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A structural equation model for the patient safety competency of clinical nurses

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Background Nurses are crucial for enhancing patient safety due to their continuous presence at patients' bedsides and close interactions with families and other healthcare providers. This study aims to examine the relationships among safety education, perception of patient safety culture, safety control, and patient safety competence in clinical nurses, while also exploring the mediating effect of perceptions on patient safety culture and safety control.

Methods. The study involved 165 nurses, including 10 males (6.1%) and 155 females (93.9%). Structural equation modeling (SEM) was used to test the hypothesized model, and data were analyzed using SPSS and AMOS programs.

Results. Significant positive correlations were among the frequency of attending safety education, the perception of patient safety culture, safety control, and patient safety competency. The number of safety education briefings attended did not directly influence patient safety competence; however, safety education for nurses indirectly influenced patient safety competence via the perception of patient safety culture and safety control. These findings suggest that enhancing safety education for nurses can improve patient safety competence by shaping their perceptions of patient safety culture and safety control.

A Structural Equation Model for the Patient Safety Competency of Clinical Nurses

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Abstract

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Introduction

Patient safety is a critical global issue, as preventable errors are increasing in hospitals (Lee, Jang, & Park, 2016). The World Health Organization initiated the World Patient Safety Day 2020 Campaign to raise global awareness about the importance of addressing patient safety (World Health Organization Patient Safety, 2020). In 2000, the Institute of Medicine (IOM) published a landmark report, “To Err is Human.” The experts estimated that as many as 98,000 people die in hospitals because of medical errors during any given year (Donaldson, 2008).

These deaths are more than those who die from car accidents, breast cancer, or AIDS (Donaldson, 2008). The publication of this report has aroused worldwide attention and consideration of patient safety issues. According to the National Health Insurance Service of Korea, 9.2% of the 5,744,566 patients who experienced an adverse event were hospitalized in 20[illegible] among whom 39,109 (7.4%) died from medical errors. This report also identified the need for education to enhance a nationwide monitoring and reporting system to achieve a patient safety-oriented system (Lee, 201[illegible]

Patient safety means eliminating preventable harm to patients in the course of healthcare and reducing the risk in connection with healthcare to a minimum acceptable level (Lee, Jang, & Park, 2016). Patent safety is one of the patient's primary rights and is very important as a critical element in the quality of care. In Korea, nurses are in a prominent position to ensure patients' safety because they are the largest team in the health workforce. The healthcare systems are changing, and patient demands are increasing. However, there is not enough work done to prepare healthcare professionals to meet those needs. Therefore, the ability to improve patient safety should be incorporated into education for healthcare professionals (Lee et al, 2014). The Institute of Medicine (IOM) also pointed out all healthcare professionals should possess core competencies in quality and patient safety care (Institute of Medicine, 200[illegible]A Chinese study reported that nurses who participated in patient safety training had higher levels of patient safety competence than those who did not (Yan et al., 2021). Another study suggested that patient safety is a necessary competency for nurses, and thus needs to be introduced early, strengthened throughout education, and continued throughout professional advancement (Wu & Busch, 2019). Patient safety competency means that all medical personnel have the knowledge, skills, and attitudes necessary to prevent medical errors and enhance patient safety (Canadian Patient Safety Institute, 2019). Patient safety competence is regarded as a broader term that indicates a set of underlying principles that positively contribute to overall safety in a workplace. Patient safety competence implies the ethical qualities and responsibility of employees during complex decision-making situations, such as prevention, recognition, reporting, and admitting safety problems. It involves not only the right actions to undertake but also the understanding of what safety is. Also, it incorporates the communication aspect of safety and educating medical personnel about reporting and sharing committed mistakes. Thus, patient safety competence includes knowledge, skills, and attitudes for improving patient safety.

Patient safety competency has been suggested to be a core competency of nurses, particularly as the medical environment changes to provide quality care centered on patients (Beischel & Davis, 2014). Early education with patient safety as a prominent feature of nursing is necessary to produce competence in patient safety (Okuyama, Martowirono, & Bijnen, 2011). However, one's clinical career somewhat influences patient safety competency, so some new nurses show low levels of patient safety competency Jin & Yi, 2019). Enhanced critical thinking and teamwork training for patient safety are needed to improve patient safety competency among nurses (Wu & Busch, 2019). Hospital policymakers and nursing educators give opportunities to nursing students and new nurses to solve safety issues continuously. The factors that influence patient

safety competency can be distinguished as individual aspects such as safety education and safety control, and organizational aspects such as patient safety culture.

