Original Article

Sleep Duration and Factors Related to Sleep Loss in 3–14-Year-Old Children in Beijing: A Cross-Sectional Survey

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Abstract

Background: It is known that short sleep duration adversely affects children's behavior and physical development. This study aimed to investigate the status of sleep duration in 3–14-year-old children in Beijing and explore the related factors of sleep loss with them.
Methods: In this study, a cross-sectional study of random stratified cluster sampling was conducted on 3–14-year-old children and adolescents in Beijing. According to the proportion of children in each district and school, the final cohort included a total of 11 kindergartens, 7 primary schools, and 8 junior high schools from 7 districts of Beijing. Children of sampled classes were included, and their parents were invited to fill a series of questionnaires including the simplified Chinese version of Pediatric Sleep Questionnaire, Sleep Questionnaire Scale, and Hong Kong-Children Sleep Questionnaire about the performance of the last 6 months.
Results: Out of the total 11,420 questionnaires, 9198 questionnaires were valid and effective with the response rate of 80.54%. The age of the investigated children was 8.8 ± 3.8 years, including 4736 males and 4462 females. The daily sleep duration of children in Beijing was 9.7 ± 0.7 h. The prevalence of sleep loss (<9 h/day) of children in Beijing was 11.8%. The daily sleep duration of children aged <6, 6 ≤ age <11, and ≥11 years was 9.7 ± 0.6 h, 9.6 ± 0.6 h, and 9.5 ± 0.8 h, respectively. The sleep duration reduced significantly in children aged ≥11 years as compared to younger children in Beijing which was mainly contributed by the variation tendency of sleep duration on weekdays. The multivariate logistic regression analysis identified factors associated with sleep loss ($P < 0.05$): male (odds ratio [*OR*] = 1.32, 95% confidence interval [*CI*]: 1.15–1.51), age ≥11 years (*OR* = 2.37, 95% *CI*: 1.92–2.93), overweight (*OR* = 1.34, 95% *CI*: 1.17–1.54), family history of snoring (*OR* = 1.35, 95% *CI*: 1.13–1.61) and activities before bedtime with watching TV (*OR* = 1.24, 95% *CI*: 1.08–1.43), sports (*OR* = 1.22, 95% *CI*: 1.01–1.48), playing cellphone (*OR* = 1.91, 95% *CI*: 1.31–2.73) and surfing the Internet (*OR* = 1.27, 95% *CI*: 1.06–1.52) and among them age ≥11 years and playing cellphone before bedtime had greater impact on children's short sleep duration than that of other factors.
Conclusions: Sleep loss was common among 3–14-year-old children in Beijing. Sleep duration decreased with age, especially among children over 11 years old. Factors associated with sleep loss covered sociodemographic characteristics, family sleep habits and routine activities before bedtime, and among those variables, age ≥11 years and playing with cellphones before bedtime had a greater impact on sleep duration, indicating that existing sleep loss in 3–14-year-old children could be, at least partly, improved by paying more attention to children aged of 11 years or entering Grade 5 and Grade 6 and to children with a family history of snoring; by reducing the use of electronic products before bedtime, especially cellphones; by managing weight and keeping fit; and by improving the bedtime routine.

Key words: Child; Cross-Sectional Survey; Sleep Duration

Introduction

Children's sleep health is of great importance for children's healthy growth and development. Adequate and effective sleep duration is the foundation of sleep health for children. Short sleep duration adversely affects school performance[1,2] and increases the risks of cognitive deficiency[3] and mood disturbance.[4] In addition, it is independently correlated

Access this article online

Quick Response Code:

Website: www.cmj.org

DOI: 10.4103/0366-6999.237403

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Received: 01-04-2018 **Edited by:** Yi Cui
How to cite this article: Li XD, Tai J, Xu ZF, Wang GX, Wu YX, Du JN, Zhang J, Peng XX, Ni X. Sleep Duration and Factors Related to Sleep Loss in 3–14-Year-Old Children in Beijing: A Cross-Sectional Survey. Chin Med J 2018;131:1799-807.

with overweight in children.[5-8] Epidemiological studies demonstrated that sleep duration varied substantially in children at different ages,[9,10] and significant differences were observed with respect to sleep habit and sleep duration among different areas and races.[11-13]

Although some studies reported the sleep duration in Chinese children, the majority of those only focused on a specific age group[14] or southern cities such as Shanghai,[15] Chengdu,[16] and Nanjing,[17] as reported 5–10 years ago. With the rapid progress of society, children's lifestyles and sleep habits are changing with each passing day. Thus, the current understanding on the status of sleep duration among 3–14-year-old Chinese children is limited. The present study aimed to (1) investigate the sleep duration in 3–14-year-old children in Beijing and (2) explore the related factors influencing the short sleep duration in order to obtain reference data of children for improving the sleep habits.

