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Development and Validation of an Instrument to Measure Nursing Information Literacy Competency

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Purpose: The purpose of this study was to develop an instrument for measuring nursing information literacy competency, and then to examine the validity and reliability of the instrument. **Methods:** The developmental process of the instrument includes construction of a conceptual framework, generation of initial items, verification of content validity, preliminary study, extraction of final items, and psychometric testing. Its content validity was verified by three experts from nursing and nursing informatics. Its construct, convergent, and discriminant validity was examined in confirmatory factor analysis. Finally, its criterion validity was measured with Pearson's correlation. The tool's reliability was examined by Cronbach's α. The participants include 382 nurses from four hospitals and one university hospital. **Results:** Twenty seven items in total were selected for the final scale, and the results of the confirmatory factor analysis were supported with acceptable model fit, which were named competency for identifying problem, potential sources for information, searching fine information, evaluating information, acquising and managing of information, using information ethically, and integrating new information. The convergent, discriminant and criterion validities were also supported. The Cronbach's α coefficient was .93. **Conclusion:** The instrument is valid and reliable to comprehensively assess nurses' information literacy competency, and to provide a basic direction for developing nursing information literacy program.

Key Words: Literacy; Nurses; Knowledge

INTRODUCTION

The information society in the 21st century provides an opportunity for people to easily access information anytime and anywhere with the explosion of information and the development of communication technologies. In modern society where information resources are rapidly increasing, selecting accurate information is taking on greater importance than ever [1]. The Association of College and Research Libraries (ACRL) in the U.S. has developed information literacy competency standards for higher education by systematically categorizing the five types of competencies that college students could effectively utilize information [1]. The Society of College, National and University Libraries in the U.K. have also developed seven pillars of information literacy competencies to foster intellectuals with information literacy as part of learning and teaching strategies of college and university education [2]. In addition, the Council of Australian University Librarians has provided the information literacy standards for Australia focused on fostering people with information literacy competency by expanding the application scope from elementary, middle, high schools, and university education to lifelong education on the basis of the ACRL standards [3]. Furthermore, the Australian and New Zealand Institute for Information Literacy has developed the information literacy framework of six standards to nurture people with information literacy competency in consid-

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eration of the Australian educational environments.

The information and communication technology is rapidly changing healthcare environments. In response to the changing healthcare environments, the Institute of Medicine in the U.S. has presented five core competencies needed for healthcare professionals: provision of patient-centered care, working in interdisciplinary teams, utilization of evidence-based practice, application of quality improvement, and utilization of informatics [5]. According to the report 'RCN competences: Finding, using and managing information' published by the Royal College of Nursing (RCN) in the U.K. in 2011, nursing information literacy competency is defined as the comprehensive concept which includes identifying why information is needed, identifying what information is needed & carrying out a search to find information, evaluating how the information meets the identified need), managing information, using information and knowledge inclusively, legally and ethically, creating new information or knowledge. Nurses' information literacy competency is a key influencing factor for evidence-based practice [6,7], and a lack of information literacy competency makes it difficult to find the best evidence in nursing practice and becomes an obstacle to evidence-based practice activities [8,9]. In addition, capacity for clinical practice performance cannot be achieved without information literacy competency [10]. Thus, it is necessary to develop curriculums and strategies for improving nursing information literacy competency in order to enhance the qualitative level of nursing in clinical practice and evidence-based practice. For this purpose, it is necessary to first understand nursing information literacy competency which includes nurses' ability to understand a nursing problem, search for necessary information, evaluate selected information, and utilize accurate information to solve a nursing problem.

Previous studies on nursing information literacy competency in Korea have shown that nursing information literacy competency could improve person's problem solving ability, self-directed learning ability and critical thinking disposition [7,14,15] and enhance capacity for evidence-based practice [7,16]. Although there have been many studies on the information literacy competency in nursing students, most of them have been conducted using a measurement by modifying the information literacy competency instrument for college students [7,15,16,17] and there is no a proper instrument to measure nursing information literacy competency. In view of the nature of nursing, an instrument to measure nursing information literacy competency should be prepared. The nursing information literacy competency instrument developed by Son et al.[18] and the Nursing Informatics Competency Questionnaire (NICQ) developed by Staggers, Gassert and Curran [19] includes subdomains of computer literacy related to hardware and software technology, knowledge and use of hospital informatization, and knowledge and skills of informatics. These two instruments can measure only the competency limited to the ability to search for information, which corresponds to only some part of nursing information literacy competency, which is the ability to recognize the need for information, determine the extent of information needed, efficiently access and evaluate information, and incorporate selected information into existing information to solve a problem. As a result, they cannot provide a valid assessment of nursing information literacy competencies presented by RCN (Royal College of Nursing) information literacy competency framework [11], ACRL (Association of College and Research Libraries) nursing information literacy competency standards [12], and TIGER (Technology Informatics Guiding Education Reform) nursing informatics competencies model, such as competencies to determine the information needed, access needed information, evaluate information, and use information.

