

# The Impact of Media Use on Sleep Patterns and Sleep Disorders among School-Aged Children in China

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**Study Objectives:** To determine the amount of television viewing and computer use in urban school-aged Chinese children, and to examine their associations with sleep/wake patterns, duration of sleep, and sleep disorders.

**Design and Setting:** Students representing 8 Chinese cities were studied during November and December 2005.

**Participants:** A total of 19,299 elementary-school children, 49.7% boys and 50.3% girls, with a mean age of 9.00 years, participated in the survey.

**Measurements:** A parent-administered questionnaire and the Chinese version of the Children's Sleep Habits Questionnaire were completed to quantify media use and to characterize sleep patterns and sleep disturbances.

**Results:** A television or computer was present in the bedroom of 18.5% and 18.3% of Chinese school-aged children, respectively. Media presence in the bedroom and media use were positively correlated with later bedtimes, later awakening times, and a shorter duration of sleep during

weekdays and weekends. They were also significantly associated with at least 2 types of sleep disturbances. Overall, the most affected sleep behaviors were bedtime and awakening time on the weekends, the duration of sleep during the weekdays, and sleep disorders of bedtime resistance and sleep anxiety. Television viewing  $\geq 2$  hours/day on weekends, with a prevalence of 48.8%, was the predominant risk factor for all sleep disorders with the exception of the sleep duration disorder. Computer use, however, had no correlation with any sleep disorder.

**Conclusion:** The presence of media in a child's bedroom and media use had a negative effect on children's sleep/wake patterns, duration of sleep, and sleep disorders.

**Keywords:** Children, television viewing, computer use, sleep patterns, sleep disorders

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## INTRODUCTION

A NUMBER OF STUDIES HAVE SHOWN THAT TELEVISION VIEWING HAS A PROFOUND NEGATIVE EFFECT ON THE PHYSICAL AND BEHAVIORAL DEVELOPMENT OF children and adolescents, specifically, increased obesity,<sup>1-3</sup> aggressive behavior,<sup>4,5</sup> attention deficits,<sup>6</sup> decreased physical activity, poor physical fitness, and reduced self-esteem.<sup>7-10</sup> Cross-sectional studies have demonstrated that television viewing may also be a risk factor for irregular sleep habits, shorter sleep duration, and sleep disorders.<sup>7,9,11-13</sup> A longitudinal study indicated that children who watched  $\geq 3$  hours of television per day during adolescence were at a significantly elevated risk for frequent sleep problems by early adulthood.<sup>14</sup> The study also indicated that adolescents who reduced their television-viewing from  $\geq 1$  hour/day to  $<1$  hour/day experienced a significant reduction in risk for subsequent sleep problems.<sup>14</sup> Other studies found that not only television viewing, but also computer game playing,<sup>7-9</sup> internet use<sup>7,9</sup> and children's

access to mobile phones,<sup>15</sup> were correlated with interrupted sleep and sleep disturbances. Similar findings also have been shown in a recent study involving adults, which demonstrated that stimulating computer games may increase sleep latency and shorten REM sleep, thereby leading to a high state of arousal, a shorter duration of sleep, and poor sleep quality.<sup>16</sup>

These results suggest that the sleep behaviors of children are influenced by the current diversity of entertainment media exposure. The impact of television viewing was not demonstrated 20 years ago,<sup>17</sup> potentially secondary to the limited exposure for the multitude of the population. A recent study revealed that 99.8% of 4- to 11-year-old children in the US watch television.<sup>13</sup> In Western countries, children aged 4-17 years old spend 16.3-29.1 hours per week on television viewing and/or other forms of entertainment, such as computer games, internet use, and movies.<sup>7,9,12,13</sup> Due to the high prevalence and potential negative influence on the development and health of children, media use has become a public health problem.<sup>7,9,12,18</sup> Concerns about the potential negative influence of media use on sleep behaviors should be emphasized since previous studies have illustrated that sleep plays a key role not only in children's physical growth, behavior, and emotional development, but also is closely related to cognitive functioning, learning, and attention.<sup>12,19-21</sup>

Several hypotheses have been proposed regarding the mechanisms of association between media use and sleep disturbances. First, media use as a form of unstructured activity, which usually lacks a clear beginning and end, is likely to be extended, sacrificing sleep time, and thus shortening sleep duration.<sup>7</sup> This sedentary form of entertainment also may alter sleep architecture<sup>16</sup> and lead to poor quality sleep.<sup>16,22</sup> Second, exposure to the bright

