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Master's Thesis

Identification of latent classes of sleep hygiene
in university using latent class analysis

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2022

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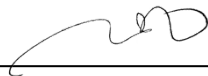
Identification of latent classes of sleep hygiene in university using latent class analysis

A thesis/dissertation submitted to
Ulsan National Institute of Science and Technology
in partial fulfillment of the
requirements for the degree of
Master of Science

Jiwoo Lim

12.22.2021 of submission

Approved by



Advisor

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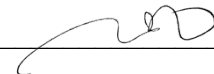
Identification of latent classes of sleep hygiene in university using latent class analysis

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Abstract

The present study utilized a Latent Class Analysis (LCA) to investigate the various profiles of sleep hygiene in university. In addition, this study explores the differences in sleep quality, emotional and college-life related variables in various sleep hygiene profiles. Undergraduate and graduate students of UNIST in Korea were administered self-report measures on sleep hygiene, sleep quality, emotional (depression, anxiety, and stress), and college-life (life satisfaction, attention deficit, perfectionism, procrastination, and alcoholism) related variables. A total of 476 respondents were used for analysis. To achieve the objectives of this study, the analysis is divided into Part 1 and Part 2. Part 1 identifies the latent classes according to levels of 8 sleep hygiene subscales. Part 2 identifies the latent classes of sleep hygiene in each of the three sub-groups divided by the level of sleep quality. Consequently, first, as a result of classifying latent classes according to the levels of 8 subscales of sleep hygiene, three heterogeneous classes were derived (Good CESH, Middle CESH, and Bad CESH). It was confirmed that they differ according to the relative average score of cognitive/emotional and sleep stability factors. In addition, the identified latent classes were significantly divided into upper, middle, and lower levels in terms of sleep quality and emotional related variables. Second, as a result of classifying the latent classes of sleep hygiene divided according to the level of sleep quality, two heterogeneous classes were derived from the GSQ group (Good SEDH and Bad SEDH) and three heterogeneous classes from the MSQ group (Bad STH, Good STH, and CPH) and BSQ group (Good CESH, Bad STH, and Bad SEDH). Through the eight latent classes classified in this way, it was confirmed that the subscales of sleep hygiene that suffer problems even if they are at the same sleep quality level were different. In addition, even if the sleep quality is poor, the type of sleep hygiene showing a good level has been confirmed. Also, they showed differences in emotional and college-life related variables. Various profiles identified through the 8 subscales of sleep hygiene were able to identify the strengths and weaknesses of each type, and other characteristics in emotional and college life-related factors could be examined. Via this, it is possible to propose discriminatory and effective interventions for each type and is expected that it will be of great help to future research by providing various information on sleep hygiene.

Contents

I. Introduction.....	1
II. Related Works.....	4
III. Method.....	6
3.1 Participants and procedure.....	6
3.2 Measurements.....	7
3.3 Statistical analysis.....	10
IV. Results.....	12
4.1 Descriptive statistics.....	12
4.2 Part 1: Types of sleep hygiene for the whole.....	13
4.2.1 Model selection.....	13
4.2.2 Latent classes on sleep hygiene.....	14
4.2.3 Characteristics between latent classes.....	18
4.3 Part 2: Types of sleep hygiene according to sleep quality level.....	19
4.3.1 Sub-groups divided according to the sleep quality level.....	19
4.3.2 Model selection.....	20
4.3.3 Latent classes identified within each sub-group.....	23
4.3.4 Characteristics between latent classes within each sub-group.....	33
V. Discussion.....	36
Reference.....	40
Acknowledgement.....	44
Appendix.....	45

List of Figures

Figure 1. Overall research flow.....	6
Figure 2. Latent Class Analysis (LCA) model.....	11
Figure 3. Radial graph of the item-response probability for each response	15
Figure 4. Radial graph of the item-response probability for each response in Good sleep quality group	25
Figure 5. Radial graph of the item-response probability for each response in Middle sleep quality group	28
Figure 6. Radial graph of the item-response probability for each response in Bad sleep quality group	30

List of Table

Table 1. Demographics.....	7
Table 2. Descriptive statistics of sleep hygiene subscales	8
Table 3. Descriptive statistics of variables.....	12
Table 4. Correlation between 8 subscales of sleep hygiene	13
Table 5. Fit statistics of latent class model.....	13
Table 6. Estimated item-response probabilities by latent class membership	16
Table 7. Sleep hygiene subscales between latent classes.....	18
Table 8. Descriptive statistics between three latent types in whole	18
Table 9. Descriptive statistics of sleep quality and sleep hygiene in three sub-groups	20
Table 10. Fit statistics of latent class model in Good sleep quality (GSQ) group	20
Table 11. Fit statistics of latent class model in Middle sleep quality (MSQ) group	21
Table 12. Fit statistics of latent class model in Bad sleep quality (BSQ) group	22
Table 13. Estimated item-response probabilities by latent class membership in Good sleep quality group	24
Table 14. Sleep hygiene subscales between latent classes in Good sleep quality group	25
Table 15. Estimated item-response probabilities by latent class membership in Middle sleep quality group	27
Table 16. Sleep hygiene subscales between latent classes in Middle sleep quality group.....	28
Table 17. Estimated item-response probabilities by latent class membership in Bad sleep quality group	30
Table 18. Sleep hygiene subscales between latent classes in Bad sleep quality group.....	32
Table 19. Descriptive statistics between two latent types in Good sleep quality group	33
Table 20. Descriptive statistics between two latent types in Middle sleep quality group.....	34
Table 21. Descriptive statistics between two latent types in Bad sleep quality group.....	35

I. Introduction

The younger generation is prone to extreme stress due to college entrance exams, military enlistment, and employment, and is the group most sensitive to socioeconomic changes. These young people have relatively better health levels than other generations, but instability and stress in mental health have begun to increase every year. According to (김동겸, 2021), the increase in people in their 20s was the largest among those who received "Mental and Behavioral Disorders" treatment in the last 5 years (2015-2019), with a growth rate of about 12.1% for male and about 13.6% for female. In addition, because of examining the ranking of frequent mental illness by age, those in their 20s had a high incidence of depression and anxiety disorders, and non-organic sleep disorders and adaptation disorders to severe stress were also at the top.

Non-organic sleep disorders, which appear in the top 4 of mental illnesses that occur in their 20s, refer to mental sleep disorders, not physical causes. These sleep disorders were found to be related not only to individual internal problems such as depression and anxiety, but also to external problems such as academic achievement, concentration, and lifestyle (Taylor et al., 2003; Carney et al., 2006; Pilcher & Walters, 1997). According to previous researches, it was reported that sleep disorders are closely related to depression, and most of those with suicidal thoughts have sleep problems (Thase, 2006; Becker et al., 2018; Verlander et al., 1999; 황은희 et al., 2016). In addition, lack of sleep and sleep disorders reduce students' academic achievement, cognition, and concentration (Curcio et al., 2006; Pilcher & Walters, 1997; Ravid et al., 2009). Some research confirmed that sleep is also related to smoking, drinking, and caffeine intake (Carole et al., 1981; Conroy & Arnedt, 2014). As such, sleep problems are a key factor that shows a strong relationship with other mental health and problems, so the sleep problem of the younger generation is a very important discussion point. Hence, this present study decided to focus on the sleep problem of the younger generation, and the university students were examined as a representative of them.

Within the sleep literatures dealing with university students, most approached sleep problems through investigations such as sleep quality, daytime drowsiness, the severity of insomnia, and sleep time. However, the factors that cause sleep problems lie in habits related to sleep, and this concept is called "*Sleep Hygiene*". Sleep hygiene refers to various lifestyles, behaviors, and environmental factors that can affect the length and quality of sleep, including various categories such as sleep schedule, physical/mental activity, food or substance, and sleep environment (Lacks & Rotert, 1986). In effect, this sleep hygiene is related to the practice of healthy sleep talked about by the Korean Society of Sleep Medicine, and in addition, advice related to sleep hygiene is also dealt with at the treatment site of patients suffering from sleep disorders (대한수면학회, 2021; Stepanski & Wyatt, 2003; Brick et al.,

2010). For instance, (Tan et al., 2012) reported sleep improvement in children and adolescents after intervention by sleep hygiene education. The researchers found that sleep hygiene is a preventive and therapeutic factor leading to healthy sleep in terms of cognitive/behavioral aspects. Although poor sleep hygiene is not the only factor causing sleep problems, there have been several studies showing that sleep quality and satisfaction are lowered (Carney et al., 2006; LeBourgeois et al., 2005; Kabrita et al., 2014). Most sleep researchers and previous studies said that it is important to follow sleep hygiene rules as a long-term treatment to alleviate sleep disorders (Irish et al., 2015; Brick et al., 2010; Buboltz Jr et al., 2001; Kim & Kim, 2013). That is, it is necessary to approach sleep problems in terms of sleep hygiene.

The university students live irregular lifestyles and stay up all night due to their studies and show various spectra characteristics by their high autonomy and independence in terms of behavior such as alcohol and tobacco. In addition, they have a variety of sleep environments such as a dormitory in a shared room, single-person housing. One study emphasized the need for sleep hygiene education to improve the sleep of university students (Brown et al., 2002). In this context, considering the characteristics and environment of these university students, their sleep problems require an approach from the perspective of sleep hygiene. Then, it seems important to evaluate individuals' specific situations and identify behaviors that are most likely to cause sleep problems. To this end, the identification of the different profiles of sleep hygiene would go a long way in making sense of this individuals' heterogeneity.

One effective way to identify different profiles of sleep hygiene is with the use of Latent Class Analysis (LCA). LCA is a useful statistical method for investigating the structure of heterogeneous diagnostic entities and systematically describing their latent classes. LCA is known to be suitable for grasping the multidimensional characteristics of human behavior, and in terms of intervention development and application, it is possible to confirm the discriminatory intervention effect according to the characteristics of the intervention participant (Lanza & Rhoades, 2013; Laursen & Hoff, 2006). These LCA has been commonly used to test subtypes of mental disorders such as anxiety, depression and schizophrenia (Wadsworth et al., 2001; Mannarini & Boffo, 2015).

Hence, the present study aims to identify the patterns of latent classes divided by conducting LCA with using responses to sleep hygiene in university. The identified latent classes were confirmed characteristics into 8 sleep hygiene subscales. Then, they were examined whether these latent classes differ not only in emotional aspects such as depression, anxiety, and stress, but also in characteristics that can be easily seen in college-life such as attention deficit, perfectionism, and procrastination. Through this, it aims to examine a variety of information on sleep hygiene for providing discriminatory therapeutic interventions. In addition, this study was explored two aspects of sleep quality and sleep hygiene together, considering the general approach which uses sleep quality to sleep problems. The

specific research questions to achieve this research purpose are as follows.

Research Question 1. Is the group classified according to the level of sleep hygiene in university?
How do the characteristics of the divided groups appear?

Research Question 2. How are the groups of sleep hygiene classified according to the level of sleep quality in university? How do the characteristics of the divided groups appear?

II. Related Works

Within the sleep literature, several studies that clusters sleep problems in the general population were examined.

(Leigh et al., 2016) measured sleep problems through the Nottingham Health Profile (NHP) Sleep Subscale consisting of four questions in a cohort of women aged 70 to 75 years old: *Do you wake in the early hours of the morning?*, *Do you lie awake most of the night?*, *Do you take a long time to get to sleep?*, *Do you sleep badly at night?*. Subsequently, they identified four latent subgroups indicating sleep disorders using repeated measures Latent Class Analysis (RMLCA). The four subgroups observed were *"Troubled sleepers (16.5%)"* which were a high probability of sleep disorders, *"Untroubled sleepers (32.1%)"* whose likelihood of sleep disorders decreases over time, *"Early wakers (28.8%)"* with a high probability of waking up early in the morning, and *"Trouble falling asleep (16.5%)"* who were likely to take a long time to fall asleep. This research showed that many elderly women have four main patterns in sleep problems and reported the possibility of changing the prognosis of chronically ill patients and the need for advice on sleep hygiene accordingly.

(Yu et al., 2017) received responses from a self-reported questionnaire on sleep problems, depression, and anxiety in 515 elderly people (Mean = 67, SD = 5). This research investigated various profiles of sleep and explored how these profiles could be related to demographic and psychiatric variables. Pittsburgh Sleep Quality Index (PSQI) was used to measure sleep problems, and Latent Class Analysis was performed using 5 of the seven components that make up PSQI: *sleep duration, sleep latency, habitual sleep efficiency, sleep disturbances, and daytime dysfunction*. The profiles of the *"Inadequate sleep"* group with reduced sleep time, *"Disturbed sleep"* group with increased sleep disturbance, *"Trouble falling asleep"* group largely defined as increased sleep delay, *"Multiple problems"* group which are complexly defined as low sleep efficiency, increased sleep incubation period, and reduced sleep duration were somewhat similar to those reported by (Leigh et al., 2016). The results of this research suggested that by identifying various profiles of sleep problems, a specific profile may appear to be related to various mental and physical health-related conditions. In addition, the identification of these different profiles for sleep problems has implications for providing information specifically for future studies on intervention coordination in each profile to maximize intervention outcomes.

Looking at the results of the preceding studies above, the proportion of studies on sleep problems in the elderly population accounts for a large portion, because chronic sleep disorders are common symptoms in the elderly. Typical symptoms of sleep problems in the elderly include difficulty falling asleep, early morning wake-up, and excessive daytime sleepiness, and these symptoms can be confirmed to be similar to the types identified in those studies. Also, looking at the tools they used to

measure sleep problems, PSQI was commonly used. This is because PSQI was originally designed to be used as a simple and valid evaluation of disorders that could affect sleep quality in clinical populations (Buysse et al., 1989). In the (Leigh et al., 2016), the NHP Sleep scale was used, but the scale was found to be highly consistent with PSQI, and similar questions were found. Notwithstanding all the above studies have explored different types of profiles in sleep problems, but because they are divided into problem areas, there is still insufficient information to suggest effective interventions for each subtype, such as what actions each type should be takes before going to sleep.