The perception of patient safety culture means an integrated pattern of individual and organizational behaviors that aims to lessen the harm coming from care delivery processes in hospitals (Kizer, 1999). To ensure patient safety, a patient safety culture has to be formed, which means that all professionals must believe that patient safety is the highest priority in patient care (Nieva & Sorra, 2003). A patient safety culture must consider all beliefs, values, attitudes, and behaviors shared by organizations, departments, and individuals in the hospital to prevent medical errors that may occur during the provision of medical services (Halligan & Zecevic, 2011). Some nurses think that safety processes and policies can be irritating, make their job more difficult, require them to work longer hours without extra pay, or reduce their ability to care for the largest number of patients possible. Others feel that safety is solely dependent on effort. However, this view has a problem. Working harder or being more vigilant cannot necessarily prevent errors (Waterson, 2014). Indeed, this view of individual choice can make it difficult to change the hospital environment. By ensuring a patient safety culture, the hospital work environment can direct the health system toward patient safety (Waterson, 2014). In addition, as nurses are optimally placed to discover mistakes and faults, safety culture is commonly considered a vital component of nursing (Najjar et al., 2015). Ninety-six percent of nurses and 90% of doctors, pharmacists, and administrators believe that nurses have the primary responsibility for preventing patient safety accidents (Cook et al., 2004). Implementing patient safety into everyday nursing duties encourages frequent reporting and discussion of medical near misses, which will, in turn, improve patient care (Amiri, Khademian, & Nikandish, 2015). Research findings showed that a robust patient safety culture is connected to a lower rate of complications and fewer harmful events (Mardon et al., 2010; Sammer et al., 2010). To establish a patient safety culture in a health organization, some actions are needed to enhance the reporting of events, and non-punitive responses to errors need to be considered (Amiri, Khademian, & Nikandish, 2015). Nurses should be aware of faults and encouraged to share their opinions. This, in turn, will improve their ability to learn from past mistakes and take corrective measures (Sammer et al., 2010; Hwang, 2015). The perception of patient safety culture could affect nurses' patient safety competency.

Safety control is related to deriving safe results in performing tasks. It is essentially a person's cognitive ability to maintain a standard of safety in a workplace and ultimately it leads to a higher level of safety competence (Kim, 2021). At the core of safety control lies a sense of self-control in making decisions related to maintaining a level of safety. A high level of safety control reduces negative safety indicators (Kim, 2014) and is also a significant predictor of safety competency (Anderson et al., 2004; Chung, 2009), which describes performing safety regulations well to lower negative safety indicators in clinical settings. It is also said that nurses with less safety control have less safety awareness (Kim, 2019). On the other hand, with a nurse who has a good level of safety control, patients will benefit both physically and psychologically (Ganster & Fusilier, 1989). Most nurses believe that they only need to report errors in the

hospital ward, but they do not realize they need to report potential errors, as these can lead to broader issues in the future (Cohen, 2001). When facing immediate demands, nurses first have to solve problems of conflicting priorities, which can cause harm in a variety of ways (Tucker & Edmondson, 2003). In these situations, nurses' safety control provides them with the correct judgment about actions that are putting patient safety at risk (Kim, 2021). Thus, nurses' safety control prevents nursing mistakes related to patient safety (Kim et al. 2012). A study by Kim et al. predicted that preventive education on nursing errors related to patient safety which incorporated examples would improve safety control and contribute to safety competency (Kim et al., 2012). A previous study also suggested how the personal perception of control was associated with nurses' patient safety competency and improved the ability to promote patient safety by emphasizing the importance of safety control for outcomes such as achievement, stress, and satisfaction (Ramanujam, Abrahamson, & Anderson , 2008). This is because the level of personal control over tasks has a direct impact on the nurse's perception of safety competence to assure the patient's well-being.