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light of the viewing screen before sleep may affect the sleep/wake cycle through suppression of the nocturnal salivary secretion of melatonin.<sup>23-25</sup> A more recent study, however, reported that endogenous melatonin played only a very minor role in the mechanism by which light reduces sleepiness.<sup>26</sup> Media use may increase the activity level of the nervous system and result in heightened alertness, physiological arousal, and difficulty falling asleep.<sup>16,23</sup> It has been reported that there is a dose-response relationship between light intensity and human alertness; exposure to a light of approximately 100 lx could increase human alertness.<sup>27</sup> Third, the content of television programs may be excessively violent and/or stimulating, which may inhibit relaxation and result in anxiety and difficulty falling asleep.<sup>13</sup> In addition, parental television viewing habits and attitudes about television<sup>28</sup> and socioeconomic status<sup>28</sup> may significantly affect both television viewing habits and sleep in their children.

Compared with studies about television viewing,<sup>8,11-14</sup> little research has surveyed the impact of multimedia use on sleep habits and sleep behaviors in children.<sup>7,9</sup> In addition, to our knowledge, no study has specifically investigated the association between multimedia use and sleep disorders in school-aged children. With the ongoing economic development in China, entertainment media such as television sets, computers, and internet connections have become commonplace in urban families. So, the present study was designed to investigate the amounts of television viewing and computer use and identify the associations between the presence of media in the bedroom of urban school-aged children in China with sleep/wake patterns, duration of sleep, and sleep disorders.

## METHODS

### Sample

The study sample was recruited from 8 cities in China by cluster-stratified selection, using geographical location, economic standards, and population density as criteria; the cities included: Urumqi, Chengdu, Xi'an, Hohhot, Wuhan, Canton, Shanghai, and Harbin. For each city, 3-10 districts were selected randomly, and 1-2 elementary schools were chosen from each district. Thirty districts and 42 schools were located in an urban area, and 9 districts and 13 schools were located in a rural/suburban area. A total of 23,791 children from 6 grades of the chosen schools yielded the sample. Of the 23,791 sampled children, 22,018 (92.5%) returned completed questionnaires.

To eliminate the possible pubertal influences on sleep, 1158 children > 11 years of age were excluded. An additional 1561 children were excluded because they had a history of a psychiatric disorder or were receiving medications with known effects on sleep. The final sample consisted of 19,299 children. The mean age of the sample was 9.00 years (SD = 1.61, range from 5.08-11.99 years), 48.5% were boys (n = 9313, mean age = 8.97 years, SD = 1.58), and 51.5% were girls (n = 9892, mean age = 9.03 years, SD = 1.63). Of the 19,299 sampled children, the vast majority of children (18,242; 95.1%) came from the Han ethnic group, with the remaining children (948; 4.9%) coming from an ethnic minority. Because in China there are no established systems to assess the socioeconomic status (SES) of individual families, parental education levels and family income (yuan/month/person) were used as indicators of family SES. In this sample, parental education levels were classified as: illiteracy (0.6%), elementary or middle school

(22.3%), high school (34.2%), college or university (32.5%), and beyond university (10.3%) for fathers; and illiteracy (1.2%), elementary or middle school (25.9%), high school (33.5%), college or university (33.3%), and beyond university (6.0%) for mothers. Family income levels were distributed as: <800 (18.6%), 800-1500 (32.8%), 1500-2500 (23.9%), and >2500 (24.6%). It was concluded that the sample was geographically representative and ethnically and socioeconomic diverse. No significant difference in sex distribution with age existed and the distribution of age and sex across the different geographical areas were also similar.

### Procedure

This study was conducted in November and December of 2005. The purposes of this research project were explained to principals and teachers of the target schools. After the permissions were obtained from schools, students who were eligible to participate in this study were invited to take the questionnaire to their parents. This questionnaire was accompanied by a letter explaining the objectives of the project and instructions for completing the questionnaire. The parents were told that participation in the survey was voluntary and that the survey was anonymous. The study was approved by the Ministry of Education and Mental Health Center of the People's Republic of China.