There were some research that confirmed various sleep profiles in other age groups. (Matricciani et al., 2020) identified sleep profiles of children and parents together, but in this, sleep, physical activity, and sitting time were collected using a GENEActiv accelerometer worn on the wrist. The four sleep profiles observed were “*Short sleepers*”, “*Late to bed*”, “*Long sleepers*”, and “*Overall good sleepers*”. As a result of confirming the correlation between each cluster member and socio-demographic and lifestyle, the “*Late to bed*” group showed lower socioeconomic status, undesirable dietary and activity patterns, and long sitting hours compared to “*Overall good sleepers*”. This research suggested that sleep should be considered in terms of focusing on sleep time and duration by investigating the sleep profile. (유창민, 2019) classified the sleep duration trajectories and analyzed predictive factors in Korean adolescents by using Latent Class Growth Analysis. It has shown that adolescents' sleep time changes were classified into four classes and explained the need to subdivide interventions by period to form healthy sleep time habits for adolescents in the future. In the case of adolescents' age groups, there were many approaches in terms of time, because most adolescents had insufficient sleep and lack of sleep due to delays in their sleep schedules or reduced time. Most of the studies on the sleep of Korean university students also confirmed sleep patterns using questionnaires such as the morning-evening questionnaire (MEQ) and cyclical rhythm (Kim et al., 2006; 김정기 et al., 2009; Lee et al., 2016).

Despite these various studies, the empirical studies on showing various aspects of sleep hygiene have not yet been actively conducted. Therefore, it is necessary to approach sleep problems from the sleep hygiene perspective. Further, it is urgent to discover and provide information on sleep hygiene patterns through empirical research on various subscales of sleep hygiene for effective intervention on sleep problems.

III. Method

The present study was divided into the Part 1 to solve *Research Question 1* and the Part 2 to solve *Research Question 2*. The Part 1 used LCA for the whole to understand the types and characteristics of sleep hygiene of university in *Research Question 1*. This is a method of identifying the latent classes according to the response pattern to the subscales of sleep hygiene. The Part 2 used LCA to understand the types and characteristics of sleep hygiene according to the sleep quality level in university in *Research Question 2*. This is a method of identifying the latent classes of sleep hygiene in each subgroup after dividing the total score of PSQI, which measures sleep quality, into three subgroups according to clinical criteria. The overall research flow could be summarized as shown in Figure 1.

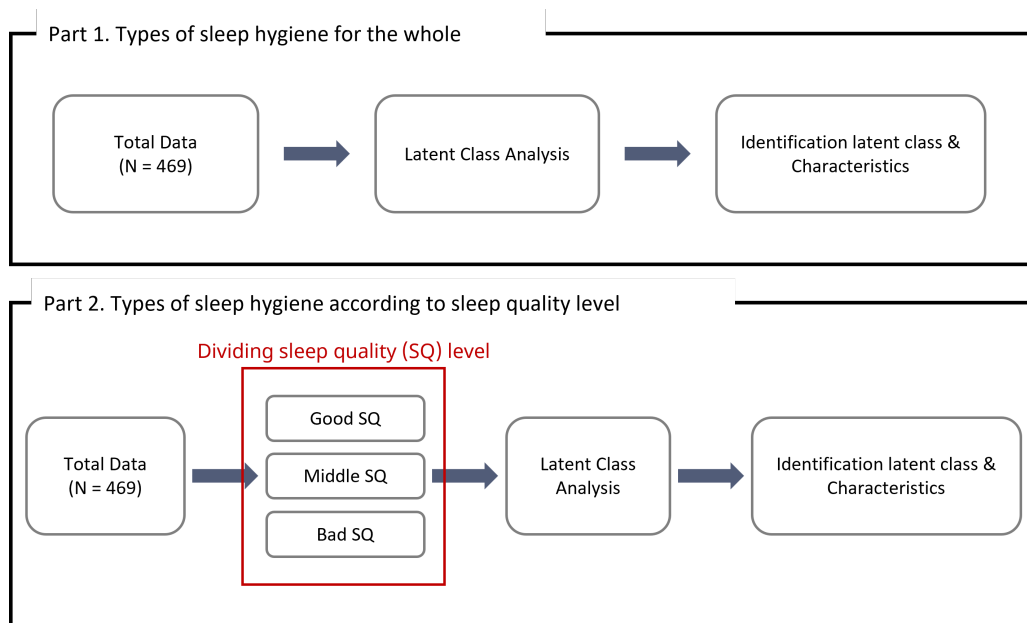


Figure 1. Overall research flow

3.1 Participants and procedure

The participants were undergraduate and graduate students at Ulsan National Institute of Science and Technology, an engineering university located in South Korea. After explaining the purpose and meaning of the study to the healthcare center of UNIST, the online survey links were distributed to all enrolled students by e-mail with their help. The survey consisted of basic information (sex, birth year, degree course) and 10 questionnaires measuring various aspects. Since all the surveys were self-reported questionnaires, the confirmation questions were additionally included to confirm the consistency of the responses. It was in the form of re-questioning about subject's basic information such as “Are you a woman?”, “Are you a male?” and “Are you a Ph.D.?”. A total of 7 confirmation questions were added in the middle of the survey.

When distributing the survey, autonomy in participating and confidentiality of responses were explained. Then, only data from respondents who agreed in writing that the survey response was used in the study were collected. This study was approved by the Institutional Review Board of UNIST (*UNISTIRB-18-41-A*), and the survey period was conducted from April 19, 2021, to June 11, 2021.

Consequently, a total of 586 responses were collected out of 4,293 enrolled students. To improve the quality of data, the consistency between the basic information and the confirmation question response was confirmed. When any inconsistent response was obtained, the data of the respondents were excluded from the analysis. It was confirmed that 60 participants were inconsistent. The remaining 526 were identified as 473 Koreans and 53 foreigners. For the study, there may be potential factors for cultural differences, so only Korean students' responses were used. In addition, 4 participants who answered "Etc" in the grade question were excluded. Finally, a total of 469 responses were used in analysis. Demographics of them were shown in Table 1.

Table 1. Demographics

		Frequency	Percent (%)
Sex	Female	210	44.78 %
	Male	259	55.22 %
Grade	Undergraduate	163	34.75 %
	Graduate \leq 4	179	38.17 %
	Graduate $>$ 4	127	27.08 %
Total		469	100.00 %

3.2 Measurements

3.2.1 Sleep hygiene indicators

The scale used to find out the heterogeneous latent class according to sleep hygiene in university was the Adolescent Sleep Hygiene Scale (ASHS; LeBourgeois et al., 2005). ASHS, which evaluates sleep hygiene, was a self-reported questionnaire consisting of a total of 33 questions and supposed to respond on a 6-point Likert scale (always = 1, never = 6) to how often the following things have happened during the past month. The questions divided into 4 qualitative questions that check the usual bedtime/weather hours on weekdays and weekends and 8 subscales: *physiological (5-items)*, *behavioral arousal (3-items)*, *cognitive/emotional (6-items)*, *sleep environment (5-items)*, *sleep stability (3-items)*, *daytime sleep (2-items)*, *substances (2-items)*, *bedtime routine (1-item)*. In the score, only 27 questions from 8 subscales were summed, and only 'bedtime routine' factor was reverse scored. The score for each of these dimensions of sleep hygiene calculated as the average for each factor. Then the score for 8 subscales was used to calculate the total score for sleep hygiene. The higher the score, the better the sleep hygiene in that factor.

For the LCA, the scores of each sleep hygiene subscale were expressed as percentiles and categorized into 4 categories: “~25%”, “25~50%”, “50~75%”, and “75%~”. Descriptive statistics values of 8 sleep hygiene subscales were presented in Table 2. All subscales could be considered to have normality because the absolute values of skewness and kurtosis satisfied < 3 , < 10 criteria, respectively. Hence, the “75%~” category response meant that the score for the corresponding factor is high in the whole, which could be seen as meaning that the hygiene of the corresponding factor is good. Conversely, the “~25%” category response meant that the hygiene of the corresponding factor is poor.

Table 2. Descriptive statistics of sleep hygiene subscales

	Factor	Mean	SD	Median	Skewness	Kurtosis
1	Physiological	5.07	0.64	5.13	-1.04	1.18
2	Behavioral arousal	3.2	1.32	3.44	0.12	-0.84
3	Cognitive/Emotional	4.45	0.93	4.32	-0.67	0.07
4	Sleep environment	5.64	0.48	5.86	-1.95	4.9
5	Sleep stability	4.7	1.24	4.98	-1.03	0.41
6	Daytime sleep	5.26	0.93	5.54	-1.88	4.27
7	Substances	5.31	0.9	5.61	-2.04	4.71
8	Bedtime routine	2.29	1.78	1.4	1.07	-0.36

3.2.2 Sleep quality

The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) was used as a measure of sleep quality. PSQI, consisting of 18 questions, consisted of 7 components: *subjective sleep quality*, *sleep incubation period*, *sleep time*, *usual sleep efficiency*, *sleep disturbance*, *use of sleep pharmaceuticals*, and *daytime dysfunction*. The score for each component was expressed as 0 (better) to 3 (worse) points, and the total score calculated between 0 and 21 points by adding all components. The cutoff score of PSQI was 5, which means that the higher the score, the worse the sleep quality.

3.2.3 Emotional related variables

Depression For depression, a Patient Health Questionnaire-9 (PHQ-9; Kroenke et al., 2001) was used. Based on the major criteria for diagnosing depressive disorders, this scale developed for the screening of depression consisted of 9 questions. The severity of depressive symptoms over the past two weeks was answered on a 3-point Likert scale (not at all = 0, nearly every day = 3), and the total score was distributed from 0 to 27. The 5~9 points indicated mild depression, 10~14 points indicated moderate depression, and 15 points or higher indicated severe depression. The cutoff score of PHQ-9 was 14.

Anxiety Generalized Anxiety Disorder-7 (GAD-7; Spitzer et al., 2006), which consists of 7 questions, was used to evaluate anxiety symptoms. Each question asked about the degree of anxiety symptoms

over the past two weeks was evaluated on a 3-point Likert scale (not at all = 0, nearly every day = 3), and distributed from 0 to 21 points in total. The higher the score, the higher the anxiety. The cutoff score of GAD-7 was 14.

Stress The Stress Response Inventory (SRI; Koh et al., 2000) was used to measure stress. Respond on a 5-point scale (not at all = 0, absolutely = 4) to questions asking how much you have experienced about each question over the past week. There was a total of 39 questions, which consist of 7 elements: *tension, aggression, somatization, anger, depression, fatigue, and frustration*. The higher the score, the higher the stress.

3.2.4 College-life related variables

Life satisfaction The Satisfaction with Life Scale (SWLS; Diener et al., 1985), which was used to measure with a focus on life satisfaction in the subjective aspect, consists of a total of 5 questions. The responses to each question are on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). The total score calculated by adding the scores of each question represents the overall satisfaction with life. The higher the score, the higher the satisfaction with life.

Attention deficit The scale used to measure the degree of attention deficiency is the Adult Attention Deficit/Hyperactivity Disorder self-report scale-V1.1 (ASRS; Kessler et al., 2005). ASRS was a tool for evaluating the degree of adult ADHD based on DSM-IV diagnostic criteria. A total of 18 questions were designed to evaluate symptoms experienced over the past 6 months on a 4-point Likert scale (none = 0, severe = 3). This scale consisted of Part A and Part B, which consists of the questions that best predict ADHD through Part A, and Part B provides additional clues to patient symptoms. In this study, only 6 questions of Part A were used, and the higher the score, the worse the attention.

Perfectionism For perfectionism, the Frost Multi-dimensional Perfectionism Scale (FMPS; Frost et al., 1993) was used. FMPS had a total of 35 questions, and the subscales consisted of organization, personal standards, parental expectations, parental criticism, doubts about actions, and concern over mistakes. Responses to each question were evaluated on a 5-point Likert scale from '*strongly disagree*' to '*strongly agree*', which means that the higher the score, the higher the tendency to perfectionism.

Procrastination Aitken Procrastination Inventory (API; Aitken, 1982) was used to measure delay behavior. The API responds with a 5-point Likert scale that gives 0 (not at all) and 5 (very much so) for a total of 19 questions. The higher the score, the more delayed behavior is throughout life.

Alcoholism The Korean Version of Alcohol Use Disorders Identification Test (K-AUDIT; Kim et al., 2008) was used to measure the degree of drinking problems. K-AUDIT, which be composed of a total of 10 questions, consisted of sub-items such as the amount of drinking, the form of drinking, and psychosocial problems. The higher the score, the more serious the drinking problem was, and the criteria

for judgment differ according to gender. In the case of female, 6~10 points were the boundary level and 10~40 points were the risk level. In the case of male, 10~20 points were divided into boundary levels and 20~40 points were divided into risk levels.

3.3 Statistical analysis

Latent Class Analysis (LCA) was a person-centered approach method that discovers individual differences based on an individual's question response pattern and classifies them into homogeneous latent classes. Unlike other cluster analyses, this estimates the probability of individuals being included in each class, so expressing it as an equation as follows.

$$P(Y = y|K = k) = \gamma_k \prod_{j=1}^J \prod_{r_j=1}^{R_j} \rho_{j,r_j|k}^{I(y_j = r_j)}$$

This equation found the probability that a specific response pattern appeared in a particular latent class k for an individual y if the optimal number of latent class K is known when there are J questions and R_j response categories for each question. Two parameters were considered in the LCA: the membership (γ_k), which represented the probability of belonging to a particular latent class k , and item-response probability ($\rho_{j,r_j|k}$), which checked with conditional probability what response patterns each latent class shows. If $I(y_j = r_j)$ showed a specific response pattern in the j question, it appeared as 1, otherwise, it appeared as 0. In summary, since the LCA aims to calculate the probability of belonging to the latent class k , that is, the posterior probability, when showing a specific response pattern, the equation for this is as follows.

$$P(k|y) = \frac{(\prod_{j=1}^J \prod_{r_j=1}^{R_j} \hat{\rho}_{j,r_j|k}^{I(y_j = r_j)}) \hat{\gamma}_k}{\sum_{k=1}^K \hat{\gamma}_k \prod_{j=1}^J \prod_{r_j=1}^{R_j} \hat{\rho}_{j,r_j|k}^{I(y_j = r_j)}}$$

When estimates of the two parameters are $\hat{\gamma}_k$ and $\hat{\rho}_{j,r_j|k}$, the individuals were classified in the latent class with the highest value by obtaining the posterior probability to belong to each class. LCA was conducted using the poLCA package in R (Linzer & Lewis, 2011), which estimates the latent class model by maximizing the log-likelihood function with respect to $\hat{\gamma}_k$ and $\hat{\rho}_{j,r_j|k}$, using the expectation-maximization (EM) algorithm (Dempster et al., 1977).

