The Effects of Irregular Bedtime on Sleep Quality, Daytime Sleepiness, and Fatigue in University Students in Taiwan

Jiunn-Horng Kang¹, Shih-Ching Chen²

¹Sleep Science Center, Taipei Medical University Hospital, and ²Department of Physical Medicine and Rehabilitation, Taipei Medical University Hospital, Taipei, Taiwan, R.O.C

Corresponding Author:

Dr. Jiunn-Horng Kang

Sleep Science Center, Taipei Medical University Hospital, Taipei, Taiwan,

No. 252 Wu-Xing Street, Taipei 110, Taiwan

Tel: 886-2-27372181 ext 2122

Fax: 886-2-27716781

E-mail: jhk@tmu.edu.tw
Abstract

Background: Having an irregular bedtime (IB) is a prevalent problem in young adults and may be a potential detrimental factor affecting sleep quality. The goal of this study was to explore the effect of an IB on sleep quality, daytime sleepiness, and fatigue of undergraduate students in Taiwan.

Methods: In total, 160 students completed the survey which included four parts: the Pittsburg Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), Fatigue Severity Scale (FSS), and rating of the frequency of an IB (FIB) via a semi-structural interview. An additional CHQ-12 (Chinese health questionnaire-12) was used to prevent the interference of recent possible psychological events in sleep assessment.

Results: We found that high FIB was associated with a significant decrease in the average daily sleep time (ADST). The worst sleep quality with highest PSQI was noted in the group who had high FIB with ADST less than 7 hours. Differences in the ESS and FSS in among the FIB groups were insignificant.

Conclusions: These results suggest that the students who have high FIB is associated with poor sleep quality especially in short sleepers.
**Background**

Some behaviors or activities such as irregular sleep schedule, frequent or prolonged daytime naps, excessive alcohol consumption near bedtime, and staying on the bed for non-sleep-related activities are known as “inadequate sleep hygiene” behaviors and are considered to be factors harmful to normal sleep [1-3]. Maintaining adequate sleep hygiene is considered to be an important adjuvant therapy in treating patients with insomnia or other sleep disturbances [1, 3, 4]. However, in normal subjects, evidence of these concepts is surprising inconsistent [5-8].

Human sleep is controlled by two main processes: the sleep homeostatic drive, which is determined by the length of sleep and wake time and the circadian system, which is an intrinsic pacemaker, and involves the pathway from the suprachiasmatic nucleus to the hypothalamus [9]. It is believed that regularizing the bedtime can strengthen the circadian rhythm and is beneficial to sleep quality [10]. It should be considered that the subjects who have high frequency of irregular bedtime (FIB) may also be prone to having a problem of chronic sleep insufficiency, and many studies have proven to impairments of cognition, vigilance, memory, and disturbing mood due to the accumulation of sleep deprivation [11-14].

Even a single shifted sleep schedule may cause a person to experience difficulties with sleep initiation and maintenance. A series of early studies conducted
by Taub et al. showed that even young adults with the same amount of sleep but an acute shift of 2 hours schedule were found to have decreased cognitive and psychological functioning in the laboratory setting [15-18]. However whether this conclusion can be applied to real life over a long duration where the frequencies of shifted nights are often irregular is still unclear. Another condition related to sleep shifting in a period is work shifting. Studies have shown that shifting the sleep-awake schedule of shift workers also has adverse effects on sleep and general health such as a decrease in sleep quality, altered sympathetic activity, an increased cardiovascular event risk, and reduced cognitive performance [19-21]. However, the shifting sleep/awake pattern of shift workers greatly differs from the observed pattern of an irregular sleep schedule in young adults whose phase shifts are shorter but the pattern is more irregular. The suitability of applying physiological changes in shift workers to the population with an irregular sleep schedule is also doubtful.

Although the exact prevalence is variable, it has been observed that many adolescents and young adults have irregular sleep schedules and a tendency to sleep late (phase delayed) [22-26]. A remarkable ratio of sleep problems and poor sleep quality in university students of many Western societies has been found by many studies. Ethnicity, social factors, and cultural effects can affect one’s sleep habits [24, 26]. To our knowledge, there has been no study exploring the epidemiological data on
the sleep habits and sleep quality of university students in Taiwan, a modern Oriental society. The purpose of this study was to explore epidemiological data about the FIB and sleep quality in Chinese undergraduate students in the Eastern society, and also to analyze whether an IB can directly affect one’s daytime functioning and sleep quality.
Methods

Sampling and study population

All participants were recruited from a medical university in Taipei, the capital of Taiwan. A semi-structured survey was given to all first-year medical students. In total, 197 students were interviewed, and 160 (81.2 %) students completed the survey. There were 81 males and 79 females. Their mean age was 20.3±1.9 years. The Taipei Medical University Hospital Review Board approved the study.