Methods

Ethical approval and consent to participate

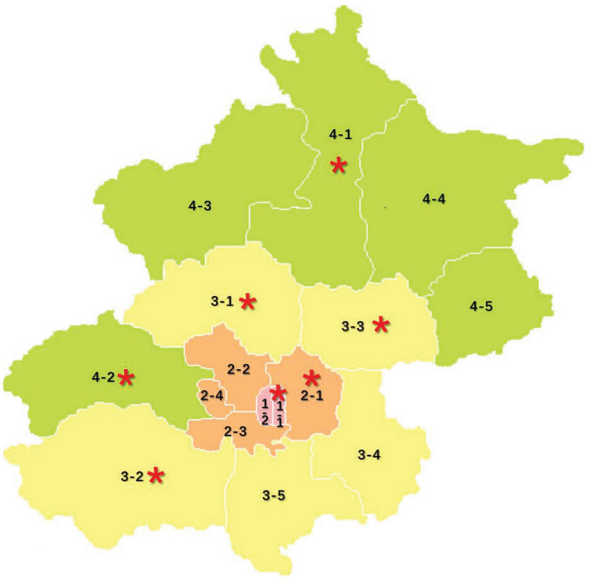
The survey was approved by the Ethics Committee of Beijing Children's Hospital (No. 2013-76). Based on the voluntary principle, informed consent was obtained from the respondents or guardians (on behalf of minors), who were free to discontinue the participation in the study at any time.

Setting, sampling, and participants

The present study comprised a cross-sectional, randomized, stratified, multistage cluster sampling methodology. According to the statistical formula, $n = \frac{Z_{\alpha/2}^{\ 2}\, p(1-p)}{\delta^2}$ (where n, p, and δ are sample size, positive rate, and acceptable error, respectively), assuming sleep disorder prevalence = 4.8% in children,[18] significance at $\alpha = 0.05$ with $Z_{\alpha/2}$ of 1.96, and acceptable error at 0.1 p, the sample size was calculated as 7619. Allowing for a 20% nonresponse rate, the final intended sample size was set as 9600.

The present study was conducted in Beijing, a city divided into 16 districts classified as four functional regions including the Capital Core Region, the Urban Developed Region, the Urban New Region, and the Ecological Region [Figure 1]. Based on the data of the Sixth Population Census in China[19] and the calculation of the proportion of children in each functional region, district, age distribution, and school, a total of 11 kindergartens, 7 primary schools, and 8 middle schools from 7 districts of Beijing (Xicheng District, Chaoyang District, Mentougou District, Fangshan District, Changping District, Shunyi District, and Huairou District) were sampled randomly. The classes in each grade were sampled as the basic cluster by random; of which, the eligible children and their guardians were invited to participate in the survey.

Children between 3 and 14 years of age with guardians agreeing to cooperate with the completion were included in the study. Children >3–14-year-old or those with severe visual, hearing,



Map appendix: Beijing regions and affiliated districts

Regions	1 the Capital Core Region (pink)	2 the Urban Developed Region (orange)
Districts	1-1 Dongcheng District *	2-1 Chaoyang District *
	1-2 Xicheng District	2-2 Haidian District
		2-3 Fengtai District
		2-4 Shijingshan District
Regions	**3 the Urban New Region (yellow)**	**4 the Ecological Region (green):**
Districts	3-1 Changping District *	4-1 Huairou District *
	3-2 Fangshan District *	4-2 Mentougou District *
	3-3 Shunyi District *	4-3 Yanqing District
	3-4 Tongzhou District	4-4 Miyun District
	3-5 Daxing District	4-5 Pinggu District

Figure 1: Beijing district map. The four functional regions were numbered as 1–4, in order from the city center to the suburbs. The districts belonging to different regions were numbered in alphabetical order. The color code in the brackets and the *matches represent the different regions and the sampled districts in the map, respectively.

or learning disabilities; major psychiatric illness; or congenital maxillofacial deformities were excluded from the survey.

Questionnaire investigation and quality control

The guardians of all respondents were asked to complete a series of questionnaires about the performance of the last 6 months within 20–30 min, including the simplified Chinese version of Pediatric Sleep Questionnaire (PSQ),[20,21] Sleep Questionnaire Scale,[22] and Hong Kong-Children Sleep Questionnaire (HK-CSQ).[23]

The final investigations were performed by parent–teacher meetings in the unit of a classroom, through which the supervisors publicized the knowledge of childhood sleep health and informed the guardians of the survey before obtaining consent for the participation. The questionnaires were self-administered by guardians, and the survey facilitators were available to clarify any concerns. The quality auditing was developed to ensure that all questionnaires were completed appropriately. A valid questionnaire was the one that had been audited and signed by a supervisor. Children's sleep information and questionnaire scores were feedbacked to the sampling schools. Children or guardians

interesting in the results have been advised to contact the school doctors for information. All the private information and the questionnaire content of children or guardians were confidential to the public.

Outcome measures

The main outcome measures were the time of falling asleep and waking up time on weekdays, weekends, and holidays from HK-CSQ, according to which the sleep durations were calculated. A weighted average was used to calculate the daily sleep duration throughout the week: the daily sleep duration = ([weekday sleep duration × 5] + [weekend sleep duration × 2])/7.[24] According to the new sleep time suggestions from the National Sleep Foundation, sleep loss is defined as less than 9 hours of daily sleep duration.