In addition, the advantage of LCA is that, unlike other cluster analyses, the number of classes could be determined based on a relatively strict statistical model. To find a model with the optimal number of classes K , an exploratory method of comparing multiple models while sequentially increasing the number of classes was used. In this study, the values converged based on the random initial values

obtained by repeating 30 times for each of the eight models with 1 to 8 latent classes were reflected in the final model decision. The final model was determined by comprehensively determining the size of class and interpretability as well as model suitability such as the likelihood-ratio statistic (G^2), information criteria, and entropy.

Common information criteria included Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and Adjusted Bayesian Information Criteria (aBIC). They were preferred a model that generates high log-likelihood values using relatively few parameters. Entropy was an indicator of how accurately the classes are classified, and the closer it is to 1, the less the error and better the classification is. Therefore, the smaller the AIC, BIC, aBIC, and G^2 values and the larger the entropy values, the better the model fit. In addition, the size of class and interpretability should be comprehensively considered, and previous studies have determined that classes which appear in a less size than 1% or 5% do not actually exist or are meaningless (Bauer & Curran, 2003). Even if statistical figures were good, it was also an important factor whether the model could be interpreted substantially meaningful from the standpoint of content validity.

After selecting the final model, the participants were assigned to their most probable latent class. Following this, the group differences about 8 sleep hygiene subscales among the LCA identified classes were confirmed through Analysis of variance (ANOVA), post-hoc test, and item-response probability. In addition, differences in characteristics by classes were analyzed in sleep quality, emotional and college-life related factors via ANOVA and post-hoc test. These were conducted in R (version 4.0.4) and the post-hoc analyses were conducted with Scheffe’s test. The model of LCA used in this current study could be expressed as shown in Figure 2.

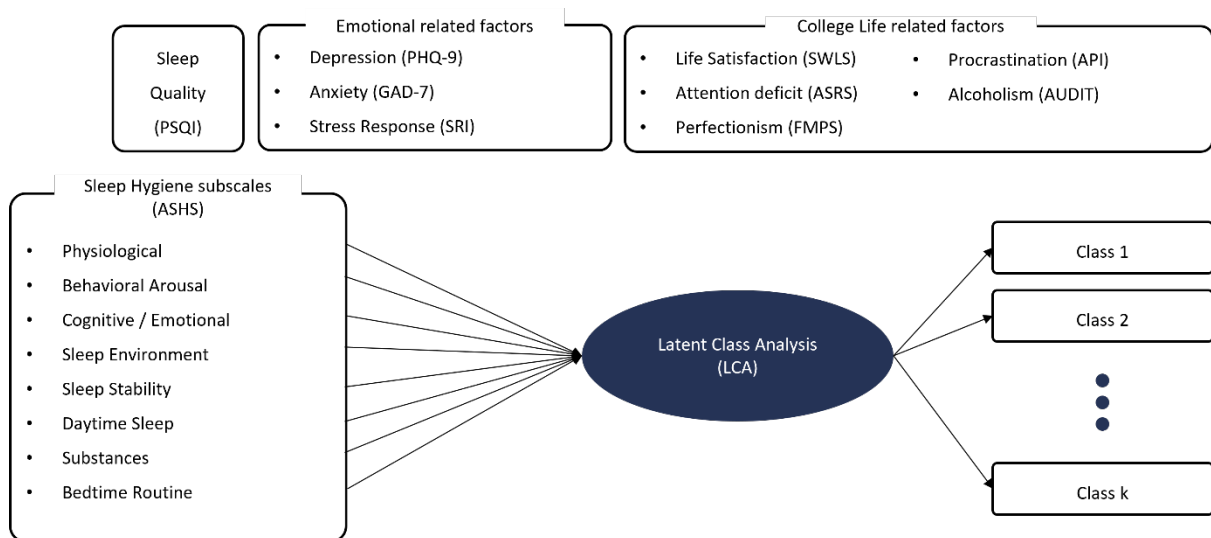


Figure 2. Latent Class Analysis (LCA) model

IV. Results

4.1 Descriptive statistics

Descriptive statistics of the variables were examined. Since the statistics for the 8 subscales of sleep hygiene used to classify the latent class were mentioned earlier, only the descriptive statistics of the variables used to check the difference in group characteristics were presented in Table 3. The variables shown were composed of sleep hygiene (ASHS), sleep quality (PSQI), emotional related factors (PHQ, GAD, SRI), and college-life related factors (SWLS, ASRS, FMPS, API, AUDIT), and represent descriptive statistics values for the total score of all factors. Based on checking skewness and kurtosis to confirm normality, all variables were satisfied with the criteria of absolute skewness < 3 , kurtosis < 10 . Consequently, it was confirmed that the distribution of all variables meets the normal distribution criteria (Kline, 2011).

Table 3. Descriptive statistics of variables

Variable	Mean	SD	Median	Skewness	Kurtosis
ASHS	4.49	0.49	4.9	-0.45	0.39
PSQI	6.58	2.71	6.42	0.53	0.29
PHQ	7.26	5.36	6.07	0.97	0.69
GAD	5.54	4.68	4.47	0.98	0.46
SRI	41.07	29.89	34.38	0.89	0.26
SWLS	20.57	6.48	21.19	-0.12	-0.61
ASRS	2.36	1.72	2.25	0.27	-0.97
FMPS	103.56	18.92	103.35	-0.05	-0.25
API	52.57	13.15	52.25	0.18	-0.42
AUDIT	6.18	5.7	4.7	1.46	2.32

Note. ASHS = Adolescent Sleep Hygiene Scale; PSQI = Pittsburgh Sleep Quality Index; PHQ = Patient Health Questionnaire-9; GAD = Generalized Anxiety Disorder-7; SWLS = Satisfaction With Life Scale; ASRS = Adult attention deficit/hyperactivity disorder Self-Report Scale; FMPS = Frost Multi-dimensional Perfectionism Scale; API = Aitken Procrastination Inventory; AUDIT = Alcohol Use Disorders Identification Test.

As a result of examining the correlation between the 8 sleep hygiene subscales that were used as indicators in LCA, there was a significant positive correlation of 0.1 ~ 0.44 between 1 (physiological) to 6 (daytime sleep). In particular, the cognitive/emotional and sleep stability factor had the highest correlation of 0.44. On the other hand, the substances factor showed a significant positive correlation of 0.13 only in physiological, and the bedtime routine factor showed a significant negative correlation of 0.11 in behavioral arousal (see Table 4). The results of the correlation with sleep quality, emotional related factors, and college-life related factors were attached to the Appendix.

Table 4. Correlation between 8 subscales of sleep hygiene

Factor	1	2	3	4	5	6	7	8
1 Physiological	1**							
2 Behavioral arousal	0.12*	1**						
3 Cognitive/Emotional	0.37**	0.26**	1**					
4 Sleep environment	0.26**	0.3**	0.21**	1**				
5 Sleep stability	0.27**	0.25**	0.44**	0.27**	1**			
6 Daytime sleep	0.25**	0.1*	0.21**	0.21**	0.2**	1**		
7 Substances	0.13**	-0.02	-0.03	0	0.01	-0.07	1**	
8 Bedtime routine	-0.05	-0.11*	-0.01	-0.08	0.02	0.03	0.04	1**

4.2 Part 1: Types of sleep hygiene for the whole

In this Part 1, the LCA was conducted to confirm the latent classes according to sleep hygiene level in university.

4.2.1 Model selection

To determine the optimal LCA model, the number of latent classes was increased from 1 to 8, and the model suitability was examined and compared. The fit by model and the size of the latent classes were presented in Table 5, and a model with three latent classes was finally adopted based on the following grounds. First, as the number of latent classes increased, the BIC decreased and then increased from model 3. If only BIC was considered, model 2 and model 3 had the smallest values. Second, AIC and G^2 decreased as the number of classes increased, but there seemed to be no significant decrease after model 3. The aBIC showed a pattern of increasing again after model 4. Third, as the number of classes increased, the entropy also increased, but there was the biggest improvement in model 3. Therefore, when considering the model fit, the size of each class, and the interpretability, it was judged that model 3 was the most suitable for the optimal latent class model.

Table 5. Fit statistics of latent class model

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Resid.df	445	420	395	370	345	320	295	270
AIC	10450	10279	10182	10136	10120	10107	10103	10095
BIC	10550	10483	10489	10547	10635	10726	10825	10921
aBIC	10474	10327	10255	10233	10241	10253	10272	10289
G ²	4655	4434	4287	4191	4125	4062	4007	3950
Entropy	-	0.59	0.68	0.72	0.74	0.78	0.75	0.81
Class 1	469	182 (38.8%)	177 (37.7%)	76 (16.2%)				
Class 2		287 (61.2%)	187 (39.9%)	145 (30.9%)				
Class 3			105 (22.4%)	86 (18.3%)				
Class 4				162 (34.5%)				

Note. Resid.df = Residual degrees of freedom; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; aBIC = adjusted Bayesian Information Criterion; G² = the likelihood-ratio statistic. Bolded represents the identified best fit model.

4.2.2 Latent classes on sleep hygiene

The understanding of each latent class could be interpreted with a score distribution for 8 subscales of sleep hygiene for each latent class. Previously, the scores for subscales were expressed as percentiles and categorized into four response categories (~25%, 25~50%, 50~75%, 75%~). Hence, it was possible to explain in terms of conditional probability what response patterns the classified latent classes exhibit for each subscale. In other words, it referred to the probability of falling under each of the response categories in 8 subscales for each latent class, which is *item-response probability*.

Table 6 was shown the size of each latent class and the item-response probability. A radial graph of the probability for each response was shown in Figure 3. The "75%~" response showed the proportion of subjects with the highest score for the subscales of sleep hygiene in each class, whereas the "~25%" response showed the proportion of subjects with the lowest score.

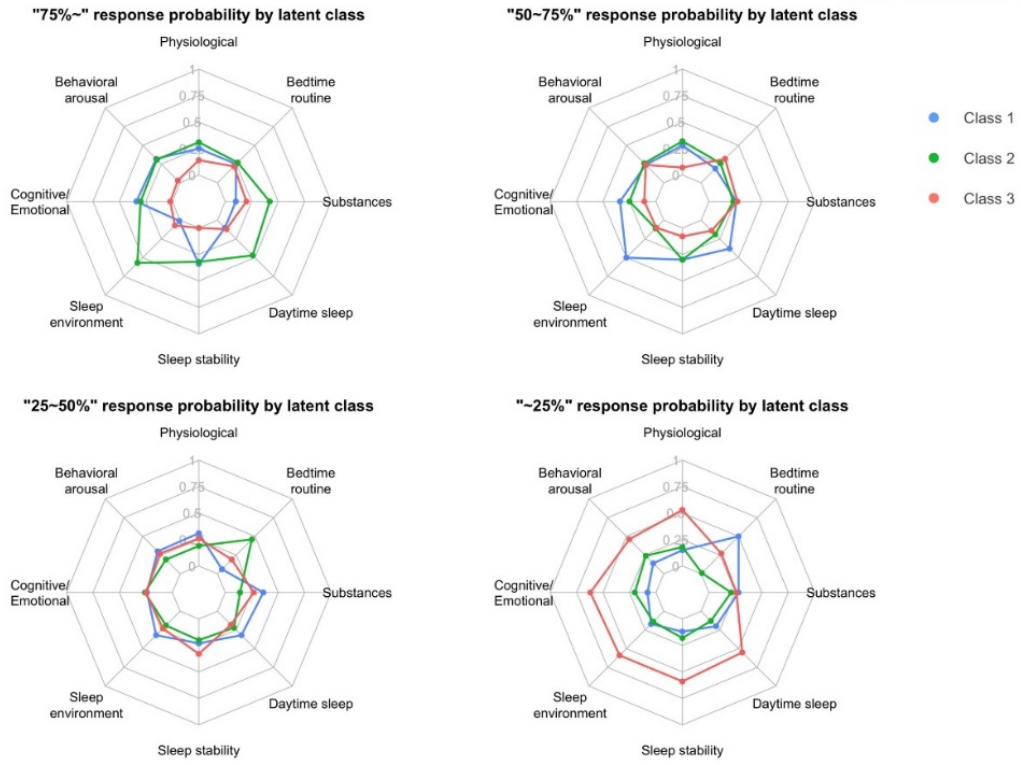


Figure 3. Radial graph of the item-response probability for each response

Table 6. Estimated item-response probabilities by latent class membership

<i>Sleep hygiene indicators</i>	Class 1 (n = 177, 37.7%)	Class 1 (n = 187, 39.9%)	Class 3 (n = 105, 22.4%)
Physiological			
75% ~	0.25	0.31	0.14
50 ~ 75%	0.28	0.32	0.07
25 ~ 50%	0.31	0.19	0.26
~ 25%	0.15	0.18	0.53
Behavioral arousal			
75% ~	0.32	0.31	0.03
50 ~ 75%	0.24	0.26	0.24
25 ~ 50%	0.30	0.19	0.27
~ 25%	0.14	0.24	0.46
Cognitive/Emotional			
75% ~	0.34	0.30	0.02
50 ~ 75%	0.34	0.25	0.11
25 ~ 50%	0.24	0.26	0.25
~ 25%	0.08	0.20	0.62
Sleep environment			
75% ~	0.01	0.57	0.07
50 ~ 75%	0.50	0.11	0.10
25 ~ 50%	0.32	0.19	0.23
~ 25%	0.17	0.14	0.59
Sleep stability			
75% ~	0.34	0.32	0.00
50 ~ 75%	0.30	0.30	0.08
25 ~ 50%	0.23	0.20	0.33
~ 25%	0.12	0.18	0.59
Daytime sleep			
75% ~	0.10	0.47	0.12
50 ~ 75%	0.38	0.19	0.14
25 ~ 50%	0.32	0.22	0.18
~ 25%	0.20	0.13	0.55
Substances			
75% ~	0.10	0.42	0.20
50 ~ 75%	0.26	0.23	0.27
25 ~ 50%	0.36	0.14	0.27
~ 25%	0.28	0.21	0.26
Bedtime routine			
75% ~	0.25	0.27	0.22
50 ~ 75%	0.19	0.26	0.32
25 ~ 50%	0.06	0.46	0.19
~ 25%	0.50	0.01	0.27

Note. Bolded indices are the highest probabilities in the rows.