### Measures

General television viewing levels were evaluated with data to answer to the following question: in a typical day, about how many hours does your child spend watching TV? Answers ranged from 0-24 and were then coded on a 4-point scale, with 1 being < 1 hour per day, 2 being 1 to < 2 hours per day, 3 being 2 to < 3 hours/d, and 4 being ≥ 3 hours/d. Based on a preliminary analysis and recommendations for daily television viewing, which suggested that children > 2 years of age should be limited to 2 hours of television viewing per day,<sup>1,29,30</sup> the 4-point scale was recoded into 2 categories: 1) 0 for 0-2 hours and 2) 1 for ≥ 2 hours. Computer use was measured by inquiring how often the child used the computer as a form of entertainment. Answers were on a 3-point scale, with 1 being "usually" if computer use occurred 5-7 times per week, 2 being "sometimes" for 2-4 times per week, and 3 being "rarely" for 0-1 time per week.

The respondents were also asked whether there was a television set or computer in the child's bedroom with 2 separate questions.

### Sleep Patterns and Sleep Behaviors

The Children's Sleep Habits Questionnaire (CSHQ) was used to assess children's sleep habits and sleep disturbances. CSHQ was a 36-item, parent report, pencil-and-paper instrument that was designed and developed to assess sleep behaviors of pre-school and school-aged children.<sup>31</sup> Respondents were asked to indicate how often sleep behaviors have occurred over a "typical" recent week using a 3-point scale: "usually" if the sleep behavior occurred 5-7 times per week, "sometimes" for 2-4 times per week, and "rarely" for 0-1 time per week. The 33 sleep disturbance items were conceptually grouped into 8 subscales: bedtime resistance, sleep onset delay, sleep duration disorder, sleep anxiety, night awakening, parasomnias, sleep disordered breathing, and daytime sleepiness. The CSHQ has satisfactory psychometric properties in the evalu-

**Table 1**—Sleep/wake patterns, sleep duration and sleep disorders by age

	Age (years)						<i>F</i> <sup>a</sup>
	5-6	7	8	9	10	11	
	Mean±SD						
Bedtime weekday	20.89±0.71	21.02±0.70	21.12±0.72	21.22±0.73	21.25±0.74	21.38±0.82	155.75 <sup>d</sup>
Bedtime weekend	21.59±0.80	21.74±0.78	21.84±0.80	21.93±0.81	21.99±0.83	22.15±0.87	157.72 <sup>d</sup>
Wake time weekday	6.68±0.45	6.67±0.45	6.64±0.44	6.63±0.47	6.60±0.46	5.98±0.48	10.42 <sup>d</sup>
Wake time weekend	7.73±0.86	7.83±0.88	7.87±0.88	7.96±0.94	7.99±0.96	8.18±1.00	75.85 <sup>d</sup>
Sleep duration weekday	9.44±0.78	9.33±0.77	9.18±0.77	9.07±0.78	9.04±0.79	9.01±0.83	139.28 <sup>d</sup>
Sleep duration weekend	9.94±1.04	9.85±1.04	9.76±1.05	9.76±1.05	9.73±1.08	9.83±1.11	14.32 <sup>d</sup>
	Prevalence (%)						$\chi^2$ <sup>b</sup>
Bedtime resistance	58.5	56.2	50.6	45.4	39.6	33.1	548.60 <sup>d</sup>
Sleep onset delay	21.0	20.9	20.3	22.8	23.3	25.4	30.89 <sup>d</sup>
Sleep duration	60.8	64.7	65.7	68.3	68.6	70.1	68.22 <sup>d</sup>
Sleep anxiety	65.2	61.9	58.0	52.9	47.1	41.4	463.78 <sup>d</sup>
Night wakings	24.6	25.8	25.3	25.8	26.6	27.4	6.70
Parasomnia	60.0	57.9	55.2	53.8	52.2	52.4	54.55 <sup>d</sup>
Sleep disordered breathing	13.5	15.2	13.6	13.5	12.8	11.9	15.93 <sup>c</sup>
Daytime sleepiness	77.3	77.2	76.4	75.5	73.7	71.2	42.81 <sup>d</sup>

<sup>a</sup>One-Way ANOVA; <sup>b</sup>K\*2 Chi-square Test; <sup>c</sup>P<0.01; <sup>d</sup>P<0.001

ation of US children.<sup>31</sup>

An individual sleep problem was defined as a sleep behavior occurring  $\geq 2$  nights/week. Based on this scoring system, an indication of a sleep disorder was calculated, i.e., the prevalence of each subscale disorder. In the present study, a sleep disorder was defined as having at least one sleep problem within a respective disorder subscale with the exception of 2 subscales. The subscales of bedtime resistance and daytime sleepiness required  $\geq 2$  sleep problems. These cut-offs were based upon clinical relevance and literature findings.<sup>32-34</sup>

The 3 sleep pattern items were established via open questions to investigate information regarding sleep habits (i.e, bedtime and morning awakening time) and daily total duration of sleep.