The information literacy competency frameworks of RCN [11], ACRL-Nurse [12], and TIGER [13] are presented as theoretical conceptual frameworks of nursing education programs that guide and support learning and teaching activities for development of information literacy competencies of nurses and nursing students. Since an instrument to assess nursing information literacy competency has not yet been developed based on the conceptual frameworks, it is necessary to develop a proper instrument. Especially, in the era of the 4th industrial revolution, information management and the legal and ethical use of information have become very important where various health information of individuals are continuously accumulated in healthcare institutions. However, it is difficult to find an instrument to comprehensively assess the nursing information literacy competency. Therefore, this study aimed to develop an instrument to comprehensively assess competency for identifying problems, competency for potential sources for information, competency for searching for information, competency for evaluating information, competency for acquiring and managing information, competency for using information ethically, and competency for integrating new information. Then, we would confirm the validity and reliability of the instrument to assess nursing information literacy competency among nurses working in various healthcare institutions.

METHODS

1. Study Design

This study is a methodological study by developing an instrument to measure nursing information literacy competency and to confirm the validity and reliability of the instrument.

2. Procedures

This study was conducted through the following processes to develop an instrument to measure nursing information literacy competency among nurses. First, we constructed a conceptual framework based on the framework or standards of nursing information literacy competency, such as RCN information literacy competency framework [11], ACRL nursing information literacy competency standards [12], and TIGER nursing informatics competencies model [13]. Second, a preliminary instrument was developed based on the constructed framework. Third, the final items were selected through the verification of content validity by three experts. Fourth, a pilot survey was conducted among nurses to examine problems of language expressions, the degree of comprehension and time needed to complete the questionnaire. Fifth, the psychometric properties of the instrument was conducted among nurses working in one tertiary hospital and three general hospitals to verify the construct validity, discriminant validity, criterion validity and reliability.

1) Construction of the conceptual framework and development of a preliminary instrument

The conceptual framework of the instrument was composed of seven components, which was derived from three nursing information literacy competency frameworks: RCN information literacy competency framework [11], ACRL nursing information literacy competency standards [12], and TIGER nursing informatics competencies model [13] (Table 1). The RCN information literacy competency framework consists of seven competencies and 35 performance indicators: Competency 1 (3 indicators) is to identify the reason why information is needed, Competency 2 (3 indicators) is to identify what information is needed, Competency 3 (5 indicators) is to perform information search to find information, Competency 4 (5 indicators) is to evaluate whether the collected information meets the requirements, Competency 5 (4 indicators) is to use information and knowledge legally and ethically, and Competency 6 (5 indicators) is to manage information, and Competency 7 (10 indicators) is to generate new information and knowledge [11].

In 2004, the TIGER group constructed the nursing informatics competencies model consisting of three parts: basic computer competencies, information literacy and information management [13]. The second subdomain of this model, recommendations for information literacy competencies, consists of five components and 40 indicators; Component 1 (3 indicators) is determine the type and extent of information needed; Component 2 (10 indicators) is to access needed information effectively and efficiently; Component 3 (11 indicators) is to evaluate information and potential sources for information critically and incorporate selected information into knowledge base and value system; Component 4 (8 indicators) is to use information effectively to accomplish a specific purpose; Component 5 (8 indicators) is to evaluate outcomes of the use of information and capacity for information ethics [13].

ACRL nursing information competency standards consist of 5 standards and 23 performance indicators based on the information literacy competency of nurses developed by the Health Sciences Interest Group (HSIG). Standard 1 (5 indicators) includes competency to identify the scope and characteristics of information needed, and Standard 2 (five indicators) includes competencies about information retrieval, retrieval strategies, and extraction, recording and management of information and information sources for effective and efficient access to information. Standard 3 (7 indicators) includes the abilities to conduct the critical evaluation of information and information sources, integration of information, comparison of new knowledge and existing knowledge, justification of understanding and interpretation of information, and evaluation of the whole process of generated information, while Standard 4 (3 indicators) included the ability to apply new information and existing information effectively and effectively communicate research results to effectively use information. Standard 5 (3 indicators) consisted of abilities to understand economic, legal and social issues related to information and information technology, and to use information ethically and legally [12].

The evaluation of the RCN information literacy competency framework [11], TIGER nursing informatics competencies model [13] and ACRL nursing information literacy competency standards [12] have shown that the core components of nursing information literacy competency consist of competencies to recognize the necessity for information to solve nursing problems, determine and identify the characteristics of necessary information, effectively and efficiently access necessary information to search

for information, critically evaluate selected information, and use acquired information ethically and legally to integrate it with existing knowledge. Based on these evaluations, the components of the instrument to assess nursing information literacy competency were identified as 7 components and 35 items: 5 items of 'competency for identifying problems', 5 items for 'competency for identifying potential sources for information', 7 items for 'competency for searching for information', 5 items for 'competency for evaluating information', 5 items for 'competency for acquiring and managing information', 4 items for 'competency for using information ethically', and 4 items for 'competency for integrating new information' (Table 1). Component 1 'competency for identifying problems' is the ability to identify what information is needed to solve a nursing problem by recognizing and clarifying the nursing problem in a nursing situation, Component 2 'competency for identifying potential sources for information' is the ability to identify various information resources and select the best information source, Component 3 'competency for searching for information' is the ability to build information search strategies to search for the information needed to solve a nursing problem and to perform information search actually, Component 4 'competency for evaluating information' is the ability to evaluate the relevance and usefulness of collected information, Component 5 'competency for acquiring and managing information' is the ability to extract key knowledge and ideas