Class 1 accounted for about 38% of the total. Class 1 showed that the proportion of subjects with scores above the 50th percentile was very high at 0.68 in cognitive/emotional factor among the 8 subscales of sleep hygiene, followed by 0.64 in sleep stability. In sleep environment factor, the "75%~" response was very low at 0.01, but the "50~75%" response rate was 0.50, half of the class. On the other hand, the proportion of subjects with scores less than 50th percentile was very high at 0.64 in substances. In bedtime routine, the response rate of "~25%" was confirmed to be 0.50. Class 1 was a group with very excellent sleep hygiene in the areas of cognitive/emotional and sleep stability. In addition, although they were not very good in sleep environment, they scored well in the area with a proportion of more than 50% within the group. However, compared to other classes, it was appeared to be experiencing problems in the substances hygiene, and it was confirmed that about half of the subjects did not have a bedtime routine.

In Class 2, the proportion of subjects with scores above the 50th percentile accounted for more than 60% of the class at 5 subscales of sleep hygiene: physiological, sleep environment, sleep stability, daytime sleep, substances. Among them, the response rate of "75%~" was very high at 0.57 in the sleep environment factor, which was followed by daytime sleep (0.47) and substances (0.42). Conversely, in the bedtime routine, the response rate of "~25%" was very low at 0.01. Class 2 seemed to have excellent sleep hygiene in the sleep environment. In addition, they were found to have higher sleep hygiene scores than Class 1 in daytime sleep and substances factors. On the other hand, the hygiene of cognitive/emotional was worse than Class 1.

Class 3 was found to be more about 70% of the proportion of the subjects with scores less than 50th percentile in the remaining 6 subscales of sleep hygiene excluding substances and bedtime routine factors. Sleep stability was very high at 0.92, followed by cognitive/emotional at 0.87. In addition, in physiological, cognitive/emotional, sleep environment, sleep stability, and daytime sleep, more than half of the class was distributed in "~25%" response, and it was very high at 0.62 in the cognitive/emotional factor. Class 3 was found to have the highest percentage of subjects with the lowest hygiene score in the remaining 6 subscales except for two factors, and they were generally judged to have poor sleep hygiene.

ANOVA and post-hoc test were conducted to confirm statistical differences in subscales of sleep hygiene according to the latent classes, and the result was presented in Table 7. All three types showed statistically significant differences in the remaining 6 subscales except substances and bedtime routine factors. These significant statistics were then followed up with post-hoc Scheffe's tests. These post-hoc tests showed that there was a significant difference between the three latent classes in the factor of cognitive/emotional and sleep stability. The mean value was high in the order of Class 1, Class 2, and Class 3. Class 3 showed significantly lower mean values than other classes in physiological, behavioral arousal, sleep environment, and daytime sleep. To examine whether there was a significant difference

between Class 1 and Class 2 in that factor, the significance level was expanded to 0.1, but no significant difference between those two classes was confirmed.

Based on these results, Class 1 was labeled as “*Good cognitive/emotional and sleep stability hygiene (CESH) group*”, Class 2 was labeled as “*Middle cognitive/emotional and sleep stability hygiene group*”, and Class 3 was labeled “*Bad cognitive/emotional and sleep stability hygiene group*”.

Table 7. Sleep hygiene subscales between latent classes

	Class 1 ^a M (SD)	Class 2 ^b M (SD)	Class 3 ^c M (SD)	F (p value)	Scheffe $\alpha = 0.05$
Physiological	5.21 (0.54)	5.21 (0.56)	4.60 (0.70)	45.17***	a, b > c
Behavioral arousal	3.56 (1.22)	3.32 (1.37)	2.40 (1.01)	30.07***	a, b > c
Cognitive/Emotional	4.88 (0.66)	4.55 (0.84)	3.55 (0.87)	97.54***	a > b > c
Sleep environment	5.73 (0.35)	5.78 (0.39)	5.25 (0.59)	58.18***	a, b > c
Sleep stability	5.20 (0.90)	4.88 (1.14)	3.54 (1.19)	83.63***	a > b > c
Daytime sleep	5.40 (0.74)	5.52 (0.67)	4.58 (1.24)	44.43***	a, b > c
Substances	5.24 (0.89)	5.39 (0.84)	5.28 (1.02)	1.396 (0.25)	-
Bedtime routine	2.36 (1.87)	2.22 (1.71)	2.30 (1.74)	0.2697 (0.76)	-

Note. ASHS = Adolescent Sleep Hygiene Scale; M = Mean; SD = Standard Deviation.

The higher the mean value, the better the corresponding sleep hygiene subscale.

* $p < .05$, ** $p < .01$, *** $p < .001$.

4.2.3 Characteristics between latent classes

ANOVA and post-hoc test were conducted to find out the differences of levels of sleep quality, emotional, and college-life related variables in each of the identified classes. As shown in Table 8, there was a statistically significant difference between the three groups in all other factors except alcoholism. Also, it was found that the mean value of sleep quality level was significantly higher in the order of Bad CESH, Middle CESH, and Good CESH groups. Among the emotional related variables, PHQ and SRI showed statistically significant differences between the three groups at the significance level of 0.08. As for GAD, the Bad CESH group showed the highest mean value compared to the other two groups. In terms of college-life related variables, the mean values of the Good CESH group and the Middle CESH group did not show a significant difference. In these two groups, the mean of SWLS was higher than that of the Bad CESH group, and the mean of ASRS, FMPS, and API was lower.

Table 8. Descriptive statistics between three latent types in whole

	Good CESH ^a	Middle CESH ^b	Bad CESH ^c	F (p value)	Scheffe $\alpha = 0.05$
	M (SD)	M (SD)	M (SD)		
ASHS	4.70 (0.38)	4.61 (0.36)	3.94 (0.44)	142.8***	a > b > c ^{††}
PSQI	5.65 (2.32)	6.30 (2.51)	8.67 (2.57)	51.85***	c > b > a
PHQ	5.49 (4.00)	6.70 (5.24)	11.27 (5.54)	48.22***	c > b > a [†]
GAD	4.16 (3.76)	4.99 (4.23)	8.85 (5.28)	41.2***	c > a, b
SRI	31.1 (22.2)	37.5 (28.3)	64.2 (31.9)	51.69***	c > b > a [†]
SWLS	21.8 (5.76)	21.1 (6.60)	17.5 (6.49)	17.07***	a, b > c
ASRS	2.06 (1.70)	2.27 (1.65)	3.01 (1.71)	10.87***	c > a, b
FMPS	99.4 (18.7)	102.8 (18.0)	111.8 (18.4)	15.17***	c > a, b
API	50.6 (12.9)	52.1 (12.2)	56.7 (14.3)	7.609***	c > a, b
AUDIT	6.63 (5.67)	5.71 (5.56)	6.26 (5.98)	1.189 (0.31)	-

Note. CESH = Cognitive/Emotional and Sleep stability Hygiene; M = Mean; SD = Standard Deviation; ASHS = Adolescent Sleep Hygiene Scale; PSQI = Pittsburgh Sleep Quality Index; PHQ = Patient Health Questionnaire-9; GAD = Generalized Anxiety Disorder-7; SWLS = Satisfaction With Life Scale; ASRS = Adult attention deficit/hyperactivity disorder Self-Report Scale; FMPS = Frost Multi-dimensional Perfectionism Scale; API = Aitken Procrastination Inventory; AUDIT = Alcohol Use Disorders Identification Test.

The higher the score of ASHS, SWLS, the better. For the rest, the higher the score, the worse.

* p < .05, ** p < .01, *** p < .001.

† The significance level was 0.08, †† The significance level was 0.1.

4.3 Part 2: Types of sleep hygiene according to sleep quality level

By the Part 1, it was found that the three latent classes identified with 8 subscales of sleep hygiene were divided into good, medium, and bad levels in sleep quality (PSQI). Through this, Part 2 was conducted to check how the types of sleep hygiene would appear according to the level of sleep quality. In this part, first, the total score of PSQI, which measures sleep quality, was divided into three sub-groups in accordance with clinical criteria: good sleep quality, middle sleep quality, and bad sleep quality. Second, for each divided sub-group, LCA was conducted with 8 sleep hygiene subscales, and the characteristics of the identified latent classes were confirmed. Finally, the level of variables related to emotional and college-life between the latent classes identified within each sub-group classified according to sleep quality level was investigated.

4.3.1 Sub-groups divided according to the sleep quality level

The average sleep quality of all participants was 6.58 (SD = 2.71), which was higher than the known cutoff 5 points of PSQI. According to previous studies, the PSQI average of college students in higher education was 7.00, and they proposed the cutoff score was 8 points. In addition, in many studies, it is commonly known that sleep quality is very poor if the PSQI exceeds 8 points. Therefore, in this study, the total participants were divided into three subgroups based on the clinical criteria of 5 points and 8 points.

The three divided subgroups were 'group with 4 points or less', 'group with 5 to 8 points', and 'group with 9 or more points' based on the total PSQI score, which means that the higher the score, the worse the sleep quality. They were named “*Good sleep quality (GSQ)*”, “*Middle sleep quality (MSQ)*”, and “*Bad sleep quality (BSQ)*” groups, respectively. The MSQ group showed the highest ratio of 53.3% (N = 250) of the total, the GSQ group showed 24.5% (N = 115) and the BSQ group showed 22.2% (N = 104). The descriptive statistics for the total score of sleep quality (PSQI) and sleep hygiene (ASHS) of each group were presented in Table 9. By ANOVA and Scheffe's test, it was confirmed that they were all significantly divided. In the GSQ group, the average of PSQI was the lowest, and the average of ASHS was the highest. That is, this group has the best sleep quality and sleep hygiene. Conversely, in the BSQ group, the highest PSQI and the lowest ASHS, which were identified as the group with the worst sleep quality and sleep hygiene.

Table 9. Descriptive statistics of sleep quality and sleep hygiene in three sub-groups

	Total	Sleep quality level			F	Scheffe ($\alpha = 0.05$)
		Good SQ ^a ($PSQI < 5$)	Middle SQ ^b ($5 \leq PSQI \leq 8$)	Bad SQ ^c ($PSQI > 8$)		
N (%)	469	115 (24.52%)	250 (53.30%)	104 (22.17%)		
PSQI	6.58	3.33 (0.90)	6.47 (1.06)	10.45 (1.67)	984***	c > b > a
M (SD)	(2.71)					
ASHS	4.49	4.72 (0.34)	4.52 (0.45)	4.17 (0.56)	40.7***	a > b > c
M (SD)	(0.49)					

Note. SQ = Sleep Quality; M = Mean; SD = Standard Deviation; N = Number of samples; PSQI = Pittsburgh Sleep Quality Index; ASHS = Adolescent Sleep Hygiene Scale.

*** p < .001.

4.3.2 Model selection

To conduct LCA with subscales of sleep hygiene for the three sub-groups, which were divided according to the sleep quality level, the optimal number of latent classes in each subgroup was explored.

First, the optimal number of latent classes in the GSQ group was determined based on the results presented in Table 10. As a result of examining the increase in the number of classes by one, it was confirmed that BIC showed an increasing pattern, but AIC and aBIC showed a decrease and then increased again in model 4. G^2 showed a continuous decrease, and the entropy decreased in model 3 and then increased again in model 4. Finally, from model 5, residual degrees of freedom came out negative, which means that the models were not suitable, so the models were excluded from model selection. Therefore, if you judged by looking at the exponential values of the remaining models, model 4 seemed to be the most optimal. However, because of comprehensively considering the size of classes and interpretability, it was judged that the model with two latent classes was the most suitable.

Table 10. Fit statistics of latent class model in Good sleep quality (GSQ) group

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Resid.df	91	66	41	16	-9	-34	-59	-84
AIC	2428	2416	2415	2417	2431	2446	2462	2481
BIC	2493	2551	2618	2689	2771	2855	2940	3027
aBIC	2418	2396	2384	2376	2379	2384	2390	2398
G ²	1288	1227	1176	1128	1091	1057	1023	991
Entropy	-	0.84	0.81	0.91	0.91	0.93	0.97	0.98
Class 1	115	22 (19.1%)	45 (39.1%)	32 (27.8%)				
Class 2		93 (80.9%)	33 (28.7%)	41 (35.7%)				
Class 3			37 (32.2%)	20 (17.4%)				
Class 4				22 (19.1%)				

Note. Resid.df = Residual degrees of freedom; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; aBIC = adjusted Bayesian Information Criterion; G² = the likelihood-ratio statistic. Bolded represents the identified best fit model.

The results of the model suitability comparison to examine the optimal number of latent classes in the MSQ group are presented in Table 11. First, as the number of classes increased, BIC showed a gradual increase, but AIC, aBIC, and G² showed a decreasing pattern. Model 3 of AIC and aBIC showed a large decrease. Second, the entropy decreased in model 4 and then increased rapidly again. Therefore, when determined in consideration of the size of classes by the model and the interpretation, the MSQ group decided on a model with three latent classes as the final model.

Table 11. Fit statistics of latent class model in Middle sleep quality (MSQ) group

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Resid.df	226	201	176	151	126	101	76	51
AIC	5576	5507	5468	5455	5444	5432	5430	5447
BIC	5660	5680	5728	5804	5881	5957	6043	6148
aBIC	5584	5525	5494	5490	5488	5485	5491	5517
G ²	2773	2654	2565	2502	2441	2379	2327	2294
Entropy	-	0.71	0.72	0.70	0.82	NM	NM	0.88
Class 1	250	66 (26.4%)	89 (35.6%)	50 (20.0%)				
Class 2		184 (73.6%)	102 (40.8%)	76 (30.4%)				
Class 3			59 (23.6%)	33 (13.2%)				
Class 4				91 (36.4%)				

Note. Resid.df = Residual degrees of freedom; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; aBIC = adjusted Bayesian Information Criterion; G² = the likelihood-ratio statistic; NM = Not Measured.

Bolded represents the identified best fit model.

Lastly, the optimal latent class model of the BSQ group was determined on the following grounds. (see Table 12) First, among the 8 models, it was confirmed that the residual degrees of freedom was negative from model 5, which means that the model was not suitable, so all of these models were excluded from model selection. Second, when compared from models 1 to 4, the BIC increased as the number of classes increased. AIC decreased rapidly until model 3 and then increased again, and aBIC and G^2 continued to decrease. In particular, the largest reduction in AIC and aBIC was confirmed in model 3. Third, it could be seen that the entropy increases as the number of classes increases, which also had the largest increase in model 3. Therefore, considering the model fit, the size of classes, and the interpretability comprehensively, it was judged that it was appropriate to divide the BSQ group into three latent classes.

