Eur Child Adolesc Psychiatry
DOI 10.1007/s00787-016-0912-8

ORIGINAL CONTRIBUTION

The relationship between screen time, nighttime sleep duration, and behavioural problems in preschool children in China

Xiaoyan Wu[1,2] · Shuman Tao[1] · Erigene Rutayisire[1] · Yunxiao Chen[1] · Kun Huang[1,2] · Fangbiao Tao[1,2]

Received: 1 February 2016 / Accepted: 17 October 2016
© Springer-Verlag Berlin Heidelberg 2016

Abstract The purpose of this study was to evaluate the relationships between screen time (ST), nighttime sleep duration, and behavioural problems in a sample of preschool children in China. A sample of 8900 children aged 3–6 years was enrolled from 35 kindergartens, in four cities, in two provinces, in China to evaluate the relationships between ST, nighttime sleep duration, and behavioural problems. Children's ST and nighttime sleep duration were assessed by questionnaires completed by parents or guardians. Behavioural problems were assessed using the Strengths and Difficulties Questionnaire (SDQ), and the Clancy Autism Behaviour Scale (CABS). Multivariate analysis was used to assess the associations between ST, nighttime sleep duration, and behavioural problems. The total SDQ and CABS scores were higher in children with ST ≥2 h/day and sleep duration <9.15 h/day (a $P < 0.001$ for all). After adjusting for potential confounders, children with ST ≥2 h/day had a significantly increased risk of having total difficulties, emotional symptoms, conduct problems, hyperactivity, peer problems, and prosocial problems, as well as behavioural symptoms of autism spectrum disorder. Similar results were found in children with sleep duration <9.15 h/day. No significantly increased risk of emotional symptoms was observed for short sleep duration. Preschool children with more ST and short nighttime sleep duration were significantly more likely to have behavioural problems. These results may contribute to a better understanding of prevention and intervention for psychosocial problems in children.

Keywords Screen time · Sleep duration · Strengths and Difficulties Questionnaire (SDQ) · Autism spectrum disorder (ASD) · Behavioural problem · Preschool children

Introduction

A growing body of evidence suggests that excessive sedentary behaviour begins at a very young age, particularly for screen-based sedentary behaviours [1]. However, a previous study found that most parents believed that their young child did not have excessive screen time (ST) [2]. There is a growing body of evidence which demonstrated that the negative health effects of ST include behavioural and emotional problems in children [3–5], as well as negative health outcomes in adults [6]. Another important health issue, which should be noted in relation to ST, is adequate sleep among children [7]. ST exposure, such as TV viewing and computer use, was associated with shorter sleep duration in a previous study [8]. Children who had insufficient sleep were significantly more likely to have had sleep and behavioural problems [9], and these associations appeared to be bidirectional in longitudinal research [10].

Behavioural problems in children are quite common worldwide [11], and persist until at least late childhood, imposing substantial burdens on children and parents [12]. To date, a small but emerging number of studies found that ST and sleep duration were risk factors for behavioural problems among young children [13–15]. Therefore, early detection of such problems in children is important. The Strengths and Difficulties Questionnaire (SDQ) is a

✉ Fangbiao Tao
fbtao@ahmu.edu.cn

[1] Department of Maternal, Child and Adolescent Health, School of Public Health, Anhui Medical University, 81 Meishan Road, Hefei 230032, Anhui, China

[2] Anhui Provincial Key Laboratory of Population Health and Aristogenics, Hefei, China

Published online: 07 November 2016

validated tool for the identification of psychosocial problems in preschool-aged children [16]. Although ST and sleep duration both affect children's behaviours and emotions, there is a limited amount of research on the effects of ST and sleep duration on behavioural problems using the most common screening instruments, such as the SDQ. Moreover, little is known about the associations between ST and sleep duration and behaviours relating to autism spectrum disorders (ASD). Previous studies have reported that the mainly leisure time for ASD children is ST [17]. This is important because behavioural problems are common in young children with ASD [18].

The purpose of this study was to further evaluate the relationships between ST and nighttime sleep duration and behavioural problems in a representative cross-sectional sample of children aged 3–6 years old. Behavioural problems were assessed using the SDQ and the CABS. We hypothesized that preschool children who had more ST and slept less were more likely to have had behavioural problems compared with those who had less ST and slept more.

Method

Study design

This cross-sectional study was conducted in Anhui and Jiangsu Provinces, located in east China, between March and June 2015. Four cities, Tongling, Anqing, Wuhu, and Yangzhou, were randomly selected in two provinces. Children aged 3–6 years, from 35 kindergartens, were enrolled in the study. Questionnaires were distributed by maternal and child health care professionals. The parents or guardians of each child completed a structured questionnaire, which included the SDQ and CABS. A total of 9103 children were identified to take part in the survey. Questionnaires which were missing too much information were excluded from the analysis. Complete or almost complete questionnaires were returned from 8900 children. This study was approved by the Ethics Committee of Anhui Medical University. Informed consent was obtained from all the parents or guardians who completed the questionnaires.