Table 1. Framework of Subcategories for Nursing Information Literacy Competency

Subcategories	Items	RCN	TIGER	ACRL-N
Identifying problem	Information needs		○	○
	Clinical question	○		○
	Difference in knowledge	○		
	Clarification of the question		○	○
	Choice of key concepts or topics	○		○
Potential sources for information	Characteristics and differences of information sources	○	○	○
	Selecting the right source	○	○	○
	Search in various disciplines.	○		○
	Nursing specialist database	○		○
	Use documents and various websites	○	○	○
Searching fine information	Advice from colleagues or other departmental staff	○	○	○
	Identification of clinical information system	○		
	Using Boolean operators	○	○	○
	Selecting a search strategy	○	○	○
	Using of keywords, synonyms, and related terms	○	○	○
	Change query terms or use various databases		○	○
	Searching reliable information or knowledge	○		
Evaluating information	Identification of validity, reliability, accuracy, and up-to-date information	○		○
	Similarities and differences between practice	○	○	
	Applicability of clinical practice	○	○	○
	Meet with the needs of the subjects	○	○	○
	Need for additional information	○	○	○
Acquising and managing of information	Use of various data	○	○	○
	Extraction of core content	○		○
	Summary of essential content	○	○	○
	Bookmark a website	○		
	Number of visits to specialized sites	○		
Using information ethically	Legal use of collected information	○	○	○
	Check for free and paid			○
	Share ID and password in EMR	○		○
	Using of collected person's information for other purposes	○	○	○
Integrating new information	Using based on collected information	○	○	○
	Integration with existing knowledge	○	○	○
	Communications into meaning that is easy to understand	○	○	○
	Share with colleagues	○		○

RCN=royal college of nursing; TIGER=technology informatics guiding education reform; ACRL-N=association of college and research libraries-nursing.

that meet the needs of nursing care recipients, Component 6 'competency for using information ethically' is the ability to use information legally and protect the personal information of nursing care recipients, and Component 7 'competency for integrating new information is the ability to solve nursing problems by integrating acquired information. Each item is rated on a 5-point scale (1 - 'strongly disagree, 2 - disagree, 3 - neither agree nor disagree, 4 - agree, 5 - strongly agree). Higher scores indicates higher levels of nursing information literacy competency.

2) Verification of content validity and a pilot survey

According to Lynn [20], the appropriate number of experts for content validity verification is 3 to 10 persons. For verification of the content validity, the developed instrument was evaluated by one nursing informatics professor, one nursing professor with a lot of experience in the research on evidence-based practice, and a head nurse with more than 10 years of clinical practice experiences. The content validity index (CVI) was calculated by dividing the sum of the scores of three experts for each item by the total score when each of the experts gave the highest score of 4 points. Regarding the content validity determination, an item was determined to have content validity if the CVI was 0.8 or higher [21]. Based on the experts' opinion, among 5 items with the CVI of 0.8 or less, 2 items of 'I use information data after checking if they are available for free or not,' and 'I search for reliable information or knowledge necessary for solving nursing problems.' The remaining 3 items with the CVI of 0.8 or less were modified by reconstructing, changing, and supplementing the contents as follows: The item 'I verify the gap between the knowledge required for solving nursing problems and the knowledge I possess' was modified into 'I recognize the gap between the knowledge required for solving nursing problems and the knowledge I possess'; the item 'I clarify general problems by changing them into concrete questions' was revised into 'I clarify vague and universal questions to clarify specific questions in order to solve the nursing problems'; the item 'I expand the search scope or change search terms to apply them to information search if there is not enough data for search' was modified into 'If the search data is insufficient to change search terms, or search using various databases' Then, the final 33 questions of the preliminary instrument were determined by a professor in nursing informatics. Then, we conducted a pilot survey for nurses from three general hospital to examine whether the preliminary instrument had overlapping items, whether each term was appropriately used, whether each item was expressed in a way easy to understand and how long it would take to complete the questionnaire. The time to complete the questionnaire was 8 minutes on average, and the instrument consisting of 7 components and 33 items was finalized.

3. Verification of validity and reliability

1) Participants

The questionnaires were distributed among 330 nurses working in four general hospitals with 200~300 beds and 100 nurses working in one tertiary hospital in J and C Cities, 418 copies were collected (recovery rate of 97.2%), and a total of 382 copies were included in the analysis excluding 36 copies with missing data. The appropriate sample size required to validate the construct validity of the instrument is reported to be 5~10 times the number of questions, or 300 people or more [21]. According to the criterion, the appropriate sample size for validity verification in this study is 165~330 people, which corresponds to 5~10 times the number of 33 items of the preliminary instrument, or 300 people or more, so the sample size of this study was found to be a satisfactory level.

