Investigation On Sleep Status and Its Influencing Factors in Children Aged 3-14 in Beijing

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Abstract

Objective: To investigate the current status of children's sleep in Beijing and analyze the influencing factors that affect it.

Methods: Using multi-stage stratified cluster random sampling, a total of 11420 children aged 3-14 in 7 districts in Beijing were included in the study. The Pediatric Sleep Questionnaire (PSQ) was used to investigate and analyze various factors influencing sleep. Multi-level model was used to analyze the relationship between PSQ score and related factors.

Results: The average PSQ score of the children surveyed was 3.60 ± 2.69 points. If the score is greater than 7, it is considered that there may be sleep quality problems. The proportion of children with sleep quality problems was more than 8%. Multi-level model analysis results show that younger children have higher PSQ scores than older children. Boys have higher PSQ scores than girls.

Conclusion: The sleep quality of children in Beijing is not optimistic. The PSQ score of preschool children is higher than school age children. It is recommended that parents pay attention to children's sleep status and try to remove influencing factors.

What Is Known:

- Obstructive sleep apnea syndrome (OSAS) is a common disease of sleep disordered breathing in children. The PSQ is recommended to evaluate children's sleep status.

What is New:

- This study is based on a large-scale population survey and analysis which can more accurately reflect the sleep status of children in Beijing. Parents should pay attention to children's sleep status, especially preschool children.

Introduction

Obstructive sleep apnea syndrome (OSAS) is a common disease of sleep disordered breathing in children [1]. The prevalence reported abroad and in Hong Kong is about 5.7% and 4.8%, respectively [2, 3]. The current gold standard for diagnosis of OSAS is polysomnography, but its cost is relatively expensive. It is currently mainly used in hospitals while sleep scales are mainly used in epidemiological investigations. The PSQ is a screening questionnaire recommended for screening by the American Academy of Pediatrics (AAP) in the 2012 OSAS guidelines. Studies at home and abroad have shown high reliability and validity [4–6]. This article mainly used the PSQ questionnaire to investigate the sleep status of 11,420 children in Beijing and to analyze the relationship between PSQ scores and children's behavior before sleep.

Materials And Methods

1. Research population: From May to July 2015, a multi-stage stratified cluster random sampling method was used to randomly select from 11 kindergartens, 7 primary schools, and 8 middle schools in 7 districts of Beijing. For all selected schools, students in all classes were surveyed. A total of 11,420 children were in the age range of 3–14 years.

2. Survey method: This study is a cross-sectional observational study done in collaboration with Beijing Children's Hospital, Peking University Institute of Children and Adolescents. The main survey includes PSQ questionnaire and influencing factors that may be related to sleep.

The PSQ measures 4 dimensions of sleep quality in children: namely: sleep disordered breathing, snoring, sleepiness, and behavior changes, with a total of 22 items. All the options are answerable by a "yes" or "no" which tallies to a total score. The higher the score, the more it suggests sleep-related problems. The specific content of the questionnaire is described in detail in previously published literature [6, 7].

This study also investigated other factors that may be related to children's sleep. This part of the study mainly analyzed children's behaviors before sleep (defined as 1 hour before bedtime), such as playing video games, eating, watching television, surfing the internet, exercising, and father/mother snoring.

All children and guardians surveyed in this study obtained informed consent.

3. Quality control: The survey was conducted in the form of a parents' meeting. Before the survey, explain to parents through teachers. The respondent was required to be a guardian who took care of the child on a daily basis and was familiar with the child's living habits, sleep status, and usual activities before sleeping. During the investigation, the questionnaire was first explained in detail by a physician who specializes in otolaryngology. The questionnaire survey was then conducted by a professionally trained investigator. All questionnaires were subjected to preliminary review and were signed by clinical experts and epidemiologists on site. The questionnaires were then collected uniformly. Double entry method was adopted for data entry of all questionnaires. Missing values, outliers, and duplicate values were cleaned to ensure reliability and accuracy during formal analysis.

4. Statistical analysis: This study first examined the distribution of PSQ. If the data is normally distributed, values are described in mean $\pm$ standard deviation. T-test and analysis of variance are used to compare between two groups and between multiple groups. If the data is not normally distributed, median (quartile) values are used. Two groups are compared using nonparametric Wilcoxon rank sum test, and three groups are compared using Kruskal-Wallis rank sum test. Due to some differences between schools and agglomeration within schools, the correlation factor analysis of PSQ in this study uses a multi-level model. The school is level 2 and student is level 1, fitting a random intercept model. $P < 0.05$ was considered statistically significant. All statistical analyses were completed using SAS 9.4.

Results

1. Basic situation: A total of 11,420 questionnaires were issued in this survey, and 10,743 (94.07%) were collected. After data cleaning, 9198 cases (80.54%) of data were considered valid. The average score of PSQ is 3.60 ± 2.69 points. According to the standard of more than 7 points recommended in the previous literature as the cutoff for sleeping problems [6], a total of 816 people were counted to have scored more than 7, comprising about 8.87% of the study population. The PSQ scores of different genders, ages and other characteristics are shown in Table 1.