Exposure variables

Screen time

The parents or guardians reported their children's ST using the following question: "How many hours per day does your child usually (a) spend watching TV; (b) spend using a computer to play games (other than homework); (c) spend using a cell phone; (d) spend using iPad and other electronic devices; at weekdays and weekend days, respectively?" Total weekly ST was the sum of TV time, computer time, cell phone time, and iPad and other electronic device time during weekdays and weekends. Average daily ST was calculated (5/7 × [ST on weekdays] + 2/7 × [ST during the weekend]). ST was categorized as low (<2 h/day) or high (≥2 h/day), according to the recommendation of the American Academy of Pediatrics.

Nighttime sleep duration

Nighttime sleep duration was assessed with the following two questions with two parts each: (1) "During the past month, when have your child usually gone to bed on a weeknight?"; "During the past month, when have your child usually gotten up on a weekday?"; and "During the past month, how long has it usually take your child to fall asleep on a weeknight?". (2) "During the past month, when have your child usually gone to bed during the weekend night?"; "During the past month, when have your child usually gotten up during the weekend day?"; and "During the past month, how long has it usually take your child to fall asleep during the weekend night?". These questions were used to create the duration of nighttime sleep on weekdays and weekends, separately. Sleep duration was calculated by (hours in bed–hour taking to fall asleep). Average daily duration of nighttime sleep was calculated (5/7 × [nighttime sleep duration on weekdays] + 2/7 × [duration of nighttime sleep on weekend days]). Duration of nighttime sleep was categorized as short (<sample mean) or long (≥sample mean), using the mean of the average nightly duration of sleep for the whole sample (9.15 h/day).

Outcome variables

The strengths and difficulties questionnaire (SDQ)

Parents or guardians completed the SDQ, a screening instrument with 25 items relating to strengths and difficulties and eight items relating to the severity and the impact of problems. The SDQ-P contained five subscales: emotional symptoms, conduct problems, hyperactivity-inattention, peer relationship problems, and prosocial behaviour. Parents or guardians rated items as 0, 1, or 2 for "not true", "somewhat true", and "certainly true", respectively. The total difficulties score (range 0–40) was obtained by summing the scores of the emotional symptoms, conduct problems, hyperactivity-inattention, and peer relationship problems. Higher scores are indicating more serious problems, except for the "prosocial behaviour" subscale, for which higher scores indicated more positive behaviours. Each subscale and the total difficulties score were dichotomized into healthy (normal category) or at-risk (borderline and

abnormal categories) group [13]. Previous research demonstrated that the internal consistency for the total difficulties score was good (Cronbach'α, 0.78) [16].

The Clancy Autism Behaviour Scale (CABS)

The CABS was assessed by parents or guardians to identify children's behavioural symptoms relating to ASD. This scale was first reported in 1969 [19] and was widely used in mainland China [20]. The CABS contained 14 items that were scored on a three point scale from 0 to 2 for "Never", "Occasionally", and "Often", respectively. The total score can be categorized into three groups using cutoffs of 14 and 21. Children who scores ≥14 and had <3 "never" responses and >6 "often" responses were considered potential cases of autism. In the present study, children with scores ≥14 were considered at-risk. The at-risk categorizations for the SDQ and CABS scales were used to identify children at risk of behavioural and emotional problems.

Covariates

The variables included in the analysis as potential confounders were gender, age, number of siblings, parental educational level, and family income. Maximum educational level of the parents was classified as the highest educational level of the parent who had more formal education. Maternal and birth information were also retrospective reported. These variables included gestational weeks, maternal age, delivery mode, birth weight, and breastfeeding. Preterm birth was defined as gestational age <37 completed weeks.

Anthropometric measurements were taken by trained maternal and child healthcare personnel at each kindergarten. Height (measured to the nearest 0.1 cm) and weight (measured to the nearest 0.1 kg) were measured when the children wore light clothes. Body mass index (BMI) was calculated by dividing weight (kg) by height squared (m^2). The World Health Organization Child Growth Standards for age- and sex-specific cutoffs were used [21]. Overweight was defined as BMI between the 85th and <95th percentile for age and sex, and obesity was defined as BMI ≥95th percentile.

