

The relationship between depression, anxiety, e-health literacy, and health-promoting behavior in nursing students during COVID-19

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Abstract

The purpose of this study was to identify the correlation between depression, anxiety, e-health literacy (eHL), and health-promoting behaviors among nursing students during the coronavirus disease 2019 (COVID-19) pandemic, and to identify the factors affecting health-promoting behaviors. A cross-sectional study was conducted online, recruiting 301 nursing students recruited from 4 universities in the Chungcheong Province and Daejeon Metropolitan City in South Korea between May 28 and June 30, 2021. Data were analyzed using SPSS WIN 27.0. The general characteristics of the study participants were analyzed by frequency and percentage, and the degree of depression, anxiety, eHL, and health-promoting behaviors were calculated as averages and standard deviations. Differences in health-promoting behaviors according to general characteristics were analyzed using independent *t* tests and analysis of variance, and a post hoc Scheffe test was conducted. Correlations between depression, anxiety, eHL, and health-promoting behaviors were measured using Pearson correlation matrices. Stepwise multiple regression was performed to identify factors affecting health-promoting behaviors. During the COVID-19 pandemic, the average level of depression and anxiety was reported to be 3.93 (4.71) and 3.40 (4.30), respectively; 33.2% of nursing students experienced more than mild depression and 29.2% experienced anxiety. The average eHL level was 3.91 (0.56), and the average of health-promoting behaviors was 2.43 (0.45). Depression was positively correlated with anxiety ($R = 0.734$, $P < .001$) and negatively correlated with health-promoting behaviors ($r = -0.198$, $P = .001$), whereas eHL had a positive correlation with health-promoting behaviors ($R = 0.347$, $P < .001$). The factors affecting health-promoting behaviors were religion ($\beta = -0.160$, standard error [SE] = 0.048), current health status ($\beta = -0.097$, SE = 0.032), frequency of searching the Internet for health-related information in a week ($\beta = -0.070$, SE = 0.026), interest in health ($\beta = -0.191$, SE = 0.039), and critical eHL ($\beta = 0.243$, SE = 0.040); the explanatory power was 27.4%. Results demonstrate that during the COVID-19 pandemic, higher depression and anxiety among nursing students decreased health-promoting behaviors, while higher eHL increased health-promoting behaviors, and eHL was a major factor affecting health-promoting behaviors. These results contribute to the provision of basic data for the development of nursing intervention programs and educational strategies that can establish correct health-promoting behaviors by managing depression and anxiety among nursing students and improving eHL.

Abbreviations: COVID-19 = coronavirus disease 2019, eHL = e-health literacy, GAD-7 = Generalized Anxiety Disorder-7, R^2 = adjusted coefficient of determination, SE = standard error.

Keywords: anxiety, depression, e-health-literacy, health-promoting behaviors, nursing student

1. Introduction

After the onset of coronavirus disease 2019 (COVID-19), the World Health Organization officially declared a global pandemic on March 11, 2020. The first case was confirmed in Wuhan in December 2019, and 624,235,272 cases and 6,555,270 deaths had occurred worldwide by October 25, 2022.

^[1] South Korea's first confirmed case was reported on January 20, 2020, and by October 25, 2022, the cumulative number of confirmed cases and deaths were 25,355,350 and 29,017 respectively.^[2] COVID-19 spreads rapidly, has an unconfirmed cause and cure, and has threatened all aspects of people's lives. Over the last 2 years, Korea's quarantine guidelines for new infectious diseases have been strengthened or eased in response

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Informed consent was obtained from all the subjects involved in the study.

The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

The study was conducted in accordance with the guidelines of the Declaration of Helsinki and approved by the Pai Chai University Institutional Review Board (IRB No.2-1040766-AB-N-01-R-2021-01).

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to surges and declines in COVID-19 cases, however, 1000 days have passed since the first outbreak of COVID-19 and the number of confirmed cases is still increasing.^[2,3] Not only are we still fighting COVID-19, but there are also growing concerns of a twindemic as the flu has begun to spread due to continuous mutant viruses and seasonal changes. Regarding COVID-19, most countries including South Korea introduced social distancing, closures, mandatory isolation, and recommendations or orders to stay home as countermeasures to limit the spread of infection.^[4,5] Infectious diseases such as COVID-19 have negative effects on physical and psychological health. In particular, quarantine systems that aim to prevent the spread of infection have been reported to cause psychological health problems such as anxiety, depression, and fear.^[6-8] In South Korea, the prolonged COVID-19 crisis has also led to the emergence of the term “Corona Blues,” which refers to the anxiety about being infected with COVID-19 and the depression or anxiety caused by the stressed social atmosphere. According to a survey of Korean adult men and women aged 20 to 65, conducted by the Korea Health Promotion Institute (2020),^[9] 40.7% of all respondents experienced Corona Blues, accounting for the majority of respondents in their 20s. The reasons for experiencing Corona Blues were social isolation caused by the restrictions on going out and interacting due to social distancing requirements, health concerns due to the spread of infection, difficulties in maintaining employment and jobs, and weight gain due to lowered physical activity.^[9] With the prolonged COVID-19, the Ministry of Health and Welfare of Korea conducted a quarterly COVID-19 National Mental Health Survey. The 2021 quarterly survey showed that anxiety and depression levels changed depending on the timing of the survey; yet compared to the early stages of COVID-19, the rate of suicidal thoughts increased by 40%, and 1 in 5 people was reported to be at risk of depression.^[10] Although quarantine measures are inevitable, it has been confirmed that they have negatively affected individuals’ mental health. Therefore, in situations such as the onset of COVID-19, it is very important to pay attention to mental health and come up with measures to effectively and efficiently prevent or cope with emerging mental health problems.

