

Gender and Sleep Health in High School Students: A Cross-Cultural Study

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Abstract

Background & Objective: Many recent studies have shown that sleep health is important for overall health and performance. However, adolescents often report poor sleep health, such as short duration and low quality sleep. In some cases, sleep characteristics are independent of gender and culture, but not in others. In this study, we tested for effects of gender, culture, and their interaction on measures of sleep health (adequacy and quality) for adolescents in an American population and a Chinese population.

Methods: A common survey instrument was administered to high school students in New Jersey, USA and Wenzhou, PRC. Students were asked to answer questions about their sleep duration, perception of sleep adequacy, daytime sleepiness, and napping for typical school days and weekends. Our final sample included 2,986 female students (2,059 American and 837 Chinese) and 2,544 male students (1,764 American and 780 Chinese).

Results: Differences in sleep duration were minor or absent, but differences in sleep health were substantial. Females were more likely than males to report inadequate sleep and daytime sleepiness, for both school days and weekends, and higher hypersomnolence scores. Chinese students were more likely than American students to report inadequate sleep and daytime sleepiness, for both school days and weekends, and higher hypersomnolence scores, with the exception that perception of adequate sleep did not differ between Chinese and American males on weekends. Especially dramatic was the difference in hypersomnolence, in which 74% of Chinese students reported inadequate sleep, sleepiness, and a nap for a typical school day, compared to only 29% of American students.

Conclusions: The results suggest the presence of gender and cultural differences in sleep quality that yield divergent outcomes for similar sleep durations.

Keywords: gender, culture, sleep health, America, China

1. Introduction

Good sleep health was defined by Buysse (2014) as being “characterized by subjective satisfaction, appropriate timing, adequate duration, high efficiency, and sustained alertness during waking hours.” The importance of sleep health for overall health and function has been a topic of much recent work, with most studies showing that reduced sleep duration and sleep quality are associated with poor health and performance. Chen, Wang, and Jeng (2006) studied adolescents aged 13-18 in Taiwan and found that low levels of “adequate sleep,” which they defined as a consistent 6-8 hours per night, were associated with health concerns such as poor stress management and obesity. In a meta-analysis of data from 26 studies, Dewald, Meijer, Oort, Kerkhof, and Bögels (2010) reported that lower academic performance was positively correlated with measures of sleepiness and negatively correlated with measures of sleep quality and duration. Further, Asarnow, McGlinchey, and Harvey (2014) found that later bedtimes were associated not only with poor academic performance in adolescents but also emotional problems such as sadness, depression, and increased incidents of crying. Finally, a cross-cultural study of children (9–11 years old) in 12 countries found correlations between later bed times and “unhealthy diet patterns,” which were

defined as increased consumption of fast food, fried foods, soda, etc. (Chaput et al., 2015).

Despite these many studies emphasizing the importance of sleep, children and adolescents tend to report diminished sleep as they age (Crowley, Acebo, & Carskadon, 2007). In particular, this diminished sleep appears to be more present during weekdays than weekends, as many individuals shift to later bedtimes and waking times, but are constrained during weekdays by school start times (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002). With these changes in biological rhythms and sleep patterns come problems in sleep health, such as insomnia and daytime sleepiness (Gradisar, Gardner, & Dohnt, 2011).

While some changes in sleep health in adolescence are not gender-specific, multiple studies highlight differences between the sleep health of boys and girls. In a study of middle school students (ages 11-14) in San Francisco, USA, it was found that girls woke earlier than boys and were more likely than boys to fall asleep on the way home from school, despite no differences in average bedtime or sleep duration (Lee, McEnany, & Weekes, 1999). Similarly, a study of Greek high school students found that sleep duration was independent of gender but that female students were more likely to report sleep problems, such as difficulty falling asleep and waking at night (Lazaratou, Dikeos, Anagnostopoulos, Sboku, & Soldatos, 2005). Some differences in sleep health have behavioral origins. For example, Grover et al. (2016) found that female adolescents were more likely than males to engage in text messaging, both before and after lights out, and more likely to report daytime sleepiness. That said, there are also biological differences that are related to hormonal changes associated with puberty in general, and menstruation in particular (Johnson, Roth, Schultz, & Breslau, 2006), that persist into adulthood (Kische et al., 2016; Romans et al., 2015).

