Light exposure and sleep quality in students with different sleep patterns

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Abstract

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Introduction: Low quality of sleep affects our health and quality of our life. University students are one group that has sleep behaviors that can cause sleep problems. This study investigated light exposure and sleep quality in students with different sleep patterns, classified as morning or evening types. **Method:** The study recruited pharmacy students at Khon Kaen University and screened for morningness/eveningness using the Morningness-Eveningness Questionnaire Thai-version (T-MEQ). A total of 14 students were selected (10 for morning and 4 for evening type) for further evaluations of sleep quality by using the Pittsburg Sleep Quality Index (PSQI), and sleep efficacy and light exposure by actiwatch. Data were analysed by software SPSS and Actiware analysis software. **Results:** The average of PSQI score in morning type was 4.21, which was better than the average of PSQI score for evening type (mean PSQI = 6.73). The sleep efficacy of morning type was 88.9%, slightly higher than average of sleep efficacy of evening type (84.4%). The onset latency (time to actually get to sleep after lights out) of morning type was 9.6 minutes less than that of the evening type (20.4 minutes). Patterns of sleep of morning types were more regular than evening types, and they were exposed to lower light at night than the evening group. **Conclusion:** The results indicate that chronotype, i.e. sleep pattern, does affect the quality and efficiency of sleep of university students. Larger sample size is needed to confirm the findings.

KEYWORDS: Melatonin, sleep quality, actiwatch, light exposure, morningness, eveningness

Introduction

Exposure to light at night can cause sleep problems by significantly suppressing nocturnal melatonin production (Levwy *et al*., 1980). Melatonin is the neuroendocrine hormone which is responsible for balancing many systems of the body through circadian rhythm control (Claustrat, 2005). One area of study that researchers have focused on is the effect of light at night and sleep. Sleep is of paramount importance for normal processes in the human body, and many health problems occur when people have sleep disorders, including reduced perceived emotional intelligence and constructive thinking skills (Killgore *et al*., 2008), neuroendocrine stress (Meerlo *et al*., 2007), impaired cognitive function (Strine and Chapman, 2005), and obesity and metabolic syndrome (Reiter *et al*., 2012).

In Thailand, a cross-sectional study evaluating sleep quality of nurses working night shift and day shifts using the Pittsburgh Sleep Questionnaire Index (PSQI) found that nurses working night shifts had significantly lower quality of sleep than those working day shifts (Plaimee *et al*., 2012). Likewise, previous study showed that individuals have different sleep patterns called morningness and eveningness, which could affect sleep

quality. Morningness is characterized by waking early, being most active during daylight and going to sleep early. Eveningness is characterized by waking late, being most active and alert during the evening and going to sleep late (Mecacci *et al*., 1983). Research into light at night and sleep deprivation in college students found a relationship between chronotype i.e. their pattern of working and sleep rhythm, and light exposure and quality of sleep. From the collected data they found that students who worked at night, and were therefore more exposed to light at night, presented lower sleep quality than students who worked during the daytime (Martin *et al*., 2012).

This study aimed at describing the difference of light exposure and sleep quality reported in different sleep patterns of students. The hypothesis of the study was that exposure to more light at night of students with evening types would lead to lower sleep quality and sleep efficacy than those of the morning type.

Methods

Subjects

This study was approved by the Khon Kaen University Ethics Committee for Human Research. Male or female pharmacy students, aged between 18-25 years old were recruited for screening of chronotype (sleep pattern) using the T-MEQ Morningness-Eveningness Questionnaire (Udomrat *et al*. 2007) in . Students who reported scores of 16-30 (definite evening type) or 70-86 (definite morning type) were asked to participate in the study. Fourteen of these students were selected (10 morning and 4 evening type) for further evaluation of sleep quality using the Thai Pittsburg Sleep Quality Index (T-PSQI), and sleep efficacy and light exposure by actiwatch, and a sleep dairy daily was kept for 7 days. The period of data collection was from December 2013 to September 2014.

Measurements

Morningness-Eveningness Questionnaire Thai-version (T-MEQ)

Chronotype is the type of sleeping pattern, classified into morning type, evening type or indeterminate, as defined by the T-MEQ. Morning type

(MT) scores were in the range of 59-86, and evening type (ET) scores were in range of 16-41. This T-MEQ is composed of 19 questions used to identify wake/sleep behavior of people, divided into three types: morning, intermediate and evening types (Horne and Ostberg, 1976). The original questionnaire had been translated into Thai-language (T-MEQ) and has proven acceptable by a panel of four experts and shown a sensitivity of 0.75, specificity of 0.91, accuracy of 0.81, and internal consistency (Cronbach's coefficient alpha) of 0.95 (Udomrat *at el*. 2007) for medical students.

Sleep diaries

A sleep diary (adapted from the American Academy of Sleep Medicine) was used for recording the daily activities that affected sleep (record of confounding factors) such as coffee, cola, tea, alcohol, medicine consumption, work, school, day off or vacation, exercise, time to go to bed, time when feeling asleep, time when waking up at the night and day napping during the day.