Nurses are the frontline risk managers who care for patients 24 hours a day. Nurses play a crucial role in improving patient safety due to their continuous presence at patients' bedsides and their interactions with their families and other healthcare professionals (Amiri et al., 2018). There have been many studies about patient safety competency (Canadian Patient Safety Institute, 2008; Beischel, 2014; Jin & Yi, 2019), the perception of safety culture (Mardon et al., 2010; Wang et al., 2014), and safety control (Cohen, 2001; Tucker & Edmondson, 2003). However, empirical evidence for the relationship between nurses' patient safety competency and perceived safety culture is limited (Cohen, 2001; Tucker & Edmondson, 2003). Patient safety competency research has purposefully sought to understand how variables are related within the individual or at the organization level, and how they interactively impact patient safety competency (Ben-Tzion Karsh & Brown, 2010). Investigating and analyzing patient safety culture, the perception of safety control, and patient safety competency are necessary to prevent medical errors and improve patient safety. This study examines hospital nurses' perceptions of patient safety culture, levels of safety control, and patient safety competency, to identify the structural relationships among factors that affect patient safety competency (See Figure 1) and to provide essential evidence for patient safety competency interventions with nurses.

Materials & Methods

2.1 Design

This research is a descriptive correlation study to examine the variables affecting patient safety competence in clinical nurses.

2.2 Sampling and Data Collection

The researcher visited the hospital, explained the purpose of this study, and delivered a questionnaire to nurses who agreed to participate in this study. A questionnaire collection box was placed in the hospital nurse's office, and when the questionnaire was completed, it was put

into the collection box. One hundred and ninety-one hospital nurses and staff in 3 hospitals agreed to participate in this study, and one hundred and sixty-five questionnaires from three in 3 hospitals were collected. The response rate was 86.1%. Finally, 165 questionnaires from the nurses were analyzed (26 incomplete questionnaires).

2.3 Measurement

2.3.1. Patient safety competence

The patient safety competence scale developed by Schnall (Schnall et al., 2008) and revised by Lee (2014) was employed in this study (e.g., "I feel confident in enhancing patient safety through effective communication with other healthcare providers"; "I feel confident in managing inter-professional conflict"). This scale is composed of 14 items which were scored using a Likert scale: 1 = "strongly disagree"; 2 = "disagree"; 3 = "neither agree nor disagree"; 4 = "agree"; and 5 = "strongly agree." Cronbach's alpha coefficient was 0.91 in this study.

2.3.2. The perception of patient safety culture

The perception of patient safety culture scale, the version modified for Korea by Lee (2015), was employed in this study (e.g., "Clinicians should routinely spend part of their professional time working to improve patient care, Hospital management provides a work climate that promotes patient safety"). This questionnaire is composed of 35 items asking 9 questions related to leadership, 6 related to teamwork, 5 related to patient safety knowledge and attitude, 4 related to patient safety policy and procedure, 4 related to non-punishment environment, 4 related to patient safety improvement system, and 3 related to patient safety priorities. Items were evaluated with a 5-point Likert scale. If the score of an item was high, it means that the awareness level for patient safety was high. The Cronbach's alpha coefficient was 0.93.

2.3.3. Safety Control

The safety control scale developed by Anderson (2004) and translated and validated by Chung (2009), to be used for hospital staff, was employed in this study (e.g., "I can take the necessary actions to prevent accidents during nursing"; "I can control myself to follow safe guidelines according to regulations"). This scale is composed of 7 items which were scored using a Likert scale: 1 = "strongly disagree"; 2 = "disagree"; 3 = "neither agree nor disagree"; 4 = "agree"; and 5 = "strongly agree.". If the score of an item is high, it means that the safety control is well under control. Cronbach's alpha coefficient was 0.84 in the study.

2.3.4. Safety Education

In this study, safety education means the number of patient safety training sessions received within the last year. In this study, safety education means the number of patient safety training sessions received within the last year. Patient safety training includes education seminars, workshops, and short-term programs to improve the quality and safety of the healthcare systems

in hospitals. Hospital nurses must be trained in statutory duties conducted in the auditorium about once a month, through a small nursing team training, or online training. Face-to-face education is conducted for about 40 people, and these days, most education is being done online due to the coronavirus. The contents of safety education are mainly about communicating effectively, identifying, and managing adverse events and near misses, being ethical, preventing medication errors, infection control, and reporting and sharing mistakes, etc.