Table 12. Fit statistics of latent class model in Bad sleep quality (BSQ) group

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Resid.df	80	55	30	5	-20	-45	-70	-95
AIC	2232	2200	2184	2185	2189	2204	2210	2221
BIC	2295	2330	2380	2447	2517	2598	2670	2747
aBIC	2219	2175	2146	2134	2125	2127	2120	2118
G^2	1223	1141	1076	1026	981	945	901	862
Entropy	-	0.76	0.88	0.95	0.95	NM	NM	0.73
Class 1	104	44 (42.3%)	15 (14.4%)	15 (14.4%)				
Class 2		60 (57.7%)	45 (43.3%)	52 (50.0%)				
Class 3			44 (42.3%)	12 (11.5%)				
Class 4				25 (24.0%)				

Note. Resid.df = Residual degrees of freedom; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; aBIC = adjusted Bayesian Information Criterion; G^2 = the likelihood-ratio statistic; NM = Not Measured.

Bolded represents the identified best fit model.

In summary, the GSQ group (N=115) was divided into two latent classes at a rate of 19.1% and 80.9%, respectively. The MSQ group (N=250) identified three latent classes with ratios of 35.6%, 40.8%, and 23.6%, respectively. The BSQ group (N=104) identified three latent classes with ratios of 14.4%, 43.3%, and 42.3%, respectively.

4.3.3 Latent classes identified within each sub-group

Like Part 1, to identify the patterns of the sleep hygiene subscales of each latent class identified within the three sub-groups, the item-response probabilities were examined. The 8 subscales of sleep hygiene consisted of four response categories, and "75%~" response category meant a high hygiene score, while "~25%" meant a low hygiene score. Sleep hygiene meant that the higher the score, the better the corresponding sleep hygiene.

Good sleep quality (GSQ) group

The item-response probabilities of the two latent classes identified in the GSQ group were presented in Table 13, and Figure 4.

Class 1, which accounted for the smallest proportion of the GSQ group with 19.3%, showed more than half of the class was distributed in "75%~" response in 4 subscales of sleep hygiene: behavioral arousal, sleep environment, sleep stability, and daytime sleep. In terms of the ratio, the sleep environment was very high at 0.84, followed by daytime sleep at 0.65, and sleep stability at 0.61. In the case of physiological, behavioral arousal, cognitive/emotional, and substances, the proportion of subjects with scores above the 50th percentile accounted for more than 60% of the class. However, in substances factor, the response rate of "~25%" was also high at 0.40. The bedtime routine had the lowest response rate of "~25%" as 0, but showed a high value of 0.57 in the "25~50%" response. Class 1 had a high percentage of scores in the 7 subscales of sleep hygiene excluding bedtime routine, and it seemed to have good hygiene for them. This class was a group with a very excellent sleep environment, and it also had good hygiene in the daytime sleep factor.

Class 2 accounted for the largest proportion of the GSQ group at 80.9%. In cognitive/emotional and sleep stability factors, the proportion of subjects with scores above the 50th percentile was very high at 0.80 and 0.83, respectively. On the other hand, the proportion of subjects with scores less than 50th percentile in daytime sleep and bedtime routine was 0.69, 0.61, respectively. Class 2 seemed to have better hygiene of cognitive/emotional factor among the subscales of sleep hygiene than Class 1. However, sleep environment and daytime sleep were found to be worse than Class 1.

It was confirmed whether the two latent classes identified within the GSQ group were statistically different in the subscales of sleep hygiene. As shown in Table 14, there was a statistically significant difference between sleep environment and daytime sleep factors. It was confirmed that Class 1 was higher than Class 2 as the mean value of these two. Therefore, Class 1 was labeled as "*Good sleep environment and daytime sleep hygiene group*", and Class 2 was labeled as "*Bad sleep environment and daytime sleep hygiene group*".

Table 13. Estimated item-response probabilities by latent class membership in Good sleep quality group

<i>Sleep hygiene indicators</i>	Class 1 (n = 22, 19.3%)	Class 2 (n = 93, 80.7%)
Physiological		
75% ~	0.25	0.34
50 ~ 75%	0.44	0.21
25 ~ 50%	0.13	0.31
~ 25%	0.17	0.14
Behavioral arousal		
75% ~	0.53	0.27
50 ~ 75%	0.13	0.24
25 ~ 50%	0.00	0.30
~ 25%	0.34	0.19
Cognitive/Emotional		
75% ~	0.42	0.47
50 ~ 75%	0.40	0.33
25 ~ 50%	0.18	0.17
~ 25%	0.00	0.02
Sleep environment		
75% ~	0.84	0.15
50 ~ 75%	0.06	0.36
25 ~ 50%	0.09	0.25
~ 25%	0.00	0.24
Sleep stability		
75% ~	0.61	0.44
50 ~ 75%	0.17	0.39
25 ~ 50%	0.17	0.16
~ 25%	0.04	0.01
Daytime sleep		
75% ~	0.65	0.09
50 ~ 75%	0.28	0.22
25 ~ 50%	0.07	0.44
~ 25%	0.00	0.25
Substances		
75% ~	0.41	0.16
50 ~ 75%	0.20	0.27
25 ~ 50%	0.00	0.30
~ 25%	0.40	0.27
Bed routine		
75% ~	0.16	0.31
50 ~ 75%	0.27	0.09
25 ~ 50%	0.57	0.23
~ 25%	0.00	0.38

Note. Bolded indices are the highest probabilities in the rows.

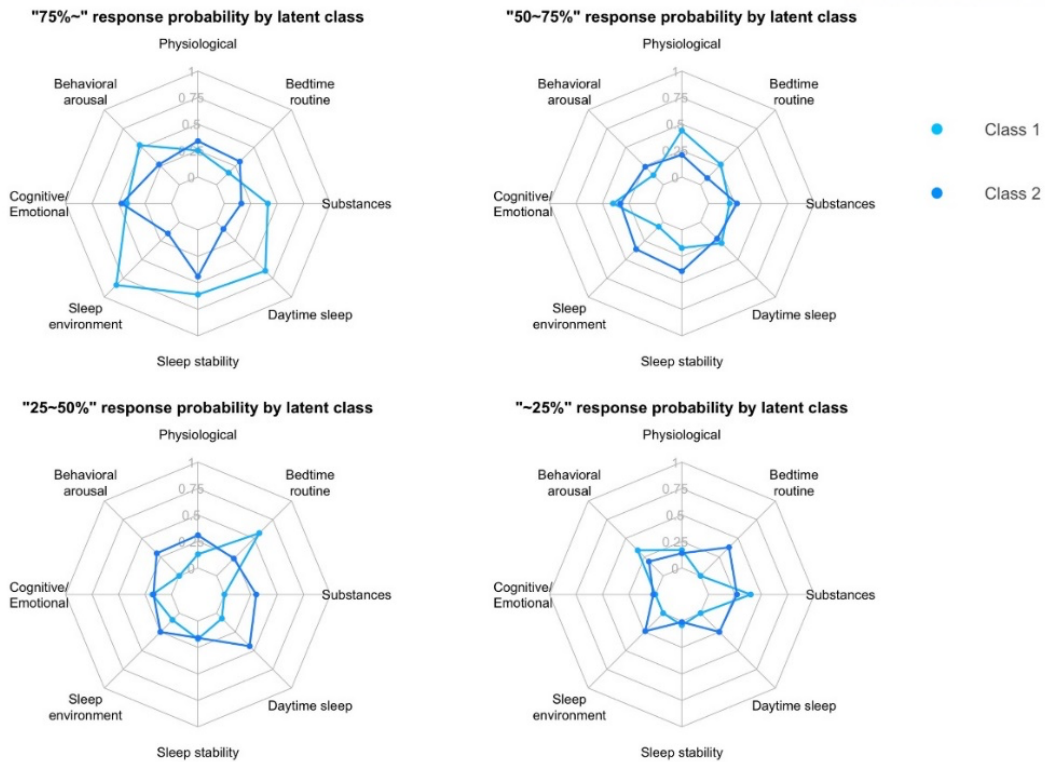


Figure 4. Radial graph of the item-response probability for each response in Good sleep quality group

Table 14. Sleep hygiene subscales between latent classes in Good sleep quality group

	Class 1 ^a	Class 2 ^b	F (p value)	Scheffe $\alpha = 0.05$
	M (SD)	M (SD)		
Physiological	5.20 (0.50)	5.24 (0.56)	0.0797 (0.78)	-
Behavioral arousal	3.49 (1.75)	3.30 (1.23)	0.3536 (0.55)	-
Cognitive/Emotional	5.03 (0.57)	5.06 (0.56)	0.0331 (0.86)	-
Sleep environment	5.95 (0.12)	5.69 (0.41)	9.277**	a > b
Sleep stability	5.45 (0.72)	5.53 (0.55)	0.3562 (0.55)	-
Daytime sleep	5.84 (0.24)	5.27 (0.62)	17.71***	a > b
Substances	5.05 (1.10)	5.31 (0.75)	1.791 (0.18)	-
Bedtime routine	1.77 (1.57)	2.37 (1.99)	1.701 (0.19)	-

Note. ASHS = Adolescent Sleep Hygiene Scale; M = Mean; SD = Standard Deviation.

The higher the mean value, the better the corresponding sleep hygiene subscale.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Middle sleep quality (MSQ) group

The item-response probabilities of the three latent classes identified in the MSQ group were presented in Table 15, and Figure 5.

Class 1 accounted for 35.6% of the MSQ group. They were founded that the proportion of subjects with a score of more than 50th percentile in daytime sleep was high at 0.64, and the "~25%" response rate of bedtime routine was very high at 0.51. For the remaining subscales, the distribution of responses was spread. In the case of sleep environment and substances, the sum of the response ratios of "25-50%" and "50-75%" was 0.86 and 0.70, respectively. Class 1 was found to have a particularly bad bedtime routine among the subscales of sleep hygiene and was found to be slightly better than Class 2 for cognitive/emotional factor.

Class 2 accounted for the largest proportion with 40.8%. In this type, the proportion of subjects with scores above the 50th percentile was high in 6 subscales: physiological (0.68), sleep environment (0.67), sleep stability (0.63), daytime sleep (0.73), substances (0.70), and bedtime routine (0.61). Particularly, the response ratios of "75%~" by sleep environment and daytime sleep were 0.54 and 0.53, respectively, accounting for about half of the class. In the case of the bedtime routine, the response ratio of "~25%" was confirmed to be 0. Class 2 confirmed that the proportion of subjects with high scores for 6 subscales exceeded about 60%, which seemed to be the best sleep hygiene group among the three latent classes identified within the MSQ group. The sleep environment, daytime sleep, and substances factors had the highest percentage of scores compared to other classes, and it was confirmed that sleep hygiene is very good for these factors. In addition, when it came to hygiene problems of bedtime routine, there seemed to be no one who suffers from serious problems.

Class 3 has a 23.6% proportion in the MSQ group. The proportion of subjects with scores less the 50th percentile was identified between approximately 60-90% in 6 subscales: physiological, cognitive/emotional, sleep environment, sleep stability, daytime sleep, and substances. Sleep stability was 0.97, and most of the subjects were distributed, and it was also high in daytime sleep (0.88), physiological (0.83), and cognitive/emotional (0.80). As a result of checking only their "~25%" responses, it was found that the 3 subscales had half the proportion within the class: physiological (0.50), sleep environment (0.57), and daytime sleep (0.57). On the other hand, the percentage of "75%~" responses was very low overall, but in the case of behavioral arousal and bedtime routine, the percentage of "50-75%" responses was high at 0.43. Class 3 seemed to have a large distribution of subjects with low scores within the MSQ group, so it was judged to be the worst type for sleep hygiene. Physiological, sleep environment, sleep stability, and daytime sleep factors were the most problematic.

Table 15. Estimated item-response probabilities by latent class membership in Middle sleep quality group

<i>Sleep hygiene indicators</i>	Class 1 (n = 89, 35.6%)	Class 2 (n = 102, 40.8%)	Class 3 (n = 59, 23.6%)
Physiological			
75% ~	0.24	0.36	0.09
50 ~ 75%	0.25	0.32	0.08
25 ~ 50%	0.35	0.14	0.33
~ 25%	0.16	0.18	0.50
Behavioral arousal			
75% ~	0.28	0.26	0.00
50 ~ 75%	0.20	0.28	0.43
25 ~ 50%	0.30	0.22	0.19
~ 25%	0.22	0.24	0.37
Cognitive/Emotional			
75% ~	0.25	0.25	0.04
50 ~ 75%	0.34	0.23	0.16
25 ~ 50%	0.27	0.28	0.40
~ 25%	0.14	0.24	0.40
Sleep environment			
75% ~	0.00	0.54	0.08
50 ~ 75%	0.48	0.13	0.14
25 ~ 50%	0.38	0.19	0.22
~ 25%	0.14	0.14	0.57
Sleep stability			
75% ~	0.27	0.29	0.00
50 ~ 75%	0.29	0.34	0.03
25 ~ 50%	0.22	0.19	0.56
~ 25%	0.21	0.18	0.41
Daytime sleep			
75% ~	0.16	0.53	0.05
50 ~ 75%	0.48	0.20	0.07
25 ~ 50%	0.22	0.15	0.31
~ 25%	0.14	0.12	0.57
Substances			
75% ~	0.09	0.45	0.16
50 ~ 75%	0.29	0.25	0.17
25 ~ 50%	0.41	0.16	0.22
~ 25%	0.21	0.14	0.44
Bedtime routine			
75% ~	0.25	0.30	0.15
50 ~ 75%	0.16	0.31	0.43
25 ~ 50%	0.07	0.39	0.17
~ 25%	0.51	0.00	0.24

Note. Bolded indices are the highest probabilities in the rows.

