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Psychometric Properties of the Arabic Version of the Self-assessment Nursing Informatics Competency Scale

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ABSTRACT

Background: Nursing informatics competency is a critical component of nursing practice, since it plays a major role in promoting the quality of patient care and safety. The Self-assessment Nursing Informatics Competency Scale (SANICS) has been developed in English to assess the nursing informatics competency level. However, a valid and reliable Arabic version of the SANICS is lacking. Therefore, it is essential to translate the SANICS instrument into Arabic language and assess its psychometric properties. ***Purpose:*** This study aims to evaluate the psychometric proprieties of the Arabic version of the self-assessment nursing informatics competency scale among Arabic-speaking nurses. ***Methods:*** A methodological, cross-sectional study was carried out on 176 nurses using a translated SANICS questionnaire. The nurses' selection was based on the non-probability convenience sampling technique, from three governmental hospitals. The psychometric proprieties were assessed using content validity, exploratory factor analysis, confirmatory factor analysis, convergent and divergent validity, and reliability tests. ***Results:*** The scale content validity index (S-CVI) was excellent, amounting to 0.93. Exploratory factor analysis revealed five factors with eigenvalues greater than 1.00, accounting for 71.62% of the total variance. Confirmatory factor analysis showed that the fit indices for the tested scale model were acceptable as follows: $\chi2/df = 1.994$, $p < 0.001$, RMSEA = 0.075, CFI = 0.916, SRMR= 0.070, TLI= 0.901, IFI = 0.917. The internal consistency of the overall scale was supported by Cronbach's α, McDonald's omega, composite reliability, and split-half reliability ranging between 0.959 and 0.984. ***Conclusion*:** The psychometric proprieties of the Arabic version of SANICS were examined using content validity, EFA, CFA, convergent validity, divergent validity, and internal consistency methodologies. It was concluded that the Arabic version of SANICS is valid and reliable. This scale can be used to assess the nursing informatics competency level among nurses and nursing students in the Arab region. ***Implications for Nursing*:** Nursing informatics plays a significant role in the areas of practice, education, research, and administration. Healthcare facilities can accurately assess a nurse's informatics competency level by using this tool. In addition, the presented tool can serve as a valuable resource for designing educational strategies aimed at enhancing nursing students' informatics competencies within the dynamic healthcare information technology environment.

Keywords: Nursing informatics, Competency level, Psychometric properties, Validity, Reliability, A-SANICS.

What does this paper add?

1. Nursing informatics competencies play a pivotal role in facilitating the effective utilization of clinical information systems and enhancing patient safety

within computerized healthcare environments.

2. This study serves as a guide in assessing the level of nursing informatics competencies among nurses.

1. Introduction

Nursing informatics (NI) is a specialty that combines computer science, information science, and nursing science to identify, gather, analyze, and manage data and information for nursing practice, administration, research, and knowledge advancement (American Nurses Association, 1992). One of the main objectives of NI is to support the "Triple Aim" of healthcare, which consists of promoting population health, improving the care provided, and lowering healthcare costs (Houston et al., 2018). Also, NI is a valuable quality resource that improves patient care by stimulating organizational growth and elevating individual levels of innovation (Hassona & Ali, 2019). However, an essential facet of NI pertains to technology, requiring a specific level of competence to ensure its effective integration into nursing practice (Al-Hawamdih & Ahmad, 2018). Additionally, nurses require certain informatics competence for safe and effective nursing care (Zareshahi et al., 2022).

NI competency is defined as holding a sufficient degree of knowledge, skills, and abilities to carry out particular informatics duties (Khezri & Abdekhoda, 2019). Also, it's a necessary skill set that enables nurses to effectively use health information technology in the healthcare delivery system (Forman et al., 2020). NI competency emerges as a pivotal determinant influencing the quality of healthcare services (Khezri & Abdekhoda, 2019). In addition, NI competency is essential for reducing medical errors, enhancing clinical information documentation, enabling nurses to effectively communicate through electronic health records and work in harmony with interdisciplinary teams, advancing evidence-based practice globally, and ensuring maximum safety and high-quality healthcare (Harerimana et al., 2021; Kleib & Nagle, 2018; Nes et al., 2021). Hence, NI competencies are necessary for all facets of nursing practice (Harerimana et al., 2021; Kinnunen et al., 2017).

The International Medical Informatics Association (IMIA) states that NI competency, which includes three major domains; namely, computer skills, informatics knowledge, and informatics abilities, is a necessary fundamental ability for providing high-quality care in digitally enabled healthcare settings (Kleib et al., 2022). The interplay and harmonization of these domains are pivotal for nurses to attain NI competency (Guo et al., 2024). Computer skills serve as the base for establishing a robust foundation in NI competency; informatics knowledge constitutes the intellectual foundation of NI competency, encompassing an in-depth comprehension of the theoretical foundations of healthcare information systems, data management, and the integration of technology within clinical nursing practice; informatics skills connect theory with practice, thereby playing an essential role in augmenting the overall NI competency (Kleib et al., 2022).

