

Original article

Effect of using smartphone before bedtime and sleep quality of middle-adulthood officers at Chulalongkorn University

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Background: Nowadays, smartphone has become part of everyday life of the people and tend to be more active continuously. However, it causes many adverse effects, both physically and mentally including potentially resulting in poor sleep quality.

Objective: The aim of this study was to investigate the effect of using smartphone before bedtime and sleep quality among the middle-adulthood university officers at Chulalongkorn University.

Methods: This cross-sectional descriptive study was conducted among middle-adulthood officers at Chulalongkorn University, aged between 45 - 64 years from 5 faculties within the university. The data were collected by using self-reported questionnaires including general characteristics and covariate factors, behavior of smartphone usage before bedtime, suanprung stress test-20 (SPST-20), and Thai version of Pittsburgh Sleep Quality Index (T-PSQI). The sleep quality was presented by number and percentage. The associated factors were analyzed by Chi-square test, Fisher's exact test and the potential predictors of poor sleep quality were analyzed by multivariate logistic regression analysis.

Results: There were 350 participants in this study, 56.0% of them were female with an average age of 49.5 ± 2.9 years old; 23.1% of them had poor sleep quality. The associated factors of poor sleep quality were included male, age > 50 years, the using of psychological pills and sleeping medicine, the using of smartphone before bedtime, light adjustment when using smartphone in a dark room, and light adjustment when using smartphone before bedtime ($P < 0.05$). The predictors of poor sleep quality were gender, age, and light adjustment when using smartphone before bedtime ($P < 0.05$).

Conclusion: Poor sleep quality problems can affect both physical health and work efficiency. Light adjustment when using a smartphone in a dark room and light adjustment when using a smartphone before bedtime has a significant correlation with sleep quality.

Keywords: Sleep quality, smartphone, bedtime, middle-adulthood, PSQI.

Nowadays, the use of smartphones has become an integral part of Thai people's daily Life and is an important factor that meets the basic needs of human beings in the digital age. More than 90.0% of Thai population use internet via smartphone and it was reported that the central region of Thailand has a high proportion of smartphone users which accounted for

56.3% especially in Bangkok over 70.0% of population use smartphones.⁽¹⁾ The recent studies show that smartphone can affect health in various aspects such as sleep quality, level of depression, level of anxiety, brain cognitive function and visual fatigue.^(2,3)

Furthermore, Harvard University conducted an experiment on the effects of blue light and sleep quality. It was reported that blue-light (screen light) can affect melatonin secretion at night more than other light and low level of melatonin can be the cause of poor sleep quality.⁽⁴⁾

Poor sleep quality is an interesting issue that commonly found in middle-adulthood and old age. The most common sleep problems are as these follows:

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delay of sleep onset, difficulty staying asleep, early morning awakening and feeling of being unrefreshed in the morning. According to previous studies, researchers indicated that there are significant changes in sleep during middle-age and old age such as decreased sleep duration, decreased sleep efficiency, and decreased brainwave performance.^(5,6) These factors affect quality of life both physical and mental health. Some studies reported that good sleep quality correlates with improved work performance while inadequate sleep has a great impact on feelings, emotions, and motivations.

In Thailand, the information on sleep quality among middle-adulthood population is still scarce, especially for those who living in city or suburbs areas. Therefore, the objective of this study was to investigate the effect of using smartphone before bedtime on sleep quality among middle-adulthood officers of Chulalongkorn University in order to fulfill the research gap. In addition, the results of this research can be used to identify the prevalence of poor sleep quality in Chulalongkorn University and to guide the policy improvement in quality of life among university officers in the future.

Materials and methods

Sample collections

This study conducted a cross-sectional study which is designed to investigate the prevalence of sleep quality and its associated factors such as demographic characteristics, covariate factors and the use of smartphone before bedtime among the middle-adulthood university officers of Chulalongkorn University, Thailand. Sample size was calculated by using $n = N/1 + Ne^2$ based on the formula of Taro Yamane's calculation with 95% confidence interval⁽⁷⁾, resulting in a calculated sample size (n) of 350.

The inclusion criteria were as follows: 1) Both Thai male and female university officer; 2) Age between 45 - 64 years; 3) Have their own smartphones; 4) Having ≥ 1 year of work experience in Chulalongkorn University; and 5) Willing to participate in the study. The exclusion criteria were as follows: 1) Those who suffer from acute or chronic diseases that cannot participate in this study (e.g. cancer, stroke, kidney failure, etc.); 2) Those who have any condition that would restrict their ability to participate in this study (e.g. hearing loss, deafness,

dumbness and blindness); and 3). Those with the use of psychological medicine which required screening the participants through preliminary interviews before confirming participation in the research.

Sampling technique

The sampling technique of this research was multi-stage sampling technique covered the following process as follows:

Step 1: Chulalongkorn University is purposely selected based on inclusion criteria.

Step 2: Researcher purposely selected 5 study areas at Chulalongkorn University that represent university officers in various fields of study

Step 3: The participants were selected by using probability proportional to size (PPS) sampling, to obtain study sample that represent the middle-adulthood university officer in each study areas.

Step 4: The participants were selected by using convenience sampling technique and must be passed the inclusion criteria before they participated in the research project.

The period of the study was approximately 3 months from March to late-May 2019. This study has been approved by the Ethics Review Committee for Research Involving Human Research Subject, Health Science Group, Chulalongkorn University with reference number 022.2/62. All study participants were informed of the objectives and methods of the present study.

Research instrument

All study participants had to complete 4 parts of self-report questionnaires as follows: 1) General characteristic and sleep covariate factors questionnaires; 2) Behavior of smartphone usage before bedtime questionnaires; 3) Suanprung Stress Test-20 or SPST-20; and 4) Thai version of Pittsburgh Sleep Quality Index or T-PSQI.

General characteristic and sleep covariate factors questionnaires consists of age, gender, religion, level of education, marital status, job positioning, monthly income, work experience, living area, current alcohol and caffeine drinking, smoking behavior, late-night eating behavior, history of medical illnesses and the use of psychiatric medicine (sleep medicine), exercise and overall health status.

Behavior of smartphone usage before bedtime consists of 2 sections as follows: 1) Attitudes and behavior of smartphone usage before bedtime; and 2) The use of application via smartphone and electronic devices before bedtime.

Suanprung Stress Test-20 or SPST-20 developed by Mahatnirunkul S, *et al.* (1997). It contains 20 self-rated questionnaires which will ask about the assessment of stress levels in various events over the past 6 months. The SPST-20 score in each question is divided into 5 levels according to the Likert scales that range from 1 (No Stress) to 5 (Excessive Stress).⁽⁸⁾ There were 4 criteria levels of evaluation as follows:

1. Low level of Stress (5 - 23 points)
2. Moderate Level of Stress (24 - 41 points)
3. High Level of Stress (42 - 61 points)
4. Severe Level of Stress (62 - 100 points)

Thai version of the Pittsburgh Sleep Quality Index or T-PSQI was used to evaluate sleep quality of study participants. It contains 19 self-rated questionnaires that asked about the sleep habit over the past 1 month among study participants and assess 7 various components of sleep quality such as: 1) Subjective sleep quality; 2) Sleep latency; 3) Sleep duration; 4) Habitual sleep efficiency; 5) Sleep disturbance; 6). The use of sleep medication; and 7). Daytime dysfunction by divided the scores in each component into 0 - 3 points.

Therefore, the interpretation of the scores ranged from 0 - 21 points, the cut-off of a global score more than 5 points indicates poor sleep quality.⁽⁹⁾

Statistical analysis

The data were analyzed by using SPSS software version 22.0 (licensed from Chulalongkorn University) for Windows. The sleep quality was presented by frequency and percentage. The associated factors of poor sleep quality were analyzed by Chi-square test and Fisher's exact test. Significant factors from theoretical review were entered into multivariate logistic regression models (Odds ratio: OR and 95% CI) in order to identify the potential predictors of poor sleep quality. Researcher used the backward stepwise (Wald) method to select variables into the equation. Probability for stepwise included entry: 0.05 and removal: 0.10. Data are presented in mean \pm standard deviation (SD). A *P* - value of less than 0.05 was considered as statistically significant.

Results

Characteristics of study participants

There were 350 middle-adulthood study participants with an average age at 49.5 ± 2.9 years. The majority of study participants were female (56.0%), age group between 45 - 50 years old (59.7%), Buddhism (92.6%), married (52.0%), bachelor's degree graduated (66.6%), supporting staffs (90.3%) which most are operational level (73.4%) followed by supervisor level (17.1%) and part-time staffs (0.3%), work experience more than 15 years (39.7%), have monthly income more than 30,000 baht per month (66.3%) and resided in Bangkok and Metropolitan areas (98.9%). Most of the study participants never had alcohol consumption (83.7%), never smoking (88.0%), and never had late-night consumption (62.0%) whereas 61.7% had caffeine consumption. More than one-third of study participants had regular exercise. 18.9% of the study participants had at least one medical illness; the four common medical illnesses in the study group were hypertension, hyperlipidemia, diabetes, and heart disease; moreover, 0.9% of study participants use sleeping medicine to help them sleep. The overall health of the study participants was considered healthy (75.7%). Most of them have moderate stress (98.9%) which is considered normal level it doesn't create violence until causing harm to the body and also makes a person more enthusiastic about their work, personal life, health, and the surrounding environment. The average stress score was 31.1 ± 3.2 score (Min 24, Max 43). The prevalence of poor sleep quality according to T-PSQI was 23.1% and the mean total score was 4.4 ± 0.3 (Table 1). In addition, the researcher analyzed the frequency of PSQI total score of all participants and found that most of the participants have scores in the range of 3 - 5 points, with the most common score being 4 points. While participants with poor sleep quality mostly found scores in the range of 6 - 7 points as shown in Figure 1.

Association between demographic characteristic and sleep quality

The results revealed that the demographic characteristic factor that affect sleep quality with statistical significance was the age group factor ($P < 0.001$). Poor sleep quality was mostly found in the participant's age range between 51 - 55 years which accounts for more than half of the participants with poor sleep quality in this study (Table 2).

Association between covariate factors, stress and sleep quality

In this part, the researcher investigated the association between covariate factors of sleep which included alcohol consumption, caffeine consumption, smoking behavior, late-night consumption, the information of using psychological pill or sleeping

medicine, exercise information, information of underlying disease and stress. The results revealed that using psychological pill or sleeping medicine was statistically associated with sleep quality (Fisher's Exact test = 9.063, $P = 0.0012$). However, other covariate factors and stress were not associated with sleep quality (Table 2).

Table 1. Characteristics of study participants.

Characteristics	N (%) Mean \pm SD	Characteristics	N (%) Mean \pm SD
Gender		Alcohol consumption	
Female	196 (56.0)	No	293 (83.7)
Male	154 (44.0)	Yes	57 (16.3)
Age (years) 49.50 \pm 2.93 Yrs. (Min = 45, Max = 57)		Caffeine consumption	
Religion		No	134 (38.3)
Buddhist	324 (92.6)	Yes	216 (61.7)
Christian	14 (4.0)	Smoking behavior	
Islam	12 (3.4)	No	308 (88.0)
Marital status		Yes	42 (12.0)
Single	163 (46.6)	Late-night consumption behavior	
Married	182 (52.0)	No	217 (62.0)
Divorced	2 (0.5)	Yes	133 (38.0)
Widowed	3 (0.9)	Regular exercise	
Education level		No	219 (62.6)
Secondary school / High school	0 (0.0)	Yes	131 (37.4)
Diploma	12 (3.4)	History of medical illness	
Bachelor's degree	233 (66.6)	No	284 (81.1)
Master's degree	86 (24.6)	Yes	66 (18.9)
Ph.D.'s degree	19 (5.4)	Common medical illness	
Job positioning		Hypertension	64 (18.3)
Academic staff	34 (9.7)	Hyperlipidemia	24 (6.9)
Supporting staff	316 (90.3)	Diabetes	23 (6.6)
Supporting staff Job's role (n = 316)		Heart disease	4 (1.1)
Supervisor level	60 (19.0)	Other	7 (2.0)
Operational level	255 (80.7)	Use of psychological drug and sleep medicine	
Part-time staff	1 (0.3)	No	347 (99.1)
Work experience		Yes	3 (0.9)
> 1 - 5 Yrs.	0 (0.0)	Overall health status	
5 - 10 Yrs.	73 (20.9)	Excellent	265 (75.7)
10 - 15 Yrs.	138 (39.4)	Good	56 (16.0)
15 - 20 Yrs.	139 (39.7)	Fair	29 (8.3)
Monthly income (per month)		Stress (SPST-20)	
20,001 β - 30,000 β	118 (33.7)	Moderate stress	346 (98.9)
\geq 30,001 β	232 (66.3)	High stress	4 (1.1)
Residential area		Sleep quality (T-PSQI)	
Bangkok and Metropolitan areas	346 (98.9)	Good sleep quality	269 (76.9)
Other provinces	4 (1.1)	Poor sleep quality	81 (23.1)
		Mean \pm SD = 4.43 \pm 0.28; Min = 0, Max = 14	

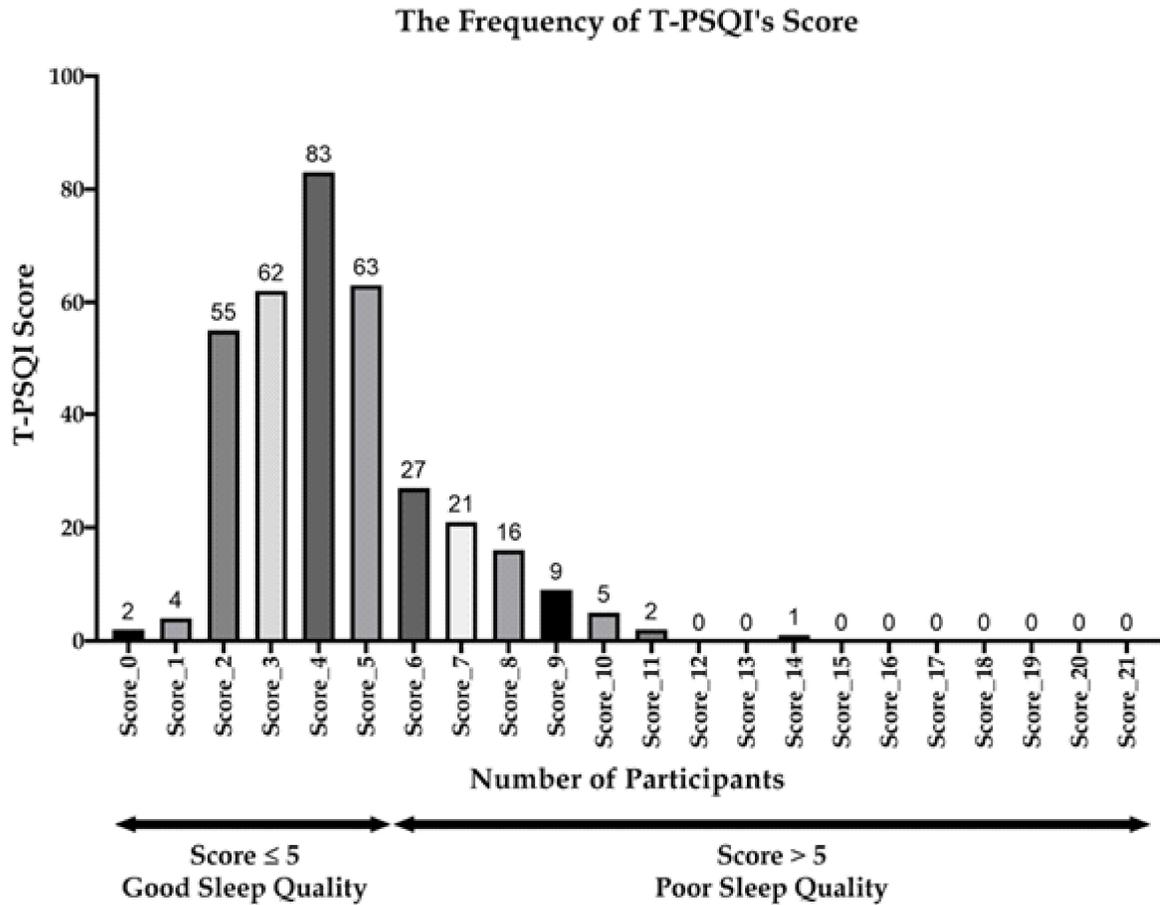


Figure 1. Frequency of Pittsburgh Sleep Quality Index's score.

Table 2. Factors associated with sleep quality.

Variables	Sleep quality				P - value
	Poor sleep quality (n = 81)		Good sleep quality (n = 269)		
	n	%	n	%	
Gender					
Female	38	46.9	158	58.7	0.060
Male	43	53.1	111	41.3	
Age group (years)					< 0.001 ^{a**}
45 - 50 years	34	42.0	175	65.1	
51 - 55 years	46	56.8	90	33.5	
56 - 60 years	1	1.2	4	1.5	
Education level					0.240
Diploma	4	4.9	8	3.0	
Bachelor's degree	50	61.7	183	68.0	
Master's degree	20	24.7	66	24.5	
Ph.D.'s degree	7	8.6	12	4.5	
Marital status					0.445 ^a
Single	121	45.0	42	51.9	
Married	144	53.5	38	46.9	
Divorced	1	0.4	1	1.2	
Widowed	3	1.1	0	0.0	
Job positioning					0.362
Academic staff	9	11.1	25	9.3	
Supporting staff	72	88.9	244	90.7	
Monthly income					0.05
20,001 ฿ - 30,000 ฿	18	22.2	100	37.2	
≥ 30,001 ฿	63	77.8	169	62.8	

Table 2. (Con) Factors associated with sleep quality.

Variables	Sleep quality				P- value
	Poor sleep quality (n = 81)		Good sleep quality (n = 269)		
	n	%	n	%	
Alcohol Consumption					
Never	69	85.2	224	83.3	0.492 ^a
Once in a month	4	4.9	12	4.5	
2 - 3 times per month	6	7.4	26	9.7	
2 - 3 times per week	1	1.2	7	2.6	
Everyday	1	1.2	0	0.0	
Caffeine consumption					
Never	26	32.1	108	40.1	0.161 ^a
1 - 2 cups per day	49	60.5	139	51.7	
≥ 3 cups per day	4	4.9	19	7.1	
Once or Twice in a week	2	2.5	3	1.1	
Smoking behavior					
None	56	69.1	252	93.7	0.321
1 - 2 cigarettes/day	14	17.3	16	5.9	
3 - 4 cigarettes/day	11	13.6	1	0.4	
Late-night consumption					
Never	56	69.1	161	59.9	0.351
Sometimes	16	19.8	62	23.0	
Often	9	11.1	46	17.1	
Use of psychological drug and sleep medicine					
No	78	96.3	269	100	0.0012 ^{**}
Yes	3	3.7	0	0.0	
Regular exercise					
Never	74	91.3	145	53.9	0.252 ^a
Once in a month	2	2.5	0	0.0	
3 - 4 times per week	3	3.7	82	30.5	
Everyday	2	2.5	42	15.6	
History of medical illness					
No	64	79.0	220	81.8	0.74
Yes	17	21.0	49	18.2	
Stress					
Moderate stress	79	97.5	267	99.3	0.653 ^a
High stress	2	2.5	2	0.7	

* $P < 0.05$, ** $P < 0.001$, ^a = Fisher's Exact Test

Association between behavior of using smartphone and sleep quality

There were 7 factors of using smartphone before bedtime which included; Time start of using smartphone before bedtime, duration of using smartphone before bedtime, the frequency of smartphone usage before bedtime, light adjustment when using smartphone in a dark place or in a darkroom, Light adjustment when using smartphone before bedtime, turning on a smartphone during sleep, Duration of using other electronic devices before bedtime. The results of this study found that using smartphone before bedtime (Fisher's Exact

Test = 11.207, $P = 0.005$), light adjustment when using smartphone in a dark room ($\chi^2 = 6.182$, $P = 0.013$), and light adjustment when using smartphone before bedtime ($\chi^2 = 6.584$, $P = 0.010$) were significantly associated with sleep quality ($P < 0.05$) (Table 3).

Potential predictors of poor sleep quality

Multivariate logistic regression analysis found 3 factors that were statistically significant predictors for poor sleep quality among middle-adulthood university officer of Chulalongkorn University, namely; gender, age and light adjustment when using smartphone before bedtime ($P < 0.05$) (Table 4).

Table 3. The association between behaviors of smartphone usage before bedtime and sleep quality.

Behaviors of smartphone usage before bedtime	Sleep quality				P - value
	Poor sleep quality (n = 81)		Good sleep quality (n = 269)		
	N	%	N	%	
Using smartphone before bedtime (n = 350)					
Yes	81	100.0	266	98.8	0.005*
No	0	0.0	3	1.2	
Time start of using smartphone before bedtime (n = 347)					
	Poor sleep quality (n = 78)		Good sleep quality (n = 269)		0.08
8 pm.	3	3.8	20	7.4	
9 pm.	24	30.8	96	35.7	
10 pm.	25	32.1	102	37.9	
11 pm.	26	33.3	43	16.0	
12 am. (midnight)	0	0.0	8	3.0	
Duration of using smartphone before bedtime (n = 347)					
> 30 min	28	35.9	77	28.6	0.628
30 min - 1 hr.	43	55.1	153	56.9	
1 - 3 hrs.	7	9.0	39	14.5	
The frequency of smartphone usage before bedtime					
3 - 4 times/week	6	7.7	46	17.1	0.686
Everyday	72	92.3	223	82.9	
Light adjustment when using smartphone in a dark place or in a darkroom					
Yes	54	69.2	209	77.7	0.013*
No	24	30.8	60	22.3	
Light adjustment when using smartphone before bedtime					
Yes	54	69.2	210	78.1	0.01*
No	24	30.8	59	21.9	
Turning on a smartphone during sleep					
Always close before sleep	12	15.4	36	13.4	0.544
Sometimes	2	2.6	24	8.9	
Open everyday	64	82.1	209	77.7	

* $P < 0.05$, ** $P < 0.001$, ^a = Fisher's Exact Test

Table 4. Stepwise multivariate logistic regression analysis.

Variables	Adjusted OR	95% CI of Adjusted OR		P - value
		Lower	Upper	
		Gender	1.708	
Age	2.984	1.826	4.875	< 0.001**
Light adjustment when using smartphone before bedtime	2.241	1.279	3.929	0.005*

* $P < 0.05$, ** $P < 0.001$

Discussion

In this study, after the analysis of Pittsburgh Sleep Quality Index Thai version or T-PSQI the researcher found that the prevalence of poor sleep quality among study participants was 23.1% and there were 3 factors that significantly associated with poor sleep quality which included using smartphone before bedtime, light adjustment when using smartphone in a dark room and light adjustment when using smartphone before bedtime. These results are consistent with previous international studies conducted in adults and adolescents.^(10, 11) In particular, this study also confirms the results of an experiment conducted by Harvard University on the effects of blue light and sleep quality which was reported that blue-light (screen light) can affect melatonin secretion at night more than other light and low level of melatonin secretion can be the cause of poor sleep quality.⁽⁴⁾

As for the association between demographic characteristics and sleep quality, the researcher found that poor sleep quality is more common in the age range of 51 - 55 years which is consistent with previous study in Finland indicated that sleep quality and sleep duration are progressively declined as the age increases.⁽¹²⁾ However, this study found that middle-adulthood males are more likely to have poor sleep quality than females which is surprising because previous studies among adult and elderly group often indicates that older women tend to experience insomnia and have more problems with poor sleep quality than men due to hormonal change from menopausal conditions.^(13 - 16) Therefore in further study, it is necessary to find out more information about workplace stress factors, family conditions and menopausal factors that change sex hormone function to investigate an additional factor of poor sleep quality between gender more.

As for the association between covariate factors, stress and sleep quality, the results showed that only using psychological pills and sleeping medicine was significantly associated with sleep quality while other covariate factors and stress were not associated with sleep quality. These findings are not consistent with a previous studies. The researcher would like to cite a recent research in China that studies on the association between occupational stress and sleep quality among worker group, the results revealed that occupational stress and depression can cause poor sleep quality.^(17, 18) Several studies indicated that the motivation of drinking alcohol was positively correlated with poor mental health (including stress, anxiety,

and depression) and leads to problem with poor sleep quality^(3, 19 - 21) and exercise had a statistically significant effect on sleep quality and can improve health outcomes for people living with mental illnesses.^(22, 23) For additional studies, the researcher should use individual interviews or qualitative research to see clearer results and should conducted a study on the association between depression factors and sleep quality.

According to a-2014 study revealed that using a smartphone at bedtime may cause sleep disturbances and negatively effect of productivity of employees in the next day which corresponds to the results of this study.⁽²⁴⁾ Therefore, the benefits of this study contribute to raising awareness on this issue and for improving the quality of life and improving the work efficiency of university officers at Chulalongkorn University and elsewhere.

Conclusion

According to the results of this study, the outcome revealed that smartphone light adjustment associated with sleep quality whether in the dark room or while in use before going to bed. Therefore, in the further study, researcher should study the association between the lengths of time-stop using smartphone before going to bed and sleep quality in order to confirm the hypothesis about the blue light from smartphone can effect sleep quality more clearly. In addition, almost every participant in the study uses a smartphone before going to bed, so we couldn't see an obvious difference between smartphone users before going to bed and those who don't use it before going to bed. With this reason, in the next study researcher should divide comparison group between study participants who use smartphone before bedtime and study participants who do not use smartphone before bedtime in order to see the exact conclusion of the effects of using smartphone before bedtime on sleep quality.

However, this study may not be representative of all middle-adulthood in Thailand because of the sample size in this study is small. For further study the researcher need to increase the generalizability of the study by increasing the sample size and expanding the study area.

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Conflict of interest

The authors, hereby, declare no conflict of interest.

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