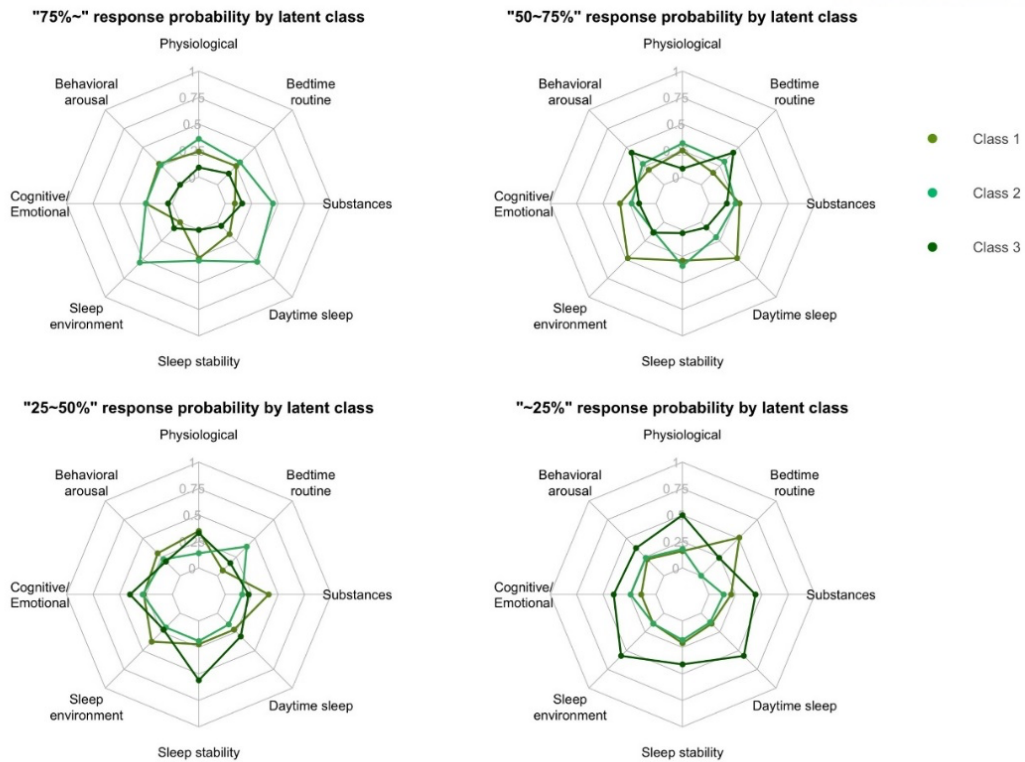


Figure 5. Radial graph of the item-response probability for each response in Middle sleep quality group

Table 16. Sleep hygiene subscales between latent classes in Middle sleep quality group

	Class 1 ^a	Class 2 ^b	Class 3 ^c	F (p value)	Scheffe $\alpha = 0.05$
	M (SD)	M (SD)	M (SD)		
Physiological	5.20 (0.52)	5.24 (0.58)	4.71 (0.62)	18.32***	a, b > c
Behavioral arousal	3.38 (1.23)	3.24 (1.36)	2.65 (0.97)	6.519**	a, b > c
Cognitive/Emotional	4.71 (0.75)	4.49 (0.83)	4.02 (0.82)	13.38***	a, b > c
Sleep environment	5.76 (0.31)	5.75 (0.43)	5.25 (0.65)	27.68***	a, b > c
Sleep stability	4.99 (1.06)	4.92 (1.10)	4.07 (0.91)	16.33***	a, b > c
Daytime sleep	5.56 (0.74)	5.58 (0.68)	4.62 (0.94)	34.58***	a, b > c
Substances	5.27 (0.94)	5.55 (0.65)	5.10 (0.96)	6.161**	b > a, c [†]
Bedtime routine	2.40 (1.90)	2.39 (1.71)	2.29 (1.59)	0.0897 (0.91)	-

Note. ASHS = Adolescent Sleep Hygiene Scale; M = Mean; SD = Standard Deviation.

The higher the mean value, the better the corresponding sleep hygiene subscale.

* $p < .05$, ** $p < .01$, *** $p < .001$.

[†] The significance level was 0.08.

The results of checking whether the three latent classes identified within the MSQ group had statistical differences in subscales were presented in Table 16. There was a significant difference for 7 subscales except the bedtime routine. It was confirmed that Class 3 had a significantly lower mean value than Class 1 and Class 2 in 6 subscales excluding substances and bedtime routine factors. In substance hygiene, Class 2 showed significantly higher mean values than the other two classes at the significance level of 0.08. Based on these results, Class 1 was labeled as “*Bad substances hygiene group*”, Class 2 was labeled as “*Good substances hygiene group*”, and Class 3 was labeled as “*Complex problem hygiene group*”.

Bad sleep quality (BSQ) group

The item-response probabilities of the three latent classes identified in the BSQ group were presented in Table 17, and Figure 6.

Class 1 was 14.4%, the smallest size in the BSQ group compared to other classes. In this type, the proportion of subjects with scores above the 50th percentile was very high at 0.65~0.84 in all subscales except the substances factor. In particular, the response ratio of “75%~” was the highest at 0.61 in the behavioral arousal, and the cognitive/emotional was 0.45. In addition, the “~25%” response ratio of 4 subscales was identified as 0: behavioral arousal, sleep environment, sleep stability, and daytime sleep. However, the “~25%” response ratio of substances factor was the highest at 0.45. Class 1 had good sleep hygiene overall and was identified as a group with excellent hygiene, especially in behavioral arousal, sleep environment, and sleep stability. However, considering the low score ratio of substances, this type seemed to have some problems with that hygiene compared to the others.

Class 2 accounted for 43.3%, and the proportion of subjects with scores less than 50th percentile in cognitive/emotional and sleep stability accounted for more than 80% of the class. Their “~25%” response rates were high at 0.59 and 0.57, respectively. The response distribution in the remaining subscales was spread, but the response ratio of “75%~” by sleep environment, daytime sleep, and substances was slightly higher. In the case of the bedtime routine, the “~25%” response was the lowest at 0.06, but the “25~50%” response was 0.47. Class 2 had the highest percentage of scores in 3 sleep hygiene subscales (sleep environment, daytime sleep, and substances), but the percentage of low scores was also distributed in about half. However, this type had a high percentage of low scores of cognitive/emotional and sleep stability, which is less than Class 3, but it was judged that hygiene problems are poor in the subscales compared to Class 1.

Class 3 accounted for 42.3%, similar to Class 2. In this type, the proportion of subjects with scores less the 50th percentile was identified as about 70% in 6 subscales: physiological, behavioral arousal, cognitive/emotional, sleep environment, sleep stability, and daytime sleep. As a result of examining only their “~25%” response rates, they showed the highest values with cognitive/emotional (0.65), sleep environment (0.63), sleep stability (0.70), and daytime sleep (0.67). On the other hand, the “~25%” response ratio of substances was 0, and it was distributed as 0.57 in “50-75%” response. Class 3 had the highest proportion of low scores in the remaining 6 subscales except for substances and bedtime routine factors. This type was found to have very poor hygiene for the following 5 subscales compared to the other classes: physiological, cognitive/emotional, sleep environment, sleep stability, and daytime sleep. However, substances hygiene was found to be better than the other two types.

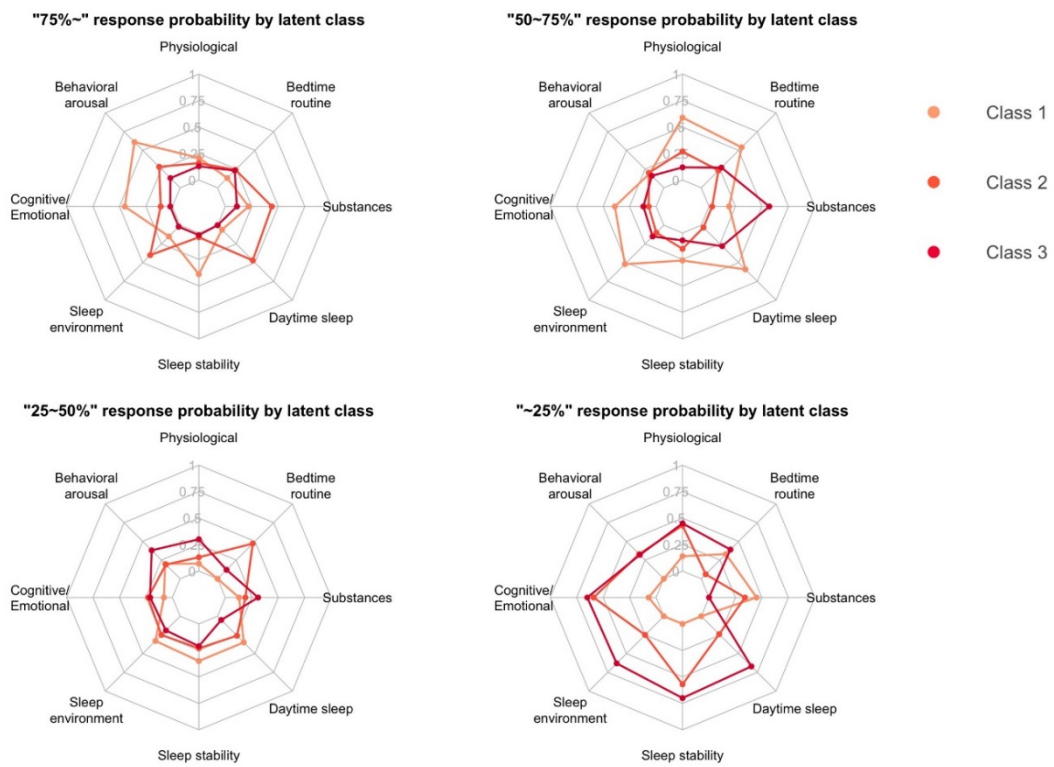


Figure 6. Radial graph of the item-response probability for each response in Bad sleep quality group

Table 17. Estimated item-response probabilities by latent class membership in Bad sleep quality group

<i>Sleep hygiene indicators</i>	Class 1 (n = 15, 14.42%)	Class 2 (n = 45, 43.27%)	Class 3 (n = 44, 42.31%)
Physiological			
75% ~	0.21	0.16	0.13
50 ~ 75%	0.59	0.27	0.12
25 ~ 50%	0.07	0.13	0.30
~ 25%	0.14	0.43	0.45
Behavioral arousal			
75% ~	0.61	0.28	0.13
50 ~ 75%	0.19	0.20	0.16
25 ~ 50%	0.20	0.19	0.38
~ 25%	0.00	0.33	0.32
Cognitive/Emotional			
75% ~	0.45	0.11	0.02
50 ~ 75%	0.39	0.07	0.12
25 ~ 50%	0.08	0.23	0.21
~ 25%	0.07	0.59	0.65
Sleep environment			
75% ~	0.15	0.40	0.02
50 ~ 75%	0.52	0.10	0.15
25 ~ 50%	0.33	0.25	0.19
~ 25%	0.00	0.25	0.63
Sleep stability			
75% ~	0.39	0.04	0.02
50 ~ 75%	0.26	0.15	0.07
25 ~ 50%	0.35	0.23	0.21
~ 25%	0.00	0.57	0.70
Daytime sleep			
75% ~	0.06	0.47	0.00
50 ~ 75%	0.59	0.03	0.28
25 ~ 50%	0.35	0.26	0.05
~ 25%	0.00	0.24	0.67
Substances			
75% ~	0.22	0.44	0.11
50 ~ 75%	0.19	0.03	0.57
25 ~ 50%	0.13	0.19	0.31
~ 25%	0.45	0.34	0.00
Bed routine			
75% ~	0.13	0.24	0.23
50 ~ 75%	0.54	0.23	0.27
25 ~ 50%	0.00	0.47	0.12
~ 25%	0.33	0.06	0.39

Note. Bolded indices are the highest probabilities in the rows.

ANOVA and Scheffe's test were performed to check whether the three latent classes identified within the BSQ group had statistical differences in the subscales of sleep hygiene. As shown in Table 18, statistically significant differences were found in 7 sleep hygiene subscales excluding the bedtime routine. Class 1 showed the highest mean value compared to the other two classes in 3 factors (physiological, cognitive/emotional, and sleep stability), and significantly higher at the significance level of 0.1 in the behavioral arousal factor. The mean of sleep environment and daytime sleep were significantly lower in Class 3 than others, and no significant difference was identified between Class 1 and Class 2. In substances factor, Class 2 was found to be a significantly lower mean value only for Class 3. Thus, Class 1 was labeled as “*Good cognitive/emotional and sleep stability hygiene group*”, Class 2 was labeled as “*Bad substances hygiene group*”, and Class 3 was labeled as “*Bad sleep environment and daytime hygiene group*”.

Table 18. Sleep hygiene subscales between latent classes in Bad sleep quality group

	Class 1 ^a	Class 2 ^b	Class 3 ^c	F (p value)	Scheffe $\alpha = 0.05$
	M (SD)	M (SD)	M (SD)		
Physiological	5.33 (0.42)	4.79 (0.77)	4.72 (0.74)	4.271*	a > b, c
Behavioral arousal	4.23 (1.34)	3.30 (1.45)	2.70 (1.25)	7.413***	a > b, c ^{††}
Cognitive/Emotional	4.84 (0.84)	3.73 (0.92)	3.47 (0.97)	12.19***	a > b, c
Sleep environment	5.84 (0.17)	5.68 (0.45)	5.34 (0.51)	9.474***	a, b > c
Sleep stability	5.23 (0.85)	3.65 (1.29)	3.21 (1.26)	15.17***	a > b, c
Daytime sleep	5.47 (0.67)	5.44 (0.68)	4.20 (1.48)	16.5***	a, b > c
Substances	5.13 (0.97)	4.88 (1.43)	5.72 (0.31)	7.528***	c > b
Bedtime routine	1.73 (1.44)	2.20 (1.77)	2.23 (1.70)	0.5185 (0.6)	-

Note. ASHS = Adolescent Sleep Hygiene Scale; M = Mean; SD = Standard Deviation.

The higher the mean value, the better the corresponding sleep hygiene subscale.

* p < .05, ** p < .01, *** p < .001.

†† The significance level was 0.1.

4.3.4 Characteristics between latent classes within each sub-group

Like the Part 1, an additional analysis was conducted to examine the level of emotional and college-life-related variables between latent classes identified within the three subgroups divided according to the sleep quality level. To this end, ANOVA and Scheffe's post-hoc test were conducted between latent classes within each sub-group.

In the Good sleep quality (GSQ) group, two types of Good SEDH and Bad SEDH were identified. As a result, there was no statistically significant difference between the two types in terms of emotional and college-life related variables (see Table 19).

