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Development and evaluation of virtual simulation for smoking cessation counseling education program for nursing students

Eun-Hye Lee[1] and Sung-Rae Shin[1*]

Abstract

Background Smoking is still a one of the critical preventable factors for human health, Nurses are healthcare providers who can help patients quit smoking. The subject for Smoking cessation counseling is not routinely included in nursing curricula.

Methods The purpose of this study was to develop a virtual simulation for smoking cessation counseling education for nursing students and to increase the motivation and competence of research participants in smoking cessation counseling intervention. A quasi-experimental, nonequivalent control group, nonconcurrent pretest-posttest design was used to evaluate the effectiveness of the virtual simulation-based smoking cessation counseling education program. The VSCCEP(Virtual simulation-based Smoking Cessation Counseling Education Program) was developed based on the ADDIE model, utilizing the content required for tobacco cessation counseling education. The subjects of this study were third-year nursing students from two universities located in S city included 39 participants in the experimental group and 36 in the control group. The research data were collected from September 30, 2024 to November 5, 2024. We were analyzed using descriptive statistics and the t-test, paired t-tests.

Results Total research participants was 76 divided 2 groups. Autonomous motivation for smoking cessation counseling increased statistically significantly in the experimental group before and after VSCCEP (t=-3.33, $p=.002$), and there was also a statistically significant difference when compared to the control group (t=-2.05, $p=.044$). There was a statistically significant increase in control motivation for cessation counseling among experimental group subjects before and after VSCCEP (t=-3.67, $p=.001$) and no statistically significant difference when compared to the control group (t=-1.44, $p=.153$). Perceived competence in cessation counseling was statistically significantly increased in the experimental group (t=-4.51, $p<001$), with a statistically significant increase in the control group (t=-2.58, $p=.014$), but not statistically significant when compared to the control group (t=-0.99, $p=.324$).

Conclusion The results of this study confirmed the efficacy of the developed VSCCEP in enhancing nursing students' motivation and perceived competence in tobacco cessation counseling. These findings suggest that integrating virtual simulation programs into nursing education can strengthen practical counseling skills and support the development of autonomous, practice-ready nurses for tobacco cessation interventions.

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Keywords Virtual reality, Simulation training, Students, Nursing, Smoking cessation, Counseling

Introduction

Background the research

In the GBD(Global Burden of Disease) 2019 Burden of Disease Evidence Report on Health Risk Factors, the burden of disease research team at the Institute for Health Metrics and Evaluation (IHME) identified hypertension control, smoking cessation, and dietary modification as plausible drivers of health improvement [1, 2]. The worsening air quality, including fine dust, and the increase in infectious diseases such as pandemics mean that the harm caused by smoking will continue to increase. For example, the incidence of COPD, the fourth leading cause of death in South Korea by 2030, is steadily increasing, and lung cancer is the overwhelmingly leading cause of death in both men and women [3, 4]. Although the cumulative number of deaths from the COVID-19 pandemic in Korea since 2020 was 35,605 (as of August 30, 2023, the date of transition to surveillance), the number of deaths from smoking in Korea in 2022 was 54,508, accounting for 17% of the total mortality rate [5, 6]. Smoking harms South Korea's public and fiscal health and threatens efforts to improve equity, alleviate poverty, and protect the environment, with direct costs associated with healthcare expenditures and indirect costs associated with productivity losses due to illness and premature death from smoking estimated at KRW 28,423,137,263,616 [6]. The pandemic environment suggests that while it has suddenly become a temporary life crisis, smoking will continue to pose a longer term and larger scale harm and threat.

A simple three-minute cessation counseling session by a healthcare provider was associated with a 30% increase in smoking cessation rates, indicating that healthcare providers, who spend the most time in direct patient contact, are important professionals who can have a significant impact on reducing smoking prevalence through cessation education [7–10]. In other countries, various tobacco cessation counseling and cessation intervention programs have been implemented in hospitals and communities, either by nurses alone or by multidisciplinary approaches that include nurses, with partial or differential success in patients [11–13]. At the government level, systematic and effective health tobacco cessation education is provided to healthcare providers in clinical settings, and specialized tobacco cessation education is continuously conducted through Alcohol, Tobacco, and Other Drug Problem prevention (ATOD) and Rx for Change (train the trainer program) as part of the regular curriculum [14–17] Healthcare providers are actively counseling patients to quit smoking through the standardized 5 A & 5R cessation counseling techniques, which are proven to be effective [18–20]. In Korea, smoking cessation counseling education is being conducted through the National Smoking Cessation Support Center's Online Smoking Cessation Counseling Education Center within the Health Promotion Development Institute, but no separate design has been made for education centered on healthcare providers. The Framework Convention on Tobacco Control (FCTC), adopted by the World Health Organization (WHO) in 2005, was adopted in Korea to comprehensively address the harmful effects of tobacco on human health. Since then, smoking cessation support has begun to be provided on a national level, and nurses have become an important key resource for smoking cessation interventions due to the national smoking cessation support project centered on medical institutions [21]. It has also been shown that a smoking cessation intervention education program has a positive effect on nursing students' intention to participate in smoking cessation interventions and their sense of efficacy [22–24]. Smoking cessation counseling training is needed in the formal curriculum to ensure that students entering the nursing profession have the essential knowledge of tobacco treatment and the confidence to apply it in the clinical setting [25–27]. On the other hand, in Korea, except for the national online smoking cessation counseling program, tobacco cessation education is very limited in health-related university curricula such as medical, dental, oriental medicine, and nursing schools, which play a key role in smoking cessation counseling [28].