Preventive actions are essential for controlling infectious diseases,^[11] and raising health awareness and knowledge of diseases is important for effective infection control and disease management.^[11] In the early stages of the COVID-19 outbreak, it was difficult for people to recognize threats to their physical and emotional well-being from new infectious diseases, and they experienced fear, uncertainty, and anxiety due to the lack of accurate information and knowledge about them.^[12] The most common route for individuals to find health information is on the Internet through their smartphones or computers.^[13] Digital communication technologies such as the Internet and social media have provided diverse and vast amounts of COVID-19-related health information at a very rapid pace within a short time. Information and communication media are suitable for providing people with professional information or health knowledge and are critical for preventing problems related to the COVID-19 pandemic.^[11] However, this information is not guaranteed to be of high quality, and the use of wrong information not only adversely affects health but also harms well-being and degrades the quality of life.^[14-16] It is important for people to find, understand, evaluate, and use information that helps protect and promote their health through critical thinking.^[15-18]

Health literacy is the ability to accurately locate, understand, evaluate, and apply the basic information needed to make appropriate health-related decisions.^[19] E-health literacy (eHL) applies health literacy to an online environment.^[20] A study on digital health literacy among college students found that a significant number of students had difficulty evaluating information.^[17,21] It can be seen that although college students are primarily getting their information through digital media, they are not

sufficiently prepared to critically analyze and judge overflowing information or make consequent decisions regarding their health.^[22] High eHL can help people effectively cope with stress and physical symptoms, and is also associated with a healthy lifestyle.^[11,14,15,23,24] College students heading into adulthood should have the ability to efficiently cope with possible stress or physical symptoms related to the COVID-19 pandemic, implement appropriate preventive actions, and find and understand accurate information related to health to form healthy lifestyle habits. Moreover, college students majoring in nursing should be able to help explore and apply accurate health information not only for their own health but also for those to whom they will be providing nursing services in the future. Therefore, nursing students should be able to manage themselves by selecting the exact information they need and translating it into healthy behavior rather than simply exploring and using health information on the Internet. Since health literacy for information flooding in the COVID-19 pandemic situation is very important,^[18] it is necessary to understand nursing students’ eHL for health information through the Internet.

Health-promoting behaviors are an individual’s initiative to prevent, treat, and manage diseases with a positive attitude and interest in maintaining or improving their health.^[25] Health-promoting behaviors are important for the prevention and management of diseases; this is particularly true among students in their early 20s who are forming healthy behavior habits that will ultimately lead to a healthy life in middle and old age. In addition, it is very important to establish health promotion among college students because it is relatively easy to correct incorrect health behavior patterns at this age.^[26-28] The significance of health promotion in establishing preventive behavior is that people should be able to search for and understand accurate health information, evaluate it and apply it. In previous studies, eHL has been reported as an important factor influencing health-promoting behavior, and the importance of eHL during the COVID-19 pandemic is further emphasized.^[11,15,22,24] eHL during the pandemic has been reported to be negatively correlated with depression,^[29] and health-promoting behaviors have been found to be related to mental health.^[30,31] Lee’s study^[30] found negative correlations between health-promoting behaviors and depression, while Bae’s researchers^[31] reported that depression amongst college students significantly influenced their health-promoting behaviors. Correct health-promoting behaviors can improve quality of life, reduce the cost of health care, and improve technology for disease prevention.^[32] Moreover, nursing students must have the ability to manage and take responsibility for themselves in order to maintain and improve their health. At the same time, nursing students play an important role in providing medical services as future nurses and educating subjects to manage their health on their own. Therefore, nursing students need to establish appropriate health-promoting behaviors for themselves and their patients after graduation.^[26,28]

In this regard, previous research conducted on college students during the pandemic demonstrate the impact of COVID-19 on mental health experienced by nursing students^[33,34] and college students.^[35] Other previous studies investigated the digital health literacy of college students during the COVID-19 period,^[17,22,24] and one study reported that there was a significant relationship between eHL and COVID-19-related health behaviors of college students.^[36] In addition, there were studies that investigated the health-promoting behaviors of nursing students,^[26,27] and investigated the relationship between health information understanding ability and health-promoting behaviors,^[28] or the relationship between e-health literature, preventive behavior, anxiety, and depression of nursing students.^[37] However, there is a dearth of studies conducted during the COVID-19 pandemic on the links between depression, anxiety, eHL, and health-promoting behaviors specifically among nursing students. Therefore, we investigated this

in order to bridge an important gap. We attempt to identify the magnitude of depression and anxiety, their relationship to eHL levels, and health-promoting behaviors of nursing students during the COVID-19 pandemic. We also aim to identify factors affecting their health-promoting behaviors. The data from this study will contribute to the development of educational strategies and intervention programs that help nursing students grow into future leaders by improving psychological well-being, improving eHL, and establishing health-promoting behaviors despite the pandemic caused by unpredictable infectious diseases.

The assumptions of this study are as follows:

First, during the COVID-19 pandemic, depression and anxiety of nursing students are negatively related to health-promoting behavior.

Second, eHL is positively related to health-promoting behaviors of nursing students during the COVID-19 pandemic.

Third, depression, anxiety, and eHL are factors that predict nursing students' health-promoting behaviors during the COVID-19 pandemic.

2. Methods

2.1. Survey design

This study was a descriptive survey aimed at understanding depression, anxiety, eHL, and health-promoting behaviors, as well as identifying factors that influence health-promoting behaviors among nursing students in the context of COVID-19.

The subjects of this study were 320 nursing college students enrolled in 4 universities in the Chungcheong Province and Daejeon Metropolitan City who participated in online surveys between May 28 and June 30, 2021. These surveys were conducted across the 4 universities within the same time period. The sample sizes suitable for multilinear regression were calculated using the G-power 3.1.9.2 program (Universität Düsseldorf, Düsseldorf, Germany) for 24 predictor variables. An effect size of 0.15, a power of 0.95, and a significance level of 0.05 were used in the linear multiple regression analysis. With these parameters, 238 participants were the required sample size. The survey was distributed to 320 nursing students, accounting for a 20% dropout rate. Convenience sampling was used to recruit the subjects. The specific selection criteria for the participants of this study were as follows: nursing students in their early adulthood (>18 years of age and <40 years of age); those who were not taking any medication for mental health disorders; and those who understood the purpose of this study and agreed to participate in the survey. The exclusion criteria were: inability to read and understand the Korean language; unable, for any reason, to communicate; not enrolled in a nursing program at college; spent 0 time on the Internet; and spent no time (per week) searching online for health-related information.