2. Multi-level model analysis: an empty model is implemented with schools as a random effect. The results showed an intraclass correlation coefficient (ICC) of 1.76 ($P = 0.003$), suggesting that the data in this study has a hierarchical structure. The difference between hierarchies is significant hence a multi-level model is used.

Table 1
PSQ scores under different characteristics

	Cases(n)	PSQ scores	t value	P value
Age (years)				
< 6	2447	3.94 ± 2.58	(33.015)	< 0.001
6–12	4512	3.58 ± 2.66		
> 12	2239	3.30 ± 2.84		
Sex				
Male	4736	3.89 ± 2.75	10.560	< 0.001
Female	4462	3.30 ± 2.60		
Obese				
Yes	1004	4.50 ± 3.06	11.278	< 0.001
No	8194	3.49 ± 2.62		
Snoring frequency*				
< 1 time/week	7987	3.19 ± 2.34	(1042.950)	< 0.001
1–2 times/week	532	6.41 ± 2.83		
≥ 3 times/week	369	7.86 ± 3.34		
Watching TV before sleep*				
Yes	5331	3.78 ± 2.71	7.333	< 0.001
No	3833	3.36 ± 2.66		
Eating before sleep*				
Yes	2683	4.08 ± 2.79	10.842	< 0.001
No	6483	3.41 ± 2.63		
Playing video game before sleep*				
Yes	1741	4.23 ± 2.91	10.787	< 0.001
No	7426	3.46 ± 2.62		
Surfing the Internet before sleep *				
Yes	1227	4.03 ± 2.94	5.950	< 0.001
*Some indicators are missing				

	Cases(n)	PSQ scores	t value	P value
No	7941	3.54 ± 2.65		
Exercising before sleep*				
Yes	1724	3.77 ± 2.64	2.826	0.005
No	7443	3.57 ± 2.70		
Father/mother snoring*				
Yes	5703	3.93 ± 2.76	14.918	< 0.001
No	3477	3.07 ± 2.49		
*Some indicators are missing				

Taking school as level 2 and student as level 1, the multi-level model is implemented by incorporating possible relevant factors. The results showed that factors such as age, gender, obesity, snoring frequency, eating before sleep, playing video games before sleep, surfing the internet before sleep, and snoring of parents may be related to PSQ score. The parameter estimation results of each index are shown in Table 2. It can be seen that children's snoring frequency has the greatest impact on PSQ. Children with snoring 1–2 times / week and snoring ≥ 3 times / week have an average PSQ score of 2.972 points and scored 4.311 points higher than those who do not snore. Obesity and snoring of parents also have a great impact. Obese children have an average PSQ score of 0.871 higher than normal children, and children with parents who snore have an average PSQ score of 0.553 higher than children who do not snore. In addition, children who eat, surf the internet, and play video games before sleep had higher PSQ scores than those who do not.

Table 2
Multi-level model analysis results of factors related to the PSQ score

	Parameter estimation	95% CI	Standard error	t value	P value
Age[< 6 years vs. >12 years]	0.615	0.386–0.844	0.115	5.354	< 0.001
Age[6–12 years vs. >12 years]	0.264	0.076–0.453	0.095	2.777	0.006
Sex [male vs. female]	0.412	0.312–0.511	0.051	8.127	< 0.001
Obesity [obese vs. normal]	0.871	0.706–1.035	0.084	10.349	< 0.001
Snoring frequency [1–2 times/week vs. none]	2.972	2.764–3.180	0.106	28.010	< 0.001
Snoring frequency [≥ 3 times/week vs. none]	4.311	4.063–4.560	0.127	34.010	< 0.001
Watching TV before sleep [yes vs. no]	0.033	-0.072–0.138	0.054	0.619	0.536
Eating before sleep [yes vs. no]	0.470	0.357–0.583	0.058	8.172	< 0.001
Playing video games before sleep [yes vs. no]	0.348	0.216–0.479	0.067	5.179	< 0.001
Surfing the Internet before sleep [yes vs. no]	0.404	0.251–0.557	0.078	5.166	< 0.001
Exercising before sleep [yes vs. no]	-0.014	-0.142–0.113	0.065	-0.220	0.825
Father/mother snoring [yes vs. no]	0.553	0.451–0.655	0.052	10.623	< 0.001

Discussion

There are many types of scales used for children's OSAS screening worldwide. Spruyt and Gozal [8] found that a large number of children's sleep-related questionnaires and scales only reported about their reliability and validity within the study. Chervin et al [4] developed a children's PSQ questionnaire based on American OSAS children's sleep habits and risk factors. This questionnaire is the only recommended screening questionnaire in the 2012 OSAS guidelines of the American Academy of Pediatrics. Its sensitivity and specificity in the United States are as high as 85% and 81% respectively, which is the main reason why PSQ is superior to other children's sleep questionnaires in screening children's OSAS. However, due to differences in region, race, environment, living habits, and growth and development, it is necessary to evaluate its reliability, validity, and applicability before applying the questionnaire outside the

United States. Taiwan's Wang et al [5] evaluated the reliability and validity of the Taiwan version of PSQ after surveying 173 Taiwanese children, and obtained conclusions applicable to OSAS screening of children and adolescents in Taiwan. Li Xiaodan and Tai Jun [6] studied the data of children in Beijing and evaluated the reliability, validity and screening ability of the simplified Chinese version of PSQ.