The secondary outcome measures were the sociodemographic information and potential factors associated with sleep loss from the above three questionnaires, including gender, age, height, weight, district, parental education, birth weight, gestational weeks, people living together, family history of snoring and smoking, and the score of PSQ and habit activities 1 h before bedtime. The continuous variables in the above measurements were graded as recognized principles: (1) Body mass index (BMI) was used to determine the children as "normal" or "overweight or above." According to the BMI growth reference value and growth curve of 0–18-year-old children and adolescents in China, the corresponding percentile of overweight was P96.3 in boys and P98.0 in girls;[25,26] (2) Region included urban areas (districts of the Capital Core Region and the Urban Developed Region) and suburban areas (districts of the Urban New Region and the Ecological Region);(3) Sleep-disordered breathing (SDB) was screened by PSQ with >7 positive items out of the 22 symptoms;[20,21] (4) Premature labor was defined as gestational age of >28 weeks and <37 weeks; and (5) History of low birth weight infant was defined as a premature infant with birth weight <1000 g or a full-term infant with a birth weight of <2500 g.

Statistical collection and analysis

Coding and double entry of questionnaire responses were carried out by two independent professional data-entry staff. EpiData 3.1 software (EpiData Foundation, Odense, Denmark) was used to access the consistency between the two sets of data entries to ensure data quality. All analyses were performed using the Statistical Package for the Social Sciences® for Windows® 13.0 (SPSS Inc., Chicago, IL, USA). Pictures were drawn with JMP for Windows® 11.0.0 (SAS Institute Inc, North Carolina, Ohio, USA).

The unreasonable values, such as abnormal outliers, were considered as missing values. Descriptive analysis was performed. Results for continuous variables with normal distributions were presented as mean ± standard deviations (SD). Results for continuous variables that were not normally distributed were presented as median (P25, P75). As the sample size was large, histogram was used to judge the distribution of continuous variables; homogeneity of variance was tested by Levene method. For the continuous variables, data were analyzed using the *t*-test, Wilcoxon rank-sum test, and Welch's test depending on the data distribution and homogeneity of variance. Interrupted time series and least squares were used to study the variation tendency of sleep duration with age. The related factors were analyzed by Chi-square test and multivariate logistic regression with odds ratio (*OR*) and 95% confidence interval (*CI*). All comparisons were two tailed, and $P < 0.05$ was required to exclude the null hypothesis.

Results

General characteristics

A total of 11,420 questionnaires were sent out, and 10,743 (94.07%) were recovered. After data cleaning, the final effective data were 9198 (effective response rate: 80.54%). The mean age of the investigated children was 8.8 ± 3.8 years, including 4736 males and 4462 females. The number of all age groups basically covered the number of planned sample size and had a satisfactory representativeness. The average BMI was 18.4 kg/m^2 (range 11.3–39.1). In addition, a total of 4592 urban children (48.35%) and 4606 (51.65%) suburban children participated in the survey. The characteristic data are summarized in Table 1, almost consistent with the census data[19] and the demographic data of Chinese children.[25-27]

Sleep duration description

The daily sleep duration of children in Beijing was 9.7 ± 0.7 h [Table 2]. The sleep duration was surveyed in different situations as 9.0 ± 0.8 h on weekdays, 9.8 ± 0.9 h on weekends, and 10.0 ± 0.9 h on holidays. Boys' daily sleep duration was lower than girls' with significant difference ($P < 0.0001$). The daily sleep durations of children aged <6, 6≤age<11, and ≥11 years were 9.7 ± 0.6 hours, 9.6 ± 0.6 hours and 9.5 ± 0.8 hours, respectively, and were significantly different ($P < 0.0001$).

Table 1: Demographic data of sampled children

Clinic variables	Total (n = 9198)	Males (n = 4736)	Females (n = 4462)
Age (years)	8.8 ± 3.8	8.8 ± 3.4	8.8 ± 3.3
Height (cm)	118.8 ± 16.5	119.5 ± 16.1	117.6 ± 15.9
Weight (kg)	25.0 ± 11.6	26.1 ± 10.9	23.9 ± 11.3
BMI (kg/m^2)	18.4 ± 4.3	18.9 ± 4.5	18.0 ± 3.9
Age group			
3.0≤ age <7.0 years	3093 (33.6)	1600 (33.8)	1493 (33.5)
7.0≤ age <11.0 years	3398 (36.9)	1745 (36.8)	1653 (37.0)
Age ≥11.0 years	2707 (29.4)	1391 (29.4)	1316 (29.5)
Region			
Urban	4592 (48.35)	2396 (50.6)	2196 (49.2)
Suburban	4606 (51.65)	2340 (49.4)	2266 (50.1)

The data are shown as mean ± SD or n (%). Urban regions refer to Xicheng District and Chaoyang District in this survey; Suburban regions refer to Mentougou District, Fangshan District, Changping District, Shunyi District, and Huairou District in this survey. SD: Standard deviation; BMI: Body mass index.

Sleep duration and age

The tendency of sleep duration [Figure 2] revealed that the sleep duration of children aged ≥11 years decreased more obviously with age than children <11 years old. The daily sleep duration curve flattens in the age range of 3–10 years; however, it changed with a significant downward tendency after 11 years of age. This trend was approximately similar to the tendency of weekdays. However, the sleep duration of weekends and holidays was significantly longer than that of weekdays, which varies slightly with age.