Statistical analysis

The frequencies and proportions of parental socio-demographic characteristics, birth information, and child information were calculated for different groups of ST and sleep duration using Chi-square tests. Descriptive statistics (mean and standard deviation [SD]) for the total CABS scores and SDQ subscale, and total scores were calculated for the different ST and sleep duration groups. The distributions of the total CABS score and SDQ subscale scores and total scores were skewed; thus, the relationships between ST, sleep duration, CABS, and SDQ scores were assessed using Mann–Whitney *U* tests. Spearman correlation coefficients (*r*) were used to assess the associations of ST and sleep duration with CABS and SDQ scores. Multiple logistic regression models were used to test whether each exposure variables was independently associated with an increased risk of behavioural problems. A wide range of variables that were correlated with behaviour and could potentially bias the associations between ST, sleep duration, and outcome were adjusted for in the regression models. These potential confounders included gender, age, number of siblings, child's BMI, maternal income, maximum educational level of parents, gestational weeks, maternal age, breastfeeding, delivery mode, birth weight, and ST/sleep duration.

Data were analysed using the SPSS version 10.0. *P* values <0.05 were considered statistically significant.

Results

Characteristics of the study sample

The mean (SD) age of the study sample was 4.37 (0.99) years, and 47.1% were female. A maximum educational level of no more than high school was reported by 28.9% of parents, and 44.1% of parents reported a family income >4000 Yuan/month. Of the children, 11.7% were overweight and 14.5% were obese.

The percentages of children with ST ≥2 h/day and <2 h/day were 42.7% (3801/8900) and 57.3% (5099/8900), respectively. The percentages of children with sleep duration <9.15 h/day and ≥9.15 h/day were 57.0% (5069/8900) and 43.0% (3831/8900), respectively. The sample characteristics stratified by ST and sleep duration are shown in Table 1. The proportion of the sample which had ST ≥2 h/day did not vary significantly by age, gestational weeks, or delivery mode. There were significant differences in the prevalence of sleep duration <9.15 h/day between different age, family income, and delivery mode groups.

Differences between ST and sleep duration and behavioural problems

Table 2 reports the mean scores for SDQ total and subscale scores, and total CABS scores for the different ST and sleep duration groups. The total SDQ and CABS scores were higher in children with longer ST (both $P < 0.001$). The SDQ subscale scores for emotional symptoms, conduct problems, hyperactivity, and peer problems were higher in children with longer ST ($P < 0.001$ for all). The prosocial

Table 1 Study participant's characteristics in preschool children aged 3–6 years

Characteristic	*n* (%)	Screen time, *n* (%)		*P* value	Sleep duration, *n* (%)		*P* value
		≥2 h/day ($n = 3801$)	<2 h/day ($n = 5099$)		<9.15 h/day ($n = 5069$)	≥9.15 h/day ($n = 3831$)	
Gender				<0.001			0.257
Boy	4710 (52.9)	2097 (44.5)	2613 (55.5)		2709 (57.5)	2001 (42.5)	
Girl	4190 (47.1)	1704 (40.7)	2486 (59.3)		2360 (56.3)	1830 (43.7)	
Age				0.053			<0.001
3 years	2087 (23.4)	862 (41.3)	1225 (58.7)		1089 (52.2)	998 (47.8)	
4 years	2795 (31.4)	1200 (42.9)	1595 (57.1)		1520 (54.4)	1275 (45.6)	
5 years	2694 (30.3)	1162 (43.1)	1532 (56.9)		1614 (59.9)	1080 (40.1)	
6 years	1324 (14.9)	577 (43.6)	747 (56.4)		846 (63.9)	478 (36.1)	
Number of siblings				<0.001			0.331
No siblings	7107 (79.9)	2936 (41.3)	4171 (58.7)		4066 (57.2)	3041 (42.8)	
One or more siblings	1793 (20.1)	865 (48.2)	928 (51.8)		1003 (55.9)	790 (44.1)	
Child's BMI				0.031			0.087
Thinness and normal weight	6574 (73.9)	2756 (41.9)	3818 (58.1)		3704 (56.3)	2870 (43.7)	
Overweight	1038 (11.7)	457 (44.0)	581 (56.0)		597 (57.5)	441 (42.5)	
Obesity	1288 (14.5)	588 (45.7)	700 (54.3)		768 (59.6)	520 (40.4)	
Family income				<0.001			0.002
<2000 Yuan/RMB	1006 (11.3)	473 (47.0)	533 (53.0)		614 (61.0)	392 (39.0)	
2000–4000 Yuan/RMB	3968 (44.6)	1746 (44.0)	2222 (56.0)		2289 (57.7)	1679 (42.3)	
>4000 Yuan/RMB	3926 (44.1)	1582 (40.3)	2344 (59.7)		2166 (55.2)	1760 (44.8)	
Maximum educational level of parents				<0.001			0.664
High school or less	2575 (28.9)	1401 (54.4)	1174 (45.6)		1492 (57.9)	1083 (42.1)	
Some college or 2-year degree	2187 (24.6)	1074 (49.1)	1113 (50.9)		1233 (56.4)	954 (43.6)	
Bachelor's	3271 (36.8)	1113 (34.0)	2158 (66.0)		1857 (56.8)	1414 (43.2)	
Graduate or professional	867 (9.7)	213 (24.6)	654 (75.4)		487 (56.2)	380 (43.8)	
Gestational weeks				0.745			0.997
Full term	8419 (94.6)	3599 (42.7)	4820 (57.3)		4795 (57.0)	3624 (43.0)	
Premature	481 (5.4)	202 (42.0)	279 (58.0)		274 (57.0)	207 (43.0)	
Maternal age				<0.001			0.569
24 years or below	1821 (20.5)	974 (53.5)	847 (46.5)		1054 (57.9)	767 (42.1)	
25–29 years	4799 (53.9)	1936 (40.3)	2863 (59.7)		2733 (56.9)	2066 (43.1)	
Above 30 years	2280 (25.6)	891 (39.1)	1389 (60.9)		1282 (56.2)	998 (43.8)	
Breastfeeding				0.002			0.486
Never	2096 (23.6)	850 (40.6)	1246 (59.4)		1173 (56.0)	923 (44.0)	
0–6 month	4101 (46.1)	1726 (42.1)	2375 (57.9)		2360 (57.5)	1741 (42.5)	
More than 6 months	2703 (30.4)	1225 (45.3)	1478 (54.7)		1536 (56.8)	1167 (43.2)	
Delivery mode				0.981			0.018
Vaginal delivery	2907 (32.7)	1241 (42.7)	1666 (57.3)		1604 (55.2)	1303 (44.8)	
Caesarean section	5993 (67.3)	2560 (42.7)	3433 (57.3)		3465 (57.8)	2528 (42.2)	
Birth weight				0.012			0.105
<2500 g	1977 (22.2)	106 (38.5)	169 (61.5)		163 (59.3)	112 (40.7)	
2500–3999 g	4016 (45.1)	3370 (42.4)	4572 (57.6)		4542 (57.2)	3400 (42.8)	
≥4000 g	2907 (32.7)	325 (47.6)	358 (52.4)		364 (53.3)	319 (46.7)	