2.4. Ethical Approval

The nurses agreed to join in this study after being informed of the purpose, potential risks, and data collection procedures of the study. We also fully explained in advance that participation could be withdrawn at any time in the interim. The Institutional Review Board approval code of this paper is Namseoul Univesity(NSU) 104179-HR-202109-007.

2.5. Data Management and Analysis

The collected data were analyzed with SPSS18.0 and AMOS. Several descriptive statistics, including Pearson product-moment correlations, were used. The standard chi-square index of statistical fit, the root means square error of approximation (Browne & Cudeck, 1993), the Tucker–Lewis index (Tucker & Lewis, 1963), and the comparative fit Index (CFI) were utilized to evaluate the fit of structural models to the data. As the patient safety competence scale and safety control scale were one-dimensional scales, item parceling was used to improve the quality of indicators and to reduce the falsifiability of the tested model (Wu & Wen , 2011).

Results

3.1 General Characteristics

Table 1 shows the characteristics of the participants. Participants were 165 nurses: 10 males (6.1%) and 155 females (93.9%). Participants were from 20 to 58 years old (M = 36.36; SD = 10.12). The mean length of clinical career was 9.80 years (SD = 7.46).

3.2 Descriptive Statistics and Correlation

Table 2 shows descriptive statistics for the perceptions of patient safety culture, safety control, and patient safety competency of nurses. The number of safety education briefings attended was 2.57±.2.71 (min = 0, max = 12). The levels of patient safety culture, safety control, and patient safety competency of nurses were 3.17±.50, 3.62±.65, and 4.18±.52.

Correlations are shown in Table 3. Nurses' perceptions of patient safety culture and safety control were positively associated with patient safety competency. However, the number of times a nurse attended a safety course was not significantly associated with safety control or patient safety competency.

3.3 Model Fit

The hypothesized model assumed relationships among safety education, perception of patient safety culture, safety control, and patient safety competency of nurses. The summarized results of the hypothesized model are shown in Table 4. The analysis of the hypothesized model showed a good fit to the data except for the $\chi 2$ value ($\chi 2 = 147.71$, df =72, $p < .001$, CFI = .96, TLI = .94, RMSEA = 0.07). The correlation between the frequency of safety education and the perception of patient safety culture; and the correlation among the perception of patient safety culture, safety control, and patient safety competency were significant (see Table 4). The correlation between safety control and patient safety competency was significant too. However, the correlation between the frequency of safety education, the safety control, and the patient safety competency of nurses was not significant. Those results partially support the hypothesized model. The hypothesized model explained 38% of the variance in nurses' patient safety competence (see Figure 2).

The estimates of the indirect effects of the frequency of safety education on the patient safety competence of nurses via role identity are shown in Table 5. The number of safety education sessions had an indirect effect on nurses' patient safety competence via the perception of patient safety culture and safety control. Nurses with frequent safety education session attendance were more likely to give patient safety more importance, and nurses who considered patient safety more important were likely to have better safety control. Nurses with strong safety control were likely to show patient safety competence. This finding highlights the importance of the nurses' perceptions of patient safety and safety control for promoting their patient safety competency.

Discussion

This study was conducted to determine whether the number of safety education briefings attended, the perception of patient safety culture, and safety control could predict patient safety competence, and to verify the mediating effects of the perception of patient safety culture and safety control.

The relationship among nurses' safety education participation, the perception of patient safety culture, safety control, and patient safety competen

First, there was a significant relationship between nurses' safety education participation and the perception of patient safety culture; however, there were no significant relationships among nurses' safety education, safety control, and patient safety competence. This finding was partially consistent with previous studies suggesting the direct relationships among participation in patient safety training, the perception of patient safety culture, and patient safety competency (P & Oh, 2017; Lee & Lee, 2016). Safety education within the last year was a crucial factor in the perception of the safety culture, patient safety competence, and safety nursing activities (Kim & Kim, 2017; Yan et al., 2021). However, this study found that the number of safety education briefings attended was not significantly related to safety control ability or safety competence,