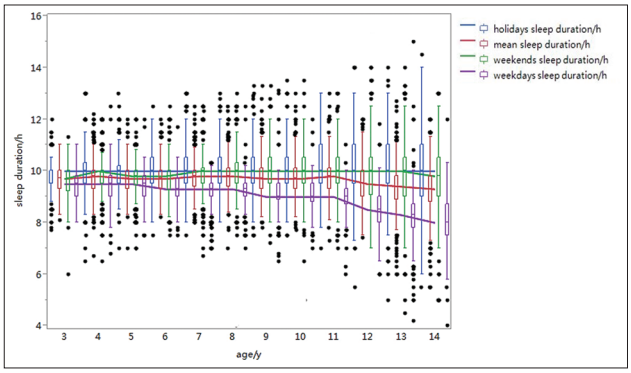


Figure 2: Change in the trend of sleep durations with age in different circumstances (weekdays, weekends, and holidays). The mean sleep duration = ([weekday sleep duration × 5] + [weekend sleep duration × 2])/7. The curve depicted the trend of the median sleep duration in different sleep circumstances (weekdays, weekends, and holidays) of each age. The box chart recorded the median, P25, P75, and outliers of each age.

Interrupted time series and least squares were used to compare the variation tendency of sleep duration in elder age group (≥11 years) and younger age group (<11 years); Interactions were introduced with combinations of age and age groups. The parameter estimates of sleep duration in different situations were statistically significant with $P < 0.0001$ [Table 3], which may be related to the larger sample size, except for the independent variable "age (<11 years)" ($P = 0.3569$) in the daily sleep duration. However, we focused on the "estimated value" which represents the slope. By comparing the slopes of "age × groups" and "age (<11 years)," the former was negative with absolute value greater than the latter, so it is confirmed that the decline of sleep duration was more

Table 2: Description and comparison of sleep durations between gender, age, and region groups

Items	Total	Gender			Age				Region		
		Female	Male	*P*	3.0≤ age <7.0	7.0≤ age <11.0	Age ≥11.0	*P*	Urban	Suburban	*P*
Daily* (h)	9.7 ± 0.7	9.7 ± 0.7	9.6 ± 0.7	<0.0001‡	9.7 ± 0.6	9.6 ± 0.6	9.5 ± 0.8	<0.0001§	9.7 ± 0.7	9.6 ± 0.7	0.9957†
Weekdays (h)	9.0 ± 0.8	9.0 ± 0.8	9.0 ± 0.8	0.9644†	9.5 ± 0.5	9.1 ± 0.5	8.5 ± 0.8	<0.0001§	9.0 ± 0.7	9.0 ± 0.8	0.9917†
Weekends (h)	9.8 ± 0.9	9.9 ± 0.9	9.8 ± 0.9	<0.0001‡	9.7 ± 0.7	9.8 ± 0.8	9.9 ± 1.1	<0.0001§	9.8 ± 0.9	9.8 ± 0.9	0.9870†
Holidays (h)	10.0 ± 0.9	10.0 ± 0.8	10.0 ± 0.9	<0.0001†	9.9 ± 0.7	10.0 ± 0.8	10.1 ± 1.0	<0.0001§	10.0 ± 0.9	10.0 ± 0.9	0.9821†

*Daily sleep duration = ([weekday sleep duration × 5] + [weekend sleep duration × 2])/7; †Comparing the two groups of continuous data, histogram shows normal distribution; Levene method shows $P>0.05$, variance is homogeneous, *t*-test is used for comparison between groups; ‡Comparing the two groups of continuous data, histogram showed normal distribution; Levene method shows $P<0.05$, and the variance was not homogeneous. Wilcoxon rank-sum test was used for comparison between groups; §Comparing the three groups of continuous data, histogram showed normal distribution; Levene method shows $P<0.05$, and the variance was not homogeneous. Welch's test was used for comparison between groups.

Table 3: Parameter estimation in the linear regression model between sleep duration and age

Parameters	Item	Estimated value	Standard error	*t*	*P*
Daily sleep duration/h	Intercept	9.646	0.028	346.81	<0.0001
	Group (≥11)–(<11)*	0.345	0.057	6.08	<0.0001
	Age (<11)†	0.003	0.004	0.92	0.3569
	Age*group (≥11)–(<11)‡	−0.143	0.013	−10.83	<0.0001
Weekdays' sleep duration/h	Intercept	9.740	0.027	359.43	<0.0001
	Group (≥11)–(<11)*	0.328	0.055	5.94	<0.0001
	Age (<11)†	−0.062	0.004	−16.74	<0.0001
	Age*group (≥11)–(<11)‡	−0.211	0.013	−16.35	<0.0001
Weekends' sleep duration/h	Intercept	9.553	0.040	239.71	<0.0001
	Group (≥11)–(<11)*	0.432	0.081	5.32	<0.0001
	Age (<11)†	0.031	0.005	5.62	<0.0001
	Age*group (≥11)–(<11)‡	−0.126	0.019	−6.65	<0.0001
Holidays' sleep duration/h	Intercept	9.647	0.039	249.54	<0.0001
	Group (≥11)–(<11)*	0.273	0.079	3.47	0.0005
	Age (<11)†	0.042	0.005	7.95	<0.0001
	Age*group (≥11)–(<11)‡	−0.093	0.018	−5.08	<0.0001