2) Instrument

For verifying criterion validity, the Evidence-based Practice Questionnaire (EBPQ) developed by Upton and Upton [22] was selected. The reason why the EBPQ was selected that it is widely used in most previous studies as an instrument to assess the capacity for evidence-based practice among nurses [16,18,24,25]. Information literacy competency is reported to be crucially required for introducing evidence-based practice [13] and as evidence-based practice competency is higher, nursing information literacy competency is higher [7,16]. The EBPQ consisted of 14 items about knowledge/skills about evidence-based practice and 6 items about performance on a 7-point scale with scores ranging from 1 to 7 points. Higher scores indicates higher levels of knowledge/skills about evidence-based practice and higher levels of the performance of evidence-based practice in clinical practice. Cronbach's α in Upton and Upton [22] was .87 with .85 for the domain of knowledge/skills and .91 for the domain of performance. In Lim et al. [23], Cronbach's α was .87 for the total items, .93 for knowledge/skills, and .85 for performance. In this study, Cronbach's α was .94 for the total items, .93 for knowledge/skills, and .85 for performance.

3) Data collection

This study was conducted after obtaining approval from the Institutional Review Board (IRB) of Gyeongsang

National University (No. GIRB-A15-Y-0048). Study participants were provided written information, and participation was voluntary. Informed consent was obtained from all participants. It took 8 to 10 minutes for participants to complete the questionnaire. After participants read and completed the questionnaires, the questionnaires were put in envelopes and sealed before collecting them. Small presents were given to the survey participants.

4) Data analysis

The collected data were analyzed using SPSS/WIN 21.0 program and AMOS 20.0. First, general characteristics of the participants were analyzed by calculating the frequency, percentage, mean and standard deviation. Second, item analysis was conducted to examine the homogeneity of items, and the item-total correlation test was used to select items with an item-total correlation coefficient of .30 or higher [26]. For verifying the construct validity, confirmatory factor analysis was carried out instead of exploratory factor analysis. Exploratory factor analysis is a method to generate a model or structure by exploring the characteristics inherent in the data without special assumptions about the number or structure of factors. It is said that if the factor structure is already established, it is desirable to perform confirmatory factor analysis [27,28]. Confirmatory factor analysis is a method of verifying whether subordinate components are bundled together by assuming the relationships between variables beforehand based on previous studies, theories or experience [29]. Therefore, in this study, confirmatory factor analysis was performed to examine whether relationships between components and between items were statistically significant. Various fit indices were used to perform the model fit test. Among various fit indices, the x^2 value shows how closely the model and the actual data are matched. If the p-value of x^2 is larger than .05, it is considered desirable. However, in general, if the sample size becomes large, a significant value of less than .05 is obtained, so it is difficult to evaluate the model fit only with the x^2 value. Thus, the model fit test was carried out using various fit indices, such as the Root Mean Square Residual (RMR), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), the Turker-Lewis index (TLI), and the Root Mean Squared Error of Approximation (RMSEA), in addition to the x^2 value. Third, the test to verify convergent validity of the developed tool was conducted based on the composite reliability (CR) of .70 or higher, average variance extracted (AVE) of .50 or higher, and standardized factor loading of .50 or higher [21]. Fourth, discriminant validity was verified by comparing the squared value of the correlation coefficient between variables with the AVE value, and if the square of the correlation coefficient between variables is lower than the AVE value, it is judged to indicate that the discriminant validity is secured [21]. Fifth, criterion validity was analyzed using Pearson's correlation coefficient [26]. Sixth, the reliability of the instrument was verified by calculating Cronbach's α.

RESULTS

1. General Characteristics of Participants

The participants of this study were a total of 382 people (374 women, 97.9%), and the mean age was 30.46 years. More than a half of them (233 people, 61.0%) were unmarried and the largest proportion of them (243 people, 63.6.%) were college graduates. They had 7.73 years of clinical experience on average. Regarding work departments, 208 people (54.5%) worked in general wards, and in terms of the position, 303 people (79.3%) were general nurses. 236 nurses (61.8%) completed nursing research, 132 nurses (34.6%) had experience in the education related to nursing informatics, and 73 nurses (19.1%) had experience of research performance (Table 2).

2. Validity Verification

Before performing factor analysis, item analysis was conducted. The correlation coefficients between 33 items and the total items ranged from .30 to .68 and there were no items with the correlation coefficient less than .30. Thus, all the items were adopted.

1) Construct validity

Confirmatory factor analysis was performed to verify the relationships among 7 components of nursing information literacy competency (competency for identifying problems, competency for identifying potential sources for information, competency for searching for information, competency for evaluating information, competency for acquiring and managing information, competency for using information ethically, and competency for integrating new information) and the items assigned to each component. Since the fitness of the model was low overall, the modification of the model was required. A total of 6 items with a standard factor load of .50 or more but not meeting the significance criteria were deleted. The deleted items were 1 item about the competency for identifying problems, 2 items about the competency for searching for information, 1 item about the competency for acquiring

and managing information, and 1 item about the competency for integrating new information. Finally, as a result of the analysis of the fit of the modified model composed of 7 components and 27 items, the fit indices of CMIN/DF, RMR, GFI, AGFI, CFI, and RMSEA met the criteria and the fit index of TLI was close to the criterion, indicating an appropriate level of the fit of the model (Table 3).

