HOW WE TEACH | *Generalizable Education Research*

Factors influencing the National License Examination step 1 score in preclinical medical students

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Lertwilaiwittaya P, Sitticharoon C, Maikaew P, Keadkraichaiwat I. Factors influencing the National License Examination step 1 score in preclinical medical students. *Adv Physiol Educ* 43: 306–316, 2019; doi:10.1152/advan.00197.2018.—The National License Examination step 1 (NLE1), which tests basic medical sciences knowledge in Thailand, is considered to be tough and stressful for medical students due to the large amount of content. This study aimed to determine factors influencing the NLE1 score (NLE1S). The NLE1S, academic achievement, and class attendance were obtained officially. Other factors, including study habits, were obtained via a questionnaire, with 81.97% (241/294) being returned. Students were divided into four groups according to the central passing score and Z-score of the NLE1S, including the fail ($<52\%$; $n = 13$), low-pass (52 to $<70\%$; $n = 121$), high-pass (70 to $<80\%$; $n = 89$), and excellent ($\geq 80\%$; $n = 18$) groups. Men had higher NLE1S ($P < 0.001$) and comprehensive examination scores ($P < 0.001$) than women. Students with high motivation to study medicine had higher NLE1S. Daily preparation time (h/day) was lower, but stress was higher, in the fail group. In the excellent group, internet for academic use and achievement of study targets were higher; internet for nonacademic use, instance of absence, and stress were lower; and check-in time was earlier. The NLE1S had strong positive correlations with the comprehensive examination score and academic achievement during preclinical studies. By setting the NLE1S as a dependent variable in multivariate regression analyses, models of significant interactions were observed by setting behavioral factors, the comprehensive examination score, and academic achievement during a regular class as independent variables. Thus exhibiting good study habits and showing good academic performance throughout preclinical studies should be encouraged among students to achieve a good NLE1S.

achievement; motivation; national license examination; preclinic; study habits

INTRODUCTION

In Thailand, the National License Examination step 1 (NLE1) held by the Center of Medical Competency Assessment and Accreditation (CMA) is considered to be equivalent to the U. S. Medical Licensing Examination (USMLE) step 1. The NLE1 is composed of 300 standardized multiple-choice questions (MCQ) testing preclinical knowledge. The examination is held at the end of the preclinical years. Preparation for the NLE1 causes students to be stressed due to the large amount of medical content. Student behaviors, including regular class

attendance and appropriate time management, have been recommended for students' exam preparation without confirmative evidences.

The USMLE step 1 score was shown to be associated with learning style (27), National Board of Medical Examiners Comprehensive Basic Science Examination score, UWorld Question Bank, and financial need, but were not associated with age and prior medical training (16). Furthermore, previous studies showed that all components of the Medical College Admissions Test (MCAT) scores, including biological sciences, physical sciences, and verbal reasoning, were positively, albeit weakly, associated with the USMLE step 1 scores (9, 15, 38).

For the NLE1 score, residence background, grade point average (GPA) of preclinical years, good learning behaviors, attitude toward learning in the classrooms, concentration on class activity, and good preparation for the examination were shown to be positively associated (31, 34). However, a previous study, which asked the participants to rate each question on a 1–5 scale of agreement, did not reveal substantial attitude, activity, or study habits of participants (31). Quantifiable factors regarding attitude, activities, or behaviors of students that have positive influences on the NLE1 score have not been studied. A previous study showed that motivation to study medicine, satisfaction in learning subjects, achievement of study targets, having friends with common educational interest, group learning, regular self-study after class, and short duration of internet use for nonacademic purpose had positive effects on academic outcome (29). These factors have not been studied in the NLE1.

This study aimed to identify factors influencing the NLE1 score, including students' demographic data, behavior, and preparation methods to guide medical students and mentors to mutually create an optimal educational environment and support a life-long learner attitude in medical students. Evidence-based analysis of factors influencing the NLE1 outcome could guide students to prepare for the NLE1 with efficient time allocation and would benefit mentors in identifying students who are at risk of failing the examination. Good study habits might be able to cultivate a good mindset in medical students, which might lead to a better outcome.

MATERIALS AND METHODS

Study protocol. The study protocol was approved by the Siriraj Institutional Review Board (certificate of analysis no. Si82/2014). Written, informed consents were obtained from all participants. Subjects of this study were enrolled from the first clinical year medical students of the 2016 class that participated in the NLE1 in March

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2014. The questionnaires were sent out to all 294 first-year clinical students during the beginning of the first clinical year, which was 4 mo after taking the NLE1, with 241 (81.97%) being returned.

Type of curriculum and course setup. The curriculum of the Doctor of Medicine program at the Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand, is a 6-yr course. Thai medical students are enrolled in medical schools after graduation from high school. The average age of students when entering the medical school is ~19 yr old. In this study, the average age of participants was ~21 yr old. The first year (*year 1*), which is a premedical year, comprises basic sciences and general education subjects. The second (*year 2*) and the third year (*year 3*) are the first and the second preclinical years, respectively. In the first preclinical year, the subjects in the curriculum include gross anatomy, physiology, biochemistry, histology, neuroanatomy, embryology, and minor subjects. Subjects taught in the second preclinical year include pathology, clinical pathology, pharmacology, parasitology, microbiology, immunology, and minor subjects. In both preclinical years, teaching was conducted by lectures, practical sessions, and group discussion, with several clinical case scenarios related to particular contents. After completion of the second preclinical year, the students enter the clinical years, which are the fourth, fifth, and sixth years.

At the end of the second preclinical year, students have to take the comprehensive examination, which is the MCQ examination, testing basic preclinical knowledge, similar to the NLE1, organized by the faculty. The comprehensive examination score was used for students' feedback before they took the NLE1. Students who complete the second preclinical year are eligible to take the NLE1 organized by the CMA.

Questionnaire. The Thai-language questionnaire was given to students as a self-report form, which included box-ticking, stress level scale rating, and writing numerical data. The questions used were classified into three aspects, including demographic data, preparation methods for the NLE1, and student behaviors during a regular class period and a period approaching the NLE1.

The demographic data aspect included sex, body weight (kg), height (cm), type of entrance, including quota (students with academic achievement in the national academic Olympiad program and students who are excellent in arts and sports), direct admission from the Consortium of Thai Medical Schools and One District One Doctor program (program for physician production for each rural district), and motivation to study medicine (high, medium, and low motivation). The questionnaire asked the students to provide their self-assessed motivation in three levels, including high, medium, and low motivation to study medicine.