BMI body mass index

Table 2 Scores on SDQ total difficulties and subscales, CABS among screen time and sleep duration groups

Characteristic	Screen time, mean score (SD)			Sleep duration, mean score (SD)		
	≥2 h/day ($n = 5099$)	<2 h/day ($n = 3801$)	*P* value	<9.15 h/day ($n = 5099$)	≥9.15 h/day ($n = 3831$)	*P* value
SDQ						
Total difficulties	11.93 ± 4.73	10.43 ± 4.68	<0.001	11.31 ± 4.75	10.75 ± 4.75	<0.001
Emotional symptoms	2.14 ± 1.77	1.89 ± 1.68	<0.001	2.04 ± 1.74	1.94 ± 1.71	0.006
Conduct problems	2.17 ± 1.49	1.88 ± 1.43	<0.001	2.07 ± 1.48	1.91 ± 1.44	<0.001
Hyperactivity	4.89 ± 2.17	4.25 ± 2.17	<0.001	4.60 ± 2.18	4.42 ± 2.21	<0.001
Peer problems	2.73 ± 1.57	2.41 ± 1.57	<0.001	2.60 ± 1.58	2.48 ± 1.57	<0.001
Prosocial	6.33 ± 2.09	6.61 ± 2.15	<0.001	6.38 ± 2.14	6.64 ± 2.11	<0.001
CABS	6.94 ± 4.13	6.01 ± 4.00	<0.001	6.55 ± 4.14	6.21 ± 4.00	<0.001

SD standard deviation, *SDQ* strengths and difficulties questionnaire, *CABS* clancy autism behaviour scale

Table 3 Spearman's correlation of screen time and sleep duration with SDQ and CABS symptoms as continuous variables

Characteristic	Mean score (SD)	Screen time		Sleep duration	
		r	*P* value	*r*	*P* value
SDQ					
Total difficulties	11.07 ± 4.76	0.190	<0.001	−0.079	<0.001
Emotional symptoms	2.00 ± 1.73	0.086	<0.001	−0.041	<0.001
Conduct problems	2.00 ± 1.47	0.126	<0.001	−0.067	<0.001
Hyperactivity	4.52 ± 2.19	0.179	<0.001	−0.061	<0.001
Peer problems	2.55 ± 1.58	0.108	<0.001	−0.048	<0.001
Prosocial	6.49 ± 2.13	−0.075	<0.001	0.058	<0.001
CABS	6.40 ± 4.08	0.133	<0.001	−0.049	<0.001

SD standard deviation, *SDQ* strengths and difficulties questionnaire, *CABS* clancy autism behaviour scale

subscale scores were lower for children with more ST ($P < 0.001$). Similar results were found for the relationship between SDQ total and subscale scores, and between total CABS scores and shorter sleep duration.

