would be obtained for children in other regions of Shanghai. Second, the accelerometer was worn over the right hip limited to capture activities with little displacement of the body, such as cycling. However, hip was probably the best placement to capture whole-body movements and on the side of the hip was also the most often site by various studies.¹⁶

PA status of Shanghai preschoolers

Approximately 73% of participants in our Shanghai cohort met the recommendation of spending more than 60 min/d engaged in MVPA. However, less than 36% accumulated at least 180 min/d of TPA. The gap between these proportions is due largely to the shift from intensity to volume. The short 1-second sampling intervals used in this study may have resulted in an underestimation of LPA time, which would then yield an underestimation of TPA time, relative to, for example, a 15-second epoch. A longer epoch is more likely to result in an underestimation of MVPA and an overestimation of LPA in young children.¹⁷ Notably, a Canadian study

with a much longer 60-second epoch found that 83.8% of young children met the 180 min/d TPA guideline,¹⁰ while only 13.7% engaged in at least 60 min/d of MVPA. This methodological inconsistency makes it quite difficult to conduct reliable inter-study comparisons. Here, we chose a shorter epoch because it has been recommended for capturing movement in young children owing to the particularly sporadic and intermittent nature of activity exhibited by children in this age group.¹⁸

Differences in PA by gender, BMI category, and date

Our empirical findings that boys spent 6.6% more time engaged in MVPA and had 5.5% more TPA time than girls are consistent with our meta-analysis results. Trost et al. suggested that a similar gender gap in PA was attributed to a VPA difference, with boys spending approximately 45% more time engaged in VPA than girls in their study.¹⁹ Meanwhile, Crespo et al. found that familial, social, and environmental characteristics correlated with higher MVPA in boys than in girls.²⁰ Possible factors in this gender gap to explore in future studies include parental modeling and location.

Our finding of similar PA data across normal-weight and overweight/obesity groups was somewhat surprising. Although we commonly thought that normal-weight children must be more active than those who overweight/obese, accelerometer-based evidence does not support this presumption for all studies.²¹ Furthermore, the opposite findings are more likely to be ture in some studies.^{22 23} These negative findings suggest that other factors, such as diet and genetic background, play more important roles in body weight. Future studies are needed to identify the relative importance of

and interactions among PA, diet, and genetics for weight status.

Our observation of greater PA on weekend days than on weekdays may be explained by participants having more opportunities to engage in PA on non-school days. Further studies should investigate and compare the specific activities engaged in on school days versus weekend days.

PA in Shanghai preschool children versus children elsewhere

Given the important of PA for physical, psychological, and cognitive health,¹ there is an increasing body of research focusing on the PA levels on preschool children from different population. Findings from a meta-analysis identified 29 studies indicated preschoolers' accelerometer-derived PA ranged from 19 min/d to 281 min/d.²⁴ However, the amounts of PA across different intensity levels varied widely depending upon the assessment methodology selected, with MVPA cut-off CPM levels having a particularly large effect on PA results.²⁵ Therefore, it is more reasonable to compare the results that using the same cut-off value for PA levels. Unfortunately, the amount of time spent engaged in MVPA in Shanghai preschool children lower than data for the most prior populations assessed with the same cut-off CPM levels by Pate (Range: 35.3-100.0 min/d; Median: 94.9 min/d).^{21 26-34} The pattern of our TPA results was comparable to that of the MVPA results (Range: 73.7-394.0 min/d; Median: 348.0 min/d).²⁶⁻³⁴

Obviously, the results of this cross-sectional study indicate that Shanghai preschool children tend to have insufficient PA, and less PA than other populations

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examined with the same cut-off CPM levels. Based on these data, we suggest that interventions may be needed to promote PA in Shanghai preschool children.

CONCLUSIONS

At least 27% of preschool children in Shanghai did not meet current age-specific PA recommendations and preschool children in Shanghai were less active than most of the populations assessed in comparable studies. These findings suggest that interventions should be explored to promote PA in Shanghai preschoolers given that the development of active lifestyle behaviors early in life are believed to yield health benefits that extend into adulthood.

We thank all the participants and kindergarten very much for their collaboration.

Author Contributions

Minghui Quan conceived and designed the study, analyzed the data and drafted the manuscript. Hanbin Zhang, Jiayi Zhang, Tang Zhou, Jinming Zhang, Guanggao Zhao, Hui Fang and Shunli Sun conducted the experiments and collected the data. Minghui Quan and Guanggao Zhao performed the literature search. Ru Wang and Peijie Chen advised on analysis and interpretation of the data, and critically revised the manuscript.

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Potential conflicts of interest

The authors declare that they have no conflicts to report.

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Characteristic	Boys (N = 174; 57.4%)	Girls (N = 129; 42.6%)	All (N = 303)
Mean age ± SD, months	58.3 ± 5.6	57.1 ± 5.3	57.8 ± 5.5
Mean height ± SD, cm	111.4 ± 5.0	110.3 ± 4.9	111.0 ± 5.0
Median weight (IQR), kg	20.6 (20.1–21.1)*	19.3 (18.8–19.8)	20.0 (19.7–20.4)
Median BMI (IQR), kg/m ²	16.5 (16.2–16.8)*	15.8 (15.5–16.1)	16.2 (16.0–16.4)
BMI category, %			
Normal	76.4*	86.8	80.9
Overweight	15.5*	10.1	13.2
Obesity	8.0^{*}	3.1	5.9

Table 1 Characteristics of participants with valid accelerometer data.

Note: *p < .05, boys vs. girls.

_	Mean CPM ±	Mean PA by category ± SD, min/d (95%CI)				
Factor	SD (95% CI)	LPA	МРА	VPA	MVPA	ТРА
Gender						
Boys	$498.3 \pm 120.3^{*}$	$99.2 \pm 18.4^{*}$	40.9 ± 9.7	$31.9 \pm 10.7^{*}$	$72.8 \pm 18.8^{*}$	$171.9 \pm 34.0^{*}$
(N = 174)	(478.7–516.7)	(96.8–102.0)	(39.5–42.3)	(30.4–33.4)	(70.1–75.4)	(167.1–176.8)
Girls	468.0 ± 109.3	94.6 ± 15.9	38.8 ± 8.0	29.6 ± 8.6	68.3 ± 15.1	162.9 ± 27.6
(N = 129)	(447.3–486.2)	(91.8–97.3)	(37.3–40.1)	(28.0–31.1)	(65.7–70.9)	(158.0–167.6)
BMI						
Normal	484.7 ± 113.6	96.9 ± 17.4	39.8 ± 8.8	30.9 ± 9.6	70.7 ± 17.0	167.6 ± 31.1
(N = 245)	(470.0–501.4)	(94.7–99.1)	(38.7–41.0)	(29.7-32.0)	(68.7–72.9)	(163.8–171.5)
Overweight	476.0 ± 121.5	99.0 ± 18.2	40.0 ± 9.7	30.3 ± 10.9	70.3 ± 19.7	169.3 ± 35.5
(N = 40)	(437.3–514.6)	(93.5–104.9)	(37.1–43.4)	(27.1–34.0)	(64.4–76.9)	(158.2–181.2)
Obesity	509.9 ± 144.2	97.7 ± 16.9	42.1 ± 11.1	32.3 ± 12.1	74.4 ± 19.0	171.0 ± 32.4
(N= 18)	(444.0–580.5)	(89.3–105.2)	(37.4–47.2)	(26.7–37.9)	(65.7-83.0)	(156.0–186.4)
Type of day						
Week	$471.0 \pm 117.4^{\dagger}$	96.4 ± 17.9	$39.3 \pm 9.3^\dagger$	30.9 ± 9.9	70.2 ± 17.5	$166.6 \pm 32.3^{\dagger}$
(N = 303)	(457.8–484.6)	(94.5–98.3)	(38.3-40.4)	(29.9–32.1)	(68.4–72.1)	(163.2–170.1)
Weekend	517.4 ± 166.2	98.6 ± 24.8	41.6 ± 12.0	30.6 ± 13.3	72.1 ± 24.0	170.6 ± 44.3
(N = 303)	(497.4–536.5)	(95.8–101.4)	(40.1-43.1)	(29.2–32.2)	(69.6–75.0)	(165.8–175.6)
ALL	485.0 ± 116.4	97.2 ± 17.5	40.0 ± 9.1	30.9 ± 9.9	70.9 ± 17.5	168.0 ± 31.7
(N = 303)	(472.6–500.0)	(95.299.2)	(39.0-40.1)	(29.8–32.0)	(68.9–72.9)	(164.6–171.6)
\mathbf{P} alative time θ'		13.1 ± 2.1	5.4 ± 1.1	4.2 ± 1.3	9.5 ± 2.2	22.6 ± 3.7
Relative time, %		(12.8–13.3)	(5.2–5.5)	(4.0-4.3)	(9.3–9.8)	(22.1–23.0)

Table 2 Analysis of time spent engaged in PA categories by gender, BMI category, and day.