Virtual simulations are divided into immersive and non-immersive types, and the biggest difference is in the level of realism and sensory involvement, and both are currently being used well in the nursing education field [29–31]. Virtual reality simulation is a suitable teaching method for flipping learning in regular courses or practical classes because it has relatively few resource constraints, can realize real-life scenarios in three dimensions, can accommodate a large number of learners at the same time, can be repeated as needed, and can be accessed from any location, making learning more accessible [32–35]. Simulation-based practical training is required for smoking cessation counseling as information acquisition alone is insufficient and can be acquired through practice in real-life situations [36–38], currently, it is not included in the regular curriculum. As for, it is believed that the development and application of educational programs using virtual simulation would be effective for the acquisition of smoking cessation knowledge and counseling training for nursing students who are unable to meet and practice counseling with virtual

smoking patients scenarios [39]. In this study, the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model was used as the process of the research program. It is the most widely used model as the general form of the teaching system design process. It was developed by Dick & Carey and is a teaching design model with five stages that are linearly and cyclically structured [40].

Based on these findings, this study aims to develop a virtual simulation program for smoking cessation counseling education for nursing students. It will also evaluate their motivation and perceived competence in tobacco cessation counseling to assess the program's effectiveness in enhancing their counseling skills.

The purpose of research

The purpose of this study was to determine the motivation and perceived competence of nursing students to use an online virtual simulated smoking cessation counseling training program to implement smoking cessation interventions.

1) Are there difference in the general characteristics, autonomous motivation to smoking cessation counseling, controlled motivation to smoking cessation counseling, and perceived competence to smoking cessation counseling of the participants?
2) What are the effects of a virtual simulation cessation counseling training program on participants' autonomous motivation, controlled motivation, and perceived competence for smoking cessation counseling?

Materials and methods

Study design

This study was a quasi-experimental study using a non-equivalent control group pretest-posttest non-synchronized design to determine the effectiveness of a virtual simulation-based smoking cessation counseling education program developed to educate nursing students about smoking cessation (Fig. 1). This study was conducted using a quasi-experimental design that can be selected in a situation where homogeneity between groups is secured and external variables cannot be completely controlled, such as in a laboratory. To compensate for the bias that can occur in convenience sampling, where random assignment is difficult, the study subjects were limited to third-year students at universities with similar curriculums.

Research participants

The subjects of this study were convenience sampled from third-year university students in two nursing programs in City S. The selection criteria were (1) students who completed the adult nursing course for respiratory

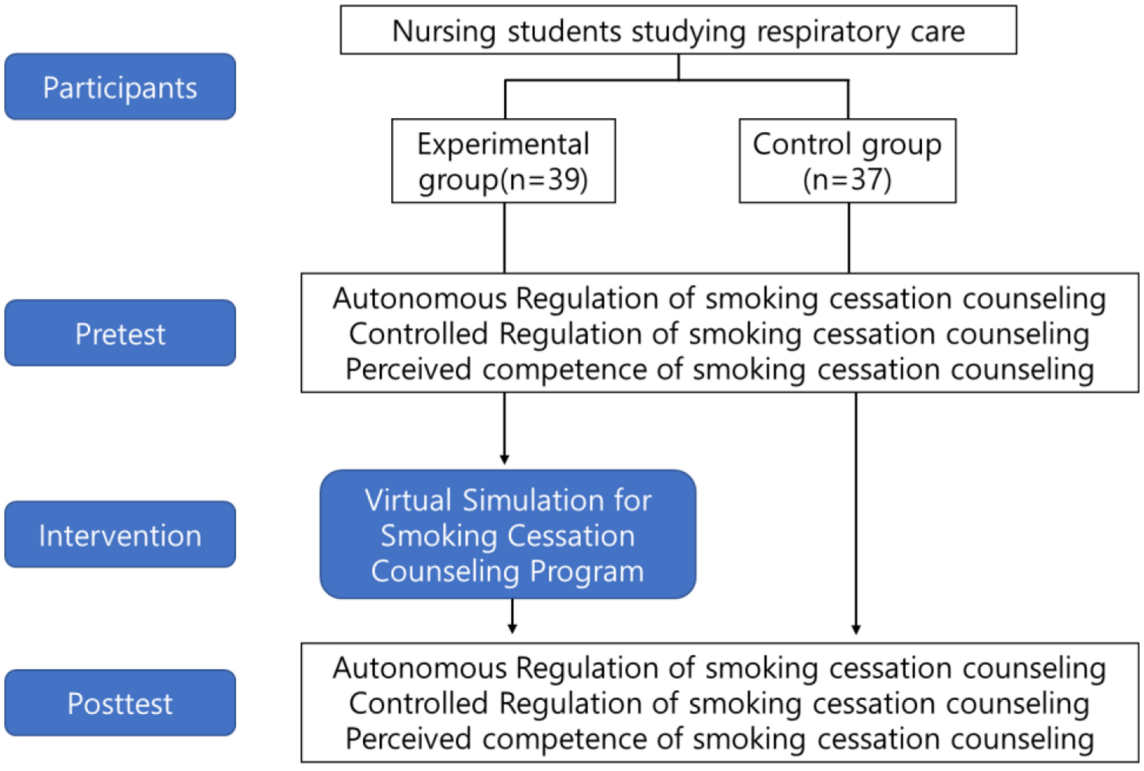

Fig. 1 Research subject and design

diseases, (2) students who understood and agreed to the purpose of the study, (3) third-year nursing college student, and (4) student who has not previously received a smoking cessation counseling and education program.