Based on these criteria, 19 participants were excluded from the study. The final analysis utilized data from 301 subjects.

2.2. Measurement tools

1) Health-promoting behavior

Health-promoting behavior was measured using a tool adapted by Seo^[38] based on the Health Promoting Lifestyle Profile II developed by Waker et al.^[39] This tool consists of 6 domains with a total of 52 items, including 9 for health responsibility, 8 for physical activity, 9 for nutrition, 9 for spiritual growth, 9 for interpersonal relationships, and 8 for stress management. Each question was measured on a 4-point Likert scale with 1 point for "not at all," 2 points for "occasionally," 3 points for "often," and 4 points for "always," with higher average scores indicating higher levels of health-promoting behavior. In Seo's study,^[38] Cronbach α was 0.92, whereas in this study it was 0.90.

2) eHL

eHL refers to the ability to find, understand, and evaluate desired information on the Internet and apply this information to solve health problems.^[20] In this study, the eHealth Literacy Scale developed by Lee^[40] was used to measure eHL. The scale consists of 31 questions across 3 domains: 8 questions on functional eHL, 11 on communicative eHL, and 12 on critical eHL. Functional eHL is defined as "an individual's reading and writing skills related to health information using the internet"; communicative eHL is "actively participating in daily activities such as the dissemination of health-related information using the internet, extracting health-related information, deriving meaning through various forms of mutual communication, and adapting to changing environments"; critical eHL is defined as a "more developed cognitive ability to analyze critically, control, apply, and utilize information suitable for an individual, obtained using the internet."^[40] Each question was measured on a 5-point Likert scale ranging from "strongly agree" (5) to "strongly disagree" (1), whereby a higher score indicates higher eHL levels. In Lee's study,^[40] Cronbach α values were 0.90, 0.92, and 0.90, respectively. In this study, Cronbach α was 0.87 for communicative eHL, 0.88 for critical eHL, 0.90 for functional eHL, and 0.91 for overall eHL.

3) Depression

The Patient Health Questionnaire-9, developed by Spitzer et al,^[41] is a self-reported test designed to screen for depression and assess the severity of depression. It consists of 9 items corresponding to the Diagnostic and Statistical Manual of Mental Disorders, fourth edition-IV diagnostic criteria for major depressive disorders and examines how often a person has experienced these problems over the last 2 weeks. The tool consists of a total of 9 items assessed for the preceding 2 weeks, with each item evaluated on a 4-point scale (0 for "not at all, 1 for "several days," 2 for "more than half the days," and 3 for "nearly every day"). Scores ranged from 0 to 27, with higher scores indicating more severe depression. The degree of depression was divided into 4 categories: normal (0–4 points), mild (5–9 points), moderate (10–14 points), and severe (15–27 points).^[42] In a study by Spitzer et al,^[42] Cronbach α was 0.84, while in this study it was 0.89.

4) Anxiety

We used the self-reported assessment scale Generalized Anxiety Disorder-7 (GAD-7), developed by Spitzer et al,^[43] to measure anxiety. This scale consists of 7 questions measuring the degree of anxiety that a subject felt personally over the last 2 weeks on a 4-point Likert scale (0 for "not at all," 1 for "several days," 2 for "more than seven days," and 3 for "nearly every day"). The total score ranges from 0 to 21 points, with a higher score indicating a higher degree of anxiety. The total GAD-7 score range indicated no anxiety symptoms (0–4), mild anxiety symptoms (5–9), moderate anxiety symptoms (10–14), and severe anxiety symptoms (15 or more). A cutoff score of 5 was used to detect anxiety. In a study by Spitzer et al,^[43] Cronbach α was 0.92, whereas in this study it was 0.90.

2.3. Data collection

Regarding subject recruitment, a professor announcing his/her participation in a study may coerce students into participating. Furthermore, owing to COVID-19, it was difficult to collect data in person. Therefore, data collection was conducted online and a recruitment advertisement containing the purpose of the study, selection criteria, participation procedure, period and location, compensation, and email and contact information of the researcher was shared on bulletin boards on the homepages of 4 nursing colleges located in Chungcheong province and Daejeon Metropolitan City where the researchers are not affiliated. Those who agreed to participate in this study voluntarily responded to the online recruitment advertisement.

The researchers explained that there would be no disadvantage to the subjects as a result of not participating in the study, and that participation was conducted with their voluntary consent. The subjects were also informed that they could voluntarily stop participating in the study at any time and that there would be no consequences for doing so. After receiving the participants' consent forms, we shared a link to the online survey and collected data. It took 20 minutes to complete the survey, and participants received a gift after completing it.

2.4. Ethical considerations

Data were collected from May 28 to June 30, 2021, after receiving approval from Pai Chai University's Institutional Review Board (IRB No.2-1040766-AB-N-01-R-2021-01). Before obtaining consent from college students that participated in the study, we informed them that the collected data would only be used for academic purposes and would be processed anonymously during analysis. We also informed them that they could withdraw from the study at any time. The subjects were also notified of other matters stipulated by the Bioethics and Safety Act. The survey link was then shared remotely after informed consent was obtained.

2.5. Data analysis

The collected data were analyzed using SPSS WIN 27.0 (IBM Corp., Armonk, NY). The general characteristics of the study participants were analyzed by frequency and percentage, and eHL, health-promoting behaviors, anxiety, and depression were described using means and standard deviations. Differences in health-promoting behavior according to the general characteristics of the study participants were analyzed using independent *t* tests and analysis of variance, and post hoc testing was conducted using the Scheffe test. Correlations between eHL, health-promoting behavior, anxiety, and depression were analyzed using Pearson correlation. Stepwise multiple regression was performed to analyze the factors influencing health-promoting behavior.