Correlations between the predictors and behavioural problems

The correlations of the total and subscale behaviour scores with the continuous predicators variables are shown in Table 3. The mean (SD) total SDQ and CABS scores were 11.07 (4.76) and 6.40 (4.08),

respectively. ST was positively correlated with the total SDQ and CABS scores. ST was positively correlated with the SDQ subscales, except for the prosocial subscale ($r = -0.075$, $P < 0.001$). Inversely, sleep duration was negatively correlated with the total SDQ and CABS scores as well as of the SDQ subscales scores, except for prosocial ($r = 0.058$, $P < 0.001$). All of the correlations described here were statistically significant ($P < 0.001$ for all).

Associations between long ST, short sleep duration, and risk for behavioural problems

Table 4 shows the odds ratios that estimated the associations between ST, sleep duration, and being at risk for behavioural problems. Most associations were evident in both crude and adjusted models. Children with more ST were significantly more likely to be at risk for behavioural problems compared with those with less ST. Children with shorter sleep duration had a significantly increased risk of behavioural problems compared with those who had longer sleep duration. These findings were consistent for each of the SDQ subscale scores.

The simultaneous associations of ST and sleep on being at risk for behavioural problems were stronger than ST or sleep, separately. All associations were evident in both crude and adjusted models (Table 4).

Discussion

As hypothesized, the present study found that preschool children with long ST and short sleep duration were significantly more likely to have behavioural problems, after controlling for potential confounding factors. Specifically, children with long ST and short sleep duration had higher scores on CABS (which assessed ASD-related behaviours) compared with children with short ST and long sleep duration.

Children are spending an increasing amount of their time engaged in screen exposure. Compared with other cultural backgrounds of children, Chinese preschool children have a less ST exposure with 2.03 h an average day.

Table 4 Associations between screen time and sleep duration and risk for behaviour problems

	OR (95% CI)[a]	*P* value	OR (95% CI)[b]	*P* value
SDQ				
Total difficulties				
Screen time ≥2 h/day	1.64 (1.49–1.80)	<0.001	1.42 (1.29–1.56)	<0.001
Sleep duration <9.15 h/day	1.19 (1.09–1.31)	<0.001	1.18 (1.08–1.31)	<0.001
Screen time ≥2 h/day and sleep duration <9.15 h/day	1.93 (1.69–2.20)	<0.001	1.72 (1.50–1.97)	<0.001
Emotional symptoms				
Screen time ≥2 h/day	1.35 (1.21–1.50)	<0.001	1.23 (1.10–1.38)	<0.001
Sleep duration <9.15 h/day	1.09 (0.98–1.22)	0.132	1.08 (0.97–1.21)	0.180
Screen time ≥2 h/day and sleep duration <9.15 h/day	1.45 (1.25–1.71)	<0.001	1.36 (1.16–1.60)	<0.001
Conduct problems				
Screen time ≥2 h/day	1.46 (1.33–1.60)	<0.001	1.32 (1.20–1.45)	<0.001
Sleep duration <9.15 h/day	1.22 (1.12–1.34)	<0.001	1.24 (1.13–1.36)	<0.001
Screen time ≥2 h/day and sleep duration <9.15 h/day	1.77 (1.55–2.01)	<0.001	1.66 (1.46–1.90)	<0.001
Hyperactivity				
Screen time ≥2 h/day	1.58 (1.45–1.73)	<0.001	1.38 (1.26–1.51)	<0.001
Sleep duration <9.15 h/day	1.10 (1.01–1.20)	0.039	1.08 (0.99–1.19)	0.088
Screen time ≥2 h/day and sleep duration <9.15 h/day	1.71 (1.51–1.94)	<0.001	1.52 (1.34–1.74)	<0.001
Peer problems				
Screen time ≥2 h/day	1.42 (1.31–1.55)	<0.001	1.29 (1.18–1.40)	<0.001
Sleep duration <9.15 h/day	1.18 (1.08–1.28)	<0.001	1.18 (1.08–1.28)	<0.001
Screen time ≥2 h/day and sleep duration <9.15 h/day	1.64 (1.46–1.84)	<0.001	1.52 (1.35–1.72)	<0.001
Prosocial				
Screen time ≥2 h/day	1.25 (1.14–1.37)	<0.001	1.14 (1.04–1.25)	0.005
Sleep duration <9.15 h/day	1.25 (1.14–1.37)	<0.001	1.29 (1.17–1.41)	<0.001
Screen time ≥2 h/day and sleep duration <9.15 h/day	1.54 (1.36–1.74)	<0.001	1.49 (1.31–1.69)	<0.001
CABS				
Screen time ≥2 h/day	1.65 (1.38–1.99)	<0.001	1.47 (1.22–1.78)	<0.001
Sleep duration <9.15 h/day	1.21 (1.00–1.46)	0.048	1.22 (1.01–1.48)	0.039
Screen time ≥2 h/day and sleep duration <9.15 h/day	1.92 (1.48–2.49)	<0.001	1.80 (1.38–2.35)	<0.001