Sample size

The sample size of this study was determined using the G*Power 3.1.9.7. program, and the sample size was calculated by referring to the research design and variables of previous studies [41]. The minimum sample size was calculated to be 70 students, 35 in each group, using an independent t-test with an effect size of 0.8, a significance level of $\alpha = 0.05$, and a power of 95%. The final number of subjects in this study was 39 in the experimental group and 37 in the control group, which met the minimum sample size.

Measurements

Motivation for smoking cessation counseling

The motivation is based on Williams and Desi [42]'s Self-Regulation Questionnaire for Learning (SRQ-L), which was developed for students learning to perform medical interviewing, modified by Kim et al. [41] instrument for nursing students learning to conduct smoking cessation counseling. The SRQ-L included 14 items in three categories of why participants engage in learning about smoking cessation interventions. It is a 14-item instrument with two subscales: autonomous motivation (intrinsic motivation) and controlled motivation (extrinsic motivation), with a Likert scale ranging from 1 (not at all) to 7 (very much so). Higher scores on each subscale indicate higher levels of autonomous or controlling motivation, and Kim et al. [41]'s study, Cronbach's α values were 0.83 for autonomous motivation and 0.81 for controlled motivation. In this study, Cronbach's α values were 0.87 for autonomous motivation and 0.83 for controlled motivation.

Perceived competency

Perceived competence is defined by Williams and Deci [42], and measured using a modified version modified by Kim et al. [41] of the Perceived Competence Scale (PCS), which is a tool to determine the extent to which participants feel competent to participate in smoking cessation interventions for smokers. It is a four-item, 7-point Likert scale item, with higher scores indicating a higher level of competence to implement a smoking cessation intervention. Kim et al. [41] 's study, Cronbach's α value was 0.90. In this study, the Cronbach's α value was .88.

General characteristics

The characteristics of the research participants in this study were gender, age, smoking status, GPA, smoking cohabitation, nursing major satisfaction, and healthy lifestyle.

Program development process

Virtual simulation of smoking cessation counseling education program (VSCCEP) for nursing students was done via ADDIE (analysis, design, development, implementation and evaluation) model [40] (Fig. 2).

Analysis

A literature review and expert consultation were conducted to secure basic data for the development of a smoking cessation counseling education program for nursing students. Based on the literature review of global guideline and national tobacco cessation counseling curricula in Korea, we identified the knowledge and counseling skills needed for tobacco cessation counseling based on the contents of the curriculum for tobacco cessation counseling professionals. The theoretical framework of the smoking cessation counseling and education program in this study is a smoking cessation counseling algorithm that is based on the clinical practice guideline for tobacco use [43] tailored to the pan-theoretical stages of smoking cessation (Fig. 3).

We analyzed the goals and content of the program by conducting online and offline research on the following topics: steps to quit smoking, harmful effects of smoking on various diseases, smoking cessation counseling techniques (5 A's (Ask, Advice, Assess, Assist, Arrange Follow-up) & 5R's(Relevance, Risks, Rewards, Roadblocks, Repetition), VBA (very brief advice), smoking cessation treatment providers, smoking cessation pharmacotherapy, and national smoking cessation support services.

Design

In the design phase, the learning objectives and content of the program were established in consultation with experts in smoking cessation education, smoking cessation counseling, and respiratory specialists working in hospitals. The learning management method and educational materials for smoking cessation counseling education were planned, and the evaluation tools and timing of the study were determined. Two experts in smoking research, one expert in health education, and one respiratory physician were consulted on the content and organization of the program, focusing on the educational content derived through the analysis phase. The virtual simulation program for smoking cessation counseling education consisted of three stages: pre-learning, virtual simulation, and debriefing. The pre-learning stage is the stage of learning the knowledge required to conduct smoking cessation counseling, and an e-book was composed to learn the characteristics of smoking cessation behavioral stages, 5 A's & 5R's/VBA smoking cessation