A Chinese version of the CSHQ was developed by translation and back-translation. Psychometric properties of the Chinese version of the CSHQ were examined: The internal consistency of the overall questionnaire and the eight subscales was good (Cronbach's alpha 0.73 [range 0.42-0.69]). The test-retest reliability was excellent (Intraclass correlation coefficients was 0.85 for the overall questionnaire and ranged from 0.60-0.88 for subscales). Factor analysis revealed a 3-factor structure accounting for 58.63% of the total variance. Factor loading was above 0.50 for the corresponding subscale. Psychometric properties of the Chinese CSHQ were comparable to those in US children for most of the subscales.<sup>31</sup>

### Sociodemographic Characteristics

This section consisted of children's sex, age, ethnicity, grade, parent education levels, occupation, household income, and family structure (single parent family, nuclear family, and large family). The heights and weights of the children were measured and reported in the questionnaire. Based on the parameters of height and weight, the body mass index (BMI) of children was calculated as weight (kg) / height (m)<sup>2</sup>.

### Statistical Analysis

Statistical descriptions were made by use of the mean, standard

deviation, frequencies, and percentages. Age differences in sleep/wake patterns and duration of sleep were analyzed by one-way ANOVA, and the K\*2 Chi-square test was used to compare age differences in the prevalence of sleep disorders, the percentage children's bedrooms with media equipment, and media use.

To evaluate the association between the presence of media equipment in the child's bedroom, media use, and sleep/wake patterns and sleep disorders, hierarchical multiple linear regression analyses were adopted, in which 3 blocks of variables were entered. The first block consisted of sociodemographic control variables of the children's age, sex, ethnicity, BMI, age of parents, parents' employment, parents' educational levels, family income, and family structure. The 2<sup>nd</sup> block consisted of structural media variables, notably the presence of a television set and a computer in the child's bedroom. The final block consisted of 3 media use variables: 1) amount of television viewing during the weekdays, 2) amount of television viewing on the weekends, and 3) the frequency of computer use.

Logistic regression analyses were performed to analyze the impact of media equipment in the child's bedroom and media use on sleep disorders, with "1" for children with a particular type of sleep problem and "0" for children without the sleep disorder. Dependent variables included 5 potential media use correlated risk factors and sociodemographic control factors, listed in the methods section. The regression model adopted a forward likelihood-ratio stepwise elimination procedure. Statistical tests of the regression estimates or odds ratios (OR) were based on Wald statistics.

All analyses were performed using the Statistical Program for Social Sciences (SPSS) for Windows, version 12.5. In the presentation of the results, the statistical significance was set at  $P < 0.05$  (two tailed).

## RESULTS

### Sleep/Wake Patterns, Sleep Duration, and Sleep Disorders

Table 1 summarizes the descriptive statistics of the sleep/wake patterns, the duration of sleep, and the sleep disorders across the



**Table 2**—The impact of media-using and media appliances on children's sleep/wake patterns and sleep duration by stepwise linear regression models

	Television-viewing during weekdays		Television-viewing on weekends		Computer using		Bedroom television		Bedroom computer	
	STDβ	t	STDβ	t	STDβ	t	STDβ	t	STDβ	t
Bedtime weekdays	0.05	7.23 <sup>c</sup>	-	NS	-	NS	-	NS	-0.08	-9.75 <sup>c</sup>
Bedtime weekend	0.03	2.92 <sup>b</sup>	0.14	16.42 <sup>c</sup>	-0.03	-3.84 <sup>c</sup>	-0.04	-5.11 <sup>c</sup>	-0.06	-7.20 <sup>c</sup>
Wake time weekday	0.08	9.65 <sup>c</sup>	-	NS	-	NS	-0.05	-6.13 <sup>c</sup>	-0.02	-2.70 <sup>b</sup>
Wake time weekend	0.02	2.20 <sup>a</sup>	0.11	11.6 <sup>c</sup>	-	NS	-0.05	-6.24 <sup>c</sup>	-0.02	-2.70 <sup>c</sup>
Sleep duration weekday	-	NS	-0.02	-2.19 <sup>a</sup>	0.02	2.00 <sup>a</sup>	0.02	2.07 <sup>a</sup>	0.03	3.28 <sup>b</sup>
Sleep duration weekend	-	NS	-	NS	0.04	4.38 <sup>b</sup>	0.04	4.40 <sup>c</sup>	-	NS

