J Occup Health 2018; 60: 348-355

Journal of Occupational Health

Original

Short sleep duration among Thai nurses: Influences on fatigue, daytime sleepiness, and occupational errors

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Abstract: Objectives: This study was conducted to: 1) describe sleep duration, fatigue, daytime sleepiness, and occupational errors among Thai nurses and 2) explore the influence of sleep duration on fatigue, daytime sleepiness, and occupational errors. **Methods:** A cross-sectional design was implemented. A convenience sample of 233 full-time nurses with at least one year of work experience was recruited to participate in the study. Data were collected using self-reported questionnaires and 1-week sleep diaries. Descriptive and logistic regression statistics were performed using SPSS software. **Results:** The mean total sleep time was 6.2 hours. Of the total participants, 75.9% (n=167) experienced short sleep duration, 38.2% (n=84) experienced fatigue, and 49.5% (n=109) experienced excessive daytime sleepiness. Occupational errors were reported by 11.7% (n=25). Medication errors, incorrectly performed procedures, and needle stick injuries were reported by 6.5% (n=13), 5.6% (n=12), and 4.7% (n=10), respectively, of participants performing the associated activities. The "Short Sleep Duration" group experienced more fatigue (p=.044) and excessive daytime sleepiness (p=.001) compared with the "Adequate Sleep Duration" group. Although occupational errors were more common in the "Short Sleep Duration" group, the difference between the two groups did not reach the level of statistical significance. Multivariable logistic regression analysis found that short sleep duration was a statistically significant risk factor for excessive daytime sleepiness (OR=2.47, 95% CI=1.18-5.19). **Conclusions:** The majority of registered nurses experience short sleep duration. Short sleep duration increased the risk of excessive daytime sleepiness but not fatigue or occupational errors. Adequate nighttime sleep is paramount for preventing daytime sleepiness and achieving optimal work performance.
(J Occup Health 2018; 60: 348-355)
doi: 10.1539/joh.2017-0258-OA

Key words: Fatigue, Nurses, Occupational errors, Sleep duration, Sleepiness

Introduction

Nurses are healthcare professionals who ensure the continuity of patient-care around the clock. Extended working hours, family responsibilities, and long commutes may deprive nurses of opportunities for adequate sleep[1]. The American Academy of Sleep Medicine and the Sleep Research Society state that the healthy sleep duration for adults is a minimum of 7 hours per night[2]. However, a review of the literature suggests that in general, nurses sleep fewer than 7 hours per day, with a range of 4.3-6.7 hours[3-5]. Short sleep duration increases the risk of a spectrum of health disorders, such as cardiovascular and metabolic syndrome, obesity, and type 2 diabetes[6]. In general, nurses with short sleep duration more frequently rank their health status as poor when compared with those with adequate nighttime sleep[7]. Additionally, they report higher levels of job strain and burnout[8], medication errors[9] and patient errors[10]. Moreover, insufficient and poor quality sleep resulted in acute or chronic fatigue and sleepiness in nurses[11].

Fatigue is a sense of exhaustion and a decreased capacity for physical and mental work. Nurses in Thailand and other countries frequently report fatigue[5,12,13]. In general,

Received September 19, 2017; Accepted March 22, 2018
Published online in J-STAGE May 9, 2018
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night shift nurses report higher fatigue scores than day shift nurses[13]. Nurse fatigue resulting from poor sleep quality is a serious issue in healthcare because it negatively impacts performance and patient safety[14].

Sleepiness is a consequence of poor quality of sleep. The prevalence of excessive sleepiness among nurses is about 24% to 26%[5,15]. For night shift nurses, sleepiness peaks at 7:00 am, which is at the end of the work shift. This imposes a potential public health hazard because of the increased likelihood of traffic accidents[13]. Similar to fatigue, excessive sleepiness in nurses may also result in performance errors leading to patient adverse events[14].