which could have been due to the content and teaching methods of the safety lessons. Above all, the content of nurse safety education should be composed of what nurses need. Patient safety education should consist of content that helps nurses efficiently cope with patient safety accidents in healthcare. Since most nurses undertake safety education through one-sided lectures or online education in the process of preparing for certification evaluations, it is believed that safety education is somewhat unfamiliar and sometimes difficult, and that education at the institutional level is not enough to effectively improve safety competence (Kim & Han, 2016). In addition, neither the awareness of safe nursing activities nor the safety culture in hospitals is built in a short time. The majority of nurses agreed that professional beliefs in nursing are highly important; however, it was difficult to apply all beliefs in practice (American Association of Colleges of Nursing, 2008). The process in which nurses acquire beliefs and practices for patient safety is gradual and continues throughout various experiences in healthcare. From a similar perspective, the reasons for nurses' continued participation in nursing education were to develop their expertise, improve services to patients, and promote solidarity and professional commitment (Han & Lee, 2010). Recently, Quality and Safety Education for Nurses (QSEN) emphasized preparing nurses with the competencies necessary to enhance the quality and safety of the healthcare systems (Cronenwett et al., 2007). Indeed, it is necessary for hospital policymakers to develop a patient safety training program for nurses from a long-term perspective and to provide nurses with continuing quality education programs.

The mediating effect of nurse's perception of patient safety culture and safety contr

Nurses' patient safety education indirectly influenced patient safety competence via a nurse's perception of patient safety culture and safety control, as predicted. However, the correlations between patient safety education and patient safety competence, and patient safety education and safety control, were not significant. This finding is partially consistent with studies on nurses' patient safety competence (American Association of Colleges of Nursing, 2008; Sammer et al., 2010; Kim & Han, 2016; Kim & Kim, 2017), which emphasized the importance of promoting the nurses' perception of patient safety culture and safety control abilities to build a safer health system. Additionally, this study proved the mediating effects of a nurse's perception of patient safety culture and safety control in the relationship between a nurse's patient safety education and patient safety competence.

This finding highlights the importance of a nurse's perception of patient safety culture and safety control to improving his/her patient safety competence. A high level of patient safety culture is associated with reducing patient complications and adverse events (Wang et al., 2014) and increasing patient safety-related nursing activities (Park, Kang, & Lee, 2012). Considering that patient safety is a top priority for all members of a medical institution (Jeong, Seo, & Nam, 2006) and that the most basic principle of patient safety is to form a patient safety culture, nurses need to raise awareness of patient safety culture. Nurses play a critical role in promoting patient safety due to their continuous care for patients and interactions with patients' families and other healthcare professionals (Patient Safety Network, 2017). However, the scores of perceptions of

patient safety culture in hospital nurses were low in Korea (Kim, Lee, & Choi, 2013). Recently, various programs have been developed to strengthen the safety culture awareness of nurses, which are effective at reinforcing their role in patient safety culture improvement (Amiri et al., 2018). Given that perceptions of patient safety culture are closely related to safety control, organizations need to provide systematic training to improve nurses' awareness of safety culture. A nurse's safety control is his/her ability to ensure patient safety in healthcare (Ramanujam, Abrahamson, & Anderson, 2023). The nurses with higher safety control are less likely to put patients in danger; they control themselves appropriately, following the guidelines of safety regulations (Kim, 2019). Considering nurses' safety control leads to correct judgments on patient safety (Kim, 2021), it is necessary to increase nurses' confidence in safety control. A nurse's safety control is influenced by his/her clinical career. Nurses' work experience and confidence in their tasks are closely related to safety control (Kim, 2016). In general, novice nurses lack experience in nursing work and have difficulty coping with unexpected situations. Therefore, a career-specific approach is needed to strengthen a nurse's safety control.

A nurse's perceptions of patient safety culture and safety control form an individual factor. No matter how good and often an institution provides safety education, the effectiveness of said education at promoting nurses' safety competence can vary depending on how an individual accepts it and internalizes it. Nurses' participation in safety education did not directly affect their patient safety competence; however, the nurses' safety education influenced their awareness of patient safety culture. Even though individual differences exist, participation in safety education and activities should improve nurses' awareness of safety culture-related activities, such as open communication and teamwork, and a positive perception of safety culture could reinforce safety control, patient safety capabilities, and finally, safe nursing activities. A change in perception leads to a change in behavior. When organizing programs to enhance nurses' safety culture competence, contents, and teaching methods are specified for novice and experienced nurses. When designing educational programs, it is necessary to focus on recognizing the importance of a safety culture for novice nurses and to address various cases that occur in real-life nursing situations for experienced nurses. Considering that nurses' patient safety capabilities result in a safer healthcare system, specific and effective educational interventions should be provided to improve nurses' perceptions of patient safety culture and strengthen safety control.