Preparation method aspect included examination expectation, total preparation time (mo) in a regular period, total preparation time (mo) in a period approaching the NLE1, daily preparation time (h/day) in a regular period, and daily preparation time (h/day) in a period approaching the NLE1. Examination expectation, an arbitrary number, is defined as the self-reported prediction of the students' expected NLE1 percentile score or, generally speaking, what mark they thought they would get. The regular period means the period during regular classes. In this period, students had to attend regular classes and started to prepare for the NLE1. On the other hand, the period approaching the NLE1 is the period during which students intensively prepared for the NLE1. Both periods were determined by an individual student based on how long he/she generally began to prepare for the NLE1 (the regular period) or intensively prepare for the NLE1 (the period approaching the NLE1). Please note that students had a 1-mo-long semester break before taking the NLE1. As a result, the period approaching the NLE1 might overlap with the semester break.

Student behaviors during the regular period and the period approaching the NLE1 included time spent on lecture review (h/day), exercise (h/wk), internet use for the academic purpose (h/day), internet use for the nonacademic purpose (h/day), individual study (h/wk), and group study (h/wk), night sleep period (h/night), dormitory stay [day(s)/wk], stress level on a scale of 1–5 (1 for the minimal stress

level and 5 for the maximal stress level), and the percentage of achievement of study targets, which is defined as the percentage of study content that students had achieved over their targets of intended content coverage before the NLE1. Dormitory stay is defined as the amount of time spent in the provided common dormitory. The faculty provides common dormitory for all medical students to promote group study among students. The question aimed to determine preference of student accommodation between the regular period and the period approaching examination.

The NLE1 score, academic achievement, and class attendance. The NLE1 score was obtained officially from the CMA. The selected questions of the NLE1 are standardized by the modified Angoff method. The passing score is calculated by the following formula: acceptable index – 1.96 × SE of mean. The average score was 180.78/300 or 60.26%, with a standard deviation of 33/300 or 11%. The pass mark was 52%. Academic achievement, including GPA, score of subjects taught in a certain academic year, cumulative GPA (cGPA), and the comprehensive examination score, and class attendance, including the check-in time and instance(s) of lateness and absence per academic year [instance(s)/yr] were officially obtained from the undergraduate education department. According to the university rules, attendance in both theory and practical classes of ≥80% is required for students to be eligible to take the exam.

Subgroup analysis. Students were categorized into four groups according to the NLE1 score, including the fail group (scoring lower than a minimal passing level of 52%; $n = 13$), the low-pass group (scoring 52 to <70%; $n = 121$), the high-pass group (scoring from 70 to <80%; $n = 89$), and the excellent group (scoring ≥80%; $n = 18$). The cut point used to define the low-pass and high-pass groups is derived from +1 Z-score, or 70%, for the low-pass group, and +2 Z-score, or 80%, for the high-pass group.

Statistical analysis. Data were analyzed by Statistical Package for Social Science (SPSS) version 18. Kolmogorov-Smirnov test was performed to test the normal distribution of data. Nonparametric test, including the χ^2 test and the binomial test, were used to determine the difference in percent distribution. The paired sample *t*-test was used to compare factors between the regular period and the period approaching the NLE1. The independent-sample *t*-test was used for comparisons between men and women, where the one-way analysis of variance was used for comparisons of more than two groups. Post hoc analyses were performed, as appropriate, using Fisher's least significant difference test. The Pearson product-moment correlation coefficient was used to determine correlations between two factors. Multiple linear regression was analyzed to calculate the factors that highly contributed to the NLE1 score by the stepwise method. In the analyses, two different sets of independent factors were applied, consisting of *1*) behavioral factors alone, and *2*) behavioral factors and academic achievement factors, including the comprehensive examination score and scores of subjects taught in the first and the second preclinical years. A nonparametric test was used for nonnormally distributed data and ordinal variables. A *P* value of <0.05 was considered statistically significant.

RESULTS

Demographic data of subjects. Demographic data of subjects, including sex, body mass index (BMI), type of entrance, motivation, examination expectation, and class attendance, are shown in Table 1. In this study, the sex distribution was quite equal (51.04% men and 48.96% women). Most of students were in the normal range of BMI (62.24%), whereas few of them were lean (16.19%), overweight (12.86%), and obese (8.71%). Most of the students were recruited from the entrance examination (87.14%), followed by quota (11.62%), and the One Doctor One District program (1.24%). Few students had low motivation to study medicine (7.88%), whereas most of

Table 1. *Demographic data of subjects*

		n
Sex, %		
Male	51.04	123
Female	48.96	118
BMI group, %		
Lean (<18.5 kg/m^2)	16.19*	39
Normal (18.5–22.9 kg/m^2)	62.24	150
Overweight (23.0–24.9 kg/m^2)	12.86*	31
Obese (≥25 kg/m^2)	8.71*†	21
Type of entrance, %		
Entrance examination	87.14	210
Quota	11.62*	28
One Doctor One District	1.24*‡	3
Motivation, %		
Low	7.88	19
Medium	40.25*	97
High	51.87*	125
Examination expectation, %tile	70.99	
Class attendance, instance(s)/yr		
Absence	7.39	
Lateness	2.59	

Values for sex, body mass index (BMI) group, type of entrance, and motivation are shown as a percentage. Values for examination expectation and class attendance are shown in percentile and instance(s)/yr, respectively. $n = 241$ Respondents. Descriptive statistics were used to perform data analysis. Comparisons of percentages between groups were analyzed by the χ^2 test and the binomial test. *$P < 0.001$ compared with the normal group, entrance examination group, or the low-motivation group. †$P < 0.05$ compared with the lean group. ‡$P < 0.001$ compared with the quota group.

them had medium (40.25%) and high (51.87%) motivation to study medicine. The mean percentile of examination expectation of students was 70.99. For class attendance, the instances of absence and lateness were 7.39 and 2.59 times per year, respectively.