OR odd ratio, *CI* confidence interval, *SDQ* strengths and difficulties questionnaire, *CABS* clancy autism behaviour scale

[a] Crude model

[b] Adjustment for gender, age, number of siblings, child's BMI, maternal income, maximum educational level of parents, gestational weeks, maternal age, breastfeeding, delivery mode, birth weight, screen time/sleep duration

Preschool-aged children in the United States spend an average 4.1 h of ST daily at home and in day care settings [22]. International statistics indicate that children in Canada, the United States, and Australia are spending between 1.5 and 7.0 h daily in screen-viewing activities [23]. ST contributes to a variety of pediatric health problems [4]. Exploration of the associations between ST exposure and behavioural problems during early childhood is an emerging research area, and a variety of assessments to identify psychosocial problems have been used [24, 25]. Previous researches have suggested that ST might be associated with increased behavioural and emotional problems in children, including aggression [26], reduced prosocial behaviour [27], and attentional problems [28], which are consistent with our results. Hinkley et al. suggested that higher levels of early childhood electronic media use were associated with risk for emotional and peer problems [13]. Findings from the present study support the conclusion that there is an adverse influence of electronic media use on children's psychosocial well-being.

Our result differs from those from a nationally representative US study, which showed no evidence that children with ASD differ in their ST habits from other children [17]. A possible explanation for this inconsistency is that the US study used parental-reported history of ASD, instead of a standardized screening tool for ASD.

ST may affect children by displacing their sleep time [29]. However, previous studies focused solely on ST or sleep duration and did not investigate associations with the two factors simultaneously, as was done in this study. The

present study provides evidence that short sleep duration was significantly associated with emotional and behavioural problems among children aged 3–6 years, even after adjustment for potential confounders. The relationship between sleep problems and behavioural problems in children is well established. A population-based longitudinal study showed that short sleep duration at 18 months of age significantly predicted the incidence of behavioural problems at 5 years of age [30]. Scharf et al. [14] reported that shorter nighttime sleep duration in preschool children is associated with higher likelihood of externalizing behavioural symptoms based on parental report, using the Preschool and Kindergarten Behaviour Scale. However, different assessments of behavioural problems were used in aforementioned studies. The use of a uniform measurement for childhood behavioural problems in future studies is necessary to confirm the observed associations. Our study found that preschool children with short sleep duration had higher risk of ASD behaviour than children with long sleep duration. These findings confirm the results of previous studies which examined the relationship between sleep problems and daytime behaviour of children with ASD [15].

Several possible mechanisms may explain the aforementioned associations. The effect of ST on children might be also via influencing beliefs and behaviours. Based on social learning theory, children can easily learn by observing and imitating contents they see on the screen [5]. High ST has been associated with poor health outcomes such as increased sleep problems among children with ASD [31]. The social withdrawal hypothesis suggests that increased ST leads to less social interaction, which may have subsequent detrimental effects on positive well-being [32]. Further researches on mechanisms are needed to undertake in the early childhood population, to identify these associations clearly.

The strengths of this study include the large sample size and the statistical adjustment for a large number of potential covariates. In addition to information the children, maternal and birth data were assessed as potential confounders to better estimate the associations between ST and sleep time and behavioural problems. Despite these strengths, our study has several limitations. The data about bed time and wakeup time were retrospective and reported by parents and might have been subject to recall biases. However, as suggested in a previous study on sleep start and end time reported by parents, the actual sleep duration was accurately estimated by actigraphy [33]. ST was also reported by parental proxy, which might have been inaccurate as parents were not always with their children. However, as preschool children's ST exposure occurs mostly at home, there is good reason to believe that ST was accurately measured. ST and sleep duration were categorized, and so small associations might not have been detected, leading to conservative estimates in this analysis. A previous study suggested that children's emerging prosocial behaviour might have been shaped by the interactive contributions of interpersonal maternal emotion socialization [34]. Our study did not control for maternal emotion status for mothers. Finally, this survey was cross-sectional and an etiologic relationship cannot be determined. It is important to note that the relationships between ST, sleep duration, and behaviour in preschool children are likely bidirectional [9]. However, there is good reason to believe that long ST and short sleep duration led to behavioural problems, as data from previous prospective studies have established the temporal order in other populations [13, 30]. Further longitudinal studies are required to examine causal pathways in these associations and to determine the potential roles of ST and sleep duration in preventing mental health problems. Particularly, the mechanism underlying these relationships requires further research.