3. Results

3.1. Differences in health-promoting behaviors according to the general characteristics of the subjects

The survey was distributed to 320 subjects; as 19 subjects with omitted or careless responses were excluded from the analysis, the final sample consisted of 301 responses (response rate 94.0%). The general characteristics of the study participants are presented in Table 1. The average age of the subjects was 21.39 (2.12) years, with 12.6% male and 87.4% female students. Of the total sample, 30.2% were in their first year, 12.3% were in their second year, 30.2% were in their third year, and 27.2% were in their fourth year of college. Of the participants, 97.0% were nonsmokers, and 65.4% answered that they did not have a religion. In terms of Internet usage, 41.2% of subjects spent >4 hours a day using the Internet, followed by 20.9% who spent between 2 and 3 hours a day, and 19.9% who spent between 3 and 4 hours a day. Regarding participants' interest in health, 35.5% answered that they were very interested in health, 56.1% were moderately interested in health, and 8.3% were little interested in health. When asked about how often they used the Internet for health information, most subjects said <3 times a month (48.8%), followed by 1 to 2 times a week (35.5%). When asked about their current overall health status, the majority (57.4%) answered that they were in "good health." Based on the Patient Health Questionnaire-9 score, 21.6% of the respondents experienced mild depression, 6.0% experienced moderate depression, 5.6% experienced severe depression, and a total of 33.2% experienced depression. Anxiety based on the GAD-7

Table 1
Subjects' general characteristics (N = 301).

Variable	Category	Mean (SD) or n (%)
Age (yr)	Range:18–33	21.39 (2.12)
Gender	Male	38 (12.6)
	Female	263 (87.4)
Grade level	Freshmen	91 (30.2)
	Sophomore	37 (12.3)
	Junior	91 (30.2)
	Senior	82 (27.2)
Smoking	Yes	292 (97.0)
	No	9 (3.0)
Religion	Yes	104 (34.6)
	No	197 (65.4)
Daily Internet use (in h)	< 1	16 (5.3)
	1–2	38 (12.6)
	2–3	63 (20.9)
	3–4	60 (19.9)
	>4	124 (41.2)
Health interest	High	107 (35.5)
	Moderate	169 (56.1)
	Low	25 (8.3)
Time spent searching online for health-related information per wk	Everyday	22 (7.3)
	3–4 days per wk	25 (8.3)
	1–2 days per wk	107 (35.5)
	<3 per mo	147 (48.8)
Health status	Good	173 (57.4)
	Moderate	89 (29.6)
	Bad	39 (13.0)
Depression	Asymptomatic (0–4)	201 (66.8)
	Mild depression (5–9)	65 (21.6)
	Moderate depression (10–14)	18 (6.0)
	Severe depression (15–27)	17 (5.6)
Anxiety	Asymptomatic (0–4)	213 (70.8)
	Mild anxiety (5–9)	61 (20.3)
	Moderate anxiety (10–14)	19 (6.3)
	Severe anxiety (15–21)	8 (2.7)

SD = standard deviation.

scores showed prevalence rates of mild, moderate, and severe symptoms of 20.3%, 6.3%, and 2.7%, respectively.

Differences in health-promoting behaviors according to the subjects' general characteristics were analyzed (Table 2). Overall, health-promoting behaviors varied depending on religion, levels of interest in health, the number of times the Internet was used to look for health-related information per week, and the current health state. The result of the post hoc Scheffe test showed that those with a high interest in health had the highest overall quality of life, and those with moderate and little interest in health had the lowest overall health-promoting behavior. Those who responded that they searched the internet for health-related information >5 times, >3 times, and <4 times a week had significantly higher health-promoting behaviors than those who used it <3 times a month. Moreover, participants' general characteristics and accordingly, their differences in the sub-domains of health-promoting behaviors were also analyzed (Table 2).

3.2. Levels of depression, anxiety, eHL, and health-promoting behavior

Table 3 presents the average scores of each variable. The mean of depression was 3.93 (4.71), the mean of anxiety was 3.40 (4.30), the mean of eHL was 3.91 (0.56), the mean of communicative eHL was 3.75(0.74), the mean of critical eHL was 3.86 (0.58), and the mean of functional eHL was 4.12 (0.58). The mean overall health-promoting behaviors were 2.43 (0.45), the mean of health responsibilities was 2.27 (0.62), the mean of physical activity was 2.19 (0.70), the mean of nutrition was

Table 2
Differences in health-promoting behavior according to general characteristics (N = 301).