Table 19. Descriptive statistics between two latent types in Good sleep quality group

	Good SEDH ^a	Bad SEDH ^b	F (p value)
	M (SD)	M (SD)	
ASHS	4.72 (0.26)	4.72 (0.36)	0.0024 (0.96)
PSQI	3.45 (0.86)	3.30 (0.91)	0.5202 (0.47)
PHQ	3.73 (3.69)	3.49 (2.97)	0.0993 (0.75)
GAD	2.32 (2.28)	2.57 (2.94)	0.1413 (0.71)
SRI	20.3 (20.4)	21.1 (17.6)	0.0365 (0.85)
SWLS	24.5 (6.85)	22.6 (5.54)	1.987 (0.16)
ASRS	1.23 (1.45)	1.72 (1.50)	1.951 (0.17)
FMPS	95.2 (18.1)	96.2 (18.7)	0.0437 (0.83)
API	46.8 (14.0)	49.8 (13.2)	0.8833 (0.35)
AUDIT	5.86 (3.54)	6.14 (4.87)	0.06279 (0.8)

Note. SEDH = Sleep Environment and Daytime sleep Hygiene; M = Mean; SD = Standard Deviation; ASHS = Adolescent Sleep Hygiene Scale; PSQI = Pittsburgh Sleep Quality Index; PHQ = Patient Health Questionnaire-9; GAD = Generalized Anxiety Disorder-7; SWLS = Satisfaction With Life Scale; ASRS = Adult attention deficit/hyperactivity disorder Self-Report Scale; FMPS = Frost Multi-dimensional Perfectionism Scale; API = Aitken Procrastination Inventory; AUDIT = Alcohol Use Disorders Identification Test.

The higher the score of ASHS, SWLS, the better. For the rest, the higher the score, the worse.

* $p < .05$, ** $p < .01$, *** $p < .001$.

The Middle sleep quality (MSQ) group was identified as three types: Bad STH, Good STH, and CPH. As a result, all three types showed statistically significant differences in emotional related variables (PHQ, GAD, and SRI), but in college-life related variables, there was a significant difference only in AUDIT (see Table 20). The CPH group had the highest mean value than the other two types in emotional related variables, and there was no statistically significant difference between Bad STH and Good STH. In the case of AUDIT, the Good STH group showed the lowest mean value than the Bad STH and CPH. ASRS and FMPS showed a p-value of 0.067, but when viewed at a significance level of 0.1, it was confirmed that the CPH group tended to show a significantly higher mean value only for Bad STH group.

Table 20. Descriptive statistics between two latent types in Middle sleep quality group

	Bad STH ^a	Good STH ^b	CPH ^c	F (p value)	Scheffe $\alpha = 0.05$
	M (SD)	M (SD)	M (SD)		
ASHS	4.66 (0.38)	4.64 (0.36)	4.09 (0.40)	49.82***	a, b > c
PSQI	6.36 (1.12)	6.30 (1.00)	6.93 (0.94)	7.726***	c > a, b
PHQ	6.42 (4.22)	6.92 (5.17)	8.97 (4.38)	5.663**	c > a, b
GAD	5.07 (4.10)	5.47 (4.21)	7.20 (4.34)	4.922**	c > a, b
SRI	34.9 (21.4)	39.8 (28.5)	52.3 (28.3)	8.063***	c > a, b
SWLS	20.8 (5.75)	21.2 (6.87)	19.4 (5.95)	1.481 (0.23)	-
ASRS	2.20 (1.68)	2.35 (1.68)	2.85 (1.69)	2.73 (0.067)	c > a ^{††}
FMPS	101 (17.8)	104 (17.3)	107 (19.2)	2.236 (0.11)	-
API	51.1 (11.8)	52.0 (12.5)	55.7 (12.1)	2.73 (0.067)	c > a ^{††}
AUDIT	6.94 (5.47)	4.69 (4.68)	7.81 (7.11)	6.929**	a, c > b

Note. STH = Substances Hygiene; CPH = Complex Problem Hygiene; M = Mean; SD = Standard Deviation; ASHS = Adolescent Sleep Hygiene Scale; PSQI = Pittsburgh Sleep Quality Index; PHQ = Patient Health Questionnaire-9; GAD = Generalized Anxiety Disorder-7; SWLS = Satisfaction With Life Scale; ASRS = Adult attention deficit/hyperactivity disorder Self-Report Scale; FMPS = Frost Multi-dimensional Perfectionism Scale; API = Aitken Procrastination Inventory; AUDIT = Alcohol Use Disorders Identification Test.

The higher the score of ASHS, SWLS, the better. For the rest, the higher the score, the worse.

* $p < .05$, ** $p < .01$, *** $p < .001$.

^{††} The significance level was 0.1.

It was confirmed that the Bad sleep quality (BSQ) group was divided into three types: Good CESH, Bad STH, and Bad SEDH. As a result, three types of statistically significant differences were identified between PHQ and SRI in emotional related variables, and FMPS and AUDIT in college-life related variables (see Table 21). The Good CESH group showed significantly lower mean values for PHQ and SRI than the other two types. In the case of FMPS, the Good CESH group showed a low mean value only for the Bad SEDH group, and AUDIT showed a significantly higher mean value only for the Bad STH group. The p-value of GAD was 0.052 but considering that the size of the samples increased in the future, it was confirmed that the Good CESH group tended to show a significantly lower mean value only for the Bad SEDH group.

Table 21. Descriptive statistics between two latent types in Bad sleep quality group

	Good CESH ^a	Bad STH ^b	Bad SEDH ^c	F (p value)	Scheffe $\alpha = 0.05$
	M (SD)	M (SD)	M (SD)		
ASHS	4.73 (0.43)	4.21 (0.50)	3.95 (0.53)	13.41***	a > b > c [†]
PSQI	9.73 (1.03)	10.71 (1.87)	10.43 (1.58)	1.981 (0.14)	-
PHQ	7.27 (3.63)	11.64 (5.81)	12.75 (5.38)	5.859**	b, c > a
GAD	5.40 (3.76)	8.67 (5.24)	9.18 (5.58)	3.042 (0.052)	c > a [†]
SRI	38.9 (20.9)	65.8 (29.6)	69.4 (33.1)	5.97**	b, c > a
SWLS	19.2 (4.43)	17.8 (6.33)	17.4 (7.48)	0.43 (0.65)	-
ASRS	2.60 (1.50)	3.09 (1.76)	3.11 (1.73)	0.5529 (0.58)	-
FMPS	102 (15.7)	112 (17.2)	116 (18.3)	3.366*	c > a
API	55.7 (13.3)	55.8 (12.4)	57.1 (16.1)	0.112 (0.89)	-
AUDIT	6.53 (6.24)	8.16 (8.22)	4.00 (3.81)	4.709*	b > c

Note. CESH = Cognitive/Emotional and Sleep stability Hygiene; STH = Substances Hygiene; SEDH = Sleep Environment and Daytime sleep Hygiene; M = Mean; SD = Standard Deviation; ASHS = Adolescent Sleep Hygiene Scale; PSQI = Pittsburgh Sleep Quality Index; PHQ = Patient Health Questionnaire-9; GAD = Generalized Anxiety Disorder-7; SWLS = Satisfaction With Life Scale; ASRS = Adult attention deficit/hyperactivity disorder Self-Report Scale; FMPS = Frost Multi-dimensional Perfectionism Scale; API = Aitken Procrastination Inventory; AUDIT = Alcohol Use Disorders Identification Test.

The higher the score of ASHS, SWLS, the better. For the rest, the higher the score, the worse.

* p < .05, ** p < .01, *** p < .001.

[†] The significance level was 0.08.

V. Discussion

In the present study, assuming that there will be differences between the levels of sleep hygiene within the subscales in university, the latent classes divided through a latent class analysis were identified. Then, the differences in sleep quality, emotional, and college-life related variables were examined according to the latent classes. It was presented and discussed based on the results revealed through the study as follows.

As a result of classifying the latent classes according to the level of the sleep hygiene subscales for all subjects, three heterogeneous classes were derived. It was confirmed that they depend on the relative average scores of cognitive/emotional and sleep stability factors. That is, they were classified into Good CESH, Middle CESH, and Bad CESH types according to the overall high or low level of those two factors. Cognitive/emotional and sleep stability factors had a positive correlation of 0.44, which is considered to have shown the pattern of these latent classes as they have the highest relevance among the subscales of sleep hygiene. There was no significant difference in the ratio of the three latent types of "Good CESH (37.7%)" with the highest hygiene level of cognitive/emotional and sleep stability about sleep, "Middle CESH (39.9%)", similar to the overall average, and "Bad CESH (22.4%)" with the lowest hygiene level.

As a consequence of the characteristics of each class in more detail, the hygiene level was also low in physiological, behavioral arousal, sleep environment, and daytime sleep among the subscales of sleep hygiene in the case of the Bad CESH group. The Good CESH group showed low levels of hygiene in substances and bedtime routine, while the Middle CESH group showed high levels in sleep environment and daytime sleep. These results suggested that even if the types of sleep hygiene were classified into high, middle, and low groups according to the hygiene level of cognitive/emotional and sleep stability, the patterns in other subscales of sleep hygiene differ and various characteristics appear for each group. Therefore, when devising cognitive behavioral therapy considering the subject's sleep hygiene pattern, it seems necessary to reflect these results to identify the characteristics of each group and prioritize which factors should be intensively considered.

In addition, there were differences in level of sleep quality, emotional and college-life related factors according to latent classes in sleep hygiene. In the case of the Good CESH group, it was confirmed that depression and stress levels tended to be lower than that of the Middle CESH group, and the Bad CESH group showed a very high level of depression, anxiety, and stress. This seems to have appeared as such because the questions corresponding to cognitive/emotional focus on emotions and thinking, which can have a high relationship with the emotional aspect. In fact, a high correlation of 0.54 to 0.6 was confirmed between emotional related factors (depression, anxiety, and stress) and the cognitive/emotional factor of sleep hygiene. The Bad CESH group showed the lowest life satisfaction,

a high level of attention deficit, procrastination, and perfectionism than other groups. These results are in a similar context to the results of (Gau et al., 2007; Sirois et al., 2015; de Azevedo et al., 2009), which reported the relationship between attention deficit, procrastination, perfectionism, and sleep. Accordingly, because of checking the correlation between the sleep hygiene subscales and the factors related to college-life, all showed very low values. However, there may be a causal relationship that has not been confirmed in this study, and further research is needed. The three identified latent classes were also classified into the upper, middle, and lower sleep levels, with the Good CESH group showing very good sleep quality and the Bad CESH group showing very poor sleep quality levels. Accordingly, it was confirmed that there was a very high correlation of 0.5 and 0.58, respectively, between the sleep hygiene of cognitive/emotional and sleep stability, which was the criteria for dividing the three groups.

In the Part 1, although the latent classes were identified as an indicator of sleep hygiene for all subjects, it was confirmed that the sleep quality level was statistically significantly divided into the upper, middle, and lower levels. As a result of correlation analysis, it was confirmed that sleep quality showed a negative correlation of 0.44 with the overall sleep hygiene, and among them, cognitive/emotional and sleep stability factors showed a very high negative correlation. Therefore, in this study, on the contrary, Part 2 was conducted to confirm whether the latent types of sleep hygiene would show a similar context to the results of Part 1 at the level of sleep quality divided into the upper, middle, and lower levels.

Part 2 divided all subjects into three subgroups on a clinical basis for the level of sleep quality and named them Good SQ (≤ 4), Middle SQ (5 ~ 8), and Bad SQ (≥ 9), respectively. The three subgroups showed differences in proportion, with the Middle SQ group accounting for the most with about 54% of all subjects. These subgroups, divided into the upper, middle, and lower levels of sleep quality, also showed significantly upper, middle, and lower levels for the average of total score of sleep hygiene. In other words, the Good SQ group had good sleep quality and sleep hygiene, while the Bad SQ group had poor sleep quality and sleep hygiene. Accordingly, a latent class analysis was conducted in each of the three subgroups to find out in more detail what the subscales of sleep hygiene show according to the sleep quality level. As a result, two latent types were derived in the Good SQ group and three latent types in the Middle SQ group and Bad SQ group, respectively.

First, in the Good SQ group, Good SEDH (19%) and Bad SEDH (89%) were classified according to the hygiene level of sleep environment and daytime sleep. The correlation value between the two factors, which was the basis for dividing the group, was found to be a low value of 0.21. As a result of examining the characteristics between the two distinct types in more detail, Good SEDH showed good hygiene levels in behavioral arousal and sleep stability, and Bad SEDH also showed good hygiene levels in cognitive/emotional. However, there was no significant difference between them in characteristics for emotional and college-life related factors.

Second, in the Middle SQ group, three types were identified: CPH (12.6%), which showed poor hygiene levels for all hygiene subscales, Bad STH (35.6%) and Good STH (40.8%), which were divided according to the hygiene level of substances. In the case of Bad STH type, the level of cognitive/emotional hygiene was high, but there were some problems with the hygiene of the Bedtime routine. On the other hand, the Good STH type showed a high level in sleep environment and daytime factor. The CPH type, which accounts for the smallest percentage within the Middle SQ group, showed very poor levels for seven sleep hygiene subscales, especially for physiological, sleep environment, and daytime sleep. However, the bedtime routine hygiene level of this type was less severe than that of Bad STH. As a result of examining whether these three types showed differences in emotional and college-life related factors, CPH type showed very poor levels in all emotional factors, and Good STH type showed very low levels of alcoholism. In addition, it was confirmed that CPH showed a higher tendency of attention deficit and procrastination than Bad STH.

Finally, the Bad SQ group was divided into three types according to the levels of different sleep hygiene subscales: Good CESH (14.4%) with the best cognitive/emotional and sleep stability, Bad SEDH (42.3%) with the worst sleep environment and daytime sleep, and Bad STH (43%) with the rest. Looking at the characteristics of the three identified types in more detail, Good CESH, which includes the smallest number of people in the Bad SQ group, showed excellent hygiene level even in behavioral arousal, but low hygiene level in substances. Bad SEDH showed low hygiene levels in cognitive/emotional and sleep stability, but substances' hygiene level was good. The Bad STH type, which has bad substances hygiene levels, showed bad cognitive/emotional and sleep stability hygiene, contrary to the Good CESH type, and showed good sleep environment and daytime sleep hygiene, unlike the Bad SEDH type. As a result of checking the difference between the three types of emotional and college-life related factors, Good CESH was found to have very low depression and stress among the types, and Bad SEDH showed a higher level of perfectionism than Good CESH. In addition, although there was no significant difference in emotional characteristics between Bad SEDH and Bad STH, it was confirmed that Bad STH had a higher level of alcoholism than Bad SEDH.