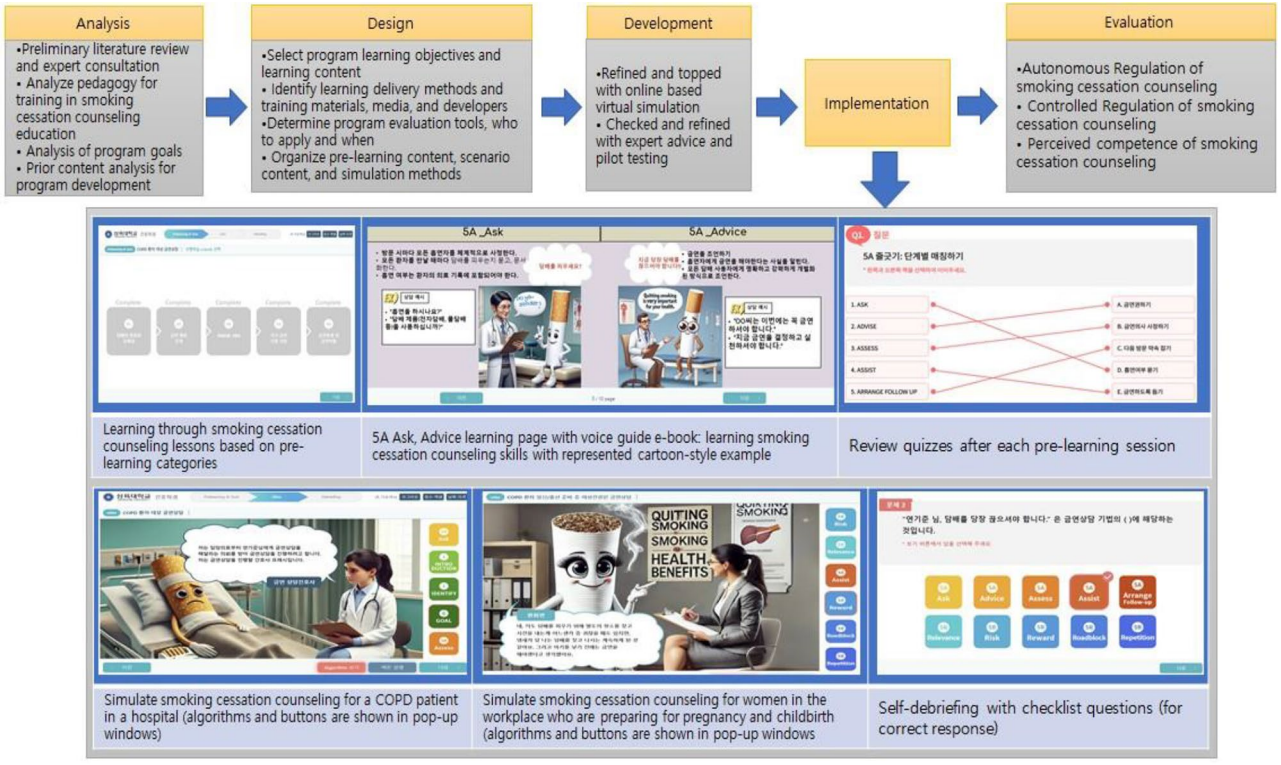

Fig. 2 Analysis, design, development, implementation, and evaluation (ADDIE) process for program development and effectiveness validation

counseling techniques, national smoking cessation support organizations and services, and smoking cessation pharmacotherapy. The preliminary learning for smoking cessation counseling consisted of five e-book sessions, and important explanations summarized by the researcher on each page were inserted as tts (text-to-speech) AI (artificial intelligence) recordings to increase concentration during self-study. The e-book is a platform that can be published online separately and can be used for learning smoking cessation counseling knowledge. The learners were able to control their own learning progress, and for each session, they could take a quiz to check their learning, and if they answered incorrectly, they could repeat the quiz once to provide feedback. After completing the pre-study, participants were asked to perform virtual simulations of a male COPD patient in the pre-contemplation stage (Not yet acknowledging that there is a problem behavior that needs to be changed) and a female office worker in the preparation stage (determination stage) who is thinking about pregnancy and childbirth. The smoker character in the visuals used in the preliminary study and scenarios was presented as a cartoon character that anthropomorphized cigarettes to generate interest without causing disgust and to recognize the smoker as a candidate for smoking cessation counseling. After completing each scenario, self-debriefing was organized through check-up questions.

Development

The developed tobacco cessation counseling training modules and scenarios were validated for content and construct validity by a tobacco cessation counselor who specializes in providing tobacco cessation counseling, two nursing professors, one health educator, and three nursing students who had previously received lecture-based tobacco cessation counseling training. Professors and counseling experts who have been engaged in smoking cessation counseling and education for more than 10 years validated focused on the appropriateness of the educational content to achieve the program's objectives and the appropriateness of the educational scenario for nursing students' smoking cessation counseling. In the validation conducted with nursing students who had previously participated in lecture-based smoking cessation counseling education, feedback was provided on the content and organization of the virtual simulation, the simulation process and organization, virtual simulation characters, and audio-visual triggers to enhance the validity and realism of the education. In this process, the contents of the scenarios were revised to correct errors or changes in the situation to make the scenarios closer to reality. The contents of the VSCCEP developed in this study and the learning activities of the learners are as follows (Table 1).