		Health-promoting behavior						
		Total	HR	PA	Nu	SG	IS	SM
Variables	Category	Mean (SD)						
Age (yr)	Range: 18–33							
Gender	Male	22.39 (4.18)	20.86 (6.13)	19.39 (5.88)	22.39 (5.22)	24.50 (4.66)	25.68 (4.43)	21.52 (4.31)
	Female	21.81 (4.12)	20.44 (5.51)	17.27 (5.56)	21.89 (4.81)	23.95 (5.40)	26.00 (4.60)	21.31 (4.23)
	<i>t</i> (<i>p</i>)	.811 (.418)	.440 (.660)	2.183 (.030)	.589 (.557)	.591 (.555)	−.397 (.692)	.286 (.775)
Grade level	Freshmen	21.55 (4.17)	19.57 (5.70)	17.92 (5.87)	21.69 (4.85)	23.73 (5.45)	25.46 (4.20)	21.03 (4.06)
	Sophomore	21.62 (4.45)	20.35 (6.39)	16.78 (6.00)	21.81 (4.66)	24.00 (5.30)	25.51 (5.44)	21.27 (4.41)
	Junior	21.85 (4.39)	20.67 (5.66)	17.27 (5.58)	21.92 (5.30)	23.73 (5.51)	26.45 (5.17)	21.06 (4.66)
	Senior	22.39 (3.63)	21.39 (4.89)	17.74 (5.31)	22.36 (4.49)	24.67 (4.95)	26.17 (3.78)	22.02 (3.81)
	<i>F</i> (<i>p</i>)	.641 (.589)	1.576 (.195)	.462 (.709)	.294 (.830)	.581 (.628)	.882 (.451)	1.003 (.392)
Smoking	Yes	21.91 (4.19)	50.57 (5.58)	17.45 (5.62)	21.79 (4.92)	24.14 (5.37)	26.20 (4.56)	21.29 (4.30)
	No	21.82 (4.01)	20.31 (5.62)	17.71 (5.71)	22.32 (4.73)	23.74 (5.18)	25.42 (4.58)	21.44 (4.0 8)
	<i>t</i> (<i>p</i>)	−.160 (.873)	−.367 (.714)	.361 (.718)	.888 (.375)	−.613 (.541)	−1.367 (.173)	.288 (.773)
Religion	Yes	22.86 (4.21)	21.64 (5.53)	18.82 (5.35)	23.24 (4.80)	24.85 (5.40)	26.81 (4.64)	21.81 (4.25)
	No	21.36 (4.00)	19.88 (5.53)	16.85 (5.68)	21.28 (4.76)	23.58 (5.22)	25.50 (4.48)	21.09 (4.21)
	<i>t</i> (<i>p</i>)	3.032 (.003)	2.616 (.009)	2.915 (.004)	3.375 (.001)	1.986 (.048)	2.378 (.018)	1.416 (.158)
Daily Internet use (in h)	<1	22.25 (2.66)	19.75 (5.66)	17.06 (5.94)	21.18 (3.72)	25.75 (4.43)	28.37 (3.68)	21.37 (3.13)
	1–2	22.12 (4.39)	20.50 (5.29)	17.94 (5.65)	22.47 (5.28)	24.42 (5.62)	25.76 (4.52)	21.63 (5.26)
	2–3	22.76 (4.07)	21.60 (5.03)	18.90 (5.23)	22.74 (5.28)	24.77 (5.29)	26.82 (4.85)	21.74 (4.07)
	3–4	21.37 (3.99)	20.36 (5.55)	16.85 (5.14)	21.55 (4.77)	23.40 (5.00)	25.43 (4.64)	20.65 (3.86)
	≥4	21.56 (4.27)	20.08 (5.59)	17.11 (5.97)	21.70 (4.97)	23.59 (5.44)	25.52 (4.43)	21.37 (4.28)
	<i>F</i> (<i>p</i>)	1.195 (.313)	.860 (.488)	1.409 (.231)	.810 (.519)	1.204 (.309)	2.206 (.068)	.567 (.672)
Health interest	High	23.63 (4.20)	22.45 (5.73)	19.85 (5.77)	23.63 (5.15)	26.00 (4.89)	27.22 (4.53)	22.64 (4.24)
	Moderate	21.20 (3.81)	19.74 (5.13)	16.65 (5.13)	21.30 (4.54)	23.28 (5.25)	25.44 (4.41)	20.79 (4.15)
	Low	18.98 (2.72)	17.16 (5.30)	13.60 (4.55)	19.20 (3.16)	20.48 (4.37)	25.96 (4.57)	19.48 (3.22)
	<i>F</i> (<i>p</i>)	20.402 (<.001)	13.618 (<.001)	19.345 (<.001)	12.835 (<.001)	16.133 (<.001)	7.750 (<.001)	9.396 (<.001)
Time per wk spent searching online for health-related information	Everyday*	23.98 (6.13)	22.86 (7.66)	19.77 (8.09)	25.18 (6.51)	25.27 (6.88)	27.63 (5.19)	23.18 (5.45)
	3–4 days per wk†	23.66 (4.30)	24.08 (5.59)	19.08 (6.06)	22.60 (5.34)	25.96 (4.82)	27.88 (4.43)	22.36 (4.58)
	1–2 days per wk‡	22.10 (3.88)	21.19 (5.03)	18.00 (4.95)	22.17 (4.49)	23.74 (5.16)	26.12 (4.56)	21.35 (3.73)
	<3 per mo§	21.11 (3.72)	19.02 (5.15)	16.59 (5.46)	21.21 (4.57)	23.70 (5.18)	25.26 (4.38)	20.88 (4.25)
	<i>F</i> (<i>p</i>)	5.466 (.001)	9.449 (<.001)	3.463 (.017)	4.770 (.003)	1.797 (.148)	3.718 (.012)	2.473 (.062)
		a, b > d	a, b > d	c > d	a > d			
Health status	Good*	22.61 (4.32)	20.85 (5.80)	18.85 (5.45)	22.68 (4.95)	24.91 (5.56)	26.36 (4.80)	22.04 (4.42)
	Moderate†	21.17 (3.73)	20.01 (5.26)	16.19 (5.35)	21.17 (4.52)	23.28 (4.69)	25.44 (4.52)	20.93 (3.87)
	Bad‡	20.26 (3.41)	20.00 (5.34)	14.76 (5.48)	20.53 (4.72)	21.74 (4.58)	25.33 (3.46)	19.17 (3.28)
	<i>F</i> (<i>p</i>)	7.362 (.001)	.845 (.431)	12.895 (<.001)	4.839 (.009)	7.209 (.001)	1.598 (.204)	8.230 (<.001)
	a > b, c		a > b, c	a > c	a > c		a > c	

HR = health responsibility, IS = interpersonal support, Nu = nutrition, PA = physical activity, SD = standard deviation, SG = spiritual growth, SM = stress management.

* =a, †=b, ‡=c, §=d.

Table 3
Levels of depression, anxiety, e-health literacy and health-promoting behaviors (N = 301).

Variables	Range	Mean (SD)
Depression	0–19	3.93 (4.71)
Anxiety	0–21	3.40 (4.30)
E-health literacy	1.58–5	3.91 (0.56)
Communicative e-health literacy	1.36–5	3.75 (0.74)
Critical e-health literacy	1.75–5	3.86 (0.58)
Functional e-health literacy	2.75–5	4.12 (0.58)
Health-promoting behavior	1.46–3.85	2.43 (0.45)
Health responsibility	1–4	2.27 (0.62)
Physical activity	1–4	2.19 (0.70)
Nutrition	1–4	2.44 (0.54)
Spiritual growth	1–4	2.66 (0.59)
Interpersonal support	1–4	2.88 (0.50)
Stress management	1–4	2.66 (0.52)

SD = standard deviation.