Note: Mean \pm SD and 95% CI are reported for normally distributed variables; Significant data are shown in bold; *p < .05, boys vs. girls; †p < .05, weekdays vs. weekend days.

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Table 3 Adherence to common established PA recommendations for preschool aged children.*

DA	Cuidalize towart	5	Subjects, % (95%C	I)
PA metric	Guideline target	Boys (N = 174)	Girls (N = 129)	All (N = 303)
MVPA	≥60 min/d accumulated, averaged across valid d	74.1 (67.2–79.9)	71.3 (63.6–79.1)	72.9 (68.3–77.9
ТРА	≥180 min/d accumulated, averaged across valid d	42.0 (34.5–48.9)	26.4 (19.4–34.1)	35.3 (30.0–40.9
<i>Note:</i> * <i>p</i> < .0	5, boys <i>vs</i> . girls.			

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

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31 32				Paged
33 34			Reporting Item	Number
35 36 37 38 39	Title	<u>#1a</u>	Indicate the study's design with a commonly used term in the title or the abstract	1 1 1 1 1 1
39 40 41	Abstract	<u>#1b</u>	Provide in the abstract an informative and balanced summary of what was done and what was found	1 2 4-5 5 5
42 43 44 45	Background / rationale	<u>#2</u>	Explain the scientific background and rationale for the investigation being reported	4-5 similar tec
46 47 48 49	Objectives	<u>#3</u>	State specific objectives, including any prespecified hypotheses	5
50 51	Study design	<u>#4</u>	Present key elements of study design early in the paper	5
52 53 54 55	Setting	<u>#5</u>	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
56 57 58 59 60	Eligibility criteria	<u>#6a</u> For pe	Give the eligibility criteria, and the sources and methods of selection of participants.	6

1 2 3 4 5		<u>#7</u>	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37	Data sources / measurement	<u>#8</u>	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	5-6
	Bias	<u>#9</u>	Describe any efforts to address potential sources of bias	6
	Study size	<u>#10</u>	Explain how the study size was arrived at	none
	Quantitative variables	<u>#11</u>	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	7
	Statistical methods	<u>#12a</u>	Describe all statistical methods, including those used to control for confounding	7
		<u>#12b</u>	Describe any methods used to examine subgroups and interactions	none
		<u>#12c</u>	Explain how missing data were addressed	none
		<u>#12d</u>	If applicable, describe analytical methods taking account of sampling strategy	none
38 39		<u>#12e</u>	Describe any sensitivity analyses	none
40 41 42 43 44 45 46 47	Participants	<u>#13a</u>	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	7
48 49 50		<u>#13b</u>	Give reasons for non-participation at each stage	6
51 52		<u>#13c</u>	Consider use of a flow diagram	none
53 54 55 56 57 58 59 60	Descriptive data	<u>#14a</u> For pe	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable. er review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml	7

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1 2 3		<u>#14b</u>	Indicate number of participants with missing data for each variable of interest	6
4 5 6 7 8 9 10 11 12 13 14 15 16	Outcome data	<u>#15</u>	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	8
	Main results	<u>#16a</u>	Give unadjusted estimates and, if applicable, confounder- adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8
17 18 19		<u>#16b</u>	Report category boundaries when continuous variables were categorized	None
20 21 22 23		<u>#16c</u>	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	none
24 25 26 27	Other analyses	<u>#17</u>	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	none
28 29	Key results	<u>#18</u>	Summarise key results with reference to study objectives	8
30 31 32 33 34 35 36 37 38 39 40	Limitations	<u>#19</u>	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	9
	Interpretation	<u>#20</u>	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	11-12
41 42 43	Generalisability	<u>#21</u>	Discuss the generalisability (external validity) of the study results	9-11
44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59	Funding	<u>#22</u>	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13
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Are preschool children active enough in Shanghai—An accelerometer-based cross-sectional study

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1	Are preschool children active enough in Shanghai—An accelerometer-based
2	cross-sectional study
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22	ABSTRACT
23	Objective: Engaging in physical activity (PA) play an important roles in promoting
24	physical and mental health, but the PA data for Chinese preschool children are lacking.
25	This study is aim to objectively assess the PA levels of preschool children in Shanghai,
26	China and to evaluate their PA levels relative to age-specific recommendations.
27	Design, Setting and Participants: A cross-sectional study was conducted among
28	preschool children in Shanghai city of China. There were a total of 303 preschool
29	children (boys, 174; girls, 129) were recruited from eight kindergarten classes in the
30	Yangpu and Baoshan Districts of Shanghai.
31	Main outcome measures: Daily PA was assessed using ActiGraph $GT3X^+$
32	accelerometers for seven consecutive days. children were required to have data from
33	at least two weekdays and one weekend day, with a minimum daily wear time of 480
34	min to be included in the analysis.
35	Results: Preschool children in Shanghai accumulated, on average, 70.9 minutes (min)
36	of moderate-to-vigorous PA (MVPA) and 168.0 min of total PA (TPA) per day (d).
37	Boys engaged in more MVPA and TPA than girls (72.8 min/d vs. 68.3 min/d and
38	171.9 min/d vs. 162.9 min/d, respectively). Overall, 72.9% of the participants met the
39	age-specific recommendations of MVPA, while 35.3% met TPA recommendations.
40	Conclusions: Findings of this study warn of the insufficiency of PA in Shanghai
41	preschool children, suggesting there is substantial room to improve their PA.
42	Key words: accelerometry, physical activity, preschool children, meta-analysis.
	2

Page 3 of 27		BMJ Open
1 2 3 4	43	Strength and limitation of this study
5	44	• Objective measures of daily physical activity were obtained by accelerometers in
7 8	45	a sample of preschool children from Shanghai, China.
9 10	46	• Daily physical activity levels in Shanghai preschool children were evaluated by
11 12	47	both moderate to vigorous physical activity and activity at any intensity
13 14	48	recommended guidelines.
15 16	49	• For feasibility, this study sample was not a random sample recruited from the
17 18 10	50	• For feasibility, this study sample was not a random sample recruited from the population.
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51 INTRODUCTION