The shift to later chronotypes appears to transcend cultures (Gradisar et al., 2011; X. Liu, L. Liu, Owens, & Kaplan, 2005), but there are nonetheless associations between culture and sleep patterns. These differences manifest themselves early on in life (Mindell, Sadeh, Kwon, & Goh, 2013; Mindell, Sadeh, Wiegand, How, & Goh, 2010) and can also be seen in adolescence. For example, a comparison of Arab and Jewish high school students found that the latter more readily fell asleep and reported less daytime sleepiness than the former (Snachat, 2013). A comparison of American and Italian adolescents (12-17 years old) revealed that the Italian students had higher sleep quality than American students, which was explained by better sleep hygiene (e.g., consistent sleep patterns) in the Italian adolescents (LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2005).

In this study, our goal was to contrast sleep health between females and males representing both American and Chinese populations. Specifically, we tested the hypotheses that females would experience worse sleep health than males and that Chinese students would experience worse sleep health than American students. Liu et al. (2005) showed that American elementary school children slept longer on average than their Chinese counterparts and were less likely to experience sleep problems, such as parasomnias and daytime sleepiness. Our work tested for differences in high-school aged adolescents. Using self-reported data from surveys, we assessed the effects of gender, culture, and their interaction on sleep duration, sleep adequacy, daytime sleepiness, and hypersomnolence.

2. Methods

2.1 Subjects and Questionnaire

In accordance with approval from the Institutional Research Board of Rutgers New Jersey Medical School, anonymous sleep surveys modeled after those used by Ming et al. (2011) were distributed to students in seven high schools across New Jersey, USA and to students in three high schools in Wen Zhou, the People's Republic of China. Surveys were in English or Chinese as appropriate. All high schools wished to remain anonymous. See Ming et al. (2011) for a full description of the instrument. We did not collect data on student ages, but the New Jersey students were spread across grades 9 through 12, and the Chinese students were equivalent to 10th - 12th grade New Jersey students. The surveys asked students to consider a typical week and answer questions about their sleep duration, sleep adequacy, and daytime sleepiness on both school days and weekends. Students were also asked about napping during the school week. Further, we calculated hypersomnolence scores for each student by summing their responses for three variables (school-night sleep inadequacy, school-day sleepiness, and one or more naps per week) (Pecor et al., 2016). Scores ranged from 0 (no hypersomnolence) to 3 (yes for all symptoms of hypersomnolence). Our initial sample included 7,172 surveys representing 3,726 females (2,657 American and 1,069 Chinese), 3,372 males (2,353 American and 1,019 Chinese), and 74 individuals who left gender blank (54 American and 20 Chinese). After removing those surveys that were incomplete or included inappropriate answers (e.g., ≥ 24 hours of sleep per day), there remained 5,440 surveys representing 2,986 female students (2,059 American and 837 Chinese) and 2,544 male students (1,764 American and 780 Chinese).

2.2 Analyses

The data that were collected from the surveys were in three forms and required three different analyses. First, sleep durations were normally distributed and were analyzed using factorial analysis of variance for a two-way assessment by sex and population. Second, sleep adequacy and daytime sleepiness were “yes” or “no” responses and were analyzed using contingency tables that contrasted observed and expected values for each variable. Finally, hypersomnolence scores were not normally distributed and were analyzed using the Scheirer-Ray-Hare extension of the Kruskal-Wallis analysis of variance by ranks for a two-way assessment by sex and population (Sokal & Rohlf 1995). Statistics were calculated using a combination of Microsoft Excel v14.5.4 and IBM SPSS Statistics v21.

3. Results

3.1 Sleep Duration

Female students reported significantly shorter sleep durations on school nights than male students ($F_{1,5436} = 27.08$, $p < 0.001$; Figure 1a), but there was no difference between females and males for weekend sleep duration ($F_{1,5436} = 1.22$, $p = 0.27$; Figure 1a). There was no difference between sleep duration for American and Chinese students on school nights ($F_{1,5436} = 0.21$, $p = 0.64$; Figure 1b), but American students reported significantly longer sleep durations than Chinese students on weekends ($F_{1,5436} = 34.42$, $p < 0.001$; Figure 1b). There was no interaction between sex and population for sleep duration on school nights ($F_{1,5436} = 0.72$, $p = 0.4$) or sleep duration on weekends ($F_{1,5436} = 1.31$, $p = 0.25$).