2.44 (0.54), the mean of spiritual growth was 2.66 (0.59), the mean of interpersonal support was 2.88 (0.54), and the mean of stress management was 2.66 (0.52).

3.3. Correlations between depression, anxiety, eHL, and health-promoting behaviors

Table 4 shows the correlations between the variables. Depression showed statistically significant positive correlations with anxiety ($R = 0.734, P < .001$). In contrast, depression was significantly negatively correlated with health-promoting behaviors ($r = -0.198, P = .001$). Health-promoting behavior was significantly positively correlated with eHL ($R = 0.347, P < .001$).

3.4. Factors influencing the health-promoting behavior of the subjects

To identify the factors influencing health-promoting behavior among the subjects, variables that showed differences in

Table 4
Correlations among depression, anxiety, e-health literacy and health-promoting behaviors (N = 301).

Variables	r (P)			
	1	2	3	4
1. Depression	–			
2. Anxiety	.734 (<.001)	–		
3. E-health literacy	–.040 (.495)	–.052 (.373)	–	
4. Health-promoting behaviors	–.198 (.001)	–.069 (.231)	.347 (<.001)	–

health-promoting behavior among the general characteristics and variables that showed significant correlations with health-promoting behavior were added to the regression model and analyzed using stepwise multiple regressions (Table 5).

As a result of the multicollinearity analysis, the range of tolerance was 0.51 to 0.98, which was ≥ 0.1 , and the Variance Inflation Factor ranged from 1.02 to 1.96, which did not exceed the reference value of 10, indicating that there was no multicollinearity. The Durbin-Watson value, which was calculated to verify the independence of the residuals, was also 2.38; as this figure is close to 2, this indicates no autocorrelation.

The factors influencing the overall health-promoting behavior of the participants were religion ($\beta = -0.160$, standard error [SE] = 0.048), current health status ($\beta = -0.097$, SE = 0.032), frequency of searching the Internet for health-related information in a week ($\beta = -0.070$, SE = 0.026), interest in health ($\beta = -0.191$, SE = 0.039), and critical eHL ($\beta = 0.243$, SE = 0.040). The prediction model of the overall health-promoting behavior of nursing students was significant ($F = 23.363$, $P < .001$), the adjusted coefficient of determination (R^2) was 0.274, and the explanatory power of this model was 27.4%.

Factors influencing the subjects' health responsibilities were religion ($\beta = -0.188$, SE = 0.067), the frequency of searching the Internet for health-related information per week ($\beta = -0.141$, SE = 0.036), interest in health ($\beta = -0.210$, SE = 0.054), and critical eHL ($\beta = 0.298$, SE = 0.056). The most influential factor was critical eHL. In addition, the R^2 was 0.212 and the model's explanatory power was 21.2%.

Factors influencing the physical activity of the participants were religion ($\beta = -0.201$, SE = 0.077), current health status ($\beta = -0.224$, SE = 0.052), frequency of searching the Internet for health-related information per week ($\beta = -0.090$, SE = 0.042),

and interest in health ($\beta = -0.324$, SE = 0.062). The most influential factor was the current health status. The R^2 was 0.190 and the model's explanatory power was 19.0%.

Factors influencing the participants' nutrition were religion ($\beta = -0.207$, SE = 0.060), current health status ($\beta = -0.092$, SE = 0.040), number of searches on the Internet for health-related information per week ($\beta = -0.081$, SE = 0.032), interest in health ($\beta = -0.177$, SE = 0.048), and critical eHL ($\beta = 0.211$, SE = 0.050). The most influential factor was critical eHL. The R^2 was 0.183 and the model's explanatory power was 18.3%.

Factors influencing spiritual growth were religion ($\beta = -0.127$, SE = 0.064), interest in health ($\beta = -0.252$, SE = 0.051), critical eHL ($\beta = -0.257$, SE = 0.053), and depression ($\beta = -0.025$, SE = 0.007). Functional eHL was found to be the most influential factor. The R^2 was 0.206 and the model's explanatory power was 20.6%.

The factors influencing participants' interpersonal support were religion ($\beta = -0.161$, SE = 0.064), the number of searches on the Internet for health-related information per week ($\beta = -0.066$, SE = 0.029), interest in health ($\beta = -0.120$, SE = 0.043), critical eHL ($\beta = 0.176$, SE = 0.066), and functional eHL ($\beta = 0.226$, SE = 0.064). Functional eHL was the most influential factor. The R^2 was 0.252 and the model's explanatory power was 25.2%.

The factors influencing stress management among the participants were current health status ($\beta = -0.112$, SE = 0.042), interest in health ($\beta = -0.140$, SE = 0.046), communicative eHL ($\beta = 0.094$, SE = 0.046), critical eHL ($\beta = 0.201$, SE = 0.059), depression ($\beta = -0.027$, SE = 0.009), and anxiety ($\beta = 0.020$, SE = 0.010). The most influential factor was critical eHL. The R^2 was 0.205 and the model's explanatory power was 20.5%.

4. Discussion

The purpose of this study was to understand the relationship between depression, anxiety, eHL, and health-promoting behaviors among nursing students during the COVID-19 pandemic, and to determine the effect of these factors on health-promoting behaviors. The results indicate that depression was positively correlated with anxiety, was negatively correlated with eHL, and was positively correlated with health-promoting behavior. In line with our assumptions, eHL was found to be positively correlated with health-promoting behavior. Among the factors predicting health-promoting behaviors, the most influential was

Table 5
Factors affecting health-promoting behaviors (N = 301).