52	Engaging in physical activity (PA) play an important roles in promoting physical,
53	psychological, and cognitive health. ¹ Moreover, establishing robust PA habits in
54	childhood has positive long-term effects on lifestyle that persist into adulthood, ²
55	including reducing the risk of chronic diseases, such as coronary artery disease,
56	diabetes, stroke, and hypertension. ^{3 4} Accordingly, Canadian PA guideline for
57	preschool children suggests that, to achieve health benefits, children aged 3 to 6 years
58	old should participate in at least 180 minutes (min) of PA at any intensity and
59	progression toward at least 60 min moderate-to-vigorous PA (MVPA) per day (d),
60	cumulatively. ⁵
61	Researchers and public health professionals are interested in establishing what
62	percentage of preschool children meet the aforementioned PA recommendations.
63	Accelerometers can be used as an objective tool to facilitate and improve the accuracy
64	of PA monitoring, overcoming the limitations of self-reported data from children and
65	the potential for recall bias in proxy reports from parents or teachers. ⁶ When
66	compared with pedometer, accelerometer can provide the data not only about the total
67	amount of daily activities, but also the pattern of daily activities, ⁷ which were
68	considered to be more important to achieve health benefits based on the current PA
69	guideline. ⁵ Thus, accelerometers have become increasingly popular as a feasible
70	strategy for capturing preschoolers' movement behavior accurately. ⁸ Furthermore,
71	accelerometer-based PA has become an important data source for examining the
72	association between PA and health-related outcomes in recent years, even in the
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73	national health survey with large sample size.910
74	Although there is a perception that preschool children are constantly active, ¹¹
75	accelerometer-based evidence does not support this presumption for all children. In a
76	sample of 3-5-year-old Canadian children, only 13.7% of participants met the PA
77	recommendation for at least 60 min per day of MVPA. ¹² In a similar study of
78	Australian preschool aged children, 22% of the sample met this guideline. ¹³ Moreover,
79	a meta-analysis of 29 reports encompassing 6,309 preschool children in Canada and
80	Australia yielded an average daily MVPA of only 42.8 (95% CI: 28.9–56.8) min. ¹⁴ As
81	of yet, accelerometer-based PA data for Chinese preschool children are lacking.
82	The aim of this study was to assess PA levels quantitatively in a sample of
83	preschool aged children in Shanghai, China with accelerometers and to determine the
84	proportion of children meeting the aforementioned age-specific PA recommendations.
85	Findings of this study will help us to understand the PA levels from a sample of
86	Shanghai, which may serve as a foundation for making strategies to maintain and
87	promote PA for preschool children.
88	
89	MATERIALS AND METHODS
90	Participants
91	This cross-sectional study forms a baseline dataset for The Physical Activity and
92	Cognitive Function Study (Trial registration: ChiCTR-OOC-15007439), in which a
93	convenience sample of 346participants (boys, 201; girls, 145) were recruited from
94	eight kindergarten classes in the Yangpu and Baoshan Districts of Shanghai, China.

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95	After contacting the kindergarten director by phone and interested in this study,
96	the aims and procedures of this study were to explain comprehensively to the
97	parents/guardians of all potential participants by parents' meeting held in the
98	kindergarten, including the right to withdraw from the study at any time. Parents
99	interested in having their children participate subsequently signed an informed
100	consent document. The inclusion criteria for the participants in this study were: (1)
101	aged 3-6 years; (2) without a diagnosed physical and mental disability; and (3) with
102	signed informed consent from the participants' parents/guardians. This study was
103	approved by the Ethics Advisory Committee of Shanghai University of Sport.
104	
105	Procedures
106	Before accelerometer data collection, parents or guardians were instructed on the
107	proper way to wear and remove the accelerometers by well-trained research staff.
108	Parents or guardians agreed to have their children wear the accelerometers during all
109	waking, including water-based activities such as bathing and swimming. And, Parents
110	or guardians asked to encourage their children to wear them as much as possible
111	during their school hours. The accelerometers were collected at the end of a
112	consecutive 7-d study period, and the accelerometer data were transferred to a
113	computer via ActiLife version 6.11.6 software.
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115	Measures
116	Anthropometric data

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117	Height and weight were measured with participants dressed in light clothing.
118	Height was measured to the nearest 0.1 cm using a freestanding portable stadiometer,
119	and weight was measured to the nearest 0.1 kg with an electronic weighting scale
120	(HN-358, Omron, Tokyo, Japan). Body mass index (BMI) was calculated with the
121	formula weight/height ² (kg/m ²). Based on his or her BMI, each child was categorized
122	as normal, overweight, or obese based on the International Obesity Task Force scale. ¹⁵
123	Physical activity data
124	PA was assessed with $GT3X^+$ accelerometers (ActiGraph, Pensacola, FL), worn
125	on the right hip attached to an elastic adjustable belt from 7 am to 11 pm every day for
126	seven consecutive days. Non-wear time was determined by the Choi algorithm; ¹⁶
127	children were required to have data from at least two weekdays and one weekend day,
128	with a minimum daily wear time of 480 min to be included in the analysis. Based on
129	these criteria, 43 participants were excluded from the final analysis.
130	Data were collected in 1-second epochs, because short epochs have been
131	recommended for capturing movement behavior in this age group. ¹⁷ Raw output was
132	expressed as counts per minute (CPM), and cut-off count levels previously developed
133	for preschool children by Pate and colleagues were used to analyze MVPA time. ⁶ We
134	classified PA into three levels: light (LPA), 101-1679 CPMs; moderate (MPA), 1680-
135	3367 CPMs; and vigorous (VPA), ≥3368 CPMs. Total physical activity (TPA) was
136	calculated as the sum of LPA, MPA, and VPA time periods. PA values were
137	compared to the established recommendations of $\geq 60 \text{ min of MVPA or } \geq 180 \text{ min of}$
138	PA at any intensity to evaluate the proportion of participants meeting these
	7

139 recommendations.

141 Data analysis

142	Assuming the coefficient of variation (CV) of MVPA ($CV = 0.28$) based on the
143	previous study, ¹⁸ confidence level as 95%, and 5% level of precision, the required
144	sample size was at least 125 in this study. The data are reported as means \pm standard
145	deviations (SDs) for normally distributed variables or as medians with interquartile
146	ranges (IQRs) for non-normally distributed variables. Independent t tests,
147	Mann-Whitney U tests, and chi-square tests were used to assess gender differences in
148	characteristics for normally distributed, non- normally distributed, and categorical
149	variables, respectively. When necessary, PA data were normalized by a log or square
150	root methods prior to analysis. Differences in PA by gender and day were determined
151	with independent t tests, and differences in PA by BMI category were determined by
152	one-way analysis of variance (ANOVA) with Bonferroni post hoc tests. Analyses
153	were performed in SPSS version 22.0 (IBM Inc., Armonk, NY). A two-sided P value
154	\leq .05 was considered statistically significant.
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156	Patient and public involvement
157	No patients or public were involved in this study.
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161	RESULTS
162	Characteristics of participants
163	The descriptive characteristics of the 303 participants included in the present
164	cohort analysis are shown in Table 1. Weight, BMI, and the proportion of
165	overweight/obese children were significantly higher in boys than in girls.
166	The amount of different intensities of PA
167	On average, the number of valid accelerometer days among participants was 6.3
168	days (95% CI = 6.2–6.4 d), and the mean duration of wear time across all valid days
169	was 748.7 min/d (95% CI = 740.3–756.7 min/d). The actual and percent time spent
170	engaged in CPM and each PA intensity level are presented in Table 2. On average,
171	participants in this study accumulated 168.0 min/d of TPA, and spent 13.0% (~97.2
172	min) of their daily waking time engaged in LPA and 9.5% (~70.9 min) of their days
173	was spent engaged in MVPA. In general, boys were more active than girls, and
174	participants engaged in more PA on weekend days than on week days. No significant
175	difference in PA was identified with respect to BMI category.
176	
177	Meeting the current PA recommendations
178	There were 72.9% of the participants met the MVPA recommendation that spent
179	at least 60 min/d engaged in MVPA across all valid days, while only 35.3% of the
180	participants met the TPA recommendation that accumulated at least 180 min/d of PA
181	at any intensity. Boys met the PA recommendations more frequently than girls (Table
182	3).

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DISCUSSION

184	In this accelerometer-based cross-sectional study of preschool children in
185	Shanghai, we found that, on average, boys accumulated 72.8 min/d of MVPA and
186	171.9 min/d of TPA, while girls accumulated 68.3 min/d of MVPA and 162.9 min/d of
187	TPA. At least 27% of the participants did not meet the established PA guidelines.
188	

189 PA status of Shanghai preschoolers

Approximately 73% of participants in our Shanghai cohort met the recommendation of spending more than 60 min/d engaged in MVPA. However, less than 36% accumulated at least 180 min/d of TPA. The gap between these proportions is due largely to the shift from intensity to volume. The short 1-second sampling intervals used in this study may have resulted in an underestimation of LPA time, which would then yield an underestimation of TPA time, relative to, for example, a 15-second epoch. A longer epoch is more likely to result in an underestimation of MVPA and an overestimation of LPA in young children.¹⁹ Notably, a Canadian study with a much longer 60-second epoch found that 83.8% of young children met the 180 min/d TPA guideline,¹² while only 13.7% engaged in at least 60 min/d of MVPA. This methodological inconsistency makes it quite difficult to conduct reliable inter-study comparisons. Here, we chose a shorter epoch because it has been recommended for capturing movement in young children owing to the particularly sporadic and intermittent nature of activity exhibited by children in this age group.²⁰