Comparisons of factors between the regular period and the period approaching the NLE1. Comparisons of factors between the regular period and the period approaching the NLE1 are shown in Table 2. Mean ± SE for the total preparation time in the regular period was 1.93 ± 0.1 mo, whereas mean ± SE for the total preparation time in the period approaching the NLE1 was 0.89 ± 0.06 mo. Daily preparation time in the period approaching the NLE1 (6.51 h/day) was significantly

Table 2. *Comparisons of factors between the regular period and the period approaching the NLE1*

Factor	Regular Period	Period Approaching the NLE1
Total preparation time, mo	1.93 ± 0.10	0.89 ± 0.06‡
Daily preparation time, h/day	1.97 ± 0.13	6.51 ± 0.22‡
Internet for academic use, h/day	1.15 ± 0.10	1.94 ± 0.32†
Internet for nonacademic use, h/day	3.23 ± 0.14	2.67 ± 0.14‡
Self-study, h/wk	8.04 ± 0.56	26.71 ± 1.67‡
Group study, h/wk	1.59 ± 0.20	3.09 ± 0.64*
Achievement of study targets, %	59.31 ± 1.61	70.62 ± 1.29‡
Sleep period, h/night	6.55 ± 0.27	6.98 ± 0.41
Exercise time, h/wk	2.85 ± 0.19	1.55 ± 0.16‡
Dormitory stay, days/wk	4.83 ± 0.14	4.02 ± 0.22‡
Stress level	2.78 ± 0.07	3.67 ± 0.07‡

Values are means ± SE; $n = 241$ respondents. Stress level is on a 5-point scale (1 = extremely low, 2 = low, 3 = moderate, 4 = high, 5 = extremely high). NLE1, National License Examination step 1. Data were analyzed by the paired sample *t*-test. *$P < 0.05$. †$P < 0.01$. ‡$P < 0.001$.

Table 3. *Comparisons of factors between men and women*

Factor	Men	Women
NLE1 score	206.79 ± 1.92	196.73 ± 2.11‡
Year 3 GPA	3.23 ± 0.04	3.20 ± 0.33
cGPA	3.34 ± 0.03	3.31 ± 0.03
Comprehensive examination score	190.70 ± 2.26	178.41 ± 2.16‡
Instance(s) of lateness/year	3.38 ± 0.44	1.76 ± 0.32†
Instance(s) of absence/year	10.34 ± 0.80	4.30 ± 0.46‡
Examination expectation, %	72.38 ± 1.44	69.24 ± 1.41
BMI, kg/m^2	22.18 ± 0.29	19.69 ± 0.21‡
Total preparation time, mo		
Regular period	1.71 ± 0.10	2.18 ± 0.17*
Period approaching NLE1	0.89 ± 0.09	0.88 ± 0.05
Daily preparation time, h/day		
Regular period	1.89 ± 0.15	2.08 ± 0.22
Period approaching NLE1	6.20 ± 0.32	6.89 ± 0.30
Internet for academic use, h/day		
Regular period	1.00 ± 0.11	1.34 ± 0.17*
Period approaching NLE1	1.99 ± 0.56	1.88 ± 0.20
Internet for nonacademic use, h/day		
Regular period	3.34 ± 0.20	3.09 ± 0.19
Period approaching NLE1	2.73 ± 0.21	2.58 ± 0.18
Self-study, h/wk		
Regular period	7.19 ± 0.77	9.08 ± 0.76†
Period approaching NLE1	24.9 ± 2.27	28.89 ± 2.46
Group study, h/wk		
Regular period	1.82 ± 0.31	1.26 ± 0.21
Period approaching NLE1	3.69 ± 0.90	2.14 ± 0.81
Achievement of study targets, %		
Regular period	60.43 ± 2.19	57.93 ± 2.38
Period approaching NLE1	70.85 ± 1.89	70.35 ± 1.71
Sleep period, h/night		
Regular period	6.67 ± 0.49	6.41 ± 0.11
Period approaching NLE1	7.46 ± 0.74	6.39 ± 0.16
Exercise, h/wk		
Regular period	3.41 ± 0.29	2.14 ± 0.20‡
Period approaching NLE1	1.76 ± 0.24	1.27 ± 1.20
Dormitory stay, day/wk		
Regular period	4.91 ± 0.22	4.73 ± 0.16
Period approaching NLE1	4.20 ± 0.32	3.80 ± 0.29
Stress level		
Regular period	2.63 ± 0.09	2.97 ± 0.09
Period approaching NLE1	3.5 ± 0.09	3.87 ± 0.09†

Values are means ± SE; $n = 241$ respondents. Stress level is on a 5-point scale (1 = extremely low, 2 = low, 3 = moderate, 4 = high, 5 = extremely high). NLE1, National License Examination step 1. Data were analyzed by the independent sample *t*-test and a nonparametric test (for stress level). *$P < 0.05$. †$P < 0.01$. ‡$P < 0.001$.

increased ($P < 0.001$) from the regular period (1.97 h/day), an increase of ~4.5 h/day. Internet for academic use (h/day), both self- and group studies (h/wk), achievement of study targets (percentage), and the stress level were significantly higher in the period approaching the NLE1, compared with the regular period ($P < 0.05$ all). On the other hand, internet for nonacademic use (h/day), exercise time (h/wk), and dormitory stay [day(s)/wk] were significantly lower in the period approaching the NLE1 than in the regular period ($P < 0.05$ all). Sleep period (h/night) was comparable between the regular period and the period approaching the NLE1.

Comparisons of factors between men and women. Comparisons of factors between men and women are shown in Table 3. The NLE1 and comprehensive examination scores were significantly higher in men than in women ($P < 0.001$ all). *Year 3* GPA, cGPA, and examination expectation were comparable between men and women. Instances of lateness/academic year and absence/academic year were significantly

higher in men compared with women ($P < 0.01$ all). BMI of men was significantly higher than that of women ($P < 0.001$). In the regular period, total preparation time (mo), time spent on internet for academic use (h/day), and time spent on self-study (h/wk) were significantly lower in men than in women, but time spent on exercise (h/wk) was significantly higher in men than in women ($P < 0.05$ all). Since total preparation time in the regular period was significantly different between men and women (1.71 vs. 2.18 mo; $P < 0.05$), we have further ascertained that this statistical difference did not introduce sex as a confounding factor by comparisons of this factor in each sex. We found that total preparation time was significantly higher in the regular period than in the period approaching the NLE1 in both men (1.71 vs. 0.89 mo; $P < 0.001$) and women (2.18 vs. 0.88 mo; $P < 0.001$). The stress level was significantly higher in women than in men only in the period approaching the NLE1 ($P < 0.01$).

Comparisons of academic achievement according to motivation to study medicine. Comparisons of academic achievement between students with low, medium, and high motivation to study medicine are demonstrated in Fig. 1. Students with high motivation to study medicine had significantly higher *year 3* GPA, cGPA, and comprehensive examination score than students with medium and low motivation (Fig. 1, *A* and *B*) and significantly higher NLE1 score than students with medium motivation (Fig. 1*B*) ($P < 0.05$ all).