Measures and data management

The survey included three questionnaires which evaluated the subjects’ sleep quality, daytime sleepiness, fatigue, and the FIB. The Pittsburg Sleep Quality Index (PSQI) which has been accepted as being a valid and reliable survey was applied to assess sleep quality [27, 28]. The PSQI includes 19 items, and the score ranges from 0 to 21 (good quality to poor quality). Sleep onset latency (SOL) and sleep efficiency (SE), defined as actual sleep time divided by the time in bed can also be obtained with the PSQI. To test for daytime sleepiness, we used the Epworth Sleepiness Scale (ESS), a widely used and reliable predictor of daytime sleepiness [29]. It is based on a four-point scale to rank a subject’s chances of falling asleep in different scenarios. The other self-reporting scale used to evaluate fatigue was the Fatigue Severity Scale (FSS), which includes nine questions with a total score of from 9 to 63 (no fatigue to
severe fatigue) and which has successfully been applied to the clinical evaluation of
fatigue [30, 31].

Frequency of variable bedtime (FIB) which was defined as the frequency of
shifting their bedtime more than 1 hour from their usual bedtime in the past 2 weeks
into three categories (‘low \( \leq 1 \) night per week’, ‘intermediate 1 to 3 nights per week’;
‘high \( \geq 3 \) nights per week or a regular bedtime cannot defined by subjects’). The
ADST in the most recent 2 weeks was estimated by subjects.

An additional CHQ-12 (Chinese health questionnaire-12) was used to prevent the
interference of recent possible psychological events in sleep assessment. CHQ-12
included 12 items which is developed to screen the possibility of mild psychological
disorders or distress and has been shown as a validate tool in Chinese population [32].
Eleven students were excluded with the CHQ-12 was more than 2 points.

**Statistical analysis**

After data collection, five main outcome scores served as the dependent variables:
SOL, SE, PSQI, ESS, and FSS. Student’s \( t \)-test was applied to compare these
variables between the two genders. In order to exclude the potential effects of sleep
insufficiency, we grouped the participants into three subgroups: an ADST less than 7
hours, between 7 and 8 hours, and more than 8 hours. Chi-square test and Spearman’s
correlation were applied to analyze the distribution between the two variables: FIB
and ADST. Two-way ANOVA was applied to compare the differences in SOL, SE, FSS, ESS, and PSQI in each FIB and ADST group. LSD analysis for the post hoc analysis was applied. The significance level was set as $p < 0.05$. 
Results

There were 81 (51%) females and 79 males (49%) in the sample. There was no statistical difference in any variable between the two genders, so the data for males and females were combined for all subsequent analysis. The SOL of all subjects was 14.2±10.6 mins, and the ADST was 6.7±1.3 hours. The FSS, ESS, and PSQI were 38.2±8.9, 6.3±3.3, and 4.9±2.4 respectively. Data on variables for all subjects are summarized in Table 1.

Regarding the FIB, 26.9% of students had a low FIB (<1 night per week), 38.8% were in the intermediated group (1 ~ 3 nights per week), and 34.4% were in the high-FIB group (>3 nights per week). Nearly half (46.9%) of the students had an ADST less than 7 hours in the survey. It was worth noting that the ADST was statistically negatively correlated with the degree of FIB (r = -0.22, p < 0.05). The distribution of ADST and FIB values of all subjects are listed in Table 2.

Results of the two-way ANOVA analysis of differences in the five dependent variables in two variables (FIB and ADST) are showed in Table 3. There was statistical significance noted in the difference in PSQI (r^2 = 0.193, adjusted r^2 = 0.150, p < 0.01), and SE (r^2 = 0.329, adjusted r^2 = 0.294, p < 0.01) in the overall effect. The interactive effect of FIB and ADST on the five variables did not reach statistical significance. However, a decreased in the ADST was associated with a high PSQI (p <
0.01) and a low SE ($p < 0.01$) but not significantly with ESS or FSS. When considering the main effects of the FIB, there was a statistical difference in PSQI ($p = 0.047$); particularly when a subject’s ADST less than 7 hours by post hoc analysis (Fig. 1). Differences in the other dependent variables did not reach a significant level.