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205	Differences in PA by gender, BMI category, and date
206	Our empirical findings that boys spent 6.6% more time engaged in MVPA and
207	had 5.5% more TPA time than girls are consistent with our meta-analysis results. Trost
208	et al. suggested that a similar gender gap in PA was attributed to a VPA difference,
209	with boys spending approximately 45% more time engaged in VPA than girls in their
210	study. ²¹ Meanwhile, Crespo et al. found that familial, social, and environmental
211	characteristics correlated with higher MVPA in boys than in girls. ²² Possible factors in
212	this gender gap to explore in future studies include parental modeling and location.
213	Our finding of similar PA data across normal-weight and overweight/obesity
214	groups was somewhat surprising. Although we commonly thought that normal-weight
215	children must be more active than those who overweight/obese, accelerometer-based
216	evidence does not support this presumption for all studies. ²³ Furthermore, the opposite
217	findings are more likely to be true in some studies. ^{24 25} These negative findings
218	suggest that other factors, such as diet and genetic background, play more important
219	roles in body weight. Future studies are needed to identify the relative importance of
220	and interactions among PA, diet, and genetics for weight status.
221	Our observation of greater PA on weekend days than on weekdays may be
222	explained by participants having more opportunities to engage in PA on non-school
223	days. Further studies should investigate and compare the specific activities engaged in
224	on school days versus weekend days.
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227	PA in Shanghai preschool children versus children elsewhere
228	Given the important of PA for physical, psychological, and cognitive health, ¹
229	there is an increasing body of research focusing on the PA levels on preschool
230	children from different population. Findings from a meta-analysis identified 29
231	studies indicated preschoolers' accelerometer-derived PA ranged from 19 min/d to 281
232	min/d. ²⁶ However, the amounts of PA across different intensity levels varied widely
233	depending upon the assessment methodology selected, with MVPA cut-off CPM
234	levels having a particularly large effect on PA results. ²⁷ Therefore, it is more
235	reasonable to compare the results that using the same cut-off value for PA levels.
236	Unfortunately, the amount of time spent engaged in MVPA in Shanghai preschool
237	children lower than data for the most prior populations assessed with the same cut-off
238	CPM levels by Pate (Range: 35.3-100.0 min/d; Median: 94.9 min/d). ^{18 23 28-35} The
239	pattern of our TPA results was comparable to that of the MVPA results (Range:
240	73.7-394.0 min/d; Median: 348.0 min/d). ^{18 28-35}
241	Obviously, the results of this cross-sectional study indicate that Shanghai
242	preschool children tend to have insufficient PA, and less PA than other populations
243	examined with the same cut-off CPM levels. Although the current Shanghai Preschool
244	Education Curriculum Guide requires daily outdoor activities for preschool children
245	to be no less than two hours, ³⁶ we also suggest that interventions and policies may
246	need to promote PA in Shanghai preschool children based on the data in this study.
247	Similar to children, adolescents and adults, a variety of settings can promote the level
248	of PA in children aged 3-5. However, in the early childhood stage, preschool is an
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249	important settings for the promotion of PA. ³⁷ Although the findings of PA intervention
250	on preschool setting are inconsistent, ³⁸⁻⁴¹ the extant literatures also provide us with
251	some strategies that may be useful for promoting young children's PA levels. These
252	included: (1) increasing time of outdoor activities, (2) providing materials that are
253	easy to get and play, such as balls and hula hoops, and (3) activities held both indoor
254	and outdoor by teacher-planned. ⁴² Furthermore, there was a growing evidence that
255	technology applications, such as exergaming, seemed to be an effective approach to
256	promote PA levels in children. ⁴³⁻⁴⁵ It should be noted that technology applications may
257	be a viable supplemental way to promote PA levels in young children in
258	preschool-based setting.
259	
260	Strengths and limitations
261	To the best of our knowledge, this is the first study to evaluate PA in Chinese
262	preschool children using accelerometers, which eliminating the recall bias associated
263	with other PA measurements. Additionally, our PA data were evaluated relative to
264	both MVPA and TPA recommended guidelines.
265	This study had some limitations. First, for sampling feasibility, all participants
266	were recruited from Northeast Shanghai. Thus, it remains to be determined whether
267	similar findings would be obtained for children in other regions of Shanghai. Second,
268	the accelerometer was worn over the right hip limited to capture activities with little
269	displacement of the body, such as cycling. However, hip was probably the best
270	placement to capture whole-body movements and on the side of the hip was also the
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271	most often site by various studies. ⁴⁶ Third, the accelerometer-based PA collection
272	process spans different seasons that may have an impact on the result, although the
273	seasonal variation in accelerometer-determined PA was not always observed in
274	different region's studies. ⁴⁷

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276 CONCLUSIONS

At least 27% of preschool children in Shanghai did not meet current age-specific 277 278 PA recommendations, and preschool children in Shanghai were less active than most of the populations assessed in comparable studies. Findings of this study implication 279 that there remains a lot of room for improvement in PA behaviors among preschool 280 281 children in Shanghai, particular in girls and weekday period. It was suggesting that 282 public health interventions and policies regarding PA should be explored to promote 283 PA levels in Shanghai preschoolers, given that the development of active lifestyle behaviors early in life are believed to yield health benefits that extend into adulthood. 284

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Author Contributions

Minghui Quan conceived and designed the study, analyzed the data and drafted the manuscript. Hanbin Zhang, Jiayi Zhang, Tang Zhou, Jinming Zhang, Guanggao Zhao, Hui Fang and Shunli Sun conducted the experiments and collected the data. Minghui Quan and Guanggao Zhao performed the literature search. Ru Wang and Peijie Chen advised on analysis and interpretation of the data, and critically revised the manuscript.

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Potential conflicts of interest

The authors declare that they have no conflicts to report.

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Characteristic	Boys (N = 174; 57.4%)	Girls (N = 129; 42.6%)	All (N = 303)
Mean age \pm SD, months	58.3 ± 5.6	57.1 ± 5.3	57.8 ± 5.5
Mean height \pm SD, cm	111.4 ± 5.0	110.3 ± 4.9	111.0 ± 5.0
Median weight (IQR), kg	20.6 (20.1–21.1)*	19.3 (18.8–19.8)	20.0 (19.7-20.4)
Median BMI (IQR), kg/m ²	16.5 (16.2–16.8)*	15.8 (15.5–16.1)	16.2 (16.0–16.4)
BMI category, %			
Normal	76.4*	86.8	80.9
Overweight	15.5*	10.1	13.2
Obesity	8.1*	3.1	5.9

Table 1 Characteristics of participants with valid accelerometer data.

*Note: *p* < .05, boys vs. girls.

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Table 2 Analysis of time spent engaged in PA categories by gender, BMI category, and day.