As a result of confirming the latent types of sleep hygiene according to the sleep quality level, a total of 8 latent classes were derived. It was confirmed that each latent class derived within the high, middle, and low sleep quality groups showed different patterns in 8 sleep hygiene subscales. These results suggest that even at the same sleep quality level, there may be different problems between subjects in terms of sleep hygiene. In other words, as can be seen in the Middle SQ group, although it has the same level of sleep quality, there may be a type in which sleep hygiene is a problem in combination or a type that has a problem in terms of substances. In addition, it was revealed that these heterogeneous types differ in characteristics related to emotional and college-life. Unlike the results of Part 1, the Part 2 confirmed that sleep hygiene can be very good even if sleep quality is poor through

the Good CESH type identified in the Bad SQ group. Indeed, this type showed similar levels of sleep hygiene to the two latent types of good SQ group (Appendix). Also, it was divided into two types in the Good SQ group, but it was shown that even if the quality of sleep was good, some sleep hygiene may be experiencing some problems.

The significance and implications of this current study derived based on the above results are as follows. First, it is significant in that the form of sleep in university is identified in various types from the perspective of sleep hygiene, and the strengths and weaknesses of each type are identified. Second, these information can be used as materials for presenting cognitive-behavioral therapy (CBT) suitable for each type in the actual treatment scene. One of the therapeutic interventions is not only to solve the problem that the client complains of, but also to help them maintain the good points of those clients. Therefore, the results of this study can select and present treatments in a priority aspect to the client by examining the characteristics of each type in more detail. Third, it is significant in that it explored the relationship between the subscales of sleep hygiene and sleep quality by simultaneously considering the aspects of those two for sleep problems. In addition, the potential association between sleep hygiene and emotional and college-life related factors was identified. This provides a variety of information and is expected to help future studies dealing with sleep hygiene.

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Appendix

Table A- 1. Items of Adolescent Sleep Hygiene Scale (ASHS)

Factor	Item	Mean (SD)
Physiological	3. After 6:00 in the evening, I have drinks with caffeine (e.g., cola, root beer, iced tea, coffee) 10. During the 1 hour before bedtime, I am very active (e.g., playing outside, running, wrestling) 12. During the 1 hour before bedtime, I drink more than 4 glasses of water (or some other liquid) 18. I go to bed with a stomachache 19. I go to bed feeling hungry	5.07 (0.64)
Behavioral Arousal	11. During the 1 hour before bedtime, I do things that make me feel very awake (e.g., playing video games, watching TV, talking on the telephone) 13. I go to bed and do things in my bed that keep me awake (e.g., watching TV, reading) 28. I use my bed for things other than sleep (e.g., talking on the telephone, watching TV, playing video games, doing homework)	3.20 (1.32)
Cognitive/Emotional	9. During the 1 hour before bedtime, things happen that make me feel strong emotions (e.g., sadness, anger, excitement) 14. I go to bed and think about things I need to do 15. I go to bed feeling upset 16. I go to bed and replay the day's events over and over in my mind 17. I go to bed and worry about things happening at home or at school 29. I check my clock several times during the night	4.45 (0.93)
Sleep Environment	20. I fall asleep while listening to loud music 21. I fall asleep while watching TV 22. I fall asleep in a brightly lit room (e.g., the overhead light is on) 23. I fall asleep in one place and then move to another place during the night 24. I fall asleep in a room that feels too hot or too cold	5.64 (0.48)
Sleep Stability	30. During the school week, I stay up more than 1 hour past my usual bedtime 32. On weekends, I stay up more than 1 hour past my usual bedtime 33. On weekends, I "sleep in" more than 1 hour past my usual wake time	4.70 (1.24)
Daytime Sleep	1. During the day, I take a nap that lasts more than 1 hour 4. After 6:00 in the evening, I take a nap	5.26 (0.93)
Substances	6. After 6:00 in the evening, I smoke or chew tobacco 7. After 6:00 in the evening, I drink beer (or some other drinks with alcohol)	5.31 (0.90)
Bedtime Routine	27. I use a bedtime routine (e.g., bathing, brushing teeth, reading)	2.29 (1.78)

Table A-2. Correlation

1	1**																		
2	0.12*	1**																	
3	0.37**	0.26**	1**																
4	0.26**	0.3**	0.21**	1**															
5	0.27**	0.25**	0.44**	0.27**	1**														
6	0.25**	0.1*	0.21**	0.21**	0.2**	1**													
7	0.13**	-0.02	-0.03	0	0.01	-0.07	1**												
8	-0.05	-0.11*	-0.01	-0.08	0.02	0.03	0.04	1**											
9	0.48**	0.51**	0.59**	0.41**	0.64**	0.45**	0.25**	0.42**	1**										
10	-0.25**	-0.07	-0.5**	-0.18**	-0.58**	-0.18**	-0.01	-0.02	-0.44**	1**									
11	-0.28**	-0.15**	-0.54**	-0.22**	-0.38**	-0.18**	0	-0.04	-0.44**	0.57**	1**								
12	-0.28**	-0.12**	-0.6**	-0.19**	-0.32**	-0.15**	0.02	-0.05	-0.4**	0.48**	0.8**	1**							
13	-0.32**	-0.2**	-0.59**	-0.27**	-0.37**	-0.15**	-0.01	0.01	-0.44**	0.55**	0.79**	0.79**	1**						
14	0.14**	0.19**	0.36**	0.14**	0.27**	0.08	0.04	0.03	0.32**	-0.33**	-0.55**	-0.5**	-0.5**	1**					
15	-0.18**	-0.21**	-0.24**	-0.18**	-0.2**	-0.12**	-0.05	0.03	-0.27**	0.3**	0.43**	0.36**	0.47**	-0.27**	1**				
16	-0.18**	-0.03	-0.39**	-0.11*	-0.23**	-0.09*	0.04	0.07	-0.2**	0.34**	0.44**	0.49**	0.45**	-0.31**	0.19**	1**			
17	-0.1*	-0.26**	-0.13**	-0.19**	-0.19**	-0.11*	-0.07	-0.05	-0.29**	0.19**	0.35**	0.22**	0.34**	-0.29**	0.62**	-0.03	1**		
18	-0.09*	0	0.02	-0.09	0.01	0.08	-0.54**	-0.06	-0.15**	0	-0.01	-0.03	0.03	-0.02	0.09*	0.04	0.08	1**	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	

Note. 1 = Physiological, 2 = Behavioral arousal, 3 = Cognitive/Emotional, 4 = Sleep environment, 5 = Sleep stability, 6 = Daytime sleep, 7 = Substances, 8 = Bedtime routine; 9 = Sleep hygiene, 10 = Sleep quality, 11 = Depression, 12 = Anxiety, 13 = Stress, 14 = Life satisfaction, 15 = Attention deficit, 16 = Perfectionism, 17 = Procrastination, 18 = Alcoholism. 1~8 are 8 subscales of sleep hygiene. 11~13 are emotional related factors, 14~18 are college-life related factors.

Table A- 3. Sleep hygiene subscales between 8 latent classes

	Good SQ		Middle SQ			Bad SQ			F(p value)	Scheffe $\alpha = 0.05$
	Class 1 M (SD)	Class 2 M (SD)	Class 3 M (SD)	Class 4 M (SD)	Class 5 M (SD)	Class 6 M (SD)	Class 7 M (SD)	Class 8 M (SD)		
Physiological	5.20 (0.50)	5.24 (0.56)	5.20 (0.52)	5.24 (0.58)	4.71 (0.62)	5.33 (0.42)	4.79 (0.77)	4.72 (0.73)	9.915***	3 > 5,8
Behavioral arousal	3.49 (1.75)	3.30 (1.23)	3.38 (1.23)	3.24 (1.36)	2.65 (0.97)	4.23 (1.34)	3.30 (1.45)	2.70 (1.25)	4.362***	6 > 5,8 1 > 5,7,8
Cognitive/Emotional	5.03 (0.57)	5.06 (0.55)	4.71 (0.75)	4.49 (0.83)	4.02 (0.82)	4.84 (0.84)	3.73 (0.92)	3.47 (0.97)	29.68***	2 > 4,5,7,8 4 > 7,8 3,6 > 7,8 1,2,3,4,6 >
Sleep environment	5.95 (0.12)	5.69 (0.41)	5.76 (0.31)	5.75 (0.43)	5.25 (0.65)	5.84 (0.17)	5.68 (0.45)	5.34 (0.51)	13.88***	5,8 7 > 5 2 > 4 > 5,7,8
Sleep stability	5.45 (0.72)	5.53 (0.55)	4.99 (1.06)	4.92 (1.10)	4.07 (0.91)	5.23 (0.85)	3.65 (1.29)	3.21 (1.26)	37.77***	1,3,6 > 5,7,8 5 > 8
Daytime sleep	5.84 (0.24)	5.27 (0.62)	5.56 (0.74)	5.58 (0.68)	4.62 (0.94)	5.47 (0.67)	5.44 (0.68)	4.20 (1.48)	22.04***	1,3,4 > 5,8 2,6,7 > 8
Substances	5.05 (1.10)	5.31 (0.74)	5.27 (0.91)	5.55 (0.65)	5.10 (0.95)	5.13 (0.97)	4.88 (1.43)	5.72 (0.31)	4.934***	8 > 1,5,7 4 > 7
Bedtime routine	1.77 (1.57)	2.37 (1.99)	2.40 (1.90)	2.39 (1.71)	2.29 (1.59)	1.73 (1.44)	2.20 (1.77)	2.23 (1.70)	0.623 (0.737)	-

Note. SQ = Sleep Quality; M = Mean; SD = Standard Deviation.

Class 1 = Good Sleep Environment and Daytime sleep Hygiene; Class 2 = Bad Sleep Environment and Daytime sleep Hygiene;

Class 3 = Bad Substances Hygiene; Class 4 = Good Substances Hygiene; Class 5 = Complex Problem Hygiene;

Class 6 = Good Cognitive/Emotional and Sleep stability Hygiene; Class 7 = Bad Substances Hygiene; Class 8 = Bad Sleep Environment and Daytime sleep Hygiene.

The higher the mean value, the better the corresponding sleep hygiene subscale.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table A- 4. Descriptive statistics between 8 latent classes

	Good SQ		Middle SQ			Bad SQ			F (p value)	Scheffe $\alpha = 0.05$
	Class 1 M (SD)	Class 2 M (SD)	Class 3 M (SD)	Class 4 M (SD)	Class 5 M (SD)	Class 6 M (SD)	Class 7 M (SD)	Class 8 M (SD)		
ASHS	4.72 (0.26)	4.72 (0.36)	4.66 (0.38)	4.64 (0.36)	4.09 (0.40)	4.73 (0.43)	4.21 (0.50)	3.95 (0.53)	33.54***	1,2,3,4,6 > 5,7,8
PSQI	3.45 (0.86)	3.30 (0.91)	6.36 (1.12)	6.30 (1.00)	6.93 (0.94)	9.73 (1.03)	10.71 (1.87)	10.43 (1.58)	293.2***	6,7,8 > 3,4,5 > 1,2
PHQ	3.73 (3.69)	3.49 (2.97)	6.42 (4.22)	6.92 (5.17)	8.97 (4.38)	7.27 (3.63)	11.64 (5.81)	12.75 (5.38)	28.27***	8 > 1,2,3,4,5,6 7 > 1,2,3,4 5 > 1,2
GAD	2.32 (2.28)	2.57 (2.94)	5.07 (4.10)	5.47 (4.21)	7.20 (4.34)	5.40 (3.76)	8.67 (5.24)	9.18 (5.58)	18.55***	7,8 > 1,2,3,4,6 4,5 > 1,2
SRI	20.32 (20.39)	21.14 (17.58)	34.89 (21.39)	39.83 (28.52)	52.32 (28.32)	38.87 (20.93)	65.76 (29.61)	69.39 (33.10)	26.58***	7,8 > 1,2,3,4,6 5 > 1,2,3 4 > 1,2
SWLS	24.50 (6.85)	22.56 (5.54)	20.81 (5.75)	21.18 (6.87)	19.44 (5.95)	19.20 (4.43)	17.76 (6.33)	17.36 (7.48)	6.086***	1,2 > 7,8
ASRS	1.23 (1.45)	1.72 (1.50)	2.20 (1.68)	2.35 (1.68)	2.85 (1.69)	2.60 (1.50)	3.09 (1.76)	3.11 (1.73)	6.994***	5,7,8 > 1,2
FMPS	95.23 (18.12)	96.15 (18.73)	100.75 (17.75)	103.50 (17.27)	107.10 (19.17)	102.27 (15.68)	112.38 (17.25)	115.84 (18.30)	8.045***	8 > 1,2,3,4,6 7 > 1,2
API	46.82 (14.05)	49.80 (13.20)	51.15 (11.83)	51.95 (12.47)	55.73 (12.13)	55.67 (13.35)	55.76 (12.42)	57.07 (16.10)	3.194**	-
AUDIT	5.86 (3.54)	6.14 (4.87)	6.94 (5.47)	4.69 (4.68)	7.81 (7.11)	6.53 (6.24)	8.16 (8.22)	4.00 (3.81)	3.786***	-

Note. SQ = Sleep Quality; M = Mean; SD = Standard Deviation; ASHS = Adolescent Sleep Hygiene Scale; PSQI = Pittsburgh Sleep Quality Index; PHQ = Patient Health Questionnaire-9; GAD = Generalized Anxiety Disorder-7; SWLS = Satisfaction With Life Scale; ASRS = Adult attention deficit/hyperactivity disorder Self-Report Scale; FMPS = Frost Multi-dimensional Perfectionism Scale; API = Aitken Procrastination Inventory; AUDIT = Alcohol Use Disorders Identification Test.

Class 1 = Good Sleep Environment and Daytime sleep Hygiene; Class 2 = Bad Sleep Environment and Daytime sleep Hygiene;

Class 3 = Bad Substances Hygiene; Class 4 = Good Substances Hygiene; Class 5 = Complex Problem Hygiene;

Class 6 = Good Cognitive/Emotional and Sleep stability Hygiene; Class 7 = Bad Substances Hygiene; Class 8 = Bad Sleep Environment and Daytime sleep Hygiene.

The higher the score of ASHS, SWLS, the better. For the rest, the higher the score, the worse.

* p < .05, ** p < .01, *** p < .001.