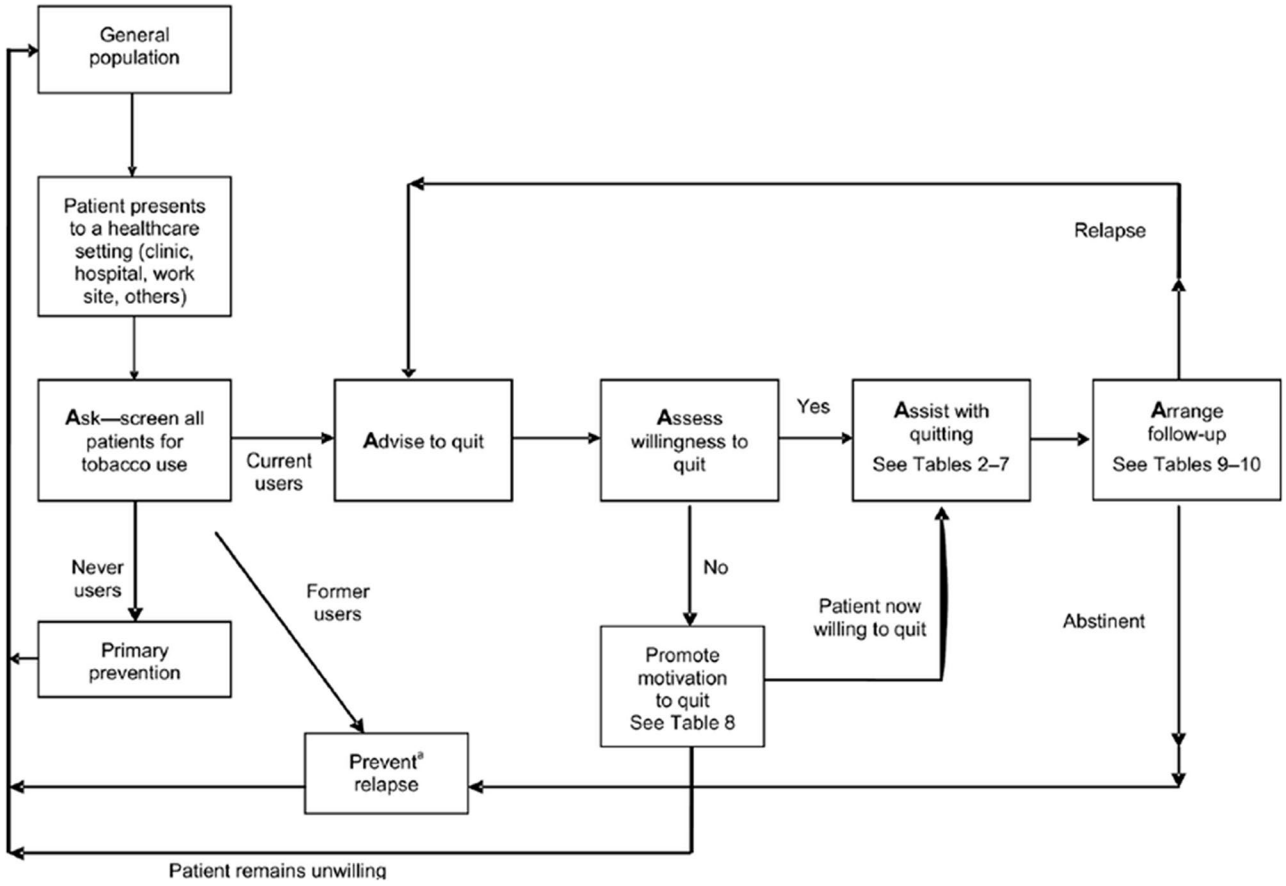

Fig. 3 Model for treatment of tobacco and Dependence, [a]Replapse prevention interventions are not necessary in the case of the adults who has not used tobacco for many years

Table 1 Virtual simulation for smoking cession counseling education program content

Stage	Content	Learning Activity
Pre-Learning & Quiz	Knowledge learning session for smoking cessation counseling -Types of Cigarettes and Their Harms -Stage of smoking Cessation -5 A&5R, VBA -National Tobacco Control Programme -Smoking Cessation Interventions and Medications	·Online learning with Voice guided on the e-book. ·Review and feedback via Quiz & Answer after each session (Repeat incorrectly answered questions)
Virtual Simulation	5 A&5R-based smoking cessation counseling virtual simulation (presented with scenario overview, patient(client) information, scenario algorithm) - Male patient with COPD - Female office worker preparing for pregnancy and childbirth	·Perform two scenarios based on the presented scenario overview, patient information, and simulation algorithms. ·Choice the proper reaction button according to the two scenarios during the simulation ·Learn appropriate verbal communication by clicking a response button in the simulation, which opens a dialog box with a voice recording.
Debriefing	Review and feedback on virtual simulation for smoking cessation counseling.	·Self-debriefing after completing each scenario based on checklist questionnaires

Implementation (intervention)

The subjects were third-year students studying respiratory system nursing at two universities with similar curricula in City S before participating in clinical practice. The study participants were third-year students from two nursing universities with similar curricula. The study was posted to the recruitment website, and students who volunteered to participate were selected. The purpose of the study and the procedure were fully explained, and the students were asked to sign a consent form to participate. For the convenience of the researchers and participants, the experimental and control groups were conveniently assigned to schools and conducted in separate locations. After participating in the pre-survey, the students

in the experimental group accessed the developed program through a link delivered online, and proceeded through the program in the order of pre-learning, virtual simulation, and debriefing shown on the first screen. The program was presented intuitively on the screen so that participants could participate in order, and a pop-up window provided a guide to participate in the program for each session, so there was no need to provide a separate explanation. The virtual simulation program was supported by voice guidance and could be paused and resumed as the student progressed. After learning the knowledge of smoking cessation counseling through the online book in the program and completing the quiz for each session, the virtual simulation was conducted. However, if there were any errors in the login, they were resolved by the developer in real time. The experimental group accessed the online-based program without any time limit according to their schedule and participated in the program for an average of 1 h and 10 min. Students in the control group who still wanted to study the program were sent a link to the program so that they could participate in the study.