Conclusion

This study offers insight into the associations between ST and sleep duration and behavioural problems among preschool children in China. Our findings suggest that preschool children with long ST and short sleep duration were significantly more likely to have behavioural problems. Only by understanding the distinct links of ST and sleep duration with behaviour, we can pinpoint potential avenues for intervention. Based on our results, it is important for parents to limit their children's ST to no more than 1–2 h/day. Parents are also advised to regulate their children's sleep habits to ensure that their children received adequate amount of sleep.

Acknowledgements The authors are grateful to parents and children who participated in the present study. The authors also thank their partners from maternal and child health care center from 4 research sites. This work was supported by National Natural Science Foundation of China (81573168, 81373012).

Compliance with ethical standards

Ethical standards Approval for the study was obtained from the Ethics Committee of Anhui Medical University. Written informed consents were obtained from all of the participants.

Conflict of interest The authors declare that there are no conflicts of interest.

References

1. LeBlanc AG, Spence JC, Carson V, Connor Gorber S, Dillman C, Janssen I, Kho ME, Stearns JA, Timmons BW, Tremblay MS (2012) Systematic review of sedentary behaviour and health indicators in the early years (aged 0–4 years). Appl Physiol Nutr Metab 37(4):753–772. doi:10.1139/h2012-063

2. Carson V, Tremblay MS, Spence JC, Timmons BW, Janssen I (2013) The Canadian Sedentary Behaviour Guidelines for the Early Years (zero to four years of age) and screen time among children from Kingston, Ontario. Paediatr Child Health 18(1):25–28
3. Hinkley T, Teychenne M, Downing KL, Ball K, Salmon J, Hesketh KD (2014) Early childhood physical activity, sedentary behaviors and psychosocial well-being: a systematic review. Prev Med 62:182–192. doi:10.1016/j.ypmed.2014.02.007
4. Strasburger VC, Jordan AB, Donnerstein E (2012) Children, adolescents, and the media: health effects. Pediatr Clin N Am 59(3):533–587vii. doi:10.1016/j.pcl.2012.03.025
5. Strasburger VC, Jordan AB, Donnerstein E (2010) Health effects of media on children and adolescents. Pediatrics 125(4):756–767. doi:10.1542/peds.2009-2563
6. Hancox RJ, Milne BJ, Poulton R (2004) Association between child and adolescent television viewing and adult health: a longitudinal birth cohort study. Lancet 364(9430):257–262. doi:10.1016/S0140-6736(04)16675-0
7. Matricciani LA, Olds TS, Blunden S, Rigney G, Williams MT (2012) Never enough sleep: a brief history of sleep recommendations for children. Pediatrics 129(3):548–556. doi:10.1542/peds.2011-2039
8. de Jong E, Visscher TL, HiraSing RA, Heymans MW, Seidell JC, Renders CM (2013) Association between TV viewing, computer use and overweight, determinants and competing activities of screen time in 4- to 13-year-old children. Int J Obes (Lond) 37(1):47–53. doi:10.1038/ijo.2011.244
9. Garrison MM (2015) The feedback whirlpool of early childhood sleep and behavior problems. JAMA Pediatr 169(6):525–526. doi:10.1001/jamapediatrics.2015.0356
10. Jansen PW, Saridjan NS, Hofman A, Jaddoe VW, Verhulst FC, Tiemeier H (2011) Does disturbed sleeping precede symptoms of anxiety or depression in toddlers? The generation R study. Psychosom Med 73(3):242–249. doi:10.1097/PSY.0b013e31820a4abb
11. Comer JS, Chow C, Chan PT, Cooper-Vince C, Wilson LA (2013) Psychosocial treatment efficacy for disruptive behavior problems in very young children: a meta-analytic examination. J Am Acad Child Adolesc Psychiatry 52(1):26–36. doi:10.1016/j.jaac.2012.10.001
12. Stone LL, Janssens JM, Vermulst AA, Van Der Maten M, Engels RC, Otten R (2015) The Strengths and Difficulties Questionnaire: psychometric properties of the parent and teacher version in children aged 4–7. BMC Psychol 3(1):4. doi:10.1186/s40359-015-0061-8
13. Hinkley T, Verbestel V, Ahrens W, Lissner L, Molnar D, Moreno LA, Pigeot I, Pohlabeln H, Reisch LA, Russo P, Veidebaum T, Tornaritis M, Williams G, De Henauw S, De Bourdeaudhuij I (2014) Early childhood electronic media use as a predictor of poorer well-being: a prospective cohort study. JAMA Pediatr 168(5):485–492. doi:10.1001/jamapediatrics.2014.94