F (Mean CPM ±	1 ± Mean PA by category ± SD, min/d (95%CI))	
Factor	SD (95% CI)	LPA	МРА	VPA	MVPA	ТРА
Gender						
Boys	$498.3 \pm 120.3^{*}$	$99.2 \pm 18.4^{*}$	40.9 ± 9.7	$31.9 \pm 10.7^{*}$	$\textbf{72.8} \pm \textbf{18.8}^{*}$	$171.9 \pm 34.0^{*}$
(N = 174)	(478.7–516.7)	(96.8–102.0)	(39.5–42.3)	(30.4–33.4)	(70.1–75.4)	(167.1–176.8)
Girls	468.0 ± 109.3	94.6 ± 15.9	38.8 ± 8.0	29.6 ± 8.6	68.3 ± 15.1	162.9 ± 27.6
(N = 129)	(447.3–486.2)	(91.8–97.3)	(37.3–40.1)	(28.0–31.1)	(65.7–70.9)	(158.0–167.6)
BMI						
Normal	484.7 ± 113.6	96.9 ± 17.4	39.8 ± 8.8	30.9 ± 9.6	70.7 ± 17.0	167.6 ± 31.1
(N = 245)	(470.0–501.4)	(94.7–99.1)	(38.7–41.0)	(29.7-32.0)	(68.7–72.9)	(163.8–171.5)
Overweight	476.0 ± 121.5	99.0 ± 18.2	40.0 ± 9.7	30.3 ± 10.9	70.3 ± 19.7	169.3 ± 35.5
(N = 40)	(437.3–514.6)	(93.5–104.9)	(37.1–43.4)	(27.1-34.0)	(64.4–76.9)	(158.2–181.2)
Obesity	509.9 ± 144.2	97.7 ± 16.9	42.1 ± 11.1	32.3 ± 12.1	74.4 ± 19.0	171.0 ± 32.4
(N= 18)	(444.0–580.5)	(89.3–105.2)	(37.4–47.2)	(26.7–37.9)	(65.7-83.0)	(156.0–186.4)
Type of day						
Week	$471.0 \pm 117.4^{\dagger}$	96.4 ± 17.9	$39.3 \pm 9.3^\dagger$	30.9 ± 9.9	70.2 ± 17.5	$166.6\pm32.3^\dagger$
(N = 303)	(457.8–484.6)	(94.5–98.3)	(38.3-40.4)	(29.9–32.1)	(68.4–72.1)	(163.2–170.1)
Weekend	517.4 ± 166.2	98.6 ± 24.8	41.6 ± 12.0	30.6 ± 13.3	72.1 ± 24.0	170.6 ± 44.3
(N = 303)	(497.4–536.5)	(95.8–101.4)	(40.1-43.1)	(29.2–32.2)	(69.6–75.0)	(165.8–175.6)
ALL	485.0 ± 116.4	97.2 ± 17.5	40.0 ± 9.1	30.9 ± 9.9	70.9 ± 17.5	168.0 ± 31.7
(N = 303)	(472.6–500.0)	(95.299.2)	(39.0-40.1)	(29.8-32.0)	(68.9–72.9)	(164.6–171.6)
Percentage time				•		
spent in different		13.1 ± 2.1	5.4 ± 1.1	4.2 ± 1.3	9.5 ± 2.2	22.6 ± 3.7
intensities of		(12.8–13.3)	(5.2–5.5)	(4.0-4.3)	(9.3–9.8)	(22.1–23.0)
PA, %						

Note: LPA, light physical activity; MPA, moderate physical activity; MVPA, moderate to vigorous physical activity; PA, physical activity; TPA, total physical activity; VPA, vigorous physical activity; Mean \pm SD and 95% CI are reported for normally distributed variables; Significant data are shown in bold; *p < .05, boys vs. girls; †p < .05, weekdays vs. weekend days.

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Table 3 Adherence to common established PA recommendations for preschool aged children.*

PA metric	Guideline target	Participants, % (95%CI)		
		Boys (N = 174)	Girls (N = 129)	All (N = 303)
MVPA	≥60 min/d accumulated, averaged across valid d	74.1 (67.2–79.9)	71.3 (63.6–79.1)	72.9 (68.3–77.9)
TPA	≥180 min/d accumulated, averaged across valid d	42.0 (34.5-48.9)	26.4 (19.4–34.1)	35.3 (30.0–40.9)

Note: MVPA, moderate to vigorous physical activity; PA, physical activity; TPA, total physical activity;

* p < .05, boys vs. girls.

1 Reporting checklist for cross sectional study. 2 3 4 5 Based on the STROBE cross sectional guidelines. 6 7 8 Instructions to authors 9 10 Complete this checklist by entering the page numbers from your manuscript where readers will find 11 12 each of the items listed below. 13 14 Your article may not currently address all the items on the checklist. Please modify your text to 15 include the missing information. If you are certain that an item does not apply, please write "n/a" and 16 17 provide a short explanation. 18 19 Upload your completed checklist as an extra file when you submit to a journal. 20 21 22 In your methods section, say that you used the STROBE cross sectional reporting guidelines, and 23 cite them as: 24 25 von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening 26 27 the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for 28 reporting observational studies. 29 30 31 32 Reporting Item 33 34 35 Title #1a Indicate the study's design with a commonly used term in the title 36 or the abstract 37 38 Provide in the abstract an informative and balanced summary of 39 Abstract #1b 40 what was done and what was found 41 42 Background / Explain the scientific background and rationale for the #2 43 44 rationale investigation being reported 45 46 Objectives <u>#3</u> State specific objectives, including any prespecified hypotheses 47 48 Study design #4 Present key elements of study design early in the paper 49 50 51 Setting Describe the setting, locations, and relevant dates, including #5 52 periods of recruitment, exposure, follow-up, and data collection 53 54 55 Eligibility criteria Give the eligibility criteria, and the sources and methods of #6a 56 selection of participants. 57 58 59 For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml 60

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1 2 3 4 5		<u>#7</u>	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
6 7 8 9 10 11 12 13	Data sources / measurement	<u>#8</u>	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	6-7
14 15	Bias	<u>#9</u>	Describe any efforts to address potential sources of bias	6
16 17 18	Study size	<u>#10</u>	Explain how the study size was arrived at	8
19 20 21 22	Quantitative variables	<u>#11</u>	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	8
23 24 25	Statistical methods	<u>#12a</u>	Describe all statistical methods, including those used to control for confounding	8
26 27 28 29		<u>#12b</u>	Describe any methods used to examine subgroups and interactions	none
30 31 22		<u>#12c</u>	Explain how missing data were addressed	none
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 9		<u>#12d</u>	If applicable, describe analytical methods taking account of sampling strategy	8
		<u>#12e</u>	Describe any sensitivity analyses	none
	Participants	<u>#13a</u>	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	8
		<u>#13b</u>	Give reasons for non-participation at each stage	8
		<u>#13c</u>	Consider use of a flow diagram	none
	Descriptive data	<u>#14a</u>	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	8
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	<u>#14b</u>	Indicate number of participants with missing data for each variable of interest	9
Outcome data	<u>#15</u>	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	9
Main results	<u>#16a</u>	Give unadjusted estimates and, if applicable, confounder- adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10
	<u>#16b</u>	Report category boundaries when continuous variables were categorized	10-11
	<u>#16c</u>	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	none
Other analyses	<u>#17</u>	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	none
Key results	<u>#18</u>	Summarise key results with reference to study objectives	12-13
Limitations	<u>#19</u>	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	13
Interpretation	<u>#20</u>	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	10-13
Generalisability	<u>#21</u>	Discuss the generalisability (external validity) of the study results	14
Funding	<u>#22</u>	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15
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Are preschool children active enough in Shanghai—An accelerometer-based cross-sectional study

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Are preschool children active enough in Shanghai—An accelerometer-based cross-sectional study

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1	ABSTRACT
2	Objective: Engaging in physical activity (PA) play an important role in promoting
3	physical and mental health, but the PA data for Chinese preschool children are
4	lacking. This study is aims to objectively assess the PA levels of preschool children in
5	Shanghai, China and to evaluate their PA levels relative to age-specific
6	recommendations.
7	Design, Setting and Participants: A cross-sectional study was conducted among
8	preschool children in Shanghai city of China. There were a total of 303 preschool
9	children (boys, 174; girls, 129) were recruited from eight kindergarten classes in the
10	Yangpu and Baoshan Districts of Shanghai.
11	Main outcome measures: Daily PA was assessed using ActiGraph GT3X ⁺
12	accelerometers for seven consecutive days. children were required to have data from at
13	least two weekdays and one weekend day, with a minimum daily wear time of 480 min
14	to be included in the analysis.
15	Results: Preschool children in Shanghai accumulated, on average, 70.9 minutes (min)
16	of moderate-to-vigorous PA (MVPA) and 168.0 min of total PA (TPA) per day (d).
17	Boys engaged in more MVPA and TPA than girls (72.8 min/d vs. 68.3 min/d and
18	171.9 min/d vs. 162.9 min/d, respectively). Overall, 72.9% of the participants met the
19	age-specific recommendations of MVPA, while 35.3% met TPA recommendations.
20	Conclusions: Findings of this study warn of the insufficiency of PA in Shanghai
21	preschool children, suggesting there is substantial room to improve their PA.
22	Key words: accelerometry, physical activity, preschool children.

23 Strength and limitation of this study

- Objective measures of daily physical activity were obtained by accelerometers in
 a sample of preschool children from Shanghai, China.
- Daily physical activity levels in Shanghai preschool children were evaluated by
 both moderate to vigorous physical activity and activity at any intensity
 recommended guidelines.
- For feasibility, this study sample was not a random sample recruited from the population.