*The parameter estimation for elder age group (≥11 years) compared with younger age group (<11 years) as binary variable; †Linear regression of age and sleep duration in younger age group (<11 years); ‡Interactive variable of age and age groups based on the centralization of age.

obvious in children aged ≥11 years. Comparing the slope of variable "age (<11 years)" and adding together with the slope of interactive variable "age × group" in different sleep situations, it was found that the decline in sleep duration on weekdays of children >11 years was most remarkable (slope = −0.062–0.211= −0.273).

Factors regarding sleep loss

The sampled children were then divided into sleep loss group (11.8%) and normal sleep group (88.2%). The Chi-square test was performed to select possible risk factors for sleep loss [Table 4]. The variables such as gender, age group, BMI group, region, parental education, SDB, family history of snoring, and activities before bedtime were included in the multiple logistic regression analysis ($P < 0.05$). Finally, male (*OR* = 1.32, 95% *CI*: 1.15–1.51, $P < 0.0001$), age ≥11 years (*OR* = 2.37, 95% *CI*: 1.92–2.93, $P < 0.0001$), overweight (*OR* = 1.34, 95% *CI*: 1.17–1.54, $P < 0.0001$), family history of snoring (*OR* = 1.35, 95% *CI*: 1.13–1.61, $P = 0.0008$), activities before bedtime with watching television (TV) (*OR* = 1.24, 95% *CI*: 1.08–1.43, $P = 0.0030$), sports (*OR* = 1.22, 95% *CI*: 1.01–1.48, $P = 0.0036$), playing cellphone (*OR* = 1.91, 95% *CI*: 1.31–2.73, $P < 0.0010$), and surfing the Internet (*OR* = 1.27, 95% *CI*: 1.06–1.52, $P < 0.0010$) were proved to be the risk factors for sleep loss in children; among them, age ≥11 years and playing cellphone before bedtime were the two most important risk factors.

Discussion

Along with the cancellation of one-child policy and the approach of second-child era in China, the number of Chinese children will reach a new peak of growth. With increasing attention on childhood sleep health, it is the priority to make sure that children have sufficient sleep. At present, the investigation of sleep problems for children is relatively limited in China, and it is difficult to implement it. This study used a cluster of random sampling to determine the status of children's sleep and explore factors influencing sleep to provide some reference value for suggestions for children's sleep duration in the future.

Representativeness of sampling

Beijing was chosen as the single-center survey city as it a highly populated region of China. By the end of the year 2010, the child population of Beijing (0–19 year olds) had raised up to 2.64 million, accounting for 0.86% of the country.[19] The distribution of sample age groups was relatively uniform and the ratio of 3–6 years' group, 7–10 years' group, and 11–14 years' group was in accordance with the census data (1:1.09:0.85 vs. 1:1.01:0.93).[19] The sample proportion of male and female was consistent with the census results in Beijing (1.06:1) and was similar to the Chinese national data of 1.05:1 in 3–16-year-old children. In this survey, the sample size was relatively large with a satisfactory rate of response; thus, the sample satisfactorily represented the child population in Beijing. Although Beijing is a multipopulation city, the childhood sleep habits of different cities may be affected by the regions. Therefore, whether the sample population is representative of other cities in China is yet to be elucidated and further multicentric survey of Chinese children will be needed.

Sleep durations

The current data of sleep durations on weekdays were compared with sleep duration reported in previous studies. The sleep duration of Chinese children in different cities was similar; it was shorter as compared to those in Spain, Australia, and the USA [Figure 3].[28-32] Liu *et al.* found that Chinese elementary schoolchildren slept approximately 1 h less than the American children.[32] A meta-analysis including children from 23 countries revealed that children from Asian countries such as Japan, Korea, and China slept 40–60 min less than the American children and 60–120 min less than the European children.[30] Interestingly, our results showed that children in Beijing slept approximately 1 h less than the Spanish and Austrian children and nearly 2 h less than the American children.

The decrease of sleep duration after puberty was similar to the findings described previously.[29,33] Similar studies conducted in Shanghai and seven other cities in China also supported that Chinese school-aged children slept less than the Caucasian children.[24] Chinese children aged 11 years were mainly primarily in Grades 5 and Grade 6, with heavy academic pressure and graduating pressure. As the academic achievements are highly emphasized by parents in many Asian countries,[34] children have a heavy load of study that might result in reduced sleep duration, especially for the graduating class of Grades 5 and 6 as well as middle school students in the current study. Based on the phenomenon that >90% of Grade 5 children in Shanghai spent >1 h on homework daily, and >50% of them spent >2 h, Sun *et al.* demonstrated that children with plenty of homework went to bed at a later time and suffered from sleep loss; thus, an appropriate amount of homework should be advocated as a major component of sleep hygiene interventions.[14] However, in this study, the factor "homework before bedtime" was