Stepwise linear regression model controlled for children's age, sex, ethnicity, BMI, parents' age, educational levels, family income, and family structure

STDβ: standardized regression coefficient; NS: not significant

<sup>a</sup>P<0.05; <sup>b</sup>P<0.01; <sup>c</sup>P<0.001

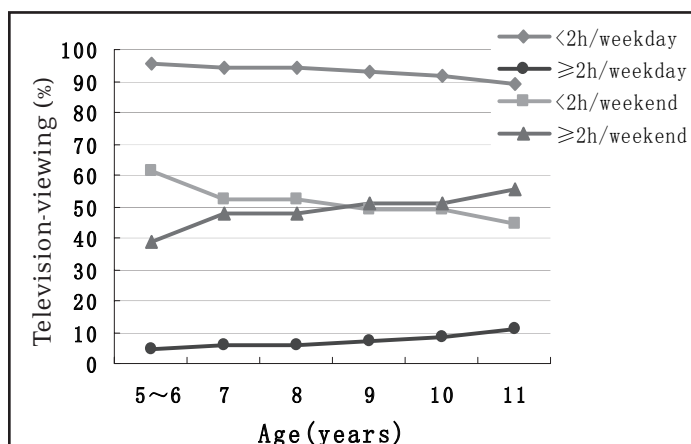
six age groups. There was a significant tendency for later bedtimes, earlier awakening times, and a shorter duration of sleep on weekdays with increasing age. In contrast, the awakening times were significantly delayed, the bedtimes were still significantly delayed, and the total duration of sleep fluctuated, showing a characteristic "U curve" on the weekends. Except for the subscale disorder of night awakening, the other subscale disorders differed significantly with age. The prevalences of the 4 subscale disorders (bedtime resistance, sleep anxiety, parasomnias, and daytime sleepiness) gradually decreased with increasing age; however, the prevalence of the sleep onset delay and the sleep duration disorders gradually increased with increasing age. For sleep disordered breathing, the prevalence fluctuated, with the highest (15.2%) occurring in the 7-year-olds, gradually decreasing to 11.9% in 11-year-olds.

### Television Viewing and Computer Use

Our survey showed that 18.5% and 18.3% of Chinese school-aged children had their own television set and computer in their bedrooms, respectively. The presence of media equipment in the bedroom was significantly associated with the child's age. The percentage of bedrooms with a television set declined significantly, from 22.6% for 5- to 6-year-olds to 13.1% for 11-year-olds ( $\chi^2 = 99.53$ ,  $P < 0.001$ ). The percentage of bedrooms with a computer increased significantly, from 14.7% in the age 5- to 6-year-olds to 21.3% in the 11-year-olds ( $\chi^2 = 45.73$ ,  $P < 0.001$ ).

The percentage of children who watched television for < 1 hour, 1 to < 2 hours, 2 to < 3 hours, and  $\geq 3$  hours/day were 59.3%, 33.6%, 5.8%, and 1.4% during the weekdays, respectively. In contrast, the corresponding percentages on weekends were 11.2%, 40.0%, 34.4%, and 14.4%, respectively. On weekends, children watched television longer than during weekdays ( $\chi^2 = 6281.96$ ,  $P < 0.001$ ). In terms of computer use, the most frequency reported was "rarely" (89.8%), followed by "often" (9.3%), and "usually" (0.8%).

Significant age differences existed in the amount of television viewing, with the percentage of children viewing television < 2 hours/day gradually declining as the percentage for television viewing  $\geq 2$  hours per day increasing with increasing age both



**Figure 1**—Prevalence of television viewing by age during weekdays and on weekends

during the weekdays ( $\chi^2 = 105.54$ ,  $P < 0.001$ ) and on the weekends ( $\chi^2 = 165.30$ ,  $P < 0.001$ ). Figure 1 shows the prevalence of television viewing during the weekdays and on the weekends as a function of age.