2) Convergent validity

The results of verifying the convergent validity showed that the standardized factor loadings ranged from .52 to .82, and thus all the items met the conformity criteria of .50. In addition, the composite reliability (CR) ranged from .83 to .92, meeting the criterion value (≥.70), so the criterion of convergence validity was satisfied (Table 4). In the sub-domains of nursing information utilization competence, the AVE was estimated to be .64 for competency for identifying problems, .53 for competency for potential sources for information, .57 for competency for searching for information, .71 for competency for evaluating information, .70 for competency for acquiring and managing information, .67 for competency for using information ethically, and .71 for competency for integrating new information, thus all satisfying the criterion value of .50 or higher.

3) Discriminant validity

In order to verify the discriminant validity of the developed tool, to see if the squared value of the correlation coefficient between variables was lower than the AVE value of the subdomains of nursing information literacy competency, the values were compared. The squared value of the correlation coefficient between most of the subfactors of nursing information literacy competency was found to be lower than the AVE value, so the discriminant validity of the tool was secured. However, the squared value of the correlation coefficient between competency for potential sources for information and competency for searching for information, between competency for evaluating information and competency for acquiring and managing information, and between competency for using information ethically and competency for integrating new information was higher than the AVE value, so discriminant validity was not completely secured (Table 5).

4) Criterion validity

The correlation between the EBPQ score and nursing information literacy competency score was .60 (p<.001), showing a positive correlation, so criterion validity was verified. The subdomains of nursing information literacy competency, such as competency for identifying problems (r=.42, p<.001), competency for potential sources for information (r=.45, p<.001), competency for searching for information (r=.45, p<.001), competency for evaluating information (r=.51, p<.001), competency for acquiring and managing information (r=.49, p<.001), competency for using information ethically (r=.42, p<.001), and com-

Table 2. General Characteristics of Participants (*N*=382)

Variables	Categories	n (%) or M±SD
Gender	Female	374 (97.9)
	Male	8 (2.1)
Age (year)		30.46±7.48
Marital status	Married	149 (39.0)
	Single	233 (61.0)
Education level	College graduation	243 (63.6)
	University graduation	139 (36.4)
Clinical careers (year)		7.73±7.83
Working unit	General unit	208 (54.5)
	Special unit	143 (37.4)
	Outpatient	31 (8.1)
Position	Staff nurse	303 (79.3)
	Charge nurse	40 (10.5)
	Head nurse	25 (6.5)
	Others	14 (3.7)
Taking nursing research course	Yes	236 (61.8)
	No	146 (38.2)
Taking education of nursing informatics	Yes	132 (34.6)
	No	250 (65.4)
Experiences of nursing research	Yes	73 (19.1)
	No	309 (80.9)

Table 3. Goodness of Fit Indices of the Confirmatory Factor Analysis

Model	x^2	p	CMIN/DF	RMR	GFI	AGFI	CFI	TLI	RMSEA
7 Factor model	718.07	<.001	2.37	.03	.88	.85	.91	.89	.06
Evaluation criteria	-	>.05	<3	<.08	≥.80	≥.85	≥.90	≥.90	≤.07

CMIN/DF=chi-square minimum/degree of freedom; RMR=root mean square residual; GFI=goodness of fit index; AGFI=adjusted goodness of fit index; CFI=comparative fit index; TLI=Turker-Lewis index; RMSEA=root mean square error of approximation.

Table 4. Confirmatory Factor Analysis and Final Items of NILC-N

Items	SE	CR	AVE
Factor 1: Competency for identifying problem		.88	.64
It recognizes the needs of nursing problem or information in the nursing situation	.61		
Make clinical questions based on nursing problem or information needs	.61		
The vague and universal questions to clarify specific questions in order to solve the nursing problem	.69		
Selects the key concepts or topics to find the information needed to solve nursing care problem	.74		
Factor 2: Competency for potential sources for information		.85	.53
Know the characteristics and differences between the information sources of various forms (e.g., head nurse, nursing books, web sites, database)	.67		
Selects the information source that provides the most appropriate information to solve the nursing problem	.71		
Find information from a variety of disciplines	.62		
Know the type of database (e.g., RISS, KISS, DBpia, MEDLNE) that can be searched the nursing related professional information	.52		
Documentation and know how to use web sites of variety can find the information	.61		
Factor 3: Competency for searching fine information		.84	.57
Checks the clinical information system, such as nursing records, progress notes, test results in order to solve the nursing problem	.54		
Thinking the search and retrieve information, such as search rankings, search terms, steps of the search	.57		
To find the required information, to searches by using keywords, synonyms, related terms	.70		
If the search data is insufficient to change search terms, or search using various databases	.69		
Factor 4: Competency for evaluating information		.92	.71
Identify whether the retrieved data is valid, reliable, accurate, current information	.61		
The retrieved information to compare the similarities and differences between practices that are performed in our hospitals or wards	.68		
The selected information is to judge whether clinical practice can be applied	.80		
Make a judgement whether the selected information conforming to needs of the client	.78		
Identify the need for additional information into solve nursing problems	.71		
Factor 5: Competency for acquising and managing of information		.90	.70
Needed to solve the nursing problem, text, images, videos, such as audio data, to use a variety of information material	.70		
Extract the core content needed to solve nursing problems in the information obtained from various sources of information	.62		
Summarize the key points collected information is to be delivered	.80		
Useful web sites related to nursing problem that often occurs is added to your favorites	.74		
Factor 6: Competency for using information ethically		.86	.67
The collected information is legally use the knowledge and ideas to try to transfer	.59		
Does not share the ID and password to be used in the electronic medical record system (EMR)	.82		
Does not use the collected information of client in order to solve the nursing problem for other purpose	.76		
Factor 7: Competency for integrating new information		.83	.71
The main content of the collected information to use as a basis to support the resolution of the nursing problem	.79		
The synthesize of newly recognized information with existing knowledge that I knew	.69		