Evaluation

A pre-survey of the study variables was administered to all participants four weeks prior to the start of the cessation counseling education program to minimize the impact of recall of the study variables on the intervention and post-survey. The control group conducted the pre-survey at a time lag from the intervention group. The pre-survey examined autonomous motivation to quit smoking, controlled motivation to quit smoking, and perceived competence to quit smoking, and was administered by a trained research assistant who was blinded to the participants' treatment group assignment on September. 2024.

The post-survey was administered by a trained researcher using the same questionnaire as the pre-survey, before the cessation counseling education program in the control group and immediately after the cessation counseling education program in the experimental group, to prevent third variable intervention and maturation effects on November. 2024. Participation in the pre- and post-surveys took about five minutes, and participants were given gift cards as compensation for their participation.

Data collection and data analysis

Data collection was conducted from September 30, 2024 to November 5, 2024. As this study was conducted among nursing students, to ensure the voluntariness of the participants, they were informed that there would be no disadvantage to their academic course and grades for participating in the study. After a trained researcher explained the purpose and method of the study, written consent was obtained from students who voluntarily agreed to participate in the study. The collected data were analyzed as follows using SPSS/WIN 25.0 Program. The general characteristics were analyzed using $\chi 2$-test, Fisher's exact test, t-test, and One-way ANOVA to test the homogeneity of general characteristics and study variables among the study groups. The normality distribution of the study variables was analyzed by kurtosis and skewness, and all variables were found to be normally distributed, and the relationship between each variable was analyzed by independent t-test and paired t-test.

Ethical consideration

This study was approved by the Institutional Review Board of S University (IRB No. SYU 2024-04-032) for the content and methods of the study. Participants were given a full explanation of the purpose and procedures of the study based on the Helsinki Declaration [44], and they understood the study through the question-and-answer process and provided written consent voluntarily after answering questions. Participants were informed that they could withdraw from the study at any point in the process and would not be penalized for doing so. Participants were informed that their involvement in the study would not result in any disadvantages related to their grades or academic progress. Explained that the data provided during the study will be kept anonymous and confidential and will not be used for any purpose other than the study.

Results

1) Participants' demographic characteristics

There were no statistically significant differences in the general characteristics of the participants between the experimental and control groups. In addition, the autonomous motivation for smoking cessation counseling, controlling motivation for smoking cessation counseling, and perceived competence for smoking cessation counseling, which are the main measures of this study, were normalized in the experimental and control groups [45]. There were no statistically significant differences (Table 2).

2) Effects of VSCCEP on nursing students' autonomous motivation to counsel tobacco cessation, controlled motivation to counsel tobacco cessation, and perceived competence to counsel tobacco cessation.

Autonomous motivation to quit smoking increased statistically significantly from 4.75 ± 1.11 to 5.38 ± 0.81 in the experimental group (t=-3.33, $p = .002$), and there was a statistically significant difference when compared to the

Table 2 Homogeneous test of general characteristics and dependent variables of the participants ($N=76$)

Variable	Category	Total	Exp.($n=39$)	Cont.($n=37$)	X^2 or t(p)
		n(%)	*n*(%)	*n*(%)	
General characteristics					
Gender	Male	9(11.8)	5(12.8)	4(10.8)	0.073(0.534)
	Female	67(88.6)	34(87.2)	33(89.2)	
Age (M ± SD)		23(2.52)	23.21(3.054)	22.78(1.813)	-
Smoking status	Non-Smoker	66(86.8)	35(89.7)	31(83.8)	0.72(0.684)[a]
	Ex-Smoker	5(6.6)	2(5.1)	3(8.1)	
	Smoker	5(6.6)	2(5.1)	3(8.1)	
GPA	4.0 ~ 4.5	12(15.8)	7(17.9)	5(13.5)	0.39(0.866)[a]
	3.5 ~ 4.0	33(43.4)	16(41.0)	17(45.9)	
	≦3.5	31(40.8)	16(41.0)	15(40.5)	
Cohabitation	Cohabitating with nonsmoker	66(86.8)	32(82.1)	34(91.9)	1.61(0.177)
	Cohabitating with smoker	10(13.2)	7(17.9)	3(8.1)	
Major Satisfaction	Satisfied	44(57.9)	21(53.8)	23(62.2)	2.07(0.372)[a]
	Neural	26(34.2)	16(41.0)	10(27.0)	
	Unsatisfied	6(7.9)	2(5.1)	4(10.8)	
Healthy Lifestyle	Yes	35(46.1)	15(38.5)	20(54.1)	5.57(0.061)[a]
	Neural	24(31.6)	11(28.2)	13(35.1)	
	No	17(22.4)	13(33.3)	4(10.8)	