Thai version of the Pittsburgh Sleep Quality Index (T-PSQI)

Sleep quality was measured by The Pittsburgh Sleep Quality Index: PSQI (Buysse et al., 1989). The Thai-Pittsburgh Sleep Quality Index (T-PSQI) used in this study is a self-related questionnaire which is composed of 7 questions in each topic having score 0-3 and a total score in the range of 0-21. Scores are then interpreted to give sleep quality. A global sum of five or greater is classified as a "poor" sleeper. T-PSQI was used to evaluate sleep in nurses and it was found that sensitivity was 89.6%, specificity 86.5% and it had a good reliability by Cronbach's alpha coefficient = 0.835 (Chonticha *et al*., 2013).

Actiwatch (Actigraphy)

An actiwatch is an instrument which is used to record sleep data. Actiwatch devices are worn on the wrist like a wristwatch and record movements of people, and some can also record light levels via a light sensor. It can be used to estimate sleep parameters using specialized algorithms in computer software programs.

In this study, sleep efficacy was measured using Phillips Actiwatch 2 with light sensor, with the data being analyzed with Respironics Actiware 5.70.0 software. It is calculated as the percentage of time spent asleep (total

sleep time) to the amount of time spent in bed. Sleep periods were the times between actiwatch detecting no movement until significant movement, verified with light sensor data, sleep diary and user recorded button press (intention to sleep).

Actigraphy has been compared to polysomnography (PSG), which is considered as the gold standard for sleep studies Many validation studies have been conducted to optimize the sleep-detection algorithm of the actiwatch. In one study, the algorithm for actigraphy in-bed recordings (n = 39) showed a minute-by-minute agreement of 85% between actigraphy and polysomnography (PSG), a correlation of 0.98, and a mean measurement error (ME) of 21 min for estimates of sleep duration. Using the same algorithm to score 24-h recordings with Webster's rules, an agreement of 89%, a correlation of 0.90, and 1 min ME were observed. A different algorithm proved optimal to score in-bed recordings (n = 31) of young adults, yielding an agreement of 91%, a correlation of 0.92, and an ME of 5 min. The strong correlations and agreements between sleep estimates from actigraphy and PSG in both studies suggest that the actigraphy can reliably monitor sleep and wakefulness both in community-residing elderly and healthy young adults (Jean-Louis et al., 2001).

Concordance between PSG and the two previously proposed algorithms showed that the accuracy was reasonably satisfactory. Actigraphy was a sensitive method, with values of 99% and 97% for Cole's and Sadeh's algorithms, respectively. The results of this study showed the utility of actigraphy as a useful method for assessment of sleep (de Souza, 2003).

Light at night

Light at night is exposure to artificial light with intensity > 10 lux at time between 7 pm - 5 am as measured by light sensor at the actiwatch. The light environment is light level in the sleeping environment with lights out as measured with a light meter.

Statistical analysis

Data were analyzed using the SPSS version 19 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to describe the demographic characteristics of the sample and to present the pattern of light exposure, sleep quality, and sleep efficacy of students with morning or evening chronotypes.

Results

After screening for chronotype, 14 students who consented to participate in the study, were measured with PSQI and actiwatch to evaluate sleep quality and sleep efficacy for seven days. These were divided into 10 morning type students and four evening type students. It was found that the average of PSQI score in morning type was 4.21, which was less than average of PSQI score for evening type (mean PSQI =6.73). The entire morning type group had good sleep quality, but only two of the evening type had good sleep quality.

Table 1 shows the sleep efficacy of the 14 students. It shows that the average of sleep efficacy of 10 students in morning type was 88.9%, slightly more than average of sleep efficacy of students of evening type (84.4%). The average bed time of morning types was 12:08 PM which was earlier than average bed time of evening types (4:31 AM). The average wake up time of morning types was 6:33 AM, earlier than average wake up time of evening types which was 8:49 AM. The average time in bed for morning types was 6.29 hours, almost the same as the average time in bed of evening types (6.20 hour).

The average total sleep time for morning types was 5.45 hours, more than average total sleep time of evening types (5.19 hours). The average for onset latency (time to actually get to sleep after lights out) of morning type was 9.6 minutes, less than average onset latency of evening type (20.4 minutes). The average of wake after sleep onset (WASO: the number of minutes awake, i.e. sleep lost between initially falling and waking up in the morning) in morning types was 21.4 minutes, less than average of wake after sleep on set (WASO) of evening types (27.2 minutes). The average of awakenings during sleep in the morning type was 31.7 times, less than average of awakenings in evening type (33.6 times).

Figure 1 and 2 show typical data of sleep efficacy collected by actiwatch during seven days. It shows that the pattern of sleep of a morning type were is more regular in the pattern of the evening type, and they

were exposed to lower light at night than the evening group. Morning type students tend to work during the day time, sleep earlier, and were less exposed to light at night (Figure 1). Evening types tend to have irregular sleep periods (compared to morning types) and have shorter real sleep time than morning types as shown in Figure 2. It is expected that light exposure at night is one of factors that disturbs sleep and causes irregular sleep patterns as shown in evening type students.