Comparisons of NLE1 preparation between groups of students classified by the NLE1 score. Comparisons of NLE1 preparation between groups of students classified by the NLE1 score are shown in Fig. 2. Total preparation time (mo) was highest in the excellent group and was lowest in the fail group in the regular period and in the period approaching the NLE1 (Fig. 2*A*). The fail group had a trend of lower daily preparation time (h/day) in the regular period and had significantly lower daily preparation time (h/day) during the period approaching the NLE1 ($P < 0.01$ all) than the other groups did (Fig. 2*B*). There was no significant difference in preparation time, regardless of the study type, either self- or group study, during both the regular period and the period approaching the NLE1 (Fig. 2*C*). Examination expectation was significantly higher in the excellent group than in the other groups, was significantly higher in the high-pass group than the low-pass and the fail groups, and was significantly higher in the low-pass group than the fail group (Fig. 2*D*) ($P < 0.01$ all). Achievement of study targets (percentage) was not different between groups in the regular period, but was significantly lower in the fail group than the other groups, and was significantly lower in the

low-pass group than the high-pass and the excellent groups (Fig. 2*D*) ($P < 0.05$ all).

Comparisons of students' behavior between groups of students classified by the NLE1 score. Comparisons of students' behavior between groups of students classified by the NLE1 score are shown in Fig. 3. Time spent on the internet for academic use was not different between groups in the regular period, but was significantly higher in the excellent group than other groups in the period approaching the NLE1 (Fig. 3*A*) ($P < 0.01$ all). Time spent on internet for nonacademic use was not different between groups in the period approaching the NLE1, but was significantly lower in the excellent group than in the fail and the low-pass groups (Fig. 3*A*) ($P < 0.01$ all). The excellent group had a trend of lower instance(s) of lateness and absence and had a significantly earlier check-in time than other groups (Fig. 3*B*) ($P < 0.05$ all). There was no significant difference in stress level between groups in the regular period (Fig. 3*C*). The fail group had significantly higher stress level than the high-pass and the excellent groups in the period approaching the NLE1 (Fig. 3*C*), whereas the difference in stress level between the regular period and the period approaching the NLE1 was significantly lower in the excellent group than the fail and the low-pass groups (Fig. 3*C*) ($P < 0.05$ all). Time spent on exercise tended to be lower in the fail group than other groups in the regular period and the period approaching the NLE1 (Fig. 3*D*). There was no difference in sleep period between groups in the regular period and the period approaching the NLE1 (Fig. 3*E*). Significantly lower duration of dormitory stay was found between excellent and fail groups, between high-pass and fail groups, and between high-pass and low-pass groups (Fig. 3*F*) ($P < 0.05$ all).

Correlations between two factors. Correlations between two factors are shown in Table 4. The comprehensive examination score was strongly and positively correlated with the NLE1 score (Table 4) ($P < 0.001$). Both comprehensive and NLE1 scores were strongly correlated with *year 1* GPA, *year 2* GPA, *year 3* GPA, and cGPA scores of subjects taught in the first and the second preclinical years, including gross anatomy, physiology, biochemistry, neuroanatomy, microscopic anatomy, embryology, pharmacology, pathology, microbiology, parasitology, and psychiatry, and percentile of examination expectation ($P < 0.001$ all), but was negatively correlated to check-in time (hours), time spent on nonacademic internet use in the regular period, and the stress level in the period approaching the NLE1 (Table 4) ($P < 0.05$ all). Instance(s) per year of absence was negatively correlated with the comprehensive score, and instance(s) per year of lateness was negatively
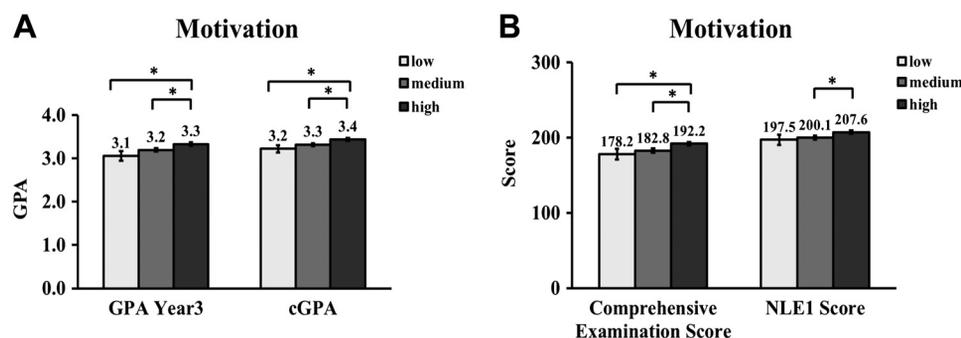

Fig. 1. Comparisons of academic achievement according to motivation to study medicine. *A*: comparisons of the third-year grade point average (GPA *year 3*) and cumulative GPA (cGPA) between groups of students with low, medium, and high motivation. *B*: comparisons of the comprehensive examination score and the National License Examination step 1 (NLE1) score between groups of students with low, medium, and high motivation. Values are means ± SE. *$P < 0.05$.