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31 INTRODUCTION

32	Engaging in physical activity (PA) play an important role in promoting physical,
33	psychological, and cognitive health. ¹ Moreover, establishing robust PA habits in
34	childhood has positive long-term effects on lifestyle that persist into adulthood, ²
35	including reducing the risk of chronic diseases, such as coronary artery disease,
36	diabetes, stroke, and hypertension. ³⁴ Accordingly, Canadian PA guideline for
37	preschool children suggests that, to achieve health benefits, children aged 3 to 6 years
38	old should participate in at least 180 minutes (min) of PA at any intensity and
39	progression toward at least 60 min moderate-to-vigorous PA (MVPA) per day (d),
40	cumulatively. ⁵
41	Researchers and public health professionals are interested in establishing what
42	percentage of preschool children meet the aforementioned PA recommendations.
43	Accelerometers can be used as an objective tool to facilitate and improve the accuracy
44	of PA monitoring, overcoming the limitations of self-reported data from children and
45	the potential for recall bias in proxy reports from parents or teachers. ⁶ When
46	compared with pedometer, accelerometer can provide the data not only about the total
47	amount of daily activities, but also the pattern of daily activities, ⁷ which were
48	considered to be more important to achieve health benefits based on the current PA
49	guideline. ⁵ Thus, accelerometers have become increasingly popular as a feasible
50	strategy for capturing preschoolers' movement behavior accurately.8 Furthermore,
51	accelerometer-based PA has become an important data source for examining the
52	association between PA and health-related outcomes in recent years, even in the

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53	national health survey with large sample size. ^{9 10}
54	Although there is a perception that preschool children are constantly active, ¹¹
55	accelerometer-based evidence does not support this presumption for all children. In a
56	sample of 3-5-year-old Canadian children, only 13.7% of participants met the PA
57	recommendation for at least 60 min per day of MVPA. ¹² In a similar study of
58	Australian preschool aged children, 22% of the sample met this guideline. ¹³
59	Moreover, a meta-analysis of 29 reports encompassing 6,309 preschool children in
60	Canada and Australia yielded an average daily MVPA of only 42.8 (95% CI: 28.9–
61	56.8) min. ¹⁴ As of yet, objectively-measured PA data for Chinese preschool children
62	are lacking. However, a questionnaire-based national survey in China reported that
63	only 29.9% of the children and youth met the guideline of PA. ¹⁵ This phenomenon of
64	lack of PA in children and youth may be more pronounced in the developed region.
65	Take Shanghai, a highly-developed city in China, for example, it was only 18.4% of
66	children and youth met the PA guideline in a representative sample. ¹⁶ Considered
67	accelerometer-based PA data for Chinese preschool children are lacking so far, and
68	the facts that many health-related benefits are achieved by regular PA. There is urgent
69	need to objectively assess the PA levels in Chinese preschool children, especially in
70	the developed regions like Shanghai.
71	Therefore, the aim of this study was to assess PA levels objectively in a sample
72	of preschool aged children in Shanghai, China with accelerometers and to determine
73	the proportion of children meeting the aforementioned age-specific PA

recommendations. Findings of this study will help us to understand the levels of PA

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from a sample of Shanghai, which may serve as a foundation for making strategies to 75 maintain or promote PA for preschool children. 76

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MATERIALS AND METHODS 8

Participants 79

This cross-sectional study forms a baseline dataset for The Physical Activity and 30 Cognitive Function Study (Trial registration: ChiCTR-OOC-15007439), in which a 1 convenience sample of 346participants (boys, 201; girls, 145) were recruited from 32 3 eight kindergarten classes in the Yangpu and Baoshan Districts of Shanghai, China. After contacting the kindergarten director by phone and interested in this study, 34 the aims and procedures of this study were explained comprehensively to the 35 36 parents/guardians of all potential participants by parents' meeting held in the kindergarten, including the right to withdraw from the study at any time. Parents 37 interested in having their child participate subsequently signed an informed consent 8 39 document. The inclusion criteria for the participants in this study were: (1) aged 3-6 years; (2) without a diagnosed physical and mental disability; and (3) with signed 90 informed consent from the participants' parents/guardians. This study was approved)1 by the Ethics Advisory Committee of Shanghai University of Sport. 2

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Procedures 4

95 Before accelerometer data collection, parents or guardians were instructed on the proper way to wear and remove the accelerometers by trained research staff. Parents 6

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or guardians agreed to have their children wear the accelerometers during all waking, including water-based activities such as bathing and swimming. And, Parents or guardians asked to encourage their children to wear them as much as possible during their school hours. The accelerometers were collected at the end of a consecutive 7-d study period, and the accelerometer data were transferred to a computer via ActiLife version 6.11.6 software. S N Measures Anthropometric data Height and weight were measured with participants dressed in light clothing. Height was measured to the nearest 0.1 cm using a freestanding portable stadiometer, and weight was measured to the nearest 0.1 kg with an electronic weighting scale (HN-358, Omron, Tokyo, Japan). Body mass index (BMI) was calculated with the formula weight/height² (kg/m²). Based on his or her BMI, each child was categorized as normal, overweight, or obese based on the International Obesity Task Force scale.17 Physical activity data PA was assessed with GT3X⁺ accelerometers (ActiGraph, Pensacola, FL), worn on the right hip attached to an elastic adjustable belt from 7 am to 11 pm every day for seven consecutive days. Non-wear time was determined by the Choi algorithm;¹⁸ children were required to have data from at least two weekdays and one weekend day, with a minimum daily wear time of 480 min to be included in the analysis. Based on

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119	these criteria, 43 participants were excluded from the final analysis.
120	Data were collected in 1-second epochs, because short epochs have been
121	recommended for capturing movement behavior in this age group. ¹⁹ Raw output was
122	expressed as counts per minute (CPM), and cut-off count levels previously developed
123	for preschool children by Pate and colleagues were used to analyze MVPA time. ⁶ We
124	classified PA into three levels: light (LPA), 101-1679 CPMs; moderate (MPA),
125	1680–3367 CPMs; and vigorous (VPA), ≥3368 CPMs. Total physical activity (TPA)
126	was calculated as the sum of LPA, MPA, and VPA time periods. PA values were
127	compared to the established recommendations of ≥ 60 min of MVPA or ≥ 180 min of
128	PA at any intensity to evaluate the proportion of participants meeting these
129	recommendations.
130	
131	Data analysis
132	Assuming the coefficient of variation (CV) of MVPA ($CV = 0.28$) based on the
133	previous study, ²⁰ confidence level as 95%, and 5% level of precision, the required
134	sample size was at least 125 in this study. The data are reported as means \pm standard
135	deviations (SDs) for normally distributed variables or as medians with interquartile
136	ranges (IQRs) for non-normally distributed variables. Independent t tests, Mann-
137	Whitney U tests, and chi-square tests were used to assess gender differences in
138	characteristics for normally distributed, non- normally distributed, and categorical

140 root methods prior to analysis. Differences in PA by gender and day were determined

variables, respectively. When necessary, PA data were normalized by a log or square

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4	141	with independent <i>t</i> tests, and differences in PA by BMI category were determined by
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6	142	one-way analysis of variance (ANOVA) with Bonferroni post hoc tests. Analyses
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9	143	were performed in SPSS version 22.0 (IBM Inc., Armonk, NY). A two-sided P value
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11	144	\leq .05 was considered statistically significant.
12	144	≥.05 was considered statistically significant.
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17	146	Patient and public involvement
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23 24	149	RESULTS
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26	450	Characteristics of nonticinants
27	150	Characteristics of participants
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29	151	The descriptive characteristics of the 303 participants included in the present
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32	152	cohort analysis are shown in Table 1. Weight, BMI, and the proportion of
33		
34	153	overweight/obese children were significantly higher in boys than in girls.
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39	155	The amount of different intensities of PA
40	200	
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42	156	On average, the number of valid accelerometer days among participants was 6.3
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44	157	days $(95\%$ CI = 6.2–6.4 d), and the mean duration of wear time across all valid days
45	137	days (557001 0.2 0.1 a), and the mean datation of wear time deross an valid days
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47	158	was 748.7 min/d (95% CI = 740.3–756.7 min/d). The actual and percent time spent
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49	150	angagad in CDM and each DA intensity level are presented in Table ? On average
50	159	engaged in CPM and each PA intensity level are presented in Table 2. On average,
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52	160	participants in this study accumulated 168.0 min/d of TPA, and spent 13.0% (~97.2
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55	161	min) of their daily waking time engaged in LPA and 9.5% (~70.9 min) of their days
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57	162	was spent engaged in MVPA. In general, boys were more active than girls, and
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60	163	participants engaged in more PA on weekend days than on week days. No significant
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difference in PA was identified with respect to BMI category.