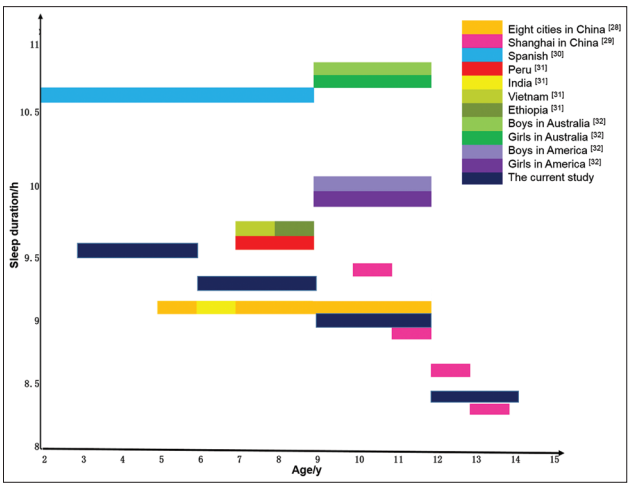


Figure 3: Comparison of the sleep duration on weekdays of children in different countries and different regions in China.

Table 4: Characteristics with and without sleep loss and their association with sleep loss

Characteristics	With sleep loss, *n* (%)	Without sleep loss, *n* (%)	Chi-square test		Multiple logistic regression	
			χ^2	*P*	*P*	*OR* (95% *CI*)
Gender	1068 (11.8)	7956 (88.2)	17.4921	<0.0001	<0.0001	
Female	454 (42.5)	3924 (49.3)				1.00
Male	514 (57.5)	4032 (50.7)				1.32 (1.15–1.51)
Age group	1068 (11.8)	7956 (88.2)	464.765	<0.0001	<0.0001	
3.0≤ age <7.0 years	161 (16.9)	2227 (30.0)				1.00
7.0≤ age <11.0 years	205 (19.2)	3038 (38.2)				1.35 (1.08–1.69)
Age ≥11.0 years	682 (63.9)	2691 (33.8)				2.37 (1.93–2.93)
BMI group	1068 (11.8)	7956 (88.2)	81.205	<0.0001	<0.0001	
Normal	551 (51.6)	5226 (65.7)				1.00
Overweight or above	517 (48.4)	2730 (34.3)				1.34 (1.17–1.54)
Region	1068 (11.8)	7956 (88.2)	4.865	0.0274	0.1701	
Urban	503 (50.7)	4033 (47.1)				
Suburban	565 (49.3)	3923 (52.9)				
Paternal education	1053 (11.8)	7911 (88.2)	55.591	<0.0001	0.3914	
High school or below	519 (49.3)	4943 (62.5)				
College or above	534 (50.7)	2968 (37.5)				
Maternal education	1050 (11.7)	7897 (88.3)	54.161	<0.0001	0.3814	
High school or below	525 (50.0)	3015 (38.2)				
College or above	525 (50.0)	4882 (61.8)				
Living with parents	1064 (11.8)	7933 (88.2)	0.109	0.7415	0.3959	
No	924 (86.8)	1073 (86.5)				
Yes	140 (11.5)	6860 (13.5)				
SDB	1068 (11.8)	7956 (88.2)	4.426	0.0354	0.3327	
No	956 (89.5)	7276 (91.4)				
Yes	112 (10.5)	680 (8.6)				
Premature labor	1068 (11.8)	7956 (88.2)	0.916	0.3385	0.7253	
No	997 (93.3)	7486 (94.1)				
Yes	71 (6.7)	470 (5.9)				
Low birth weight	1068 (11.8)	7956 (88.2)	1.693	0.1932	0.2081	
No	1050 (98.3)	7772 (97.7)				
Yes	18 (1.7)	184 (2.3)				
Family history of snoring	1068 (11.8)	7956 (88.2)	5.217	0.0400	0.0008	
No	190 (17.8)	1629 (20.5)				1.00
Yes	878 (82.2)	6327 (79.5)				1.35 (1.13–1.61)
Family history of smoking	1068 (11.8)	7956 (88.2)	1.103	0.2935	0.7167	
No	437 (40.9)	2490 (42.6)				
Yes	631 (59.1)	4566 (57.4)				
Homework before bedtime	1065 (11.8)	7930 (88.2)	17.552	<0.0001	0.0960	
No	553 (51.9)	4653 (58.9)				
Yes	512 (48.1)	3277 (41.3)				
Watching TV before bedtime	1064 (11.8)	7928 (88.2)	13.279	0.0003	0.0030	
No	499 (46.9)	3253 (41.0)				1.00
Yes	565 (53.1)	4675 (59.0)				1.24 (1.08–1.43)
Sports before bedtime	1064 (11.8)	7931 (88.2)	11.787	0.0006	0.0036	
No	908 (85.3)	6423 (81.0)				1.00
Yes	156 (14.7)	1508 (19.0)				1.22 (1.01–1.48)
Playing cellphone before bedtime	1065 (11.8)	7931 (88.2)	26.651	<0.0001	0.0010	
No	1018 (95.6)	7778 (98.1)				1.00
Yes	47 (4.4)	153 (1.9)				1.91 (1.31–2.73)
Eating before bedtime	1064 (11.8)	7929 (88.2)	5.006	0.0253	0.1337	
No	781 (73.4)	5558 (70.1)				
Yes	283 (26.6)	2371 (29.9)				
Reading before bedtime	1065 (11.8)	7930 (88.2)	18.602	<0.0001	0.1129	
No	565 (53.0)	3650 (46.0)				

Contd...