Variables	Total	HR	PA	Nu	SG	IS	SM
	β (SE)						
Constant	2.465 (.207)**	2.260 (.284)**	3.274 (.208)**	2.681 (.258)**	2.417 (.251)**	1.958 (.241)**	1.987 (.223)**
Gender							
Religion	–.160 (.048)**	–.188 (.067)	–.201 (.077)**	–.207 (.060)**	–.127 (.064)*	–.161 (.054)**	
Health status	–.097 (.032)**		–.224 (.052)**	–.092 (.040)*			–.112 (.042)**
Time per wk spent searching online for health-related information	–.070 (.026)**	–.141 (.036)	–.090 (.042)*	–.081 (.032)*		–.066 (.029)*	
Health concern	–.191 (.039)**	–.210 (.054)	–.324 (.062)**	–.177 (.048)**	–.252 (.051)**	–.120 (.043)**	–.140 (.046)**
Communicative e-health literacy							.094 (.046)*
Critical e-health literacy	.243 (.040)**	.298 (.056)		.211 (.050)**	.257 (.053)**	.176 (.066)**	.201 (.059)**
Functional e-health literacy						.226 (.064)**	
Depression					–.025 (.007)**		–.027 (.009)**
Anxiety							.020 (.010)**
R^2	.284	.223	.201	.196	.217	.265	.221
Adj. R^2	.274	.212	.190	.183	.206	.252	.205
F	23.363 (<.001)	21.114 (<.001)	18.548 (<.001)	13.364 (<.001)	20.400 (<.001)	21.187 (<.001)	13.853 (<.001)

HR = health responsibility, IS = interpersonal support, Nu = nutrition, PA = physical activity, SE = standard error, SG = spiritual growth, SM = stress management.

* $P < .05$.

** $P < .01$.

critical eHL. However, in contrast to our assumptions, depression, and anxiety did not predict health-promoting behaviors.

In this study, depression and anxiety were investigated to understand the mental health of nursing students during the COVID-19 pandemic. Depression averaged 3.93 (4.71) and anxiety averaged 3.40 (4.30). It was confirmed that 33.2% of the participants experienced depression with mild or higher symptoms, and 29.2% had experienced anxiety with an anxiety screening standard of 5 points or higher. In a study conducted by Mulyadi et al^[44] between 2020 and 2021, a systematic literature review and meta-analysis of mental health problems in nursing students during the COVID-19 pandemic showed that the prevalence range was 22.28 to 81.40%, the pooled prevalence was 52%, and about one-third of nursing students experienced anxiety. In a study by Zhu, Wang, and Wang,^[33] which was conducted among Chinese nursing college students between March and April 2020 (i.e., during the COVID-19 pandemic), the prevalence of depression and anxiety was found to be 56.4% and 55.0%, respectively. A meta-analysis study of community-based depression by Bueno-Notivol et al^[45] from January to May 2020 showed that the prevalence of depression was 7.45 to 48.30% and the integrated prevalence of depression was 25%, which was 7 times higher than the global prevalence of depression in 2017. Depression and anxiety do not discriminate according to age, and their prevalence varies. In particular, the increased rate of depression related to COVID-19 is reported to be related to young age and health status, and college students in their 20s are particularly vulnerable.^[9,33,35,45] Our findings show a slightly lower prevalence of depression or anxiety than previous studies, which found a high prevalence of mental health problems among nursing students during the COVID-19 pandemic.^[33,44] These results are consistent with other previous findings^[10,35] that showed that depression or anxiety levels increased and decreased over time. Compared to the early days of the COVID-19 outbreak, when quarantine measures such as social distancing were stronger, this study was conducted at a later stage of the pandemic. Nevertheless, our findings showed that there is still a risk of mental health problems such as depression and anxiety in nursing students. Nursing students experience greater stress and mental health problems than other students because of stronger academic needs, including clinical practice.^[46] Moreover, during the pandemic, nursing students experienced much higher levels of depression and anxiety than before the COVID-19 outbreak.^[34] Results showed that depression was positively correlated with anxiety ($R = 0.734, P < .001$). And depression was found to have a negative correlation with health-promoting behavior ($R = 0.201, P = .001$), consistent with previous findings,^[27] which reported that health-promoting behavior of nursing students had a negative correlation with depression; consequently, there should be careful monitoring of depression and anxiety among nursing students, as well as effective management approaches to reduce these levels. Regular mental health evaluations should be conducted to identify and intervene in nursing students' health problems, and individual approaches to providing services tailored to each student should be included. The present results showed that depression had no meaningful relationship with eHL, contrasting with previous research,^[29] which reported that depression and eHL had a negative correlation. A possible explanation for the differences in these results may be that Yang and colleagues^[29] recruited ordinary people, while our study subjects were nursing college students. Nursing college students have more knowledge of infectious diseases due to the nature of their majors and can be aware of the potential risk and consequences of infection.^[33] Therefore, to help them, it is necessary to make them feel confident that they can ensure their safety, by providing clear guidelines and information on infection control, as well as academic stress management and psychological support through online platforms.^[34]