SE=standardized estimate; NILC-N=nursing information literacy competency for nurses; AVE=average variance extracted; CR=composite reliability.

petency for integrating new information (r=.47, $p<.001$), showed a significant positive correlation with evidence-based practice (Table 5).

3. Reliability

The internal consistency coefficient (Cronbach's α) for the reliability was .93, showing a high level of reliability. In terms of sub-domains, Cronbach's α was .76 for competency for identifying problems, .76 for competency for identifying potential sources for information, .71 for competency for searching for information, .84 for competency for evaluating information, .80 for competency for acquiring and managing information, .75 for competency for us-

Table 5. Correlations between NILC-N and EBPQ

Variables		AVE	NILC-N								EBPQ	
			Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Total	Knowledge /skills	Practice
			r (*p*)	r (*p*)	r (*p*)	r (*p*)	r (*p*)	r (*p*)	r (*p*)	r (*p*)	r (*p*)	r (*p*)
NILC-N	Factor 1	.64	1									
	Factor 2	.53	.73 (< .001)	1								
	Factor 3	.57	.60 (< .001)	.76 (< .001)	1							
	Factor 4	.71	.68 (< .001)	.65 (< .001)	.82 (< .001)	1						
	Factor 5	.70	.64 (< .001)	.70 (< .001)	.79 (< .001)	.87 (< .001)	1					
	Factor 6	.67	.59 (< .001)	.62 (< .001)	.69 (< .001)	.74 (< .001)	.80 (< .001)	1				
	Factor 7	.71	.56 (< .001)	.53 (< .001)	.65 (< .001)	.70 (< .001)	.69 (< .001)	.86 (< .001)	1			
	Total		.72 (< .001)	.77 (< .001)	.80 (< .001)	.85 (< .001)	.84 (< .001)	.74 (< .001)	.68 (< .001)	1		
EBPQ	Knowledge/ skills		.40 (< .001)	.47 (< .001)	.48 (< .001)	.50 (< .001)	.49 (< .001)	.40 (< .001)	.44 (< .001)	.59 (< .001)	1	
	Practice		.42 (< .001)	.37 (< .001)	.40 (< .001)	.44 (< .001)	.40 (< .001)	.36 (< .001)	.47 (< .001)	.52 (< .001)	.69 (< .001)	1
	Total		.42 (< .001)	.45 (< .001)	.45 (< .001)	.51 (< .001)	.49 (< .001)	.42 (< .001)	.47 (< .001)	.60 (< .001)	.95 (< .001)	.84 (< .001)

NILC-N=nursing information literacy competency for nurses; EBPQ=evidence-based practice questionnaire; Factor 1=competency for identifying problem; Factor 2=competency for potential sources for information; Factor 3=competency for searching fine information; Factor 4=competency for evaluating information; Factor 5=competency for acquising and managing of information; Factor 6=competency for using information ethically; Factor 7=competency for integrating new information.

ing information ethically, and .75 for competency for integrating new information. Thus, in all subdomains, Cronbach's α was .70 or higher, so the reliability of the instrument was confirmed.

DISCUSSION

The Nursing Information Literacy Competency for Nurses (NILC-N) in this study was developed to measure nurses' information literacy competency to use information based on evidence by searching information from various resources and evaluating information quality to solve the nursing problems encountered in clinical practice. The NILC-N is composed of 7 components and 27 items based on the RCN information literacy competency framework [11], ACRL nursing information literacy competency standards [12], and TIGER nursing informatics competencies model [13]. Specifically, it consists of 4 items about competency for identifying problems, 5 items about competency for potential sources for information, 4 items about competency for searching for information, 5 items about competency for evaluating information, 4 items about competency for acquiring and managing information, 3 items about competency for using information ethically, and 2 items about competency for integrating new information. The validity and reliability of this instrument was verified using various methods to evaluate validity, such as construct validity, convergent validity, and criterion validity.