166 Meeting the current PA recommendations

There were 72.9% of the participants met the MVPA recommendation that spent at least 60 min/d engaged in MVPA across all valid days, while only 35.3% of the participants met the TPA recommendation that accumulated at least 180 min/d of PA at any intensity. Boys met the PA recommendations more frequently than girls (**Table 3**).

173 DISCUSSION

In this accelerometer-based cross-sectional study of preschool children in
Shanghai, we found that, on average, boys accumulated 72.8 min/d of MVPA and
176 171.9 min/d of TPA, while girls accumulated 68.3 min/d of MVPA and 162.9 min/d
of TPA. At least 27% of the participants did not meet the established PA guidelines.
PA status of Shanghai preschoolers

recommendation of spending more than 60 min/d engaged in MVPA. However, less

Approximately 73% of participants in our Shanghai cohort met the

than 36% accumulated at least 180 min/d of TPA. The gap between these proportions

- is due largely to the shift from intensity to volume. The short 1-second sampling
- intervals used in this study may have resulted in an underestimation of LPA time,
- 185 which would then yield an underestimation of TPA time, relative to, for example, a

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186	15-second epoch. A longer epoch is more likely to result in an underestimation of
187	MVPA and an overestimation of LPA in young children. ²¹ Notably, a Canadian study
188	with a much longer 60-second epoch found that 83.8% of young children met the 180
189	min/d TPA guideline, ¹² while only 13.7% engaged in at least 60 min/d of MVPA.
190	This methodological inconsistency makes it quite difficult to conduct reliable inter-
191	study comparisons. Here, we chose a shorter epoch because it has been recommended
192	for capturing movement in young children owing to the particularly sporadic and
193	intermittent nature of activity exhibited by children in this age group. ²²
194	
195	Differences in PA by gender, BMI category, and date
196	Our empirical findings that boys spent 6.6% more time engaged in MVPA and
197	had 5.5% more TPA time than girls are consistent with meta-analysis results. ¹⁴ Trost
198	et al. suggested that a similar gender gap in PA was attributed to a VPA difference,
199	with boys spending approximately 45% more time engaged in VPA than girls in their
200	study. ²³ Meanwhile, Crespo et al. found that familial, social, and environmental
201	characteristics correlated with higher MVPA in boys than in girls. ²⁴ Possible factors
202	in this gender gap to explore in future studies include parental modeling and location.
203	Our finding of similar PA data across normal-weight and overweight/obesity
204	groups was somewhat surprising. Although we commonly thought that normal-weight
205	children must be more active than those who overweight/obese, accelerometer-based
206	evidence does not support this presumption for all studies. ²⁵ Furthermore, the opposite
207	findings are more likely to be true in some studies. ^{26 27} These negative findings
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208	suggest that other factors, such as diet and genetic background, play more important
209	roles in body weight. Future studies are needed to identify the relative importance of
210	and interactions among PA, diet, and genetics for weight status.
211	Our observation of greater PA on weekend days than on weekdays may be
212	explained by participants having more opportunities to engage in PA on non-school
213	days. Further studies should investigate and compare the specific activities engaged in
214	on school days versus weekend days.
215	
216	PA in Shanghai preschool children versus children elsewhere
217	Given the important of PA for physical, psychological, and cognitive health, ¹
218	there is an increasing body of research focusing on the PA levels on preschool
219	children from different population. Findings from a meta-analysis identified 29
220	studies indicated preschoolers' accelerometer-derived PA ranged from 19 min/d to
221	281 min/d. ²⁸ However, the amounts of PA across different intensity levels varied
222	widely depending upon the assessment methodology selected, with MVPA cut-off
223	CPM levels having a particularly large effect on PA results. ²⁹ Therefore, it is more
224	reasonable to compare the results that using the same cut-off value for PA levels.
225	Unfortunately, the amount of time spent engaged in MVPA in Shanghai preschool
226	children lower than data for the most prior populations assessed with the same cut-off
227	CPM levels by Pate (Range: 35.3-100.0 min/d; Median: 94.9 min/d). ^{20 25 30-37} The
228	pattern of our TPA results was comparable to that of the MVPA results (Range: 73.7-
229	394.0 min/d; Median: 348.0 min/d). ^{20 30-37}

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230	Obviously, the results of this cross-sectional study indicate that Shanghai
231	preschool children tend to have insufficient PA, and less PA than other populations
232	examined with the same cut-off CPM levels. Although the current Shanghai Preschool
233	Education Curriculum Guide requires daily outdoor activities for preschool children
234	to be no less than two hours, ³⁸ we also suggest that interventions and policies may be
235	needed to promote PA in Shanghai preschool children based on the data in this study.
236	Similar to children, adolescents and adults, a variety of settings can promote the level
237	of PA in children aged 3-5. However, in the early childhood stage, preschool is an
238	important settings for the promotion of PA. ³⁹ Although the findings of PA
239	intervention on preschool setting are inconsistent, ⁴⁰⁻⁴³ the extant literatures also
240	provide us with some strategies that may be useful for promoting PA levels of young
241	children. These included: (1) increasing time of outdoor activities, (2) providing
242	materials that are easy to get and play, such as balls and hula hoops, and (3) activities
243	held both indoor and outdoor by teacher-planned. ⁴⁴ Furthermore, there was a growing
244	evidence that technology applications, such as exergaming, seem to be an effective
245	approach to promote PA levels in children. ⁴⁵⁻⁴⁷ It should be noted that technology
246	applications may be a viable supplemental way to promote PA levels in young
247	children in preschool-based setting.
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249 Strengths and limitations

To the best of our knowledge, this is the first study to evaluate PA in Chinesepreschool children with accelerometers, which eliminating the recall bias associated

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> with other PA measurements. Additionally, our PA data were evaluated relative to both MVPA and TPA recommended guidelines.

This study had some limitations. First, for sampling feasibility, all participants were recruited from Northeast Shanghai. Thus, it remains to be determined whether similar findings would be obtained for children in other regions of Shanghai. Second, the accelerometer was worn over the right hip limited to capture activities with little displacement of the body, such as cycling. However, hip was probably the best placement to capture whole-body movements and on the side of the hip was also the most often site by various studies.⁴⁸ Third, the accelerometer-based PA collection process spans different seasons that may have an impact on the result, although the seasonal variation in accelerometer-determined PA was not always observed in Lien different region's studies.49

CONCLUSIONS

At least 27% of preschool children in Shanghai did not meet current age-specific PA recommendations and preschool children in Shanghai were less active than most of the populations assessed in comparable studies. Findings of this study implication that there remains a lot of room for improvement in PA behaviors among preschool children in Shanghai, suggesting that public health interventions and policies regarding PA should be explored to promote PA levels in Shanghai preschoolers given that the development of active lifestyle behaviors early in life are believed to yield health benefits that extend into adulthood.

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Author Contributions

Minghui Quan conceived and designed the study, analyzed the data and drafted the manuscript. Hanbin Zhang, Jiayi Zhang, Tang Zhou, Jinming Zhang, Guanggao Zhao, Hui Fang and Shunli Sun conducted the experiments and collected the data. Minghui Quan and Guanggao Zhao performed the literature search. Ru Wang and Peijie Chen advised on analysis and interpretation of the data, and critically revised the manuscript.

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Potential conflicts of interest

The authors declare that they have no conflicts to report.

Data sharing statement

No additional data are available.