Nurses hold an important responsibility for maintaining patients' safety. It has been known that fatigue and sleepiness may result in errors with negative consequences for patient safety[10]. However, the association between sleep duration and occupational errors is a subject of controversy. For example, a report from Saudi Arabia suggested that sleep-deprived nurses at all shift lengths (8, 10, and 12 hours) had a higher rate of medication errors compared to nurses with sufficient sleep[9]; while a study of emergency nurses in the US indicated that the total number of sleep hours was not associated with minor, moderate, or severe occupational accidents[16].

In Thailand, there is a paucity of research on sleep duration, fatigue, daytime sleepiness, and occupational errors among nurses. In previous studies among nurses in other countries, short sleep duration was defined using 6 hours or less[7,8], but our study used the recent recommendation by the American Academy of Sleep Medicine and the Sleep Research Society[2] which suggested that the optimum duration of sleep is at least 7 hours. To our knowledge the association between sleep duration and the risk of occupational errors among nurses has not been addressed in Thailand. In addition, previous studies have relied on one-time, self-reported sleep data, which may be subjected to recall bias. Sleep is a pattern and habit; therefore, the quality of data can be improved by consecutively collecting sleep variables and by using sleep diaries. Due to the shortage of nurses in Thailand, nurses are required to work longer hours which can interfere with their sleep duration. Given the potential negative consequences of insufficient sleep, we conducted a study with the objective of discerning if inadequate sleep duration increases the risk of fatigue, excessive daytime sleepiness, and occupational errors.

Subjects and Methods

Study design, population, and setting

A cross-sectional study was designed and implemented. A total of 233 full-time registered nurses with at least one year of employment at a tertiary hospital in Thailand were recruited from 10 different nursing departments. The number of participants recruited from each department was adjusted by the total number of nurses in each department.

Measurements

Self-administered questionnaires were used to collect data. The questionnaires were designed to collect information on demographic variables, work conditions, sleep pattern, fatigue, daytime sleepiness, and occupational errors. Sleep duration was measured using a 1-week sleep diary adapted from the National Sleep Foundation (www.sleepfoundation.org)[17]. Participants were asked to record the following information: the time of retiring to bed at night, the duration between retiring to bed and falling asleep, the number and duration of nighttime awakenings, and the time of rising in the morning. Total sleep time was calculated for each day by:

A) Documenting the total time in bed (the time of retiring to bed minus the time of rising in the morning).

B) Estimating sleep latency (the duration between retiring to bed and falling asleep).

C) Totaling the duration of awakenings throughout the night.

The total sleep time was then calculated by summing the values for B and C, and then subtracting this from A. We then calculated the mean sleep-time value of the reported seven days for each study participant.

Fatigue was measured using the Fatigue Questionnaire (FQ) developed by Chalder et al. (1993)[18]. The FQ is composed of 11 items measuring physical and mental fatigue which employs a 4-point Likert scale ranging from 0 (less than usual) to 3 (much more than usual). Summed scores ≥ 4 indicate fatigue[19]. In our study, the questionnaire was translated from English into the Thai language, using a back-translation process. The final back-translated version was sent to the instrument developer (Prof. Trudie Chalder) for confirmation of its equivalency with the original FQ. The developer approved the equivalency of the two versions. In our pilot study, the internal consistency reliability of the Thai version of the FQ was established with a Cronbach's alpha value of 0.91.

To assess excessive daytime sleepiness, the Thai version of the Epworth Sleepiness Scale (Thai-ESS)[20] was used. The questionnaire is composed of 8 items asking how likely the respondent is to doze off or fall asleep during the day in different situations, such as sitting and watching television, sitting inactive in a public place, or talking with someone. The Thai-ESS uses a 4-point Likert scale ranging from 0 (would never doze) to 3 (high chance of dozing). Total scores range from 0 to 24, and scores ≥ 10 indicate excessive daytime sleepiness[21]. In our study, the test-retest reliability of the instrument was 0.88.