Limitation

This study focused on the variables of personal characteristics that influence the nurse's patient safety capabilities. However, since nurses' patient safety capabilities are also affected by environmental factors such as national medical policies and hospital medical policies, future studies need to examine variables affecting nurses' patient safety capabilities from an ecological perspective (microscopic, intermediate, and macroscopic perspective). Also, there is a limitation in that the nurse's safety education, which was a major variable in this study, could not take into account the qualitative differences in education as various types of education (e.g. workshops, seminars, online lectures, and so on) were included. In future studies, it is necessary to examine

whether there are differences in patient safety competency according to the type of education and teaching method.

Conclusions

We investigated direct and indirect associations among variables affecting the patient safety competence of nurses in Korea in this study. Our findings highlight the importance of a nurse's perception of patient safety culture and safety control to improving patient safety competence. These results will help encourage nurses to improve their safety competencies. However, this study could not include nurses' actual safe nursing activities. Environmental factors such as institutional policies affecting patient safety should be included in future studies.

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Figure 1

Hypothesized model of the antecedents of patient safety competence

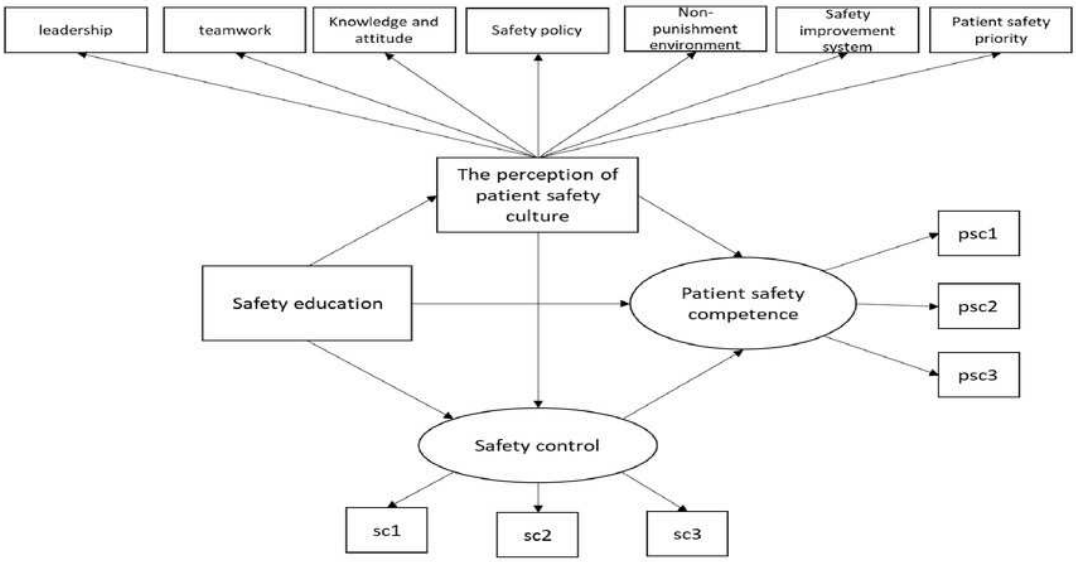

Figure 1. Hypothesized model of the antecedents of patient safety competence

Figure 2

Final model

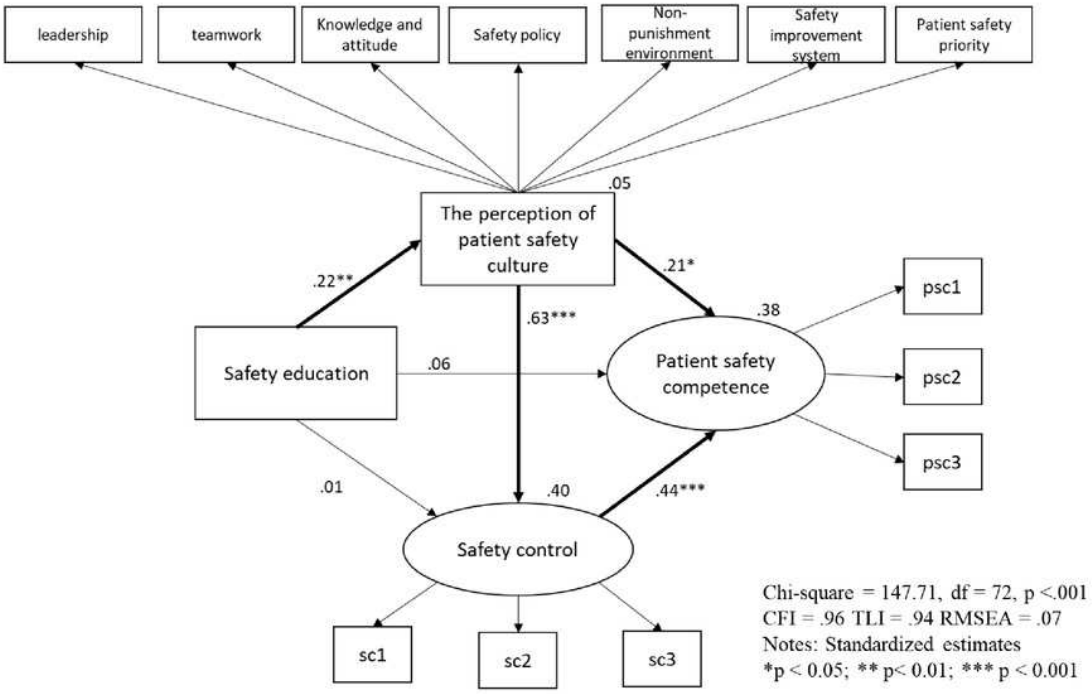

Figure 2. Final model

Table 1(on next page)

General characteristics

Table 1. General characteristics ($N = 165$).

Variable	Category	n (%)
Gender	Male	10 (6.1)
	Female	155 (93.9)
Participation in The Accreditation Program for Healthcare Organizations *	Yes	40 (24.2)
	No	125(75.8)
Status	Staff	1(7)
	Nurse	106(75.7)
	Charge nurse	18(12.9%)
	Head nurse	15(10.7)
Department	Ward	67(40.9)