A **Total Preparation Time**

B **Daily Preparation Time**

C **Study Type**

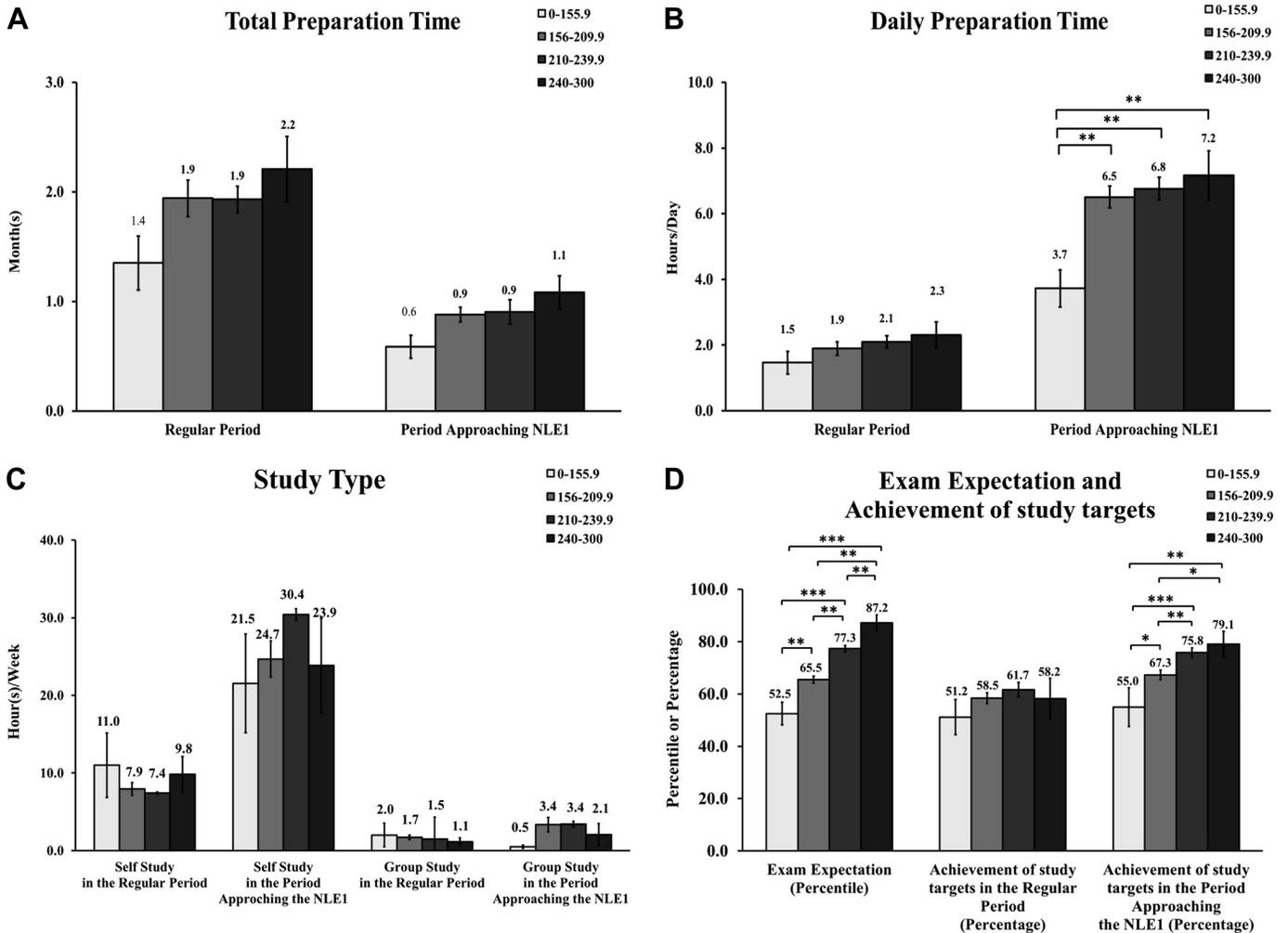**D** **Exam Expectation and Achievement of study targets**

Fig. 2. Comparisons of the National License Examination step 1 (NLE1) preparation between groups of students classified by the NLE1 score into the 0–155.9 (the fail group), 156–209.9 (the low-pass group), 210–239.9 (the high-pass group), and 240–300 scores (the excellent group) for many factors, including total preparation time (mo; *A*), daily preparation time (h/day; *B*), time spent on self-study and group study (h/wk; *C*), and examination expectation (percentile) and achievement of study targets (percentage; *D*). Values are means ± SE. *$P < 0.05$, **$P < 0.01$, and ***$P < 0.001$.

correlated with the NLE1 score ($P < 0.05$ all) (Table 4). Time spent on self-study in the period approaching the NLE1 (h/wk) was positively correlated with the comprehensive score ($P < 0.05$) (Table 4). Achievement of study targets (percentage) was positively correlated with the NLE1 score in the regular period ($P < 0.05$) and with the comprehensive and NLE1 scores in the period approaching the NLE1 ($P < 0.001$ all) (Table 4).

BMI had a trend to have negative correlations with *year 2* GPA ($P = 0.075$), *year 3* GPA ($P = 0.086$), pathology score ($P = 0.071$), and psychiatry score ($P = 0.065$). BMI was positively correlated with instance(s) per year of absence and lateness and time spent on nonacademic internet use in the regular period, but was negatively correlated with achievement of study targets in the regular period (percentage) ($P < 0.05$ all) (Table 4).

Multivariate regression analysis. By setting the NLE1 score as a dependent variable, five models of significant interactions were observed by setting behavioral factors without academic achievement as independent variables, including percentile of examination expectation (*model 1*); percentile of examination expectation and stress level in the period approaching the NLE1 (*model 2*); percentile of examination expectation, stress level in the period approaching the NLE1, and motivation to study medicine (*model 3*); percentile of examination expectation, stress level in the period approaching the NLE1, motivation to study medicine, and achievement of study targets (percentage) in the period approaching the NLE1 (*model 4*); and percentile of examination expectation, stress level in the period approaching the NLE1, motivation to study medicine, achievement of study targets (percentage) in the period approaching the NLE1, and time spent on nonacademic internet use (h/day) in the regular period (*model 5*) (Table 5). Furthermore, taking the NLE1 score as a dependent variable, four models of significant interactions were found by using behavioral factors and academic achievement as independent variables, including the comprehensive score (*model 1*); the comprehensive score, percentile of examination expectation, gross anatomy score, and pharmacology score (*model 2*); the comprehensive score and pharmacology score (*model 3*); and the comprehensive score, gross anatomy score, and pharmacology score (*model 4*) (Table 6).