Occupational errors were measured using a self-report questionnaire developed by our team and based on a review of the literature. One of the nursing directors and the

Table 1. Demographic and work characteristics of participants (N= 220).

Characteristics	N	%
Gender		
Male	17	7.7
Female	203	92.3
Age (years)		
≤ 40	144	65.5
41-49	76	34.5
Marital status		
Single	127	57.7
Married	82	37.3
Divorced/separated	11	5
Shift type		
Day only	42	19.1
Rotating shifts	178	80.9
Work experience (years)		
≤ 20	172	78.2
> 20	48	21.8
Working hours/day (hours)		
≤ 8	122	55.5
> 8	98	44.5
Working hours/week (hours)		
≤ 40	183	83.2
> 40	37	16.8
Number of night shifts/month (shifts)		
< 10	105	47.7
≥ 10	115	52.3
Extra breaks during working hours		
No	138	62.7
Yes	82	37.3

nursing staff evaluated the face validity of our questionnaires. The questionnaire consists of three categories: medication errors, incorrectly performed procedures, and needle stick injuries. Nurses were asked if they performed a specific task and if they did, if they experienced occupational errors within the previous month. Responses were dichotomized to "Yes" or "No".

Data Collection

Data was collected between February and March 2016. Sleep diaries and questionnaires were distributed in sealed envelopes to 233 participants; all study participants met the inclusion criteria. The participants were instructed to record 7 consecutive days of sleep patterns in their sleep diaries and to complete the one-time, self-administered questionnaires. Completed diaries and questionnaires were returned in sealed envelopes.

Data Analysis

Nurses were categorized into two groups: the "Short Sleep Duration" group which consisted of individuals who had reported < 7 hours of sleep, and the "Reference Group" which consisted of individuals with at least 7 hours of sleep. Descriptive statistics were used to describe demographic variables, work characteristics, fatigue, excessive daytime sleepiness, and occupational errors. Differences in fatigue, excessive daytime sleepiness, and occupational errors between the "Short Sleep Duration" and "Reference Group" were analyzed using the Chi-square test of significance.

We applied multivariable logistic regression analysis to estimate the association between sleep duration and each outcome of interest (i.e. fatigue, excessive daytime sleepiness, or occupational errors) after adjusting for potential confounding variables. Because of the small sample size of occupational errors in each group, the statistical model could not converge; therefore, it became necessary to dichotomize the occupational error variable into two categories: "Experienced Occupational Errors" and "Did Not Experience Occupational Errors".

In developing the best fit model, we first estimated the individual effect of each variable on the outcome of interest. Variables were evaluated because of their potential biological or clinical importance on each outcome. Variables with a p-value < 0.25 from univariable analysis were considered as the candidate variables, as well as variables with clinical importance[22]. The final model contained only variables that were significant at p-value < 0.05. All statistical analyses were performed using The Statistical Package for the Social Sciences (Version 22.0, IBM SPSS Statistics).

Ethical Considerations

The Research Ethics Committee of the Faculty of Nursing at Chiang Mai University approved the research study. In addition, permission for data collection was obtained from hospital authorities. Information sheets that explained the study's objectives were provided to the study participants along with the questionnaires and sleep diaries. Informed consent was obtained from the study participants. Information about individual participants was kept secure to maintain their confidentiality.

Results

A total of 226 nurses returned completed questionnaires (97% response rate). Of these, we excluded 6 participants because of incomplete sleep diaries. Therefore, 220 questionnaires and sleep diaries were included in the data analysis. The majority of participants were female (92.3%, n= 203) and under 40 years of age (65.5%, n= 144).

Most of the nurses (80.9%, n= 178) worked a rotating shift, 45.5% (n=98) worked > 8 hours per day, and 52.3% (n=115) had ≥ 10 nightshifts per month (Table 1).

Table 2. Sleep duration, fatigue, excessive daytime sleepiness, and occupational errors.