	Emergency room	13(7.9)
	Operating room	25(15.2)
	Ambulatory part	31(18.9)
	Special part	28(17.9)

Variable	Means ± SD
The number of safety education briefings attended	2.57±.2.71
Clinical career	9.80± 7.46
Age	36.36± 0.12

* The Accreditation Program for Healthcare Organizations is a scheme designed to induce medical institutions to continuously and voluntarily make endeavors to enhance patient safety and the level of healthcare quality, thereby providing quality medical services to the public [39].

Table 2(on next page)

Descriptive statistics for variables.

Table 2. Descriptive statistics for variables.

Variable	Means ± SD
The perception of patient safety culture	3.71±.50
Safety control	3.62±.65
Patient safety competency	4.18±.52

Table 3(on next page)

Correlations among main variables

Table 3. Correlations among main variables.

	perception of patient safety culture	safety control	patient safety competency
the number of safety education briefings attended	.20*	.10	.14
perception of patient safety culture	1	.51**	.51***
safety control		1	.41***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4(on next page)

Regression weights of hypothesized model

Table 4. Regression weights of hypothesized model

	Estimate (Unstandardized)	Estimate (Standardized)	SE	CR
Safety education → the perception of patient safety culture	.04	.22**	.01	3.04
Safety education → safety control	-.00	-.01	.01	-.18
the perception of patient safety culture → safety control	.73	.63***	.09	8.31
the perception of patient safety culture → patient safety competency	.21	.21*	.08	2.39
safety control → patient safety competency	.39	.44***	.08	4.77
Safety education → patient safety competency	.01	.06	.01	1.00

*** $p < 0.001$. SE = standard error. CR= composite reliability.

Table 5(on next page)

Standardized Indirect Effect

Table 5. Standardized Indirect Effect

	Indirect effect+	Lower Bounce	Upper Bounce
Safety education → safety control	.14(.07) **	.07	.21
Safety education → patient safety competency	.08(.04) **	.04	.18
the perception of patient safety culture → patient safety competency	.16(.17) **	.17	.40

**$p < 0.01$

Note: + Unstandardized estimate (Standardized estimate)