A

Internet Use

☐ 0-155.9
▨ 156-209.9
▧ 210-239.9
■ 240-300

B

Absence, Lateness, and Check-in Time

☐ 0-155.9
▨ 156-209.9
▧ 210-239.9
■ 240-300

C

Stress

☐ 0-155.9
▨ 156-209.9
▧ 210-239.9
■ 240-300

D

Exercise Time

☐ 0-155.9
▨ 156-209.9
▧ 210-239.9
■ 240-300

E

Sleep Period

☐ 0-155.9
▨ 156-209.9
▧ 210-239.9
■ 240-300

F

Dormitory stay

☐ 0-155.9
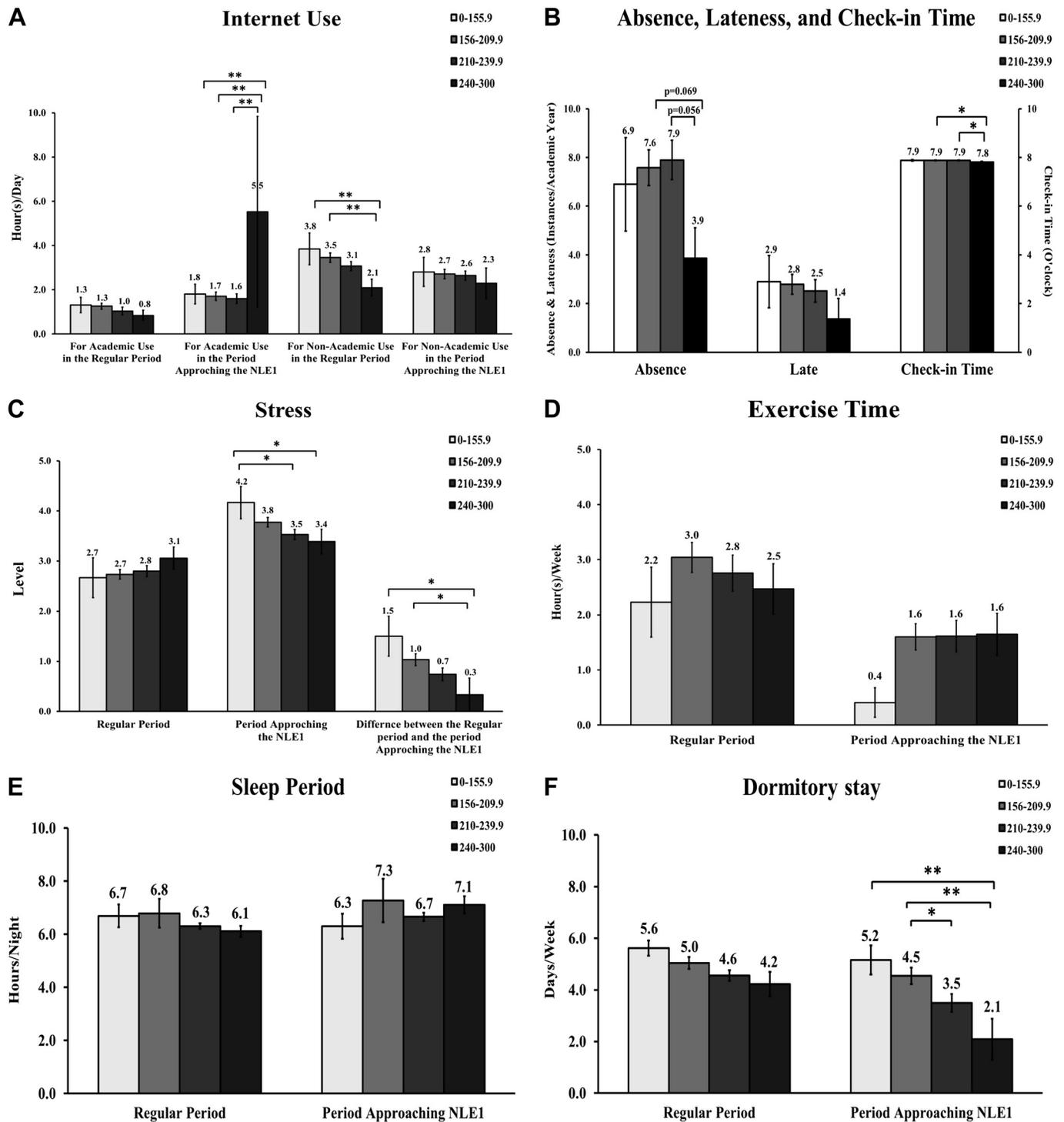▨ 156-209.9
▧ 210-239.9
■ 240-300

Fig. 3. Comparisons of students' behavior between groups of students classified by the National License Examination step 1 (NLE1) score into the 0–155.9 (the fail group), 156–209.9 (the low-pass group), 210–239.9 (the high-pass group), and 240–300 scores (the excellent group) for many factors, including time spent on internet for academic use and internet for nonacademic use (h/day; A); instances per academic year of absence, lateness (scale on the left y-axis), and check-in time (scale on the right y-axis; B); stress level (C); time spent on exercise (h/wk; D); sleep period (h/night; E); and dormitory stay (days/wk; F). Values are means $\pm$ SE. $*P < 0.05$ and $**P < 0.01$.

DISCUSSION

This study aimed to determine factors affecting the NLE1 score, including attitudes toward study, motivation to study medicine, stress level, examination expectation, sex, preparation methods, and student behaviors. We found that 51.87% of

students had a high motivation to study medicine, followed by students with medium motivation (40.25%) and students with low motivation (7.88%). Students with high motivation had higher academic achievement, including *year 3* GPA, cGPA, the comprehensive examination score, and the NLE1 score,

Table 4. *Correlations between academic achievement or body mass index with other factors*

Factor	Academic Achievement		BMI, R
	Comprehensive score, R	NLE1 score, R	
NLE1 score	0.892‡		−0.062
Comprehensive examination score		0.892‡	−0.079
Year 1 GPA	0.639‡	0.596‡	−0.061
Year 2 GPA	0.775‡	0.796‡	−0.118
Year 3 GPA	0.845‡	0.853‡	−0.114
cGPA	0.825‡	0.820‡	−0.099
Gross anatomy score	0.762‡	0.783‡	−0.056
Physiology score	0.781‡	0.775‡	−0.084
Biochemistry score	0.772‡	0.764‡	−0.067
Neuroanatomy score	0.717‡	0.742‡	−0.063
Microscopic anatomy score	0.733‡	0.734‡	−0.104
Embryology score	0.650‡	0.657‡	−0.108
Pharmacology score	0.828‡	0.858‡	−0.115
Pathology score	0.854‡	0.858‡	−0.119
Microbiology score	0.852‡	0.835‡	−0.058
Parasitology score	0.700‡	0.699‡	−0.059
Psychiatry score	0.546‡	0.519‡	−0.122
Percentile of exam expectation	0.601‡	0.622‡	−0.017
Absence, instance(s)/yr	−0.109*	−0.70	0.220†
Lateness, instance(s)/yr	−0.096	−0.114*	0.164†
Check-in time, h	−0.170†	−0.141*	0.029
Nonacademic internet use in the regular period, h/day	−0.189†	−0.151*	0.171*
Nonacademic internet use in the period approaching the NLE1, h/day	−0.027	−0.020	0.077
Stress level in the regular period	0.107	0.079	−0.062
Stress level in the period approaching the NLE1	−0.212†	−0.202†	−0.112
Self-study in the regular period, h/wk	0.073	0.006	0.17
Self-study in the period approaching the NLE1, h/wk	0.140*	0.114	−0.101
Achievement of study targets in the regular period, %	0.119	0.141*	−0.154*

$n = 241$ Respondents. BMI, body mass index; GPA, grade point average; cGPA, cumulative GPA; NLE1, National License Examination step 1. Data were analyzed by the Pearson product-moment correlation coefficient (R). *$P < 0.05$. †$P < 0.01$. ‡$P < 0.001$.

than students with lower motivation. As a result, motivation to study medicine is one of the important factors that determines academic achievement, including the NLE1 score. Our results correspond with previous studies showing that students with high motivation had higher academic achievement (5, 21, 29). Motivation is shown to be associated with three components of self-regulated learning (SRL), the learning process that lets individuals be motivationally, metacognitively, and behaviorally proactive (11), which are *1*) an expectancy component, which consists of students' beliefs that they have an ability to do a task; *2*) a value component, which consists of goals and beliefs of students that the task is important and interesting;