Table 4: Contd...

Characteristics	With sleep loss, *n* (%)	Without sleep loss, *n* (%)	Chi-square test		Multiple logistic regression	
			χ^2	*P*	*P*	*OR* (95% *CI*)
Yes	500 (47.0)	4280 (54.0)				
Playing electronic games before bedtime	1065 (11.8)	7930 (88.2)	13.112	0.0003	0.0949	
No	819 (76.9)	6466 (81.5)				
Yes	246 (23.1)	1464 (18.5)				
Surfing the Internet before bedtime	1065 (11.8)	7931 (88.2)	56.114	<0.0001	0.0100	
No	843 (29.1)	6940 (87.5)				1.00
Yes	222 (20.9)	991 (12.5)				1.27 (1.06–1.52)

Short sleep duration was defined as mean total sleep duration <9 h per day. Daily sleep duration = ([weekday sleep duration × 5] + [weekend sleep duration × 2])/7. *OR*: Odds ratio; *CI*: Confidence interval; SDB: Sleep-disordered breathing; BMI: Body mass index.

not included in the factors by multiple regression analysis. Therefore, through the data of this study, it may be possible that comprehensive academic pressure affected children's sleep time. However, because of the development of quality education reform in Beijing, homework may play a less obvious role in academic pressure.

A meta-analysis including children from 23 countries demonstrated that children sleep more on nonschool days than on school days, and the sleep duration on the nonschool days increases to 25 min and 86 min in children aged 9 years and 18 years, respectively.[30] Similarly, the current study also found that the children older than 11 years had longer sleep duration on weekends and long holidays than on weekdays, and the sleep duration on the nonschool days was approximately 10 h in children at all age groups. This might imply that children have an insufficient sleep during the weekdays and compensate their sleep on weekends.

Factors regarding sleep loss

This study included twenty potential influential factors elicited from six domains as follows: sociodemographic characteristics, family education, history of birth, routine activities before bedtime, bedtime hygiene, and family sleep habits. Taking the potential confounding effects into account, the multivariate regression model demonstrated that eight factors could increase the risk of short sleep duration in our sampled children. The eight factors covered three domains: sociodemographic characteristics, family sleep habits, and routine activities before bedtime.

Boys had a higher risk of suffering from sleep problems than girls, especially less sleep duration in this survey, which is in agreement with that of previous studies.[24,35] For BMI, Li *et al*. reported that short sleep duration was significantly associated with high adiposity indices in Chinese adolescents, suggesting it to be a modifiable risk factor for adiposity.[36] Another study by Jiang *et al*. also verified that short sleep duration was positively associated with obesity in preschoolchildren.[37] On the other hand, short sleep duration was speculated to be associated with increased chances of obesity among girls and 13–18-year-old boys; thus, age and gender were regarded as specific characteristics for the effects of short sleep on obesity.[15]

Our survey shows that family history of snoring was an important factor in lack of sleep. It was an interesting finding that parents' sleep habits were associated with their children's sleep duration. Similarly, Liu *et al*.[38] reported that Chinese adolescents and their parents had correlations in sleep/wake patterns, perceived sleep need, and insomnia symptoms. Another study also revealed that there was a linkage in sleep behaviors between children and their parents.[24] Although the intrinsic mechanisms underlying the association (maybe family environment, genetic effects, or both) have not been interpreted, the finding had important clinical implications for formulating intervention of childhood sleep loss.

In the current study, activities related to electronic products or media exposure before bedtime increased the incidence of sleep loss in children. Especially, with the popularity of smartphones and incoming of mobile internet area, cellphone playing in children will cause a series of critical health problems. In this study, children who had playing cellphone habit before bedtime had nearly 2 times more likely to get short sleep duration than other children. Accumulating studies for the past 10 years suggested that media exposure such as TV viewing, Internet usage, and videogame playing contributed to the increase of sleep loss in children.[39,40] Consistent with these studies, Li *et al*. demonstrated that more TV viewing during weekdays and more frequent computer/Internet usage was associated with short sleep duration in Chinese school-aged children.[24] Besides, in a cross-sectional study, Marinelli *et al.* found that children in Spain watching TV for >1.5 h/day had shorter sleep duration than those spending less time on watching TV.[11] Moreover, Jiang *et al.* demonstrated that a prolonged duration of playing electronic games and surfing the Internet correlated with short sleep duration and late bedtime in Chinese schoolchildren in Grades 4–8.[29] With the progress of science and technology, this factor is still a serious problem, but the media have changed from TV and computer to cellphone.