Characteristics	Total (N=220)	Short sleep duration group	Normal sleep duration group	*p*-value
	N (%)	N (%)	N (%)	
Sleep duration (hr.)				
Short sleep duration	167 (75.9)			
Normal sleep duration	53 (24.1)			
Mean±SD	6.2 ± 1.2			
Range	2.9-8.5			
Fatigue				.044*
No (0-3 scores)	136 (61.8)	99 (58.2)	37 (74)	
Yes (≥4 scores)	84 (38.2)	71 (41.8)	13 (26)	
Excessive daytime sleepiness				.001*
No (<10 scores)	111 (50.5)	75 (44.1)	36 (72)	
Yes (≥10 scores)	109 (49.5)	95 (55.9)	14 (28)	
Occupational errors				
Experienced occupational errors (n=214)				.059
No	189 (88.3)	142 (86.1)	47 (95.9)	
Yes	25 (11.7)	23 (13.9)	2 (4.1)	
A-Medication errors (n=198)				.069
No	185 (93.4)	143 (92.9)	42 (95.5)	
Yes	13 (6.6)	11 (7.1)	2 (4.5)	
B-Incorrectly performed procedures (n=213)				.072
No	201 (94.4)	153 (92.7)	48 (100)	
Yes	12 (5.6)	12 (7.3)	0 (0)	
C-Needle stick injuries (n=212)				.121
No	202 (95.3)	154 (93.9)	48 (100)	
Yes	10 (4.7)	10 (6.1)	0 (0)	
A+B	2 (1.0)	2 (100)	0 (0)	
A+C	2 (1.0)	2 (100)	0 (0)	
B+C	2 (0.9)	2 (100)	0 (0)	
All 3 categories	2 (1.0)	2 (100)	0 (0)	

Note: A = medication errors, B = incorrectly performed procedures, C = needle stick injuries
* $p < .01$

About 76% (n=167) of the study participants were categorized into the "Short Sleep Duration" group. Based on our analyses, 38.2% (n=84) of the nurses experienced fatigue and about half of them (49.5%, n=109) had excessive daytime sleepiness. Finally, 11.7% (n=25) of the nurses were classified into the "Experienced Occupational Errors" group, 6.6% (n=13) reported errors in medication administration, 5.6% (n=12) reported errors in procedure performance, and 4.7% (n=10) reported needle stick injuries (Table 2).

As shown in Table 2, a higher proportion of nurses in the "Short Sleep Duration" group reported fatigue (p =.002) and excessive daytime sleepiness (p=.001) compared to the reference group. Occupational errors were also more common in the "Short Sleep Duration" group than the reference group, although this difference did not reach the level of statistical difference (p=.059).

The variables from univariate analysis were incorporated into the multivariate analysis (Table 3). Results from our final multivariable logistic regression analysis model found that nurses in the "Short Sleep Duration" group had a higher risk of excessive daytime sleepiness (OR= 2.47, 95% CI=1.18-5.19) relative to the reference group. Interestingly, our analyses found that short sleep duration did not increase the risk of fatigue (OR=1.44, 95% CI= 0.66-3.12) or occupational errors (OR= 1.19, 95% CI= 0.22-6.33) (Table 4).

Table 3. Univariate analyses of sleep duration, demographic, and work characteristics on fatigue, excessive daytime sleepiness, and occupational errors.

Factors	OR	95% CI	*p*-value
Fatigue			
Sleep duration < 7 hr.	2.04	1.01-4.12	.046*
Age ≥ 40	0.49	0.27-0.90	.020*
Married	0.97	0.55-1.71	.910
Divorced	0.91	0.25-3.27	.885
Working hours > 8 hr./day	1.55	0.89-2.67	.120
Working hours > 40 hr./wk.	2.40	1.37-4.22	.002**
Rotating shift	1.70	0.82-3.54	.157
Night shifts > 10/month	1.92	0.94-3.91	.073
Work experience > 20 yr.	0.77	0.39-1.50	.435
Extra breaks during working hours	0.95	0.54-1.66	.843
Excessive daytime sleepiness	4.06	2.27-7.27	.000**
Excessive daytime sleepiness			
Sleep duration < 7 hr.	3.26	1.64-6.48	.001**
Age ≥40	0.54	0.31-0.94	.031*
Married	0.54	0.31-0.95	.032*
Divorced	0.29	0.07-1.13	.074
Working hours > 8 hr./day	2.18	1.27-3.75	.005**
Working hours > 40 hr./wk.	2.09	1.22-3.59	.007**
Rotating shift	2.99	1.44-6.22	.003**
Night shifts > 10/month	1.42	0.70-2.89	.338
Work experience > 20 yr.	0.83	0.44-1.57	.561
Extra breaks during working hours	0.77	0.45-1.33	.347
Fatigue	4.06	2.27-7.27	.000**
Occupational errors			
Sleep duration < 7 hr.	3.81	0.87-16.76	.077
Age ≥40	0.07	0.01-0.56	.010*
Married	0.20	0.06-0.71	.012*
Divorced	0.50	0.06-4.12	.519
Working hours > 8 hr./day	5.95	2.14-16.53	.001**
Working hours > 40 hr./wk.	3.13	1.20-8.19	.020*
Night shifts > 10 /month	2.60	1.03-6.57	.044*
Work experiences > 20 yr.	0.15	0.02-1.11	.063
Extra breaks during working hours	0.73	0.32-1.70	.468
Fatigue	4.25	1.74-10.38	.001*
Excessive daytime sleepiness	4.69	1.67-13.02	.001*

Note: OR = Odds ratio, CI = confidence interval
* $p < .05$, ** $p < .01$

Discussion

Most of the nurses in our study were not able to meet the minimum recommended 7 hours of sleep. When compared to the previous studies using sleep diaries, the mean sleep duration of our sample (6.2 hours) was comparable to that of nurses in the post anesthesia care unit (6.7 hours)[4], but greater than that of night shift nurses in the intensive care unit (5 hours or less)[9]. We recruited nurses from 10 departments, and most of them were from general wards. Therefore, nurses in our study were likely able sleep longer than nurses who worked in intensive care units due to their work schedules. Although previous studies among nursing professionals in Thailand did not assess total nighttime sleep duration, the findings did in-

Table 4. Multivariate logistic regression analyses of short sleep duration on fatigue, excessive daytime sleepiness, and occupational errors after controlling for demographic and work characteristics.

Short sleep duration [a]	Adjusted OR	95% CI	*p*-value
Fatigue	1.44	0.66-3.12	.357
Excessive daytime sleepiness	2.47	1.18-5.19	.017*
Occupational errors	1.19	0.22-6.33	.837

Note: [a] compared with sleep duration <7 hr.
* $p < .05$

dicate an overall low quality of sleep[23,24].

The nurses who contributed to our study experienced fatigue and excessive daytime sleepiness. Our findings are consistent with previous studies conducted in Thailand and in other countries. For instance, Yodchai et al. (2007)[12] found that nurses in the southern region of Thailand had a moderate level of fatigue and a high level of daytime sleepiness. Nurses in the U.S. also reported high levels of fatigue, with mental fatigue exceeding physical fatigue[25]. In a study performed by Geiger-Brown et al. (2012)[13], over one-third of nurses reported a high level of fatigue, with inter-shift fatigue reportedly the most common. The authors also reported that fatigue was a consequence of insufficient sleep between shifts, which has been reported to compromise recovery from physical and cognitive exhaustion.

We found that short sleep duration increased the risk of daytime sleepiness. In our study, nurses who slept less than 7 hours per night were almost 3 times more likely to complain of excessive daytime sleepiness than the reference group. Our literature search did not yield a specific study assessing the link between sleep duration and daytime sleepiness among nurses. However, two previous studies, one among adult Americans[26] and one among Japanese bus drivers, support our finding that the risk of daytime sleepiness increases with short sleep duration (less than 6 hours)[27]. When sleep is restricted on a workday, it can cause a large sleep deficit that can result in sleepiness[28].