Table 5. *Multivariate regression analysis of the NLE1 score using behavioral factors without academic achievement*

No.	R	R^2	Model of the NLE1 Score	Coefficient	SE	T Value
1	0.622‡	0.387	(Constant)	130.165	6.571	19.808‡
			Percentile of exam expectation	1.054	0.090	11.658‡
2	0.653‡	0.427	(Constant)	150.680	8.159	18.467‡
			Percentile of exam expectation	1.024	0.087	11.751‡
			Stress level in the period approaching the NLE1	−4.933	1.297	−3.802‡
3	0.666‡	0.444	(Constant)	131.364	10.701	12.276‡
			Percentile of exam expectation	0.978	0.086	11.360‡
			Stress level in the period approaching the NLE1	−4.615	1.269	−3.638‡
			Motivation to study medicine	10.279	3.832	2.682†
4	0.698‡	0.487	(Constant)	119.784	10.757	11.135‡
			Percentile of exam expectation	0.890	0.087	10.242‡
			Stress level in the period approaching the NLE1	−4.810	1.228	−3.916‡
			Motivation to study medicine	10.335	3.707	2.788†
			Achievement of study targets (percentage) in the period approaching the NLE1	0.260	0.066	3.921‡
5	0.704‡	0.496	(Constant)	124.590	11.112	11.212‡
			Percentile of exam expectation	0.874	0.087	10.066‡
			Stress level in the period approaching the NLE1	−4.632	1.229	−3.768‡
			Motivation to study medicine	9.532	3.774	2.525*
			Achievement of study targets (percentage) in the period approaching the NLE1	0.281	0.067	4.204‡
			Time spent on nonacademic internet use (hour(s)/day) in the regular period	−1.219	0.589	−2.069*

$n = 241$ Respondents. NLE1, National License Examination step 1. Data were analyzed by multiple linear regression. *$P < 0.05$. †$P < 0.01$. ‡$P < 0.001$.

Table 6. *Multivariate regression analysis of the NLE1 score using behavioral factors and academic achievement*

	Model of the NLE1 Score					
No.	R	R^2		Coefficient	SE	T Value
1	0.892‡	0.795	(Constant)	52.810	4.242	12.449‡
			Comprehensive score	0.807	0.023	35.570‡
2	0.912‡	0.832	(Constant)	12.418	7.211	1.722
			Comprehensive score	0.396	0.051	7.770‡
			Percentile of exam expectation	0.182	0.058	3.147†
			Gross anatomy score	0.473	0.129	3.665‡
			Pharmacology score	0.879	0.145	6.073‡
3	0.917‡	0.840	(Constant)	19.689	5.110	3.853‡
			Comprehensive score	0.522	0.036	14.499‡
			Pharmacology score	1.108	0.116	9.553‡
4	0.917‡	0.841	(Constant)	11.279	5.775	1.953
			Comprehensive score	0.462	0.038	12.112‡
			Gross anatomy score	0.381	0.105	3.648‡
			Pharmacology score	0.986	0.117	8.391‡

$n = 241$ Respondents. NLE1, National License Examination step 1. Data were analyzed by multiple linear regression. †$P < 0.01$. ‡$P < 0.001$.

and *3*) an affective component, which consists of emotional reactions of students to the task (28). Furthermore, a previous study (28) showed that increased intrinsic value of motivation had a strong association with cognitive strategies and self-regulation of the learning components of SRL (32). Students with high motivation tend to have good study strategies and study effort, leading to enhancement of SRL, which is shown to be positively associated with academic performance (7, 12, 30). As a result, high motivation to study medicine might be one of the factors that has a positive impact on the NLE1 score and academic achievement. It could be suggested that motivation to study medicine should be included in the enrollment process. Students with low motivation could be detected early and monitored to promote their motivation to achieve sufficient academic achievement and a good NLE1 score.

In this study, the number of male and female participants was equal, being 51.21% men and 48.79% women. Interestingly, men had higher NLE1 and comprehensive scores than women. The results corresponded to previous studies showing that men perform slightly better than women during preclinical years (36), on the national board of medical examination part I (10), and on the USMLE step 1 (14). However, multiple studies showed a converging trend or even an opposite trend of academic performance between men and women throughout higher years of clinical clerkship (20, 36). GPA at the end of the clinical years of both sexes was comparable (20), and another study suggested that female students performed better on clinically based evaluation than male students (17). Older female students had better academic performance with increasing age (17), indicating that lower academic outcome in female students in preclinical years observed in this study might be partly because of their age.

Behavioral factors that were different between sexes demonstrated in Table 3 were stress level, time spent on exercise during the regular period, and instance(s) of lateness per year and absence(s) per year. For stress level, previous studies suggested that men and women have different adaptations to stresses in medical school in ways that might be difficult for women in the early years of medical study (8a, 13a, 25, 26,). This study also found that the stress level in women was significantly higher in the regular period and in the period approaching the NLE1. Furthermore, we found that stress level

in the period approaching the NLE1 was negatively correlated with both NLE1 and comprehensive scores. In addition, students who failed the NLE1 also had a higher stress level than students who passed during the period approaching the NLE1, suggesting that stress might be one of the factors relating to the NLE1 score. As a result, the higher stress level in female students might be related to the lower NLE1 score. An intervention that reduces stress in students, especially female students, should be promoted to achieve better academic performance.

In this study, we found that male students had a higher instance of lateness, absence, and lateness and absence per year than female students. In the male group, instances of absence and lateness were negatively correlated with the NLE1 and comprehensive scores (data not shown). These results suggested that the higher instance of absence/lateness in men was not the cause of higher comprehensive and NLE1 scores than in women. Furthermore, the higher instance of lateness/absence in men than women might be because of lower self-discipline in men, as reported in many studies (13, 37).

In this study, we found that male students had higher time spent on exercise than female students during the regular period. Many studies revealed a positive correlation between physical activity and academic performance (2, 4, 23). Thus higher time spent on exercise found in male students during the regular period might partly contribute to the higher academic performance. Promoting exercise during the regular period might be considered to achieve better academic performance (23).