Research Variables

	Total ($n=76$)	Exp. ($n=39$)			Con. ($n=37$)			
	M ± SD	M ± SD	Skewness	Kurtosis	M ± SD	Skewness	Kurtosis	X^2
Autonomous Regulation of SCC	4.90 ± 1.07	4.75 ± 1.11	-0.85	2.47	5.06 ± 1.01	-0.61	0.53	27.59(0.428)[a]
Controlled Regulation of SCC	4.36 ± 1.14	4.29 ± 1.14	0.15	-0.16	4.43 ± 1.15	-0.11	-0.44	20.50(0.956)[a]
Perceived competence of SCC	4.26 ± 1.47	3.95 ± 1.32	0.53	-0.17	4.58 ± 1.55	-0.37	-0.35	17.71(0.807)[a]

[a]Fisher's exact test

Exp.: experimental group; Cont.: control group; SCC: smoking cessation counseling

Table 3 Differences of variables between the experimental and control group ($N=76$)

Variables	Group	Pre-Test	Post-Test	Within Group	Difference	Between Group
		M ± SD	M ± SD	t(p)	M ± SD	t(p)
Autonomous Regulation of SCC	Exp.($n=39$)	4.75 ± 1.11	5.38 ± 0.81	-3.33(0.002)	0.63 ± 1.18	-2.05(0.044)
	Cont.($n=37$)	5.06 ± 1.01	5.20 ± 1.06	-0.97(0.339)	0.14 ± 0.87	
Controlled Regulation of SCC	Exp.($n=39$)	4.29 ± 1.14	5.02 ± 1.00	-3.67(0.001)	0.74 ± 1.26	-1.44(0.153)
	Cont.($n=37$)	4.43 ± 1.15	4.76 ± 1.12	-1.61(0.117)	0.32 ± 1.23	
Perceived competence of SCC	Exp.($n=39$)	3.95 ± 1.32	4.94 ± 1.24	-4.51(0.000)	0.99 ± 1.37	-0.99(0.324)
	Cont.($n=37$)	4.58 ± 1.55	5.24 ± 1.08	-2.58(0.014)	0.66 ± 1.54	

*SCC: smoking cessation counseling

control group (t=-2.05, $p=.044$). There was a statistically significant increase in the control motivation for smoking cessation intervention from 4.29 ± 1.14 to 5.02 ± 1.00 (t=-3.67, $p=.001$) and no statistically significant difference when compared to the control group (t=-1.44, $p=.153$). The cognitive competence for smoking cessation intervention of the experimental group increased statistically significantly from 3.95 ± 1.32 to 4.94 ± 1.24 (t=-4.51, $p<001$), and the control group increased statistically significantly from 4.58 ± 1.55 to 5.24 ± 1.08 (t=-2.58, $p=.014$), but there was no statistically significant difference in comparison with the control group (t=-0.99, $p=.324$) (Table 3).

Discussion

The purpose of this study was to develop a virtual simulation training program for smoking cessation counseling that can be used in undergraduate nursing education to enhance nursing students' motivation and perceived competence in smoking cessation counseling and to verify its effectiveness. The virtual simulation cessation counseling training program (VSCCEP) developed in this study is significant in that it was developed to deliver the practical skills needed for counseling in a traditional tobacco cessation intervention training program for nursing students. It is very unique major difference that this program includes the theory and practice covered

in the existing smoking cessation intervention counseling training, but conducted without face-to-face contact with the instructor [22–24, 41, 46]. Previous studies have shown that virtual simulation increases student and instructor effectiveness in nursing education through blended learning for nursing skills and medical knowledge [34, 47], therefore, this program may be beneficial to both students and instructors. VSCCEP can make minimizing instructor's intervention may possible solving to address nursing faculty time constraints, lack of content expertise, and concerns about an already overburdened undergraduate nursing curriculum, which may be an issue in tobacco cessation intervention education [25]. Communication skills, which are essential to counseling skills, can be enhanced through practice with virtual characters in virtual simulations [48–50]. It is believed that modeling communication, including voice, through virtual simulation in this program will help learners improve their counseling skills [51, 52]. In addition, this study suggests that simulation-based smoking cessation counseling training can be effectively used in conjunction with traditional learning methods [53, 54]. We would like to suggest that a well-structured virtual simulation-based program can be used not only for smoking cessation counseling training, but also for efficiently learning standardized counseling and interview techniques for patients in various medical situations.

This study found that nursing students in the experimental group increased their autonomous motivation to smoking cessation counseling, controlled motivation to smoking cessation counseling, and perceived competence in smoking cessation counseling after participating in a virtual simulation-based smoking cessation counseling education program. These results are consistent with previous studies that have shown significant improvements in autonomous motivation, controlled motivation, and perceived competence in smoking cessation interventions after participating in a smoking cessation intervention education program using blended learning in the experimental group [41]. It is also consistent with a study that found statistically significant results in the same variables after participation in a theory-based education program for smoking cessation counseling intervention in psychiatric patients [22]. It is also consistent with the results of a program to innovate smoking cessation education curriculum for pre-licensure nursing students [46]. On the other hand, it is different from studies that showed significant differences in both experimental and control groups with previous studies [22, 41, 46]. This is in contrast to the enhancement of controlled motivation due to the role of the instructor in face-to-face smoking cessation intervention programs in previous studies. Autonomous motivation has been positively associated with engagement in higher education students [55] and engagement has been shown to increase learning outcomes in higher education students [56, 57]. In addition, when students are self-motivated, they are more likely to persevere with assignments and interact with the learning content because they are able to connect the learning to their personal values and interests [58]. Autonomous motivation has been found to be useful in studies predicting college students' interest in self-improvement [59]. The significant difference in self-motivation to engage in tobacco cessation counseling among nursing students in the VSCCEP in this study may be a result of increasing learner autonomy and minimizing instructor intervention. In the current situation where tobacco cessation counseling is not a healthcare provider mandate, it is significant that the self-motivation of pre-nurse, who are the ones who will provide tobacco cessation counseling, was enhanced.