**Discussions and conclusions**

An IB is considered to be one kind of inadequate behavior for maintaining good sleep quality. Our study supports an IB possibly being an independent factor affecting sleep quality. The negative effect of IB in sleep quality is more severe in subjects whose ADST was less than 7 hours. We postulate that the relationship between sleep quality and FIB is due to the irregularity of the participants’ sleep shifts which can cause disturbances in the circadian cycle. Circadian system disturbances, as described by previous studies are characterized by disturbances in sleep architecture, and sleep quality and inability to fall asleep or stay awake. These disturbances are known to further cause fatigue, vigilance problems, and a decrease in productivity and to have negative health side effects [10, 33]. In addition to the circadian disturbance, particularly when a subject tries to get more sleep after shifting the phase later, environmental factors such as light or noise in the morning can affect the overall sleep quality.

Interestingly, we found subjects whose ADST is more than 8 hours, the adverse
effects of an IB on sleep quality become insignificant. We believe that the effects of an IB may become subtle if a subject can get sufficient sleep. We also found some adverse trends with a high FIB regarding FSS and ESS, although the differences did not reach statistical significance. It is worth noting that students who had a high FIB were significantly associated with a low ADST which puts them at risk for potential sleep insufficiency. This finding can be explained by daytime activities (class or recreation) which restricted their sleep time in the students whose bedtimes were irregular since they were unable to get enough sleep in the morning.

According to our data, prevalence of an IB and short ADST are high in undergraduate students in Taiwan. These findings are very similar to previous studies done in other countries and reflect sleep problems in university students may be a universal and prevalent problem in modern society [22, 23, 25]. One study reviewed the published papers regarding university students’ sleep patterns, and found the median sleep time had dropped about one hour in the past 20 years [34]. The lifestyle, social and academic schedules, insufficient sleep education could be the etiology of chronic sleep insufficiency and poor sleep in university students [22, 23, 35]. This study provides evidence that the IB of young adults may have a direct adverse effect on sleep quality.

Social cues, subjects’ willingness, activities, and environmental factors all play
important roles in setting human circadian rhythms and these factors can entrain the
sleep-awake cycle as a way to fine-tune to intrinsic human circadian rhythm [10].

Causes of the development of irregular sleep habits in young adults are still not
well-known, and are likely multi-factorial, including biological, behavioral, and social
factors. Two different types of people were observed in expression of alertness and
sleepiness in the endogenous circadian cycle in the general population: a morning
type (M-type) and an evening type (E-type) [36]. One study showed that individual
variations in behavior especially in sleep/wake schedules differed between the two
types. The E-type tends to vary their bedtime and waking time [37]. Taillard et al.
showed that the E-type was associated with an increase of sleep need and irregularity
of sleeping habits but not subjective daytime sleepiness [38]. A delayed sleep phase
disorder which leads to a sleep phase delay and often-variable bedtimes is another
prevalent circadian sleep disorder in adolescents and young adults, and a biological
mechanism such as an altered melatonin circadian response was found in some studies
[39, 40]. However, no studies have explored the biological mechanism or model of
developing a variable sleep schedule. Further studies need to explore the circadian
markers and physiological features of subjects who have an IB in order to clarify the
underlying mechanism and model.

Our study showed an IB had adverse effects on sleep quality. Although the
consequence of an IB may be less than sleep insufficiency, the long-term effect should not be overlooked. There is a need to address the importance of a regular sleep schedule which should be maintained. Students who have an IB should be advised to make their bedtime regular and increase their ADST which might help increase their sleep quality and daytime functioning. A structured approach to enhancing the sleep hygiene and knowledge of university students was suggested but the effects still need to be confirmed [35].

However, one limitation of this study is related to the estimation of the ADST and FIB from the self-reported questionnaires which may have a recall bias. An objective assessment such as actigraphy of these parameters would be required for more-accurate estimations of the ADST and FIB. Moreover, the undergraduate subjects we studied at the medical university might not be a representative sample of the general population of university students. A random population-based sample with a large sample size would be required to confirm the effects of an IB observed in our study. Also, the real causality is still difficult to determine in this cross-sectional study. The possibility that subjects who have poor sleep quality with sleep onset difficulty or sleep fragmentation will develop some inadequate sleep habits such as irregular sleep schedules, etc cannot be ruled out. Longitudinal studies would be required to clarify the direction of causality between the IB and poor sleep quality. Finally, it should be
noted that there are many different types of inadequate sleep habits and sleep-related behaviors; only the FIB was taken into account in our study. Other poor sleep habits would likely also have harmful impacts in sleep quality in normal subjects, and these factors should be considered in further studies.
Reference


16. Taub JM, Berger RJ: Performance and mood following variations in the
length and timing of sleep. *Psychophysiology* 1973, 10:559-570.


24. Hicks RA, Lucero-Gorman K, Bautista J, Hicks GJ: Ethnicity, Sleep Hygiene

25. Lack LC: Delayed sleep and sleep loss in university students.

*JAmCollHealth* 1986, 35:105-110.


*JNeurolNeurosurgPsychiatry* 2005, 76:1403-1405.


Tables

Table 1 All measured variables in both genders

<table>
<thead>
<tr>
<th>Variable*</th>
<th>Female (n = 81)</th>
<th>Male (n = 79)</th>
<th>Total (n = 160)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOL (mins)</td>
<td>15.2 (11.3)</td>
<td>12.9 (9.8)</td>
<td>14.2 (10.6)</td>
</tr>
<tr>
<td>SE (%)</td>
<td>89.0 (14.4)</td>
<td>91.1 (10.5)</td>
<td>90.1 (12.6)</td>
</tr>
<tr>
<td>ADST (hours)</td>
<td>6.8 (1.4)</td>
<td>6.6 (1.1)</td>
<td>6.7 (1.3)</td>
</tr>
<tr>
<td>ESS</td>
<td>6.7 (3.2)</td>
<td>5.9 (3.4)</td>
<td>6.3 (3.3)</td>
</tr>
<tr>
<td>FSS</td>
<td>38.0 (8.5)</td>
<td>38.5 (9.4)</td>
<td>38.2 (8.9)</td>
</tr>
<tr>
<td>PSQI</td>
<td>5.0 (2.4)</td>
<td>4.8 (2.3)</td>
<td>4.9 (2.4)</td>
</tr>
</tbody>
</table>

SOL, sleep onset latency; SE, sleep efficiency; ADST, average daily sleep time; ESS, Epworth Sleepiness Scale; FSS, fatigue severity scale; PSQI, Pittsburg Sleep Quality Index.

All variables were expressed as mean (standard deviation).

* No variables exhibited a statistical difference between the two genders at the level of $p<0.05$. 
Table 2 FIB and ADST in all subjects

<table>
<thead>
<tr>
<th>ADST*</th>
<th>FIB*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>intermediate</td>
</tr>
<tr>
<td>&lt; 7 h/day</td>
<td>14 (8.8)</td>
<td>26 (16.3)</td>
</tr>
<tr>
<td>7 ~ 8 h/day</td>
<td>17 (10.6)</td>
<td>24 (15.0)</td>
</tr>
<tr>
<td>≥ 8 h/day</td>
<td>12 (7.5)</td>
<td>12 (7.5)</td>
</tr>
<tr>
<td>Total</td>
<td>43 (26.9)</td>
<td>62 (38.8)</td>
</tr>
</tbody>
</table>

Values are given as the number (%).

FIB, frequency of an irregular bedtime; ADST, average daily sleep time.

*The low-FIB group was < 1 night/week, while intermediate group was 1 to 3 nights/week, and high group was more than three nights/week. An irregular bedtime was defined as a more than 1-hour variation from the usual bedtime.

All variables were expressed as mean (standard deviation).

* Chi-Square analysis of the distribution between two variables had statistical significance (χ² = 11.68, p = 0.022), and the Spearman correlation was -0.22 (p = 0.05).
Table 3 Two-way ANOVA of FIB and ADST for five dependents variables

<table>
<thead>
<tr>
<th>p-value</th>
<th>SOL</th>
<th>SE</th>
<th>ESS</th>
<th>FSS</th>
<th>PSQI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>0.101</td>
<td>&lt; 0.001</td>
<td>0.562</td>
<td>0.245</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>FIB</td>
<td>0.127</td>
<td>0.782</td>
<td>0.091</td>
<td>0.313</td>
<td>0.047</td>
</tr>
<tr>
<td>ADST</td>
<td>0.761</td>
<td>&lt; 0.001</td>
<td>0.843</td>
<td>0.605</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Interaction</td>
<td>0.126</td>
<td>0.202</td>
<td>0.871</td>
<td>0.287</td>
<td>0.099</td>
</tr>
</tbody>
</table>

SOL, sleep onset latency; SE, sleep efficiency; FIB, frequency of the irregular bedtime; ADST, average daily sleep time.
Legends

Figure 1 Pittsburg Sleep Quality Index (PSQI) of subjects in different groups of the average daily sleep time (ADST) and subgroup of the frequency of an irregular bedtime (FIB).

*# Post hoc analysis of the difference with statistical significance ($p < 0.05$).