**Table 1** Actiwatch sleep parameter of selected subjects

	Circadian Type		
	Morning, N (10)	Evening, N (4)	Total, N (14)
Gender, N (%)			
Male	1 (10)	1 (25)	2 (14)
Female	9 (90)	3 (75)	12 (86)
18-25 Age, n (%)	10 (100)	4 (100)	14 (100)
Actigraph data†			
Bed Time, Median (SD)	12:08 AM (0.45)	4:31 AM (0.28)	9:54 AM (0.29)
Get Up Time, Median (SD)	6:33 AM (0.06)	8:49 AM (0.14)	7:13 AM (0.14)
Time In Bed (hour), Average (SD)	6.29 (0.08)	6.20 (0.06)	6.26 (0.07)
Total Sleep Time (hour), Average (SD)	5:45 (0.07)	5:19 (0.05)	5:37 (0.05)
Onset Latency (minutes), Average (SD)	9.6 (12.7)	20.4 (38.1)	12.8 (38.7)
Sleep Efficacy (%), Average (SD)	88.9 (5.9)	84.4 (9.0)	87.6 (9.1)
WASO (minutes), Average (SD)	21.4 (13.2)	27.2 (12.5)	23.1 (12.1)
Awakening (time), Average (SD)	31.7 (18.5)	33.6 (13.4)	32.3 (13.3)
PSQI score‡, Average (SD)	4.21 (2.22)	6.73 (2.19)	4.87 (1.72)
Score PSQI sleep quality index * (%)			
Good	7 (70)	2 (50)	9 (64)
Bed	3 (30)	2 (50)	5 (36)

†Bed time: time started to go bed, Get up time: time getting up in morning, Time in bed: Duration (in hours) on bed, Total sleep: Duration (in hours) of actual sleep at night, Onset latency: Duration (in minutes) of time taken to fall asleep, Sleep efficacy: Percent of time spent asleep (total sleep time) to the amount of time spent in bed, WASO is wake after sleep onset: the number of minutes awake detected by the actiwatch after initially

falling asleep, Awakenings: number of times waking up during sleep time ‡Pittsburgh Sleep Quality Index (PSQI) scores range 0 -2 1 points *PSQI sleep quality index interpret from PSQI score; score $\leq$ 5 means good and score more than 5 means poor. PSQI sleep quality index indicate of sleep quality if good mean good quality in sleep and if poor mean poor in sleep quality
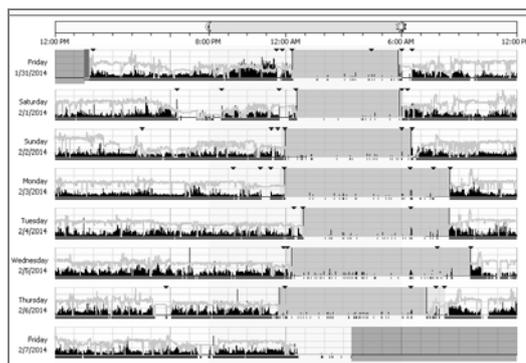
Figure 1 Typical sleep duration (blue bar), light exposure (yellow trace) and activity (black trace) of morning type collect by actigraph
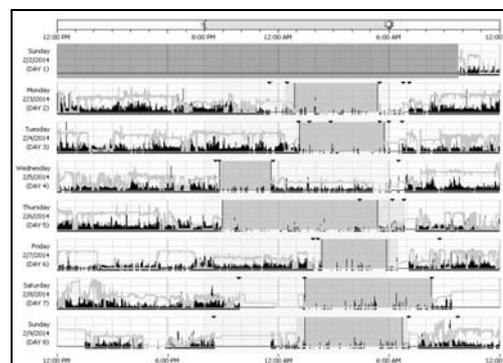
Figure 2 Typical sleep duration (blue bar), light exposure (yellow trace) and activity (black trace) of evening type collect by actigrarh

Conclusions

In university students, a lot of learning activities such as reviewing lessons and homework occurs at night time. Sleep pattern in university students could affect their daily lives, health status and learning abilities. Students who prefer working at nighttime (evening chronotype) will be exposed to more light at night than students who prefer working during the daytime (morning chronotype). Light exposure at night is expected to disturb their sleep quality.

The hypothesis of the study was that exposure to more light at night of the evening types would lower the sleep quality and efficacy of the evening types than the morning types. This hypothesis is supported by the study where better sleep was reported in morning types than evening types. This result indicates that chronotype, i.e. sleep pattern does affect the quality and efficiency of sleep of university students.

This study had a small sample size, limiting statistical analysis. Future study will collect more sleep quality and sleep efficacy data of morningness/eveningness types of university students using a larger sample size to confirm these findings.

Acknowledgments

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