14. Scharf RJ, Demmer RT, Silver EJ, Stein RE (2013) Nighttime sleep duration and externalizing behaviors of preschool children. J Dev Behav Pediatr 34(6):384–391. doi:10.1097/DBP.0b013e31829a7a0d
15. Sikora DM, Johnson K, Clemons T, Katz T (2012) The relationship between sleep problems and daytime behavior in children of different ages with autism spectrum disorders. Pediatrics 130(Suppl 2):S83–S90. doi:10.1542/peds.2012-0900F
16. Theunissen MH, Vogels AG, de Wolff MS, Reijneveld SA (2013) Characteristics of the strengths and difficulties questionnaire in preschool children. Pediatrics 131(2):e446–e454. doi:10.1542/peds.2012-0089
17. Montes G (2016) Children with autism spectrum disorder and screen time: Results from a large nationally representative US Study. Acad Pediatr 16(2):122–128. doi:10.1016/j.acap.2015.08.007
18. Hanratty J, Livingstone N, Robalino S, Terwee CB, Glod M, Oono IP, Rodgers J, Macdonald G, McConachie H (2015) Systematic Review of the Measurement Properties of Tools Used to Measure Behaviour Problems in Young Children with Autism. PLoS One 10(12):e0144649. doi:10.1371/journal.pone.0144649
19. Clancy H, Dugdale A, Rendle-Short J (1969) The diagnosis of infantile autism. Dev Med Child Neurol 11(4):432–442
20. Sun X, Allison C, Auyeung B, Matthews FE, Zhang Z, Baron-Cohen S, Brayne C (2014) Comparison between a Mandarin Chinese version of the Childhood Autism Spectrum Test and the Clancy Autism Behaviour Scale in mainland China. Res Dev Disabil 35(7):1599–1608. doi:10.1016/j.ridd.2014.02.005
21. World Health Organization (2006) WHO Child Growth Standards: methods and development. http://www.who.int/childgrowth/standards/Technical_report.pdf?ua=1. Accessed 2006
22. Tandon PS, Zhou C, Lozano P, Christakis DA (2011) Preschoolers' total daily screen time at home and by type of child care. J Pediatr 158(2):297–300. doi:10.1016/j.jpeds.2010.08.005
23. Vanderloo LM (2014) Screen-viewing among preschoolers in childcare: a systematic review. BMC Pediatr 14:205. doi:10.1186/1471-2431-14-205
24. Griffiths LJ, Dowda M, Dezateux C, Pate R (2010) Associations between sport and screen-entertainment with mental health problems in 5-year-old children. Int J Behav Nutr Phys Act 7:30. doi:10.1186/1479-5868-7-30
25. Manganello JA, Taylor CA (2009) Television exposure as a risk factor for aggressive behavior among 3-year-old children. Arch Pediatr Adolesc Med 163(11):1037–1045. doi:10.1001/archpediatrics.2009.193
26. Mistry KB, Minkovitz CS, Strobino DM, Borzekowski DL (2007) Children's television exposure and behavioral and social outcomes at 5.5 years: does timing of exposure matter? Pediatrics 120(4):762–769. doi:10.1542/peds.2006-3573
27. Cheng S, Maeda T, Yoichi S, Yamagata Z, Tomiwa K (2010) Early television exposure and children's behavioral and social outcomes at age 30 months. J Epidemiol 20(Suppl 2):S482–S489
28. Swing EL, Gentile DA, Anderson CA, Walsh DA (2010) Television and video game exposure and the development of attention problems. Pediatrics 126(2):214–221. doi:10.1542/peds.2009-1508
29. Strasburger VC (2011) Children, adolescents, obesity, and the media. Pediatrics 128(1):201–208. doi:10.1542/peds.2011-1066
30. Sivertsen B, Harvey AG, Reichborn-Kjennerud T, Torgersen L, Ystrom E, Hysing M (2015) Later emotional and behavioral problems associated with sleep problems in toddlers: a longitudinal study. JAMA Pediatr 169(6):575–582. doi:10.1001/jamapediatrics.2015.0187
31. Engelhardt CR, Mazurek MO, Sohl K (2013) Media use and sleep among boys with autism spectrum disorder, ADHD, or typical development. Pediatrics 132(6):1081–1089. doi:10.1542/peds.2013-2066
32. Varni JW, Magnus B, Stucky BD, Liu Y, Quinn H, Thissen D, Gross HE, Huang IC, DeWalt DA (2014) Psychometric properties of the PROMIS (R) pediatric scales: precision, stability, and comparison of different scoring and administration options. Qual Life Res 23(4):1233–1243. doi:10.1007/s11136-013-0544-0
33. Werner H, Molinari L, Guyer C, Jenni OG (2008) Agreement rates between actigraphy, diary, and questionnaire for children's sleep patterns. Arch Pediatr Adolesc Med 162(4):350–358. doi:10.1001/archpedi.162.4.350
34. Scrimgeour MB, Davis EL, Buss KA (2016) You get what you get and you don't throw a fit!: Emotion socialization and child physiology jointly predict early prosocial development. Dev Psychol 52(1):102–116. doi:10.1037/dev0000071