Nurses comprise the largest group of health professionals in all healthcare settings, and their informatics competency is crucial to delivering high-quality care in a changing healthcare environment (Woods et al., 2021; Zareshahi et al., 2022). Nurses must be competent in NI to carry out their professional duties (Varatharajan & Shringi, 2024). Also, nurses must possess the necessary knowledge, skills, and abilities to use the various NI tools to support care (Raghunathan et al., 2023). Additionally, as NI was thought to be a prerequisite for evidence-based practice (EBP), nurses with high NI competency levels will be more prepared for EBP (Jouparinejad et al., 2020). Consequently, numerous countries have expressed significant concern regarding the competency of nurses entering clinical practice settings in effectively utilizing technology to enhance patient care and support healthcare professionals (Hassona & Ali, 2019). However, the absence of informatics standards and competencies renders information technology ineffective within the healthcare context, thereby posing risks to patient safety and health outcomes (Farzandipour et al., 2021).

NI competency can be measured using a variety of instruments, each covering a broad range of concepts (Seo et al., 2019). Among these are: The Nursing Informatics Competency Assessment (NICA), the Nursing Informatics Competencies Questionnaire (NICQ), the Nursing Informatics Competency Assessment Tool (NICAT), and the Canadian Nurse Informatics Competency Assessment Scale (C-NICAS) (Chung & Staggers, 2014; Hill et al., 2014; Nagle et al., 2014; Rahman, 2015). However, these NI competency scales inadequately capture critical advancements in the field, including standardized terminology, electronic health record systems, evidence based practice, as well as wireless communication (Seo et al., 2019). Therefore, the Self-assessment Nursing Informatics Competencies Scale (SANICS) was developed with these elements included (Seo et al., 2019; Yoon et al., 2009).

The SANICS was developed in English and demonstrated robust validation and internal consistency across nurses and nursing students with diverse educational and demographic profiles (Godsey, 2015; Seo et al., 2019; Yoon et al., 2009). Although students study in English language at universities and nurses are using it in healthcare settings, some nurses are not English competent (Al-Yateem et al., 2023). Although nurses constitute the largest portion of the healthcare workforce (Alquwez et al., 2023), and the Arabic language is the world's third most often spoken language (CIA, 2024), there is no valid and reliable measurement tool used to assess NI competency among Arab nurses. Additionally, Yoon et al. (2009) recommended further testing of SANICS in other samples. Furthermore, the absence of publicly available confirmatory factor analysis and invariance outcomes, coupled with the inconsistent factor structure, necessitates additional testing of the psychometric proprieties of the SANICS within larger, broader, and more diverse samples. Therefore, this study aims to evaluate the psychometric proprieties of the Arabic version of the Self-assessment Nursing informatics competency scale among Arabic-speaking nurses.

2. Methods

2.1 Design and Settings

This study involves a secondary analysis of the data from a previously published study by Akhu-Zaheya and Etoom (2024). Specifically, this study implemented a methodological, cross-sectional design to evaluate the psychometric proprieties of the Arabic version of the Self-assessment Nursing informatics competency scale among Arabic-speaking nurses. This design was used because of its alignment with the study aims. It allows the examination of associations among study factors and provides evidence regarding their relationships (Spector, 2019). This study employed a four-phase approach to translate and conduct a psychometric assessment of the instrument. These phases included translation, content validity, construct validity, and reliability. Specifically, the construct validity types were exploratory factor analysis (EFA), confirmatory factor analysis (CFA), convergent validity, and divergent validity.

This research was carried out across three healthcare facilities in Jordan: one located in the northern region, and two situated in the central region. All of these hospitals maintain affiliations with the Jordanian Ministry of Health (MoH) and use an electronic health system (EHS) named “Hakeem”. Nurses can access patients’ EHS records through the Hakeem system by entering the patient’s national ID number. These records encompass comprehensive medical and surgical histories, physical examinations, procedural and surgical reports, current medications, allergies, and clinic visit notes for both inpatient and outpatient care (Aldiqs & Ahmad, 2023). Additionally, nurses routinely use the Hakeem system to record and review patient care information, access laboratory and imaging results, and document patient care plans (Akhu-Zaheya & Etoom, 2024). Accordingly, training programs have been established through Hakeem Academy to educate nurses on the use of EHS (Hakeem, 2024). The hospitals selected in this study were Irbid Field Hospital in the North, Al-Basheer Governmental Hospital, and Al-Zarqa Governmental Hospital in the Middle region. These hospitals were chosen, because they completely implemented EHS “Hakeem”.

2.2 Sampling

The study employed a non-probability convenience sampling method to recruit participants. This method was used due to its applicability, cost effectiveness, and little time requirements for participants’ selection (Golzar et al., 2022). Eligibility criteria for inclusion encompassed registered nurses who demonstrated both ability and willingness to participate in the study, had a minimum of three months of nursing experience, and possessed the ability to read and understand the Arabic language.

The estimated sample size was determined based on the recommendation suggesting that a factor analysis sample size should be between 5 and 10 times the number of scale items (Wu, 2010). Given that the scale used in this study comprises 30 items, a sample size of at least 150 participants was deemed appropriate. However, to account for incomplete responses, an over-sampling approach was employed, resulting in a total anticipated sample size of 173 nurses.

2.3 Ethical Considerations

The study obtained ethical approval from the

Institutional Review Board (IRB) at the Jordan University of Science and Technology (JUST), under protocol number 45/143/2021. