A Study of Relationship between Sleep Quality and Academic Performance

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I. Abstract

The objective of this research is to investigate and explore the relationship between sleep quality and academic performance of students in CUHK(SZ). Based on 91 received questionnaires of self-reported GPA and PSQI index, our finding is that PSQI score has positive correlation with higher GPA, and negative correlation with lower GPA. Among seven components in PSQI index system, subjective attitudes towards sleep quality are found to have most significant impact on self-reported GPA.

II. Introduction

Reports in recent years indicate that high school and college students are facing a perceptible decrease on their average sleep qualities and sleep duration (Soong & Gau, 1995; Wolfson & Carskadon, 1998; Larberge, Petit, Simard, Vitaro, Tremblay & Montplaisir, 2001), and it can be verified by observations and interviews of self-behavior from students in CUHK(SZ). With physiological research showing that both sleep qualities and sleep duration are correlated with one's cognitive functions (Paavonen et al, 2010; Nebes, Buysse, Halligan, Houch & Monk, 2009), a reasonable hypothesis can be proposed that the effect of sleep qualities and sleep duration might also intermediately affect one's academic performance by affecting the cognitive functions.

A supporting report proposed by a study group from Netherlands claimed that, sleep qualities and sleep duration have slight but affect on students' academic performance (Dewald, Meijer, Oort, Kerkhof, & Bogels, 2010). Concluded from their report and previous reports they referred to, the common and unavoidable problem in the research is lack of appropriate approaches to measure the real academic performance of the respondents. Principally previous researchers applied self-reported GPA and parent-reported GPA in their research to represent the academic performance, which would explicitly cause publication bias while respondents concerning about the potential privacy leak. For purpose of hedging the subjective bias, even though in our research the adopted approach is still subject-reported GPA, cross-validation section was designed and performed. If the cross-validation can support the result based on subject-reported GPA, the impact of publication bias would be reduced.

Research principally focuses on the correlation between sleep qualities and academic performance, and therefore the questions to investigate are

- The relationship between sleep qualities and academic performance
- The respective relationship between academic performance and each factors of sleep qualities

III. Methodologies

A. Measurements of Sleep Quality

The Pittsburgh Sleep Quality Index (PSQI) was used to scientifically and quantitively measure the sleep qualities of respondents, which contains 19 self-rated questions. Questionnaire is divided into 7 components which represents distinct factors of sleep qualities. The score is added up to 21 (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989).

B. Measurements of Academic Performance

1) Self-reported GPA: A questionnaire including PSQI questions and GPA information was posted online and published for 2 weeks.

2) In-class evaluation in MAT2040 Lecture: Since every two week there is an in-class evaluation in Linear Algebra lecture this semester, that students will be asked to answer one question relative to lecture and assignments. Under the permission of teaching stuffs questionnaires on PSQI were handed out and collected together with their submitted quiz. The objective of evolving in-class evaluation in the research is to cross-validate the conclusions inferred by the first method, which will eventually contribute to a stronger conclusion.

C. Correlation Analysis

Statistical correlation analysis was applied in analyzing the collected data. The procedure of correlation analysis is to calculate the correlation coefficients of two variables, self-reported GPA and PSQI score, using the formula

$$\rho = \frac{E[(X-\mu_x)(Y-\mu_y)]}{\sigma_x \sigma_y}$$

The correlation is represented by the correlation coefficient ρ, which has a range of $-1 \leq \rho \leq 1$, where positive ρ indicates positive correlation and negative ρ indicates negative correlation. Closer the absolute value of ρ to 1 corresponds to a stronger correlation between two variables(Hogg, Tanis, & Zimmerman, 2010).

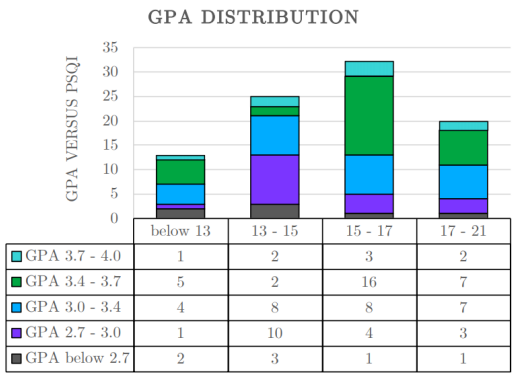
D. Participants

Our research was performed in The Chinese University of Hong Kong, Shenzhen, a young university in southern China. Different from majority of universities in mainland China, CUHK(SZ) inherits the education and evaluation system from CUHK. The study fee in CUHK(SZ) is 98500 CNY per year according to official announcement.

IV. Results

A. Received Data

1) Self-reported GPA and PSQI: From November 22nd to December 4th, a questionnaire covering self-reported GPA and PSQI questions was posted online, and 117 students in CUHK(SZ) participated in the research with 91 answer sheets being eventually received. Collected and clustered data are shown as Figure 1.



	below 13	13 - 15	15 - 17	17 - 21
GPA 3.7 - 4.0	1	2	3	2
GPA 3.4 - 3.7	5	2	16	7
GPA 3.0 - 3.4	4	8	8	7
GPA 2.7 - 3.0	1	10	4	3
GPA below 2.7	2	3	1	1

Fig. 1. Statistics of Self-reported GPA and PSQI

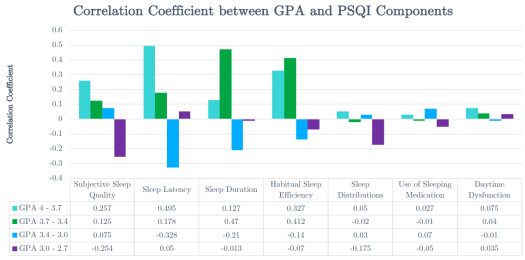
From Figure 1 it can be observed that when the PSQI score increases, there is a significant growth in the proportion of GPA interval 3.4 - 3.7 and 3.7 - 4.0, and also a notable decrease in the proportion of GPA interval 2.7 - 3.0. In order to look deep into the correlation of two variables, we then performed correlation analysis based on 91 received questionnaires.

After calculating the correlation coefficients for each GPA interval a table was obtained as Figure 2. From Figure 2 the PSQI score is found to be positively correlated with the proportion of higher self-reported GPA and negatively correlated with the proportion of lower self-reported GPA.

GPA Interval	4.0 – 3.7	3.7 – 3.4	3.4 – 3.0	3.0 – 2.7
Correlation Coefficient	0.4685	0.2717	-0.4646	-0.2607

Fig. 2. Calculation of Correlation Coefficients between PSQI and Self-reported GPA

In order to look deep into the correlation we then performed correlation analysis between each distinct components of PSQI and self-reported GPA. Figure 3 shows the correlation coefficient of self-reported GPA and each distinct component of PSQI.



	Subjective Sleep Quality	Sleep Latency	Sleep Duration	Habitual Sleep Efficiency	Sleep Distributions	Use of Sleeping Medication	Daytime Dysfunction
GPA 4 - 3.7	0.257	0.495	0.127	0.327	0.05	0.027	0.075
GPA 3.7 - 3.4	0.125	0.178	0.47	0.412	-0.02	-0.01	0.04
GPA 3.4 - 3.0	0.075	-0.328	-0.21	-0.14	0.03	0.07	-0.01
GPA 3.0 - 2.7	-0.254	0.05	-0.013	-0.07	-0.175	-0.05	0.035

Fig. 3. Calculation of Correlation Coefficients between PSQI Components and Self-reported GPA

2) Corrigendum of Linear Algebra Quiz and PSQI: In November 27th, we handed out PSQI questionnaires in MAT-2040 in-class evaluation and the collected result are shown as Figure 4. From Figure 4 we can conclude that the rate of wrong submission decreases when PSQI score increases.

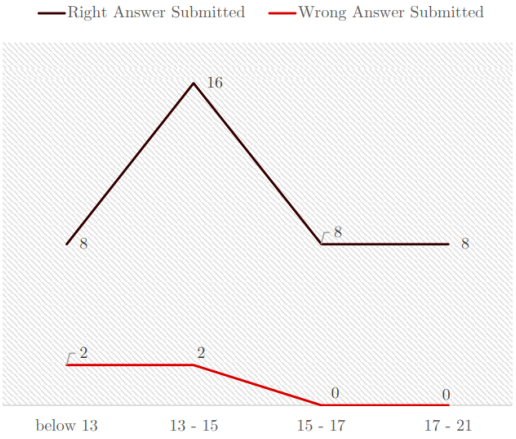


Fig. 4. Statistics of In-class Evaluation Corrigendum and PSQI

V. Discussion

The objective of this research is to investigate the relationship between sleep qualities and academic performance. Different from previous researches a cross-validation was engaged in our research, which aimed to enhance the reliability and credibility of our result.

Based on the result from self-reported GPA and PSQI questions high overall sleep qualities are found to enhance students academic performance while poor sleep qualities turn to reduce students' academic performance. This finding supports the hypothesis proposed before the research that self sleep qualities have influences on self academic performance. Conclusion can also be cross-validated by Figure 4 that when PSQI score increases the proportion of wrong submissions in in-class evaluation decreases.

To further explore the implicit factors which play key roles in affecting academic performance, we then performed correlation analysis among each distinct component of PSQI and self-reported GPA. The graph shows that sleep latency is the most significant factor to the academic performance

of students in GPA interval 3.7 - 4.0 and interval 3.0 - 3.4, while students in GPA interval 3.4 - 3.7 are affected by sleep duration most. Also, the majority of students in interval 2.7 - 3.0 are unsatisfied with their current sleep quality. Among the seven components in PSQI questionnaire psychological factors are found to have stronger influences to students' academic performance compared with the influences physiological factors have to students' academic performance.

After analyzing received result, we can propose our explanation to the previous discoveries. First, sleep duration have the least impact to students who obtained higher GPA, and the majority of students who obtained higher GPA are subjectively satisfied with their sleep quality. Compared with a catholic unsatisfactory among students who obtained lower GPA to their sleep quality, we hold that subjective attitudes towards self sleep quality are vital factors to self academic performance. Second, students who have higher GPA turn to have less difficulties in keeping a reasonable rest schedule, and easier to fell into sleep, either. A possible reason is controllable lifestyle might help them maintain a suitable and reasonable study plan, and also contribute to a relaxed mood in studying.

Even though a valid conclusion was obtained from the research we designed, limitations and shortcomings of our research still appeared. First, the correlation analysis is over concentrate on the psychological and physiological factors which makes our research not practical and general enough. Second, an advanced research is necessary to enroll cognitive functions into correlation analysis as an intermediate role like the way our hypothesis proposed. Last, as a cross-validation in our research, proofs on the relationship between math score and overall academic performance are implicit and insufficient.

VI. Conclusion

In this research we tried to explore the relationship between sleep qualities and academic performance. We applied a scientific and quantitive index PSQI to measure the sleep quality of respondents, and self-reported GPA was utilized to represent the academic performance of respondents. Also, a cross-validate section was performed to verify the conclusion. Although there are limitations and shortcomings in our research, we discovered and concluded that sleep quality is positively related to academic performance and positive attitudes towards one's sleep quality are important factors contributing to excellent academic performance. By showing the correlation between sleep quality and academic performance we hope our research can help college students in CUHK(SZ) notice the importance of sleep quality and maintain a reasonable and balanced rest schedule.

VII. Bibliography

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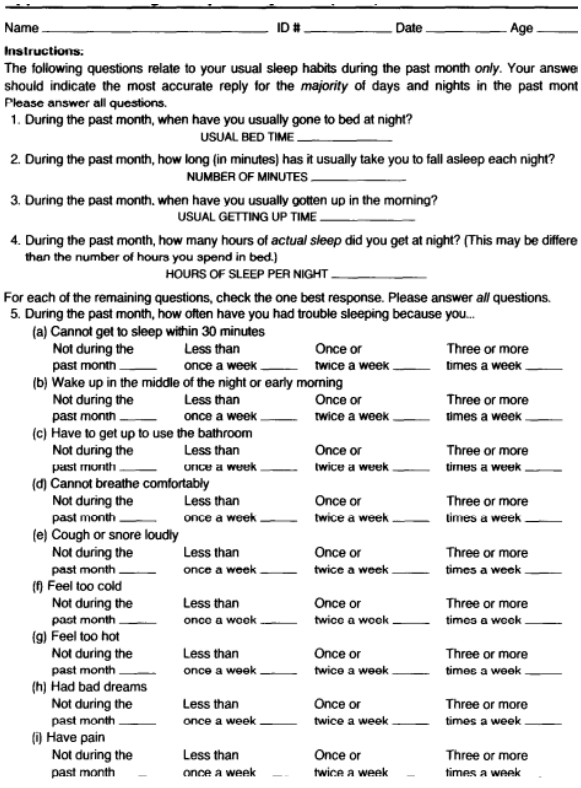
Appendix

Sample Questionnaire of PSQI (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989)



Name _____ ID # _____ Date _____ Age _____

Instructions:

The following questions relate to your usual sleep habits during the past month *only*. Your answe should indicate the most accurate reply for the *majority* of days and nights in the past mont Please answer all questions.

1. During the past month, when have you usually gone to bed at night?
   USUAL BED TIME _____
2. During the past month, how long (in minutes) has it usually take you to fall asleep each night?
   NUMBER OF MINUTES _____
3. During the past month, when have you usually gotten up in the morning?
   USUAL GETTING UP TIME _____
4. During the past month, how many hours of *actual sleep* did you get at night? (This may be differe than the number of hours you spend in bed.)
   HOURS OF SLEEP PER NIGHT _____

For each of the remaining questions, check the one best response. Please answer *all* questions.

5. During the past month, how often have you had trouble sleeping because you...

(a) Cannot get to sleep within 30 minutes				
	Not during the past month ____	Less than once a week ____	Once or twice a week ____	Three or more times a week ____
(b) Wake up in the middle of the night or early morning				
	Not during the past month ____	Less than once a week ____	Once or twice a week ____	Three or more times a week ____
(c) Have to get up to use the bathroom				
	Not during the past month ____	Less than once a week ____	Once or twice a week ____	Three or more times a week ____
(d) Cannot breathe comfortably				
	Not during the past month ____	Less than once a week ____	Once or twice a week ____	Three or more times a week ____
(e) Cough or snore loudly				
	Not during the past month ____	Less than once a week ____	Once or twice a week ____	Three or more times a week ____
(f) Feel too cold				
	Not during the past month ____	Less than once a week ____	Once or twice a week ____	Three or more times a week ____
(g) Feel too hot				
	Not during the past month ____	Less than once a week ____	Once or twice a week ____	Three or more times a week ____
(h) Had bad dreams				
	Not during the past month ____	Less than once a week ____	Once or twice a week ____	Three or more times a week ____
(i) Have pain				
	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week

(j) Other reason(s), please describe _____

How often during the past month have you had trouble sleeping because of this?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
_____	_____	_____	_____

6. During the past month, how would you rate your sleep quality overall?
   - Very good _____
   - Fairly good _____
   - Fairly bad _____
   - Very bad _____
7. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
_____	_____	_____	_____

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
_____	_____	_____	_____

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?
   - No problem at all _____
   - Only a very slight problem _____
   - Somewhat of a problem _____
   - A very big problem _____
10. Do you have a bed partner or roommate?
    - No bed partner or roommate _____
    - Partner/roommate in other room _____
    - Partner in same room, but not same bed _____
    - Partner in same bed _____

If you have a roommate or bed partner, ask him/her how often in the past month you have had...

(a) Loud snoring

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
_____	_____	_____	_____

(b) Long pauses between breaths while asleep

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
_____	_____	_____	_____

(c) Legs twitching or jerking while you sleep

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
_____	_____	_____	_____

(d) Episodes of disorientation or confusion during sleep

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
_____	_____	_____	_____

(e) Other restlessness while you sleep; please describe

_____

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
_____	_____	_____	_____

Scoring Instructions for the Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) contains 19 self-rated questions and 5 questions rated by the bed partner or roommate (if one is available). Only self-rated questions are included in the scoring. The 19 self-rated items are combined to form seven "component" scores, each of which has a range of 0-3 points. In all cases, a score of "0" indicates no difficulty, while a score of "3" indicates severe difficulty. The seven component scores are then added to yield one "global" score, with a range of 0-21 points, "0" indicating no difficulty and "21" indicating severe difficulties in all areas.

Scoring proceeds as follows:

Component 1: Subjective sleep quality

Examine question #6, and assign scores as follows:

Response	Component 1 score
"Very good"	0
"Fairly good"	1
"Fairly bad"	2
"Very bad"	3

Component 1 score: _____

Component 2: Sleep latency

1. Examine question #2, and assign scores as follows:

Response	Score
≤ 15 minutes	0
16-30 minutes	1
31-60 minutes	2
> 60 minutes	3

Question #2 score: _____

2. Examine question #5a, and assign scores as follows:

Response	Score
Not during the past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

Question #5a score: _____

3. Add #2 score and #5a score

Sum of #2 and #5a: _____

4. Assign component 2 score as follows:

Sum of #2 and #5a	Component 2 score
0	0
1-2	1
3-4	2
5-6	3

Component 2 score: _____

Component 3: Sleep duration

Examine question #4, and assign scores as follows:

Response	Component 3 score
> 7 hours	0
6-7 hours	1
5-6 hours	2
< 5 hours	3

Component 3 score: _____

Component 4: Habitual sleep efficiency

(1) Write the number of hours slept (question # 4) here: _____

(2) Calculate the number of hours spent in bed:

Getting up time (question # 3): _____

− Bedtime (question # 1): _____

Number of hours spent in bed: _____

(3) Calculate habitual sleep efficiency as follows:

(Number of hours slept/Number of hours spent in bed) × 100 = Habitual sleep efficiency (%)

(_____/_____) × 100 = _____%

(4) Assign component 4 score as follows:

Habitual sleep efficiency %	Component 4 score
> 85%	0
75-84%	1
65-74%	2
< 65%	3

Component 4 score: _____

Component 5: Sleep disturbances

(1) Examine questions # 5b-5j, and assign scores for *each* question as follows:

Response	Score
Not during the past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

#5b score _____
c score _____
d score _____
e score _____
f score _____
g score _____
h score _____
i score _____
j score _____

(2) Add the scores for questions # 5b-5j:

Sum of # 5b-5j: _____

(3) Assign component 5 score as follows:

Sum of # 5b-5j	Component 5 score
0	0
1-9	1
10-18	2
19-27	3

Component 5 score: _____

Component 6: Use of sleeping medication

Examine question # 7 and assign scores as follows:

Response	Component 6 score
Not during the past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

Component 6 score: _____

Component 7: Daytime dysfunction

(1) Examine question # 8, and assign scores as follows:

Response	Score
Never	0
Once or twice	1
Once or twice each week	2
Three or more times each week	3

Question # 8 score: _____

(2) Examine question # 9, and assign scores as follows:

Response	Score
No problem at all	0
Only a very slight problem	1
Somewhat of a problem	2
A very big problem	3

Question # 9 score: _____

(3) Add the scores for question # 8 and # 9:

Sum of #8 and #9: _____

(4) Assign component 7 score as follows:

Sum of # 8 and #9	Component 7 score
0	0
1-2	1
3-4	2
5-6	3

Component 7 score: _____

Global PSQI Score

Add the seven component scores together:

Global PSQI Score: _____