In this study, the subjects' eHL averaged 3.91 (0.56) points. In a study by Kim and Jon,^[47] which investigated eHL of nursing students using the same tool, eHL averaged 3.71 (0.65), similar to our findings. Although it is difficult to directly compare previous findings to this study, the average score for eHL among Vietnamese nursing students was between 3.63 (0.81) and 4.09 (0.66),^[37] 2.71 to 3.08 for Danish nursing freshmen, and 2.81 to 3.37 for graduate students.^[48] In addition, eHL was higher than average. A study by Kim and Oh^[49] conducted with nursing students during the pandemic also reported on the positive correlation between eHL and health-promoting behaviors. Our study indicates that the eHealth information of nursing students can help health-promoting behaviors improve and easily access their health-related information. The eHL results of nursing students in previous studies were higher than those of digital health literacy (2.99, standard deviation 0.51)^[24] among college students in the U.S. These results support those of Yang et al,^[48] who found that college students majoring in the medical field have higher eHL. It is thought that nursing students may have relatively higher eHL than non-medical students in the process of acquiring health-related information through various health-related subjects in addition to major subjects. Nevertheless, it is necessary to improve the eHL of nursing students because this is directly related to communication and patient health management in the medical system and their safety when performing their duties as clinical nurses in the future. Therefore, it is necessary to provide appropriate education so that nursing students can critically search for, evaluate, and filter out unnecessary information. When eHL is high, people are more likely to participate in positive health-promoting behaviors.^[48] Individual eHL enhancements have a positive impact on their health decisions and affect future behaviors to help achieve better health.^[27,37,47,48] In other words, if eHL is high, individuals are highly likely to comply with preventive behavior,^[37,48] and this enables a healthy lifestyle and promotes engagement with preventive behavior during the COVID-19 outbreak.^[36] A study by Li et al^[36] found a positive correlation between eHL and health-promoting behaviors, and the same results ($R = 0.347, P < .001$) were confirmed in our study. Li, et al^[36] suggested that eHL improvement may also help individuals to more actively choose a healthy lifestyle and adapt to isolation by social distancing to block the spread of infectious diseases. In this respect, if the eHL level of nursing students is sufficient, it will have a positive effect on preventive behavior for effective infection prevention in COVID-19 pandemic situations, and it will be possible to evaluate and apply accurate and useful information to solve and manage the subject's health problems in their future careers. Therefore, the department needs to develop and apply an education curriculum based on eHL, along with education that can improve eHL among nursing students. In addition, most Korean university students use smartphones, tablets, and laptops that can be connected to the Internet on campus, therefore, sufficient technical infrastructure must be built for students to always use Internet communication networks such as Wi-Fi on campus.

In this study, the average health-promoting behaviors of the subjects were 2.43 (0.45). Compared to 2.31,^[50] 2.57,^[51] and 2.79,^[27] which were found when college students were surveyed in a previous study, health-promoting behaviors of the subjects in this study were found to be moderate. Most of the participants in this study were in their early 20s and were generally less interested in lifestyle-related diseases; therefore, an intervention strategy is required to promote health-promoting behaviors during this period.

The factors affecting health-promoting behaviors were religion ($\beta = -0.160, SE = 0.048$), current health status ($\beta = -0.097, SE = 0.032$), frequency of searching the Internet for health-related information in a week ($\beta = -0.070, SE = 0.026$), interest in health ($\beta = -0.191, SE = 0.039$), critical eHL ($\beta = 0.243, SE = 0.040$), and explanatory power of 27.4%. Among the

factors affecting each subdomain of health-promoting behaviors, the most influential factors were critical eHL; physical activity, critical growth, interpersonal relations, and stress management were found to be functional eHL. In previous studies, religion,^[52] subjective health status,^[51,52] and frequency of searching the Internet for health-related information in a week,^[11] interest in health,^[53] and critical eHL^[48] have been identified as factors influencing health-promoting behaviors. Individuals perform health-promoting behaviors well when they perceive their health to be good.^[51] Previous studies have also shown that people who prioritize health or have many sources of health information tend to adopt more health-promoting lifestyles.^[54] Our findings also support those of Yang, Luo, and Chiang,^[48] which showed that people who were more interested in their health tended to search for health information more frequently, and those with more critical eHL levels participated in more positive health-promoting lifestyle behaviors. We found that 94.7% of the participants used the Internet for more than an hour every day and 41.2% used the Internet for >4 hours a day, confirming that most nursing students use the Internet every day. These results support existing research that found that university students primarily use digital technology and web-based information.^[22,55] As for the number of searches for health-related information on the Internet, most used it <3 times a month (48.8%), followed by 1 or 2 times a week (35.5%). It was also confirmed that health-related information was searched for on the internet more than once a month. These results are similar to the results of a study by Zakar et al,^[22] in which 55.7% of college students searched for COVID-19 information on the Internet within 4 weeks. In a study of medical students by Nguyen et al,^[15] it was found that a high level of health knowledge was associated with low fear of COVID-19. Nursing college students with sufficient eHL levels will be able to increase their health knowledge through health information on the Internet, and they will be able to choose and participate in more positive health-promoting behaviors. Since eHL is necessary for transforming and acting on health information obtained online, and thus for promoting a healthy lifestyle, improving eHL levels among college students is of fundamental importance. In this study, communicative eHL averaged 3.75 (0.74), functional eHL averaged 4.12 (0.58), and critical eHL averaged 3.86 (0.58), confirming that functional eHL was at a high level, but communication eHL and critical eHL were relatively low. In this study, critical eHL was found to be a major factor influencing health-promoting behaviors. The importance of critical eHL is emphasized because much of the health information available online contains false information in addition to useful information. Therefore, efforts should be made to develop programs that can improve not only functional eHL, but also critical eHL so that nursing students can search for accurate information, use reliable information through critical evaluation, and lead to health-promoting behaviors.

The results of this study should be interpreted in consideration of several limitations. First, the factors affecting health-promoting behaviors identified in this study should not be considered causal because they came from a single cross-sectional survey. Second, since the subjects of this study were convenience sampled, results cannot be generalized across all nursing college students. Data from a previous study in 2020^[56] reported that men constituted 14.7% of the Korean registered nurse workforce, up from 2.8% in 2008.^[57] Therefore, the proportions of female and male nursing students in this study were unbalanced. Third, as the survey was conducted over a short period after the COVID-19 pandemic occurred, additional investigations are required to confirm how these findings might vary across time or different contexts.

In the future, we cannot rule out the possibility of suffering from unpredictable new infectious diseases such as COVID-19. Considering these points, this study suggests that it is necessary

to develop an intervention strategy to lower levels of depression and anxiety and improve eHL in order to consistently promote health-promoting behaviors among nursing students.

5. Conclusion

This study found that anxiety and depression experienced by nursing students during the COVID-19 pandemic were negatively correlated with health-promoting behavior, and eHL was positively correlated with health-promoting behaviors. In addition, eHL was found to be the main factor influencing health-promoting behaviors. The results of this study showed the importance of reducing anxiety and depression and improving eHL levels to improve health-promoting behaviors, even in the COVID-19 pandemic and other similar situations; nursing students should manage their health and take charge of counseling and education for their careers. In addition, identifying factors affecting health-promoting behaviors contributes to providing basic data that can be used for the development of effective intervention programs.

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