Perceived competence in smoking cessation counseling after VSCCEP was not statistically significant between the experimental and control groups, but there were significant differences in the pre- and post-surveys within the groups. It is possible that nursing students' internalization of smoking cessation interventions as a professional nurse duty was enhanced and pressured by the information about the research progress of the educational program [60]. The mention of smoking cessation counseling education program research in the consent process may be a result of the norming process of modeling themselves in a desirable direction through the knowledge and attitudes acquired through the curriculum in nursing school. Educational interventions have been shown to increase perceived competence among nurses caring for patients with behavioral and substance abuse disorders [61], the perceived competence was associated with nurses' willingness to take risks in disaster situations [62]. In the present study, it can be inferred that perceived competence in smoking cessation counseling will lead to successful cessation counseling. Furthermore, for nursing students who already have a sense of perceived competence, self-motivation through the VSCCEP may be an effective way to increase their cessation counseling skills.

The limitations of this study are as follows. Since the study was conducted with nursing students in their third year who may already have prior knowledge of respiratory care, it may be difficult to determine the single effects of the smoking cessation counseling training program. It is necessary to verify the program by applying it to nursing students in their second year who have not yet completed their major courses. Furthermore, the program should be expanded to include students from other health-related majors to confirm its effectiveness. And, since the experimental and control groups in this study used convenience sampling rather than randomization,

selection bias may have been introduced due to the interest in smoking cessation interventions according to the schools. In addition, the intervention was not delivered face-to-face by the researcher, which limits to truly understand the constraints of virtual simulation learning that learners may experience. To compensate for this, a qualitative understanding of the training experience is required.

Significance and application of research

The academic and practical significance of this research can be summarized as follows:

Academic significance

This study has significant implications for the current nursing curriculum as it developed a standardized, virtual simulation-based smoking cessation counseling education program tailored for nursing students. As future healthcare professionals responsible for providing smoking cessation support, nursing students benefit from educational tools that enhance both competence and autonomy. By applying the ADDIE instructional design model, the program was developed to support learner-led, self-directed learning while minimizing instructor intervention. This shift aligns with contemporary educational goals that emphasize learner autonomy and engagement. The study's findings, particularly the increase in learners' autonomous motivation for smoking cessation counseling, suggest that future curriculum development should prioritize programs that enhance learner participation and immersion over traditional instructor-led methods. Furthermore, the integration of preliminary learning, scenario-based simulation, and self-debriefing into one cohesive program highlights a new direction for developing comprehensive, standalone learning materials. Given the high demand for problem-based and case-based learning in nursing education, this virtual simulation program serves as a model for future curriculum innovations. It not only supports active learning but also offers scalability and consistency across diverse learning environments. Therefore, the study is expected to inform future curriculum changes and contribute meaningfully to educational advancements in nursing.

Practical significance

This study demonstrated the effectiveness of a virtual simulation-based program (VSCCEP) in enhancing nursing students' autonomous motivation, controlled motivation, and perceived competence in smoking cessation counseling. The program allowed learners to acquire counseling skills and knowledge without direct instructor intervention. This learner-led approach promoted voluntary motivation, which is crucial for effective learning and practical application. As a result, future nurses can be better prepared to deliver smoking cessation support in clinical settings. The findings highlight the importance of self-directed learning in building real-world counseling competence. The program also serves as a model for developing digital, interactive educational tools. It offers potential for integration into online textbooks and core nursing training modules. By enhancing both motivation and skill, the program supports higher standards in smoking cessation training. It suggests a shift from instructor-led to learner-centered education in nursing. Overall, the program can contribute to advancing professional training standards in preventive healthcare counseling.

Conclusions

In conclusion, this study is significant in that it confirms the improvement in autonomous motivation for active smoking cessation counseling through a virtual simulation-based smoking cessation counseling education program, which is the most important preventable risk factor for respiratory health. By acquiring such practical knowledge through virtual simulations, nursing students will be able to improve their capabilities as prospective medical professionals and specifically increase their motivation and ability to intervene in smoking cessation.

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Author contributions
EHL and SRS made substantial contributions to the article's conception, design, and drafting. EHL was developed a program and built on-line with a contracted company, then implemented program to the research participants. EHL and SRS collected, analyzed, and interpreted data. EHL and SRS read and approved the manuscript.

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Data availability
The dataset supporting the conclusions is available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethics approval and consent to participate prior to data collection, ethical approval was obtained from the Institutional Review Board of Sahmyook University (No. SYU 2004-04-032). The anonymity and confidentiality of the participants were assured and data were treated as strictly confidential. Nursing students who agreed to participate in the study were provided with an informed consent form stating that the data would not be used for any purpose other than the research. All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication
Not applicable.

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Competing interests
The authors declare no competing interests.

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