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Characteristic	Boys (N = 174; 57.4%)	Girls (N = 129; 42.6%)	All (N = 303)
Mean age \pm SD, months	58.3 ± 5.6	57.1 ± 5.3	57.8 ± 5.5
Mean height \pm SD, cm	111.4 ± 5.0	110.3 ± 4.9	111.0 ± 5.0
Median weight (IQR), kg	20.6 (20.1–21.1)*	19.3 (18.8–19.8)	20.0 (19.7–20.4)
Median BMI (IQR), kg/m ²	16.5 (16.2–16.8)*	15.8 (15.5–16.1)	16.2 (16.0–16.4)
BMI category, %			
Normal	76.4*	86.8	80.9
Overweight	15.5*	10.1	13.2
Obesity	8.1*	3.1	5.9
<i>Note:</i> * <i>p</i> < .05, boys <i>vs</i> . girls.			

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Factor	Mean CPM ± SD (95%		Mean PA by c	ategory ± SD,	min/d (95%C	I)
racion	CI)	LPA	MPA	VPA	MVPA	ТРА
Gender						
Boys (N = 174)	498.3 ± 120.3 * (478.7–516.7)	99.2 ± 18.4 * (96.8–102.0)	40.9 ± 9.7 (39.5–42.3)	31.9 ± 10.7 * (30.4–33.4)	72.8 ± 18.8 * (70.1–75.4)	171.9 ± 34.0 [°] (167.1–176.8
Girls	468.0 ± 109.3	94.6 ± 15.9	38.8 ± 8.0	29.6 ± 8.6	68.3 ± 15.1	162.9 ± 27.6
(N = 129)	(447.3–486.2)	(91.8–97.3)	(37.3–40.1)	(28.0–31.1)	(65.7–70.9)	(158.0–167.6
BMI						
Normal	484.7 ± 113.6	96.9 ± 17.4	39.8 ± 8.8	30.9 ± 9.6	70.7 ± 17.0	167.6 ± 31.1
(N = 245)	(470.0–501.4)	(94.7–99.1)	(38.7–41.0)	(29.7–32.0)	(68.7–72.9)	(163.8–171.5
Overweight	476.0 ± 121.5	99.0 ± 18.2	40.0 ± 9.7	30.3 ± 10.9	70.3 ± 19.7	169.3 ± 35.5
(N = 40)	(437.3–514.6)	(93.5–104.9)	(37.1–43.4)	(27.1–34.0)	(64.4–76.9)	(158.2–181.2
Obesity	509.9 ± 144.2	97.7 ± 16.9	42.1 ± 11.1	32.3 ± 12.1	74.4 ± 19.0	171.0 ± 32.4
(N=18)	(444.0–580.5)	(89.3–105.2)	(37.4–47.2)	(26.7–37.9)	(65.7–83.0)	(156.0–186.4
Type of day						
Week (N = 303)	471.0 ± 117.4 [†] (457.8–484.6)	96.4 ± 17.9 (94.5–98.3)	39.3 ± 9.3 [†] (38.3-40.4)	30.9 ± 9.9 (29.9–32.1)	70.2 ± 17.5 (68.4–72.1)	166.6 ± 32.3 (163.2–170.1
Weekend	517.4 ± 166.2	98.6 ± 24.8	41.6 ± 12.0	30.6 ± 13.3	72.1 ± 24.0	170.6 ± 44.3
(N = 303)	(497.4–536.5)	(95.8–101.4)	(40.1-43.1)	(29.2–32.2)	(69.6–75.0)	(165.8–175.6
ALL	485.0 ± 116.4	97.2 ± 17.5	40.0 ± 9.1	30.9 ± 9.9	70.9 ± 17.5	168.0 ± 31.7
(N = 303)	(472.6–500.0)	(95.299.2)	(39.0-40.1)	(29.8–32.0)	(68.9–72.9)	(164.6–171.6
Percentage time			1			
spent in different		13.1 ± 2.1	5.4 ± 1.1	4.2 ± 1.3	9.5 ± 2.2	22.6 ± 3.7
intensities of PA, %		(12.8–13.3)	(5.2–5.5)	(4.0–4.3)	(9.3–9.8)	(22.1–23.0)

Table 2 Analysis of time spent engaged in PA categories by gender, BMI category, and day.

Note: LPA, light physical activity; MPA, moderate physical activity; MVPA, moderate to vigorous physical activity; PA, physical activity; TPA, total physical activity; VPA, vigorous physical activity; Mean \pm SD and 95% CI are reported for normally distributed variables; Significant data are shown in bold; *p < .05, boys vs. girls; †p < .05, weekdays vs. weekend days.

Table 3 Adherence to common established PA recommendations for preschool aged
children.*

	Guideline target	Participants, % (95%CI)			
PA metric		Boys (N = 174)	Girls (N = 129)	All (N = 303)	
MVPA	≥60 min/d accumulated, averaged across valid d	74.1 (67.2–79.9)	71.3 (63.6–79.1)	72.9 (68.3–77.9)	
TPA	≥180 min/d accumulated, averaged across valid d	42.0 (34.5–48.9)	26.4 (19.4–34.1)	35.3 (30.0–40.9)	

Note: MVPA, moderate to vigorous physical activity; PA, physical activity; TPA, total physical activity; *p < .05, boys vs. girls.

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

 Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

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32				Pag
33			Reporting Item	Numb
34 35 36 37 38	Title	<u>#1a</u>	Indicate the study's design with a commonly used term in the title or the abstract	1
39 40 41 42 43 44 45 46 47 48 49 50	Abstract	<u>#1b</u>	Provide in the abstract an informative and balanced summary of what was done and what was found	2
	Background / rationale	<u>#2</u>	Explain the scientific background and rationale for the investigation being reported	4-5
	Objectives	<u>#3</u>	State specific objectives, including any prespecified hypotheses	5
	Study design	<u>#4</u>	Present key elements of study design early in the paper	5
51 52 53 54	Setting	<u>#5</u>	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
54 55 56 57 58 59	Eligibility criteria	<u>#6a</u>	Give the eligibility criteria, and the sources and methods of selection of participants.	6
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1 2 3 4 5		<u>#7</u>	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
6 7 8 9 10 11 12 13 14 15 16 17 18	Data sources / measurement	<u>#8</u>	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	6-7
	Bias	<u>#9</u>	Describe any efforts to address potential sources of bias	6 сору
	Study size	<u>#10</u>	Explain how the study size was arrived at	8 9,
19 20 21	Quantitative variables	<u>#11</u>	Explain how quantitative variables were handled in the analyses If applicable, describe which groupings were chosen, and why	
22 23 24 25	Statistical methods	<u>#12a</u>	Describe all statistical methods, including those used to control for confounding	8 4363 16
26 27 28 29		<u>#12b</u>	Describe any methods used to examine subgroups and interactions	none g
30 31		<u>#12c</u>	Explain how missing data were addressed	none
32 33 34 35	<u>#1</u>	<u>#12d</u>	If applicable, describe analytical methods taking account of sampling strategy	8
36 37 38		<u>#12e</u>	Describe any sensitivity analyses	none
 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 	Participants <u>#13a</u>	<u>#13a</u>	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	8 8
		<u>#13b</u>	Give reasons for non-participation at each stage	8 000
		<u>#13c</u>	Consider use of a flow diagram	none
	Descriptive data	<u>#14a</u>	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	8
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	Outcome data	<u>#15</u>	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	9	BMJ Open: first published as 10.1136/bmjopen-2018-024090 on 25 April 2019. I Enseigner Protected by copyright, including for uses relatec
	Main results	<u>#16a</u>	Give unadjusted estimates and, if applicable, confounder- adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10 Protected by cc	
		<u>#16b</u>	Report category boundaries when continuous variables were categorized	10-11 no	
		<u>#16c</u>	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	none nor gird	
	Other analyses	<u>#17</u>	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	none relate	
	Key results	<u>#18</u>	Summarise key results with reference to study objectives	12-13 to	Downlo
	Limitations	<u>#19</u>	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	13 data min	baded from htt uperieur (ABES
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	Generalisability	<u>#21</u>	Discuss the generalisability (external validity) of the study results	, and s	
	Funding	<u>#22</u>	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15 15	
	Generalisability #21 Discuss the generalisability (external validity) of the study results 14 Funding #22 Give the source of funding and the role of the funders for the 15 present study and, if applicable, for the original study on which the present article is based 15 The STROBE checklist is distributed under the terms of the Creative Commons Attribution License CC-BY. This checklist can be completed online using https://www.goodreports.org/ , a tool made by the EQUATOR Network in collaboration with Penelope.ai				
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