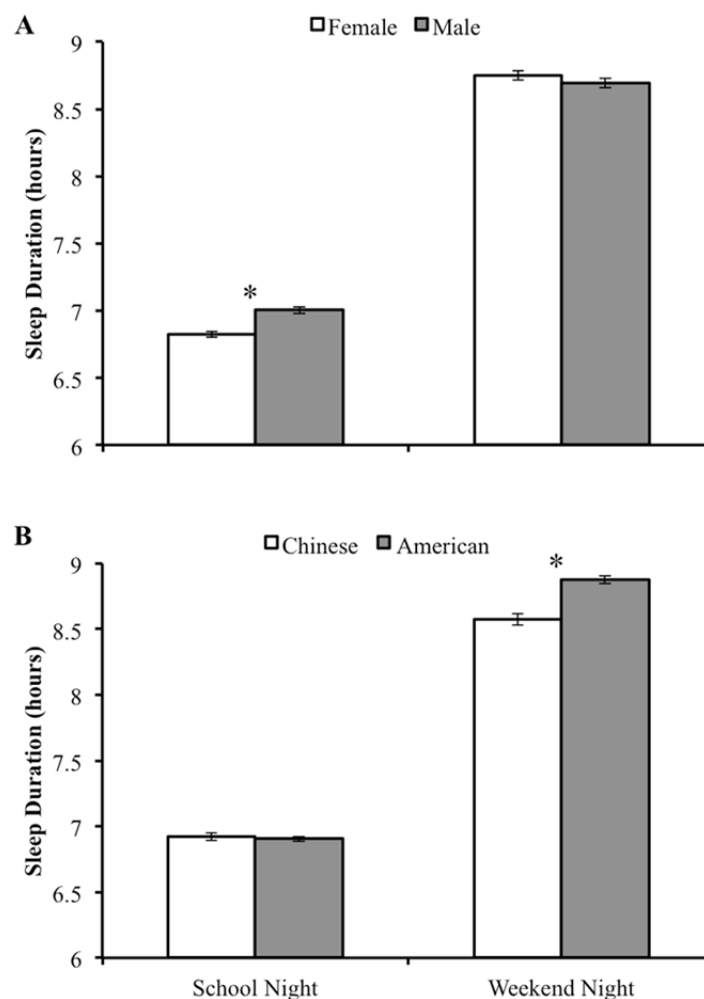


Figure 1. Mean sleep duration (\pm standard error of the mean) for school nights and weekends for (a) female ($n = 2,986$) and male ($n = 2,544$) students and (b) Chinese ($n = 1,617$) and American ($n = 3,823$) students. * $p < 0.001$

3.2 Sleep Adequacy and Daytime Sleepiness

For both American and Chinese students, females were more likely than males to report inadequate sleep and daytime sleepiness, both on school days and weekends (Table 1). American females were more likely than Chinese females to report adequate sleep and less likely than Chinese females to report daytime sleepiness, both on school days and weekends (Table 2). American males were less likely than Chinese males to report inadequate sleep on school nights, sleepiness on school days, and sleepiness on weekends, but there was no difference between American and Chinese males for perception of adequate sleep on weekends (Table 2).

Table 1. Percentage of individuals answering “yes” to questions about sleep health grouped by culture*

	Chinese				American			
	Female	Male	χ^2	p	Female	Male	χ^2	p
Adequate sleep on school nights	16%	22%	11.27	0.001	35%	46%	45.36	< 0.001
Adequate sleep on weekends	73%	80%	12.88	< 0.001	78%	83%	13.41	< 0.001
Sleepiness on school days	90%	81%	27.30	< 0.001	80%	68%	71.54	< 0.001
Sleepiness on weekends	42%	29%	32.95	< 0.001	28%	18%	58.04	< 0.001

* Percentages are presented for ease of interpretation, but raw numbers were used for analysis.

Table 2. Percentage of individuals answering “yes” to questions about sleep health grouped by gender*

	Female				Male			
	Chinese	American	χ^2	p	Chinese	American	χ^2	p
Adequate sleep on school nights	16%	35%	105.16	< 0.001	22%	46%	124.07	< 0.001
Adequate sleep on weekends	73%	78%	10.29	< 0.001	80%	83%	2.66	0.1
Sleepiness on school days	90%	80%	42.98	< 0.001	81%	68%	45.18	< 0.001
Sleepiness on weekends	42%	28%	56.05	< 0.001	29%	18%	40.04	< 0.001

* Percentages are presented for ease of interpretation, but raw numbers were used for analysis.