The mean total preparation time for the NLE1 was 1.93 mo during the regular period and was 0.89 mo during the period approaching the NLE1. For the period approaching the NLE1, daily preparation time (h/day), time spent on academic internet use, self-study and group study, achievement of study targets (percentage), and the stress level were higher, whereas time spent on nonacademic internet use and exercise and dormitory stay were lower compared with the regular period. These results suggested that students adjusted their own study habits in favor of increasing their academic activity voluntarily in the period approaching the NLE1. Correlation analyses showed that the NLE1 score was strongly and positively correlated with the comprehensive examination score, and both scores

were positively correlated with *year 1*, *2*, and *3* GPA and cGPA scores of subjects taught in the first and the second preclinical years, including gross anatomy, physiology, biochemistry, neuroanatomy, microscopic anatomy, embryology, pharmacology, pathology, microbiology, parasitology, and psychiatry. For multiple linear regression analyses, the comprehensive examination score and scores of subjects taught in the first and the second preclinical years, especially gross anatomy and pharmacology scores, contributed significantly to the models predicting the NLE1 score. Our results were consistent with previous studies showing that the higher comprehensive score (16, 38), GPA (31), and academic performance (38) were associated with the higher score of the national license examination. These results suggest that academic achievement during regular classes and a comprehensive examination had very strong associations with the NLE1 score. So, effective teaching and learning strategies in regular classes should be encouraged to promote students' engagement. This can lead students to have good basic medical knowledge, resulting in achievement on the NLE1.

When compared between four groups of the NLE1 score, including the fail, low-pass, high-pass, and excellent groups, we found that (a) group(s) of students with the higher NLE1 score had higher daily preparation time, examination expectation, achievement of study targets (percentage), and time spent on internet for academic use, but lower time spent on nonacademic internet use and stress level. Correlation analyses showed that both NLE1 and comprehensive examination scores were positively correlated with percentile of exam expectation and were negatively correlated with nonacademic internet use in the regular period (h/day) and stress level in the period approaching the NLE1. Our results were consistent with a previous study showing that good learning behavior and good exam preparation were positively correlated with the higher NLE1 score (31). Furthermore, the results regarding time spent on nonacademic internet use corresponded with a previous study showing that the higher time spent on internet use for nonacademic purposes was associated with the lower academic performance (29). In addition, our result was in accordance with a previous study showing that the higher exam expectation was associated with the higher academic outcome (29). Students who predicted high examination scores arbitrarily might have high determination on exam achievement, leading to setting their own goal and driving their behaviors toward high exam accomplishment. In addition, students who had a high NLE1 score also had high achievement of study targets and low stress level. This might be because, when students could prepare for the exam to the level close to their study target, they might feel relief and less stressful in the period approaching the NLE1. As a result, high exam expectation, appropriate daily preparation time, increased time spent on internet for academic use, decreased time spent on internet for nonacademic use, and adequate achievement of study targets could be encouraged among students to accomplish the NLE1.

The comprehensive examination and NLE1 scores were negatively correlated with instance(s) of lateness and/or absence per year and check-in time. Our results were in accordance with previous studies revealing that class attendance was associated with academic performance (1, 22, 29). Although the students had an opportunity to access a variety of online materials, including recorded e-lecture from regular classes,

textbook, handout, and computer-assisted instruction, our study showed that students who came to class early and attended class regularly had higher academic achievement and NLE1 score. This might be because the students who attend class regularly probably had high self-regulation to control and direct their own action toward good learning behaviors (28, 37, 39). Thus good study habits with class attendance should be encouraged to promote students' academic achievement, including the NLE1 score.

Furthermore, students who passed the NLE1 (the low-pass, the high-pass, and the excellent groups) had a comparable sleep period and a trend of higher time spent on exercise compared with the fail group. These results suggested that time allocated for sleep and exercise was not decreased in groups of students passing the NLE1, but rather appropriate time management might be an important factor in achieving the better academic outcome.

The mean number of days of dormitory stay was not much different, but was significantly higher in the regular period (4.83 days/wk) than in the period approaching the NLE1 (4.02 days/wk). This factor was determined because we would like to know whether, in the period approaching the NLE1, students preferred to go home to stay with their family or stay in the dormitory. The result suggests that, although the mean number of days was lower in the period approaching the NLE1, which approximately fell in the semester break period, students still stayed in the dormitory for 4 days/wk, which might probably be because they prepared for the NLE1 with their friends. Interestingly, students in the excellent and high-pass groups had a shorter dormitory stay than the low-pass and/or the fail group(s). These results indicate that the higher NLE1 score students had less preference to stay at the dormitory than the lower NLE1 score students.

BMI tended to have negative correlations with *year 2* GPA, *year 3* GPA, pharmacology score, and pathology score, but was not associated with the NLE1 and comprehensive examination scores. Our results were in accordance with previous studies showing that BMI was not related to academic performance (8, 35). Furthermore, the weak negative correlations of BMI and academic achievement in our results corresponded to previous studies showing negative association between BMI and academic outcome (3, 6, 19). Interestingly, we found that BMI was positively correlated with instance(s) per year of absence and/or lateness, and time spent on nonacademic internet use in the regular period (h/day). Our results were in accordance with a previous study showing that the higher BMI was associated with the lower academic self-efficacy (3). A previous study suggested that obesity is related to poor self-regulation (18), which might explain poor study habits in the higher BMI students.

In multiple linear regression analyses, by setting the NLE1 score as the dependent variable, models of significant interactions were observed by setting behavioral factors without academic achievement as independent variables, including percentile of examination expectation, stress level in the period approaching the NLE1, motivation to study medicine, achievement of study targets (percentage) in the period approaching the NLE1, and time spent on nonacademic internet use (h/day) in the regular period. Interestingly, these behavioral factors could predict the NLE1 score for 49.6% (R^2). By using behavioral factors and academic achievement as independent vari-

ables, models of significant interactions were observed by setting the comprehensive score, pharmacology score, gross anatomy score, and percentile of examination expectation. By using academic achievement and behavioral factors to be independent variables, the significant models could predict the NLE1 score for >80%. These results suggest that both behavioral factors and academic achievement during a regular class are factors that affect the NLE1 score.

In conclusion, maintaining good academic achievement during preclinical studies, maintaining good study habits, including lower time spent on nonacademic internet use, reduced instances of lateness/absence, earlier check-in time, as well as higher time spent on the internet for academic use and achievement of study targets, should be recommended to students to promote their achievement on the NLE1.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

P.L., C.S., and P.M. performed experiments; P.L., C.S., P.M., and I.K. analyzed data; P.L., C.S., P.M., and I.K. interpreted results of experiments; P.L., C.S., P.M., and I.K. prepared figures; P.L., C.S., and I.K. drafted manuscript; P.L., C.S., P.M., and I.K. edited and revised manuscript; P.L., C.S., P.M., and I.K. approved final version of manuscript.

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