As a result of confirmatory factor analysis to verify the construct validity of the NILC-N, the nursing information literacy competency model consisting of 7 factors was found to be suitable. The instrument developed by Son et al.[18] to measure nursing information literacy competency was composed of two subdomains of knowledge and utilization about computers and competency for searching for data. As for the competency of searching for data, specifically, it was composed of the items about competency for e-library utilization, competency for reference data utilization, understanding and utilization of the database,

and utilization of the Internet and e-mail. The recognition of how to use documents and various websites in the competency for identifying potential sources of information of this study is related to the ability to use an e-library and the ability to utilize reference data, and competency for searching for information which enables individuals to actually search for information using various search strategies is directly or indirectly related to the understanding and utilization of database and the utilization of the internet. In the instrument of Son et al.[18], computer literacy related to the knowledge and use of computers was separately classified as a sub-domain. However, the competency for potential sources for information and competency for searching for information of NILC-N could measure nursing information literacy competencies in a more concrete manner. In addition, it is expected to have high applicability because it includes essential competencies on information source identification and information search competency with fewer items.

The NICQ proposed by Staggers, Gassert and Curran [19] was developed to measure extensive nursing information literacy competencies regarding three areas of computer skills, informatics knowledge, and informatics skills. However, competency for searching for information of NICQ which corresponds to part of the areas of nursing information literacy competency is partially included in the communication and data access areas of computer skills. Because the NICQ mainly deals with the concepts of informatization and computer knowledge and skills, it is difficult to measure the attributes of nurses' recognization of information needs, finding and evaluating necessary information, and applying it to problem solving using the NICQ. In this regard, the NILC-N instrument has the advantage that it can comprehensively measure a nursing information literacy competency. Especially, 'the competency for using information ethically' of the NILC-N has significant implications because it is an essential competency for nurses who are responsible for legally acquiring and protecting the personal information and health information of nursing care recipients. In the 21st century, healthcare institutions are constantly accumulating a large number of health-related information and personal information. The results of this study are significant in that since nurses as professionals legally acquire the information of healthcare consumers, protect personal information, and ensure personal information security, it is essential to cultivate sound ethical awareness among nurses.

With respect to convergent validity, the standardized factor loadings of 27 items ranged from .51 to .82, all being higher than .50, and composite reliability ranged from .83 to .92, all being higher than .70, The AVE value ranged from .52 to .71, so it was also higher than .50 in all seven components. Therefore, convergence validity of the NILC-N was verified.

In terms of discriminant validity of the NILC-N, the squared value of the correlation coefficient between competency for identifying potential sources of information and competency for searching for information, between competency for evaluating information and competency for acquiring and managing information, and between competency for using information ethically and competency for integrating new information was higher than the AVE value, so discriminant validity was not completely secured. In some standards and models, information source identification and information search and information acquisition and evaluation are not handled as separate sub-domains, but selection of information sources, construction of search strategies, and performance of information search are included in information access and information evaluation and information extraction and integration are all included in the same component [12,13]. In the RCN information literacy competency framework, the legal and ethical aspects of information are dealt with together with information utilization [11]. It is thought that since some subdomains did not maintain their independence for this reason, it may have affected discriminant validity.

The criterion validity of the NILC-N was verified by examining correlations with the EBPQ. The correlations between the EBPQ and competency for identifying potential sources of information and competency for using information ethically were rather lower than the correlation with other subdomains, but overall, there was a positive correlation between all subdomains of NILC-N and EBPQ. Finally, criterion validity was also verified. In the reliability test, Cronbach's α of the subdomains of NILC-N ranged from .70 to .84, and the overall instrument reliability was as high as .93. In general, it is said that internal consistency reliability is established if Cronbach's α is .70 or higher in the case of a newly developed instrument, and if it is .80 or more in the case of the developed and mature instrument [30]. Therefore, the NILC-N was shown to be a reliable instrument with internal consistency.

The components of the NILC-N were derived as seven subdomains of problem identification, information source identification, information search, information evaluation. information acquisition and management, information ethics, and information utilization. All attributes of the NILC-N includes seven competencies of the RCN information literacy competency framework, five elements

of the TIGER nursing informatics competencies model, and five standards of ACRL nursing information literacy competency standards. In the NILC-N instrument, nursing information literacy competency was defined as the competency for nurses to identify nursing problems, identify information needed and information sources to solve problems, identify and evaluate appropriate information, use information ethically, and utilize information in practice to perform the best nursing practice.