3.3 Hypersomnolence

Females reported significantly higher hypersomnolence scores than males ($H = 64.52$, $df = 1$, $p < 0.001$; Table 3), and Chinese students reported significantly higher hypersomnolence scores than American students ($H = 954.08$, $df = 1$, $p < 0.001$; Table 3). There was no interaction between gender and culture ($H = 2.42$, $df = 1$, $p = 0.12$).

Table 3. Percentage of individuals with different hypersomnolence scores.

		Hypersomnolence Score			
		0	1	2	3
Gender	Females	6%	16%	32%	47%
	Males	12%	20%	31%	38%
Population	Chinese	0%	8%	18%	74%
	American	12%	22%	37%	29%

4. Discussion

For this sample of American and Chinese high school students, we found that there were minimal or no differences in sleep duration. Weekend sleep duration did not differ statistically between the genders, and school-night sleep durations did not differ statistically between the cultures (Figure 1). There were statistical differences between males and females for sleep duration on school nights and between American and Chinese students for sleep

duration on weekends, but these statistical differences were minor and were driven more by small distributions around the means than by separation of the means (Figure 1). Males only slept approximately 11 minutes longer on average than females on school nights, and American students only slept approximately 18 minutes longer on average than Chinese students on the weekend. It would be difficult to make the case that such small differences are biologically meaningful, despite their statistical significance, and interestingly, the patterns observed for sleep health measures were the same, regardless of any differences in sleep duration. For example, females were more likely than males to report daytime sleepiness on school days and weekends, whereas males only reported a longer sleep duration on weekends. This suggests that sleep quality, more so than sleep quantity, contributed to the differences in sleep health observed between the genders and cultures.

Irrespective of culture, females reported poorer sleep health than males for all measures (Tables 1,3). These findings are consistent with other studies indicating that females experience worse sleep health than males during adolescence (Merikanto, Lahti, Puusniekka, & Partonen, 2013; Munezawa et al. 2010; Pecor et al., 2016; Söderqvist, Carlberg, & Hardell, 2008). Much of this difference is likely attributable to menarche and the onset of menstruation (Johnson et al., 2006). For both American and Chinese females, over 90% of individuals experience menarche by age 14 (Chumlea et al, 2003; Mao et al., 2011). Given our sample of American adolescents in 9th through 12th grade (typically 14 – 18 years of age) and Chinese adolescents equivalent to 10th through 12th grade Americans in age, we expect that nearly all of the females in the sample were post-menarche.

For the cross-cultural analyses, Chinese students reported poorer sleep health than American students for all measures except perception of adequate sleep on weekends (worse for females only; Table 2). Not only were the results statistically significant, the differences between cultures were dramatic. In particular, over 80% of both female and male Chinese students reported sleepiness on school days (Table 1), and 74% of Chinese students were assigned hypersomnolence scores of 3 (Table 2), indicating that they reported inadequate sleep on a typical school night, sleepiness during a typical school day, and at least one nap per week.

The reasons that Chinese students reported more sleep health problems are not entirely clear. However, two possible explanations include school-related stress and school-day lengths. First, Chinese students tend to feel greater stress from academics than other students (Sun, Dunne, & Hou, 2012; Ng, Pomerantz, & Deng, 2014). Second, there was disparity in the American and Chinese high school schedules for the participating schools. School started at or before 7:30 in all three Chinese schools and 7:30-8:30 in the American schools. School ended 16:30-17:00 for the Chinese high schools in comparison with 14:30-15:30 for the American high schools. As a result, the Chinese students were undertaking a much longer school day than the American students, but with similar sleep durations. This difference could account in part for the poorer sleep health reported by the Chinese students. Further, the Chinese schools in our sample provided a two-hour lunch break, which would give the students an opportunity to take a nap, and 100% of the Chinese students reported at least one nap per week. Interestingly, the focus of variation in school day length has been differences in academic performance, rather than effects on sleep health (Patall, Cooper, & Batts Allen, 2010). Sleep health tends to be more commonly considered in discussions of school start time rather than school duration (Boergers, Gable, & Owens, 2014). Our work suggests that the length of the school day should be taken into account when contrasting sleep health among populations.

5. Conclusions

In summary, we found gender and cultural disparities in sleep health, with females being more likely to report poor sleep health than their male counterparts and Chinese students reporting worse sleep health than American students. A combination of biological and cultural factors was invoked to explain these differences. The study was observational in nature and relied upon the accuracy of self-reported data, but the trends were quite robust across genders and cultures.

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Competing Interests Statement

Each author declares no conflict of interest.

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