The frequency of computer use varied with age; the percentage of children who "usually" or "often" used the computer as entertainment significantly increased with age ( $\chi^2 = 27.67$ ,  $P < 0.001$  and  $\chi^2 = 189.72$ ,  $P < 0.001$ , respectively). By contrast, the percentage of children who "rarely" used the computer as entertainment significantly decreased with age ( $\chi^2 = 214.43$ ,  $P < 0.001$ ) (as shown in Figure 2).

### Association between Media Use and Sleep Behavior

Table 2 showed the results of hierarchical multiple linear regression analyses in which the standardized regression coefficient and t values were listed. Children who watched television for longer periods of time during the weekdays tended to have later bedtimes and awoke later on weekdays and weekends. Children who viewed more television on the weekends had significantly later bedtimes and awakening times on the weekends and weekdays, and the duration of sleep was significantly shorter during the weekdays. Children who used computers more frequently

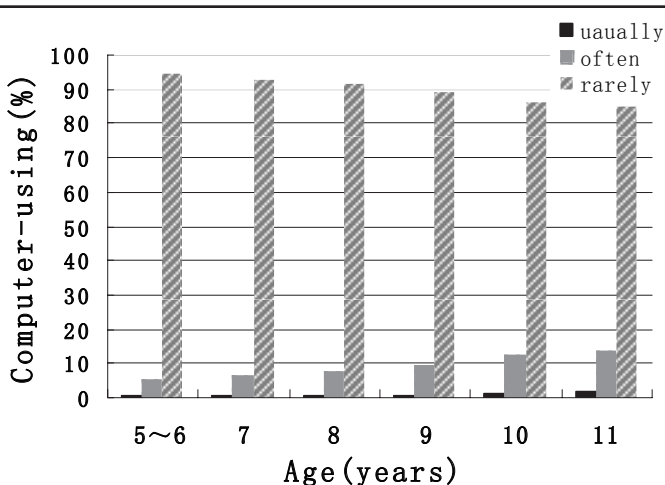
**Table 3**—The impact of media-using and media-setting on children's sleep disorders by multivariate regression model

	Odds Ratio (95% confidence interval)							
	Bedtime resistance	Sleep onset delay	Sleep duration disorder	Sleep anxiety	Night wakings	Parasomnias	Sleep disordered breathing	Daytime sleepiness
Television-viewing during weekdays								
≥2 hour/day	1.63 (1.42-1.87) <sup>c</sup>	1.24 (1.07-1.43) <sup>b</sup>	1.37 (1.19-1.58) <sup>c</sup>	1.31 (1.14-1.50) <sup>c</sup>	NS	NS	NS	NS
<2 hours/day	1.00	1.00	1.00	1.00	NS	NS	NS	NS
Television-viewing on weekends								
≥2 hour/day	1.32 (1.23-1.41) <sup>c</sup>	1.15 (1.06-1.25) <sup>b</sup>	NS	1.31 (1.22-1.40) <sup>c</sup>	1.12 (1.04-1.21) <sup>b</sup>	1.21 (1.14-1.30) <sup>c</sup>	1.23 (1.11-1.35) <sup>c</sup>	1.14 (1.06-1.23) <sup>b</sup>
<2 hours/day	1.00	1.00	NS	1.00	1.00	1.00	1.00	1.00
Computer-using								
Usually	NS	NS	NS	NS	NS	NS	NS	NS
Often	NS	NS	NS	NS	NS	NS	NS	NS
Rarely	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bedroom television								
Yes	NS	NS	NS	NS	NS	1.11 (1.01-1.20) <sup>a</sup>	1.16 (1.04-1.32) <sup>b</sup>	NS
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bedroom computer								
Yes	1.18 (1.09-1.28) <sup>c</sup>	NS	1.12 (1.03-1.23) <sup>b</sup>	1.16 (1.06-1.27) <sup>b</sup>	NS	NS	NS	NS
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Multivariate regression model controlled for children's age, sex, ethnicity, BMI, parents' age, educational levels, family income, and family structure

NS: not significant

<sup>a</sup>P<0.05; <sup>b</sup>P<0.01; <sup>c</sup>P<0.001

**Figure 2**—Prevalence (%) of computer use by age.

went to bed later on the weekends and slept less during both the weekdays and weekends.