The first factor 'competency for identifying problems' includes 4 items about recognition of nursing problems, recognition of information needs, and clarification of nursing problems. It is the competency for recognizing that information is needed in a nursing situation and identifying a nursing problem by clarifying what information is needed to solve the nursing problem. Considering that it is the first step in the process of nursing problem solving to recognize the needs of the nursing care recipient in a nursing situation and clarify what the nursing problem is, it can be seen that it is an important factor in nursing information literacy competency. The second factor 'competency for identifying potential sources of information' includes 5 items about identification of information sources, selection of information sources, and understanding how to use information sources. It is the capacity to identify what information is needed to solve a nursing problem, identify various information sources, and select the best information source. After identifying a nursing problem accurately, identifying the sources of information available to resolve the identified nursing problem and selecting the best source of information is an important process that must be undertaken before performing information search and provides a method to deal with the needs or problems of nursing care recipients [11]. The third factor 'competency for searching for information' includes 4 items about construction of search strategies, information search, and modification of search strategies. It is the competency to find reliable and useful information by building search strategies to access the selected information source and find useful information to solve nursing problems. The derivation of competency for searching for information is thought to be meaningful in that nurses should be able to search for information based on available information sources including colleagues, policies, and various types of literature to find useful information to solve the problems of nursing care recipients [13]. The fourth factor 'competency for evaluating information' include 5 items about the identification of the reliable and accurate information, appropriateness and applicability of selected information, and determination of the necessity for additional information. It is the capacity to determine whether the information acquired from information sources is appropriate for information needs and the solution of nursing problems. The evaluation of the reliability, validity, accuracy, authority and timeliness of information to determine whether collected information can be used as an effective intervention to meet the needs of a nursing care recipient is an essential element in solving the nursing problem using accurate information. The fifth factor 'competency for acquire and manage information' includes 4 items of knowledge, information extraction, information use, and management of useful information sources. It is the capacity for a nurse to access information to determine what information is valuable in a particular situation and extract knowledge and information data suitable for solving nursing problems. The ability to summarize and acquire useful information that can be applied to actual problem solving is an important competence in that it is the ability for a nurse to understand the individual needs of a nursing care recipient and effectively solve a nursing problem. The sixth factor 'competency for using information ethically' consists of 3 items about the legal use of information and protection of the information of the nursing care recipient. It is the competency related to legal, ethical and social problems encountered when nurses access information sources, obtain necessary information and actually use the information. The seventh factor 'competency for integrating new information' consists of 2 items about information synthesis and application, and it is the competency to integrate and synthesize new information acquired with existing knowledge, select appropriate delivery methods to meet the needs of nursing care recipients and actually apply them to the solution of nursing problems.

Nurses are responsible for maintaining up-to-date knowledge and skills for continuous professional development. Nursing staff should improve clinical practice through assessment and supervision [11] and develop the ability to use the information system and information literacy competency to improve the safety of care and quality of nursing in a new healthcare environment [13]. Nursing information literacy competency is an essential capacity needed to identify nursing problems to solve the nursing problems encountered in clinical practice, find necessary information, and apply the information that meets the needs of nursing care recipients in order to provide high quality nursing care to them [11]. As described above, since the NILC-N developed to measure the level of information literacy competency of nurses can accurately measure the current nursing information literacy competency of nurs-

ing workforce, it can be utilized in the field of nursing practice such as the development of a curriculum to improve nursing information literacy competency by identifying strengths or weaknesses of nursing staff regarding the factors of nursing information literacy competency.

The significance of this study can be considered in terms of nursing theory, nursing research, and nursing practice as follows. First, since theories and models for nursing information literacy competency have not been developed to date, the NILC-N instrument was developed based on the RCN information literacy competency framework [11], ACRL nursing information literacy competency standards [12], and TIGER nursing informatics competencies model [13]. Second, in terms of nursing research, it is necessary to accurately assess the information literacy competencies of nursing staff by using the NILC-N instrument to identify strong or weak points among the seven kinds of competencies. Additionally, there is a need for a follow-up study to develop a customized nursing information literacy competency enhancement program based on the strengths and weaknesses regarding nursing information literacy competency of nursing workforce identified by the NILC-N instrument and to verify the effects. Finally, in terms of nursing practice, previously, it was not possible to accurately measure nursing information literacy competency among nurses because the information literacy competency measurement instrument developed for college students was used to measure nursing information literacy competency before this study. For improving the quality of nursing, it is necessary to evaluate the nursing information literacy competency by using the NILC-N.

Despite several significances, this study has some limitations. First, since the participants of this study were nurses working in one tertiary hospital and four medium-sized hospitals, it may be difficult to generalize our findings to the entire nursing workforce. Second, since the item of 'competency for integrating new information' were extracted as two items about the synthesis and application of information in the validity verification process of the NILC-N instrument through confirmatory factor analysis, it remains a question whether it can explain the attribute of information synthesis sufficiently. Therefore, we recommend that these aspects should be carefully reviewed in using the instrument.

CONCLUSION

This study is a methodological study to develop an instrument to measure nursing information literacy competency among nurses who can help solve nursing problems by selecting the best information acquired through various sources and applying it to nursing care recipients. The NILC-N was developed through extensive reviews, the recommendations for nursing information literacy competency, and the verification of psychometric properties. The validity of the NILC-N was verified using construct validity, convergent validity, discriminant validity and criterion validity. As a result, the NILC-N instrument was developed as a 5-point Likert scale composed of 7 components and 27 items. It was proven to be a simple tool with validity and reliability which well reflects the characteristics of nursing information literacy competency.

Based on our findings, we recommend several suggestions. First, considering that nursing staffs should have nursing information literacy competency as the core competencies, follow-up research is needed to evaluate the nursing information literacy competency of nursing staff working in various fields of nursing practice in the future. Second, it is necessary to conduct a research on the development programs to enhance nursing information literacy competency using the NILC-N.

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