Sleep is of great significance to the growth and development of children, especially of the central nervous system [9]. The secretion of growth hormone, which is necessary for children's physical development, appears mostly in the first slow-wave sleep after sleep initiation [10]. Therefore, the quality of sleep may directly affect children's physical and mental development. Poor sleep quality may even cause behavioral problems [11]. Therefore, good sleep quality plays a very important role in the development and maturity of children's central nervous system. At present, there are few studies on the use of maturity scales to investigate children's sleep disorders. Most studies simply use sleep questionnaires to measure sleep quality. The results obtained from such questionnaires often have poor reliability and validity.

This study used the PSQ scale recommended by the American Pediatric Association to investigate a large population of children and found that the average PSQ score of children in Beijing was 3.60 ± 2.69 points. About 8.87% of children scored above 7 points, suggesting that there may be a certain proportion of children in Beijing with sleeping problems.

The results of this analysis show that snoring may be an important factor in scoring high in PSQ, and the frequency of snoring has a clear positive relationship with PSQ score. As the frequency of snoring increases, the PSQ score is also higher. Previous articles reported that the proportion of snoring among school-aged children aged 6–14 in Beijing was about 9.08% [12]. These results strongly suggest that children with sleep disorders in Beijing cannot be ignored. In this study, it was found that younger children scored higher in the PSQ, with preschool children having the highest PSQ score, and adolescent children after the age of 12 having a lower PSQ score. In terms of sex, boys scored significantly higher than girls in PSQ. This suggests that more attention should be paid to the sleeping conditions of boys and preschool children.

The study also found that some activities before sleep such as eating, surfing the internet, and playing video games may be related to a higher PSQ score. Children who eat, surf the internet, and play video games before sleep all had relatively higher PSQ scores. Harvard University research shows that playing smartphones, watching TV shows, or playing video games before bedtime exposes individuals to blue light which can inhibit melatonin secretion and affect sleep quality and increasing disease incidence [13]. Children and adolescents are in a period of growth and development in which the harms of poor sleep may be greater than in adults. After studying the influencing factors of children's sleep, professor Owens of the United States [11] found that playing games and watching TV for too long can seriously affect sleep quality in children.

The family is the main environment in children's early life. Children's sleep will inevitably be affected by the family environment and parents' education methods. A quiet environment helps children to start and maintain sleep; parents who adopt persuasive education and who pay attention to parent-child

communication often fosters good emotional experience to their children, and thus effectively promoting good quality sleep. For parents who do otherwise, the lack of conducive environment to foster good sleeping habits in children makes it an easy environment for sleep disorders to develop. Poor sleep habits are an important factor influencing children's sleep disorders [14]. Liu Xicheng et al [15] used the clinical questionnaire of the Sleep Center of Sydney Children's Hospital that sleep time generally decreased and the incidence of sleep disorders was higher among children in Beijing.

This research is innovative. First, this study uses the AAP approved PSQ questionnaire for the first time in China, thus the results are more reliable. Second, this study is based on a large-scale population survey and analysis which can more accurately reflect the sleep status of children in Beijing. Limitations include the cross-sectional study design where relationships between factors and PSQ scores were analyzed at one point in time, and thus cannot confirm causal relationships. Further studies are needed to confirm causality and association.

Conclusion

According to the findings of this study, it is recommended that parents should pay attention to children's sleep status, especially preschool children. If parents find that children have a high snoring frequency, physician consultation is recommended. Children's bedtime behaviors such as surfing the internet and playing video games are suggested to negatively affect sleep quality in children.

Abbreviations

AAP American Academy of Pediatrics

ICC intraclass correlation coefficient

OSAS Obstructive sleep apnea syndrome

PSQ Pediatric Sleep Questionnaire

Declarations

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Data availability statement

The data sets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Code availability

N/A.

Author Contributions

Li Hongbin and Li Zhuo, drafting and revising the manuscript; Li Xiaodan, Zhao Jing, Wang Guixiang and Wang Hua, questionnaire survey and data analysis; Zhang Jie and Ni Xin, critical revision, and final approval.

Ethics approval

This research was in compliance with the Declaration of Helsinki. **Consent to participate**

All participants signed appropriate consent for the clinical assessments.

Consent for publication

N/A.

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