Children with television sets in their bedrooms went to bed significantly later on the weekends and awoke significantly later on weekdays and weekends. Overall, children with television sets in their bedrooms slept less time both during the weekdays and on the weekends. Similarly, children with computers in their bedrooms went to bed and awoke significantly later on weekdays and weekends and slept less during the weekdays.

The results of multivariate logistic regression analyses of sleep disorders with media use and media equipment in the bedroom are shown in Table 3. Among 5 potential risk factors correlated with media use, television viewing ≥ 2 hours/day during the weekdays and on the weekends and the presence of a computer in the bed-

room predicted bedtime resistance. Television viewing ≥ 2 hours during weekdays and weekends was significantly associated with sleep onset delay. Television viewing ≥ 2 hours/day during the weekdays and the presence of a computer in the bedroom may thus be risk factors for a sleep duration disorder. Children who watched television ≥ 2 hours/day during the weekdays and on the weekends and had a computer in their bedrooms tended to have a higher prevalence of sleep anxiety. Television viewing ≥ 2 hours/day on the weekends and the presence of a television set in the child's bedroom was significantly correlated with both parasomnias and sleep disordered breathing. For night awakenings and daytime sleepiness, television viewing ≥ 2 hours/day on the weekends was a significant factor. Compared with the other 4 factors, computer use was not significantly correlated with any sleep disorders.

## DISCUSSION

The present study demonstrates that the presence of media equipment in a child's bedroom and media use were correlated with unhealthy sleep patterns and significantly associated with sleep disturbances. The results indicate that media presence in the bedroom and media use tended to be linked with later bedtimes, later awakening times, and a shorter duration of sleep during the weekdays and on the weekends, and thus may be risk factors for all types of sleep disorders. Among 5 media factors, television viewing ≥ 2 hours/day on the weekends, with a prevalence of 48.8%, was the predominant risk factor for sleep disorders; it was a significant predictor for all sleep disorders with the exception of sleep duration disorder. Computer use appeared to have the least overall impact on sleep, possibly because the majority of children in our sample (89.8%) rarely used computers.

The sleep/wake patterns that appeared to be most affected by media use and media presence were bedtimes and awakening times on the weekends. All 5 media-use factors (television viewing more time per day during weekdays and weekends, more frequent computer use, presence of a television set in the child's bedroom, and the presence of a computer in the child's bedroom) significantly predicted later bedtimes on the weekends. Except for computer use, the other 4 factors were also associated with an increased likelihood for later awakening times on the weekends. Compared with the duration of sleep on the weekends, sleep duration during the weekdays was more easily influenced by media use and the presence of media equipment in the bedroom. Four factors, including more television viewing per day on the weekends, more frequent computer use, the presence of a television set in the child's bedroom, and the presence of a computer in the child's bedroom predicted a shorter duration of sleep on the weekdays. Only 2 factors, more frequent computer use and the presence of a television set in the child's bedroom, were significantly correlated with a shorter duration of sleep on the weekends.

These findings were similar to the result of a survey involving 2546 secondary school children in Belgium, which indicated that television viewing more time per day, more frequent computer game playing and internet use, and the presence of media equipment in the child's bedroom resulted in later bedtimes and awakening times on the weekends and later bedtimes and shorter hours in bed during the weekdays.<sup>7</sup> Another study involving 1143 Japanese school children aged 6-11 years demonstrated that television game playing  $\geq 1$  hour/day was linked to sleep deprivation and symptoms of daytime sleepiness.<sup>8</sup> Similarly, a recent study involving 1039 10-13 year old Australian children reported that children with more frequent screen use were likely to sleep less.<sup>9</sup>

Among 8 types of sleep disorders, bedtime resistance and sleep anxiety were most affected by media use and the presence of media equipment in the child's bedroom. Previous research involving 495 US school children similarly found that bedtime resistance was most easily affected by television viewing habits, including the amount of television viewing per day (OR = 2.2) and the presence of a television set in the child's bedroom (OR = 2.4).<sup>13</sup> The content of television/computer programs may also be correlated with sleep anxiety because excessively violent and/or stimulating episodes may inhibit relaxation and result in difficulty falling asleep; however, the data on television/computer programs were unavailable in our survey, so it was impossible to assess the relationship between television/computer programs and sleep anxiety in the present study. In agreement with a previous study,<sup>13</sup> our study demonstrated that daytime sleepiness and night awakenings were least affected by television viewing habits. There was evidence that the sleep onset delay was predominantly influenced by amount of television viewing per day<sup>12,13</sup> and the presence of a television set in the child's bedroom,<sup>13</sup> while our study illustrated that only viewing television  $\geq 2$  hours/day was a significant risk factor for the sleep onset delay.

A study of adults about the effects of computer game playing on sleep architecture illustrated that increased sleep latency resulting from computer game playing before going to bed was caused by increased activity levels of the central and autonomic nervous systems.<sup>16</sup> Similarly, television viewing also may heighten nervous alertness, physiological arousal, and result in difficulty falling asleep in children. This may be the mechanism of association between television viewing and sleep onset delay. A study involv-

ing 2068 children  $<3$  years of age indicated that the number of hours of television watched per day was associated with both an irregular naptime schedule and an irregular bedtime schedule.<sup>11</sup> Our study did not specifically examine the impact of media use on naptime/bedtime schedules, but our study did show that television viewing  $\geq 2$  hours/day on weekdays was a significant risk factor for sleep duration disorder, which was an analogous result. In agreement with a study conducted in Finland,<sup>12</sup> we found that media exposure was related to sleep-wake transition disorders. Our study showed that television viewing  $\geq 2$  hours/day on weekends and the presence of a television set in a child's bedroom predicted parasomnias; however, a study involving US school children did not find a correlation between television viewing and parasomnias.<sup>13</sup> In contrast to previous studies,<sup>12,13</sup> the present study showed that media exposure was correlated with sleep disordered breathing. This correlation may be artifactual since both television viewing and sleep disordered breathing increased with age. The sample in the present study was older than those in previous studies, which may explain this correlation. Among 5 media use correlated factors, television viewing  $\geq 2$  hours per day on the weekends was the predominant risk factor for sleep disorders. Compared with children who watched television  $<2$  hours/day on the weekends, children who viewed television  $\geq 2$  hours showed a higher prevalence of all sleep disorders with the exception of a sleep duration disorder. Prospective longitudinal studies confirmed that television viewing had a long-term negative effect on sleep disorders,<sup>14,35</sup> thus, this passive influence may be cumulative.

There are several limitations that should be considered in interpreting these results. The first limitation lies in the reliance on parental reported data on their child's sleep behaviors and media use without objective confirmation. Parents' ratings of media use and sleep behaviors for children may increase the possibility of rater biases. Because of socially desirable response bias and parents' underestimation, a child's amount of media use may be underreported. Second, because data on television programs were unavailable during our study, it was impossible to assess the relationship between television programs viewed and sleep behaviors in school-aged children. Similarly, our survey did not include specific information as to how children used the computer, e.g. game playing or internet browsing, so we could not examine the impact of specific computer use on sleep behaviors. Third, although we tried to control for many potential confounding factors that could affect children's sleep behaviors, our adjustment may not have been comprehensive. Other factors, such as health status, parents' sleep habits, and family stress may be significantly associated with school-aged children's sleep behaviors, so these factors may be potential confounders in interpreting the relationship between media use and sleep behaviors. Finally, the present study was cross-sectional and retrospective, so the results of our study should be further confirmed through a prospective study.

In conclusion, to our knowledge, this is the first report to provide information about television viewing, computer use, and the relationship between multimedia use and sleep behaviors in Chinese school-aged children. Our findings showed that computer use was not as prevalent as television viewing, but it had a similar negative impact on sleep behaviors. This suggests that concerns about media use should no longer be limited to television viewing. It is also important to realize that presence of media equipment in a child's bedroom may be a predictor for disturbed sleep patterns



and sleep disorders. The present findings may have significant clinical and public health implications. Based on these results, we recommend that both the use of media and the presence of media equipment in a child's bedroom should be limited. This may be beneficial to the child's quantity, as well as quality of sleep, and may lead to beneficial changes in a child's daytime performance. Specifically, media use, as a public health problem with the development of society, should be considered as a potential influence on a child's physiological, psychological, emotional, behavioral, and cognitive development.

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