In our study, short sleep duration was not associated with the risk of fatigue. Our findings concur with the findings of Barker and Nussbaum (2011)[25] who reported that the duration of nighttime sleep was not associated with mental fatigue. The authors argue that mental fatigue was related to characteristics of the work environment, e. g. shift hours, duration, and total number of working hours per week. Others have reported that in older adults, fatigue is associated with sleep durations of 6 hours or less[29]. In our study, we defined short sleep duration as 7 hours or less. The lack of association between short sleep duration and fatigue in our study may depend on the criteria used to define short sleep duration.

Nurses in our study reported making errors, which were most commonly medication errors, followed by incorrectly performed procedures and needle stick injuries. These errors were also reported by Japanese nurses in a study by Suzuki et al. (2005)[15], with medication errors reported most frequently. However, the findings from our study suggest that short sleep duration did not increase the risk of occupational errors. Our results concur with previous studies among nurses in other countries[9,30], but contrast with one study which reported that decreasing the number of sleep hours increased the number of medication errors[31]. However, this study had failed to report the cutoff value for sleep deficiency.

An explanation is needed to account for the general lack of statistically significant associations between sleep duration and occupational errors in our study. First, due to the small number of occupational errors reported in our study, we may not have achieved the statistical power necessary to detect a statistically significant association. Second, factors other than sleep duration may have accounted for the occupational errors in previous studies. For example, one study reported that mental health problems, night or irregular shift work, and younger age were associated with medication errors[30]. Another study showed that the number of patients under the nurses' care and the nurses' depression scores were related to errors[31]. In addition, work experience may help to account for numbers of errors among nurses. Working in a hospital for 1 year or less was associated with an increased rate of medication errors[32]. Finally, we used 7 hours of sleep as the cutoff value for short sleep duration, while other studies used 6 hours[7,8]. One study indicated that decreased cognitive performance only occurred when 5 to 6 hours of sleep was obtained[33]; therefore, setting the cutoff point for short sleep duration at 7 hours could have reduced the likelihood of occupational errors among the participants in our study.

Some limitations of our study should be acknowledged. We used self-reporting to obtain data on occupational errors, which may have resulted in under-reporting. Future research with objective measurement of occupational errors can likely improve the accuracy of error quantification. In addition, we measured fatigue and excessive daytime sleepiness in general situations. In future studies, it would be beneficial to measure fatigue and daytime sleepiness directly related to work performance. We collected sleep duration data using 1-week sleep diaries, but we did not collect data on the number of shifts during the week when sleep was recorded; therefore, we were not able to conduct statistical analyses focused on work shift. More extensive and comprehensive sleep diary recordings and detailed data collection about work shift variables should be considered for future research.

In summary, fatigue, excessive daytime sleepiness, occupational errors, and sleep duration are important health and work-related issues among nurses. Short sleep duration affects daytime sleepiness in Thai nurses. Although there was no statistically significant association between short sleep duration and fatigue or occupational accidents, nurses with short sleep duration reported fatigue and occupational errors more often than the reference group. Hospitals should establish policies that allow nurses to have enough sleep between their shifts. This may decrease excessive daytime sleepiness, lower fatigue levels, and decrease work errors.

Acknowledgments: The authors would like to thank the study participants for their time and dedication to the study. Special thanks to Dr. Azadeh Stark for comments, suggestions, and editing; and Mr. Jon Mann of the UIC Academic Center for Excellence for editing the manuscript. The research received a grant from Chiang Mai University, Thailand.

Conflicts of interest: None declared.

Contributions: The study was designed by JC, JD, BS, WS, and NI. Data was collected by JC, JD, and NI. Data was analyzed by JC, and JD. Manuscript was written by JC, JD, BS, WS, and NI.

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