Nevertheless, the current study has some limitations. The first is the reliance on parental reported data on children's sleep duration without objective confirmation, which may increase the possibility of rater biases and inaccuracy. In addition, some reported domains of factors such as family

structure and socioeconomic status, sleep environments, chronic health problems, and school schedules were not included in the analysis, which may be significantly associated with Chinese children's sleep duration.

In conclusion, this survey provides information on the sleep duration and the risk factors for sleep loss in 3–14-year-old children in Beijing. The daily sleep duration was 9.7 ± 0.7 h with the prevalence of sleep loss as high as 11.8%. The sleep duration decreased with age, especially among children over 11 years old. Factors associated with sleep loss covered sociodemographic characteristics, family sleep habits, and routine activities before bedtime; among them, age ≥11 years and playing cellphone before bedtime had greater impact on short sleep duration. The findings of our survey have important clinical significance since the results suggested that the existing sleep loss in 3–14-year-old children could be, at least partly, intervened by paying more attention to the children who enter the age of 11 years or Grade 5 and Grade 6, or to the children with family snoring history, by reducing the use of electronic products before bedtime, especially cellphone, by weight management and keeping fit, and by improving the routine habit before sleep. Based on our results, we advocated the combination of school with family intervention, which may be more effective in resolving childhood sleep loss.

Acknowledgments

The authors greatly acknowledged the cooperation of team comprising otolaryngologists, evidence-based medicine specialists, sleep medicine specialists, child health-care teachers, school doctors, and other medical personnel who collected the data for this project. The authors would like to thank the 26 schools from the 7 districts of Beijing for the cooperation and arrangement of the survey. More importantly, the authors want to give great thanks to the responders and their guardians for their participation in the survey.

Financial support and sponsorship

This study was funded by National Key Research Program of China (No. 2017YFC0112502), Beijing Municipal Science and Technology Project (No. Z161100000116050) and the Capital Health Research and Development of Special Funding (No. 2018-1-2091).

Conflicts of interest

There are no conflicts of interest.

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北京市3-14岁儿童睡眠时间及其影响因素的横断面研究

摘要

背景： 睡眠不足会对儿童的行为和身体发育产生不利影响，本研究通过对北京市儿童睡眠时间的横断面调查，了解3-14岁儿童睡眠时间现状及相关影响因素。

方法： 通过随机分层整群抽样的横断面研究调查北京市3-14岁儿童及青少年。根据各区、各学校儿童及青少年人数所占比例制定抽样计划，共有来自北京市四大功能区的七个区县（西城区、朝阳区、门头沟区、房山区、昌平区、顺义区、怀柔区）的11所幼儿园，7所小学和8所初中参与调查。本研究最终以班级作为整群纳入被调查儿童，并邀请其父母就儿童近半年睡眠情况，完成系列问卷包括简体中文版儿童睡眠问卷（PSQ）、睡眠问卷调查表和香港儿童睡眠问卷（HK-CSQ）。

结果： 本研究共发放问卷11,420份，其中有效数据9198条（有效应答率80.54%）。调查儿童年龄为8.8±3.8岁，其中男性4736人，女性4462人。全市3-14岁儿童的每日睡眠时间为9.7±0.7小时，睡眠不足（每日睡眠＜9小时）阳性率为11.8%；其中＜6岁，6-11岁以及≥11岁儿童的每日睡眠时间分别为9.7±0.6小时，9.6±0.6小时和9.5±0.8小时，≥11岁儿童睡眠时间随年龄的增长而下降的趋势较小年龄组明显，相似的下降趋势在工作日睡眠时间中更为突出。经过多元回归分析，与睡眠不足显著相关(P<0.05)的因素包括：男性(OR=1.32, 95% CI: 1.15-1.51),年龄≥11岁(OR=2.37, 95% CI: 1.92-2.93),超重(OR=1.34, 95% CI: 1.17-1.54),家庭打鼾史(OR=1.35, 95% CI: 1.13-1.61)， 睡前看电视(OR=1.24, 95% CI: 1.08-1.43),睡前运动(OR=1.22, 95% CI: 1.01-1.48),睡前玩手机(OR=1.91, 95% CI: 1.31-2.73)和睡前上网(OR=1.27, 95% CI: 1.06-1.52)；其中年龄≥11岁和睡前玩手机对儿童睡眠不足的影响更大。

结论： 睡眠不足在北京市3-14岁儿童中是普遍存在的。睡眠时间随着年龄的增长而呈下降趋势，尤其对于11岁及以上儿童而言，下降趋势更加明显。本研究所纳入的睡眠不足相关影响因素包括社会人口学特征、家庭睡眠习惯和睡前日常活动，其中年龄≥11岁和睡前玩手机对睡眠不足的影响更大。本研究重要的临床意义在于提示我们，11岁或者五、六年级以上的儿童及有家庭打鼾史的儿童的睡眠需要更多关注，另外通过减少睡前电子产品的使用，特别是玩手机的频率和时间，管理体重和优化睡前生活习惯是对儿童睡眠不足进行干预或预防的有效措施。基于本研究的结论，我们呼吁家庭与学校一起努力，为预防和缓解儿童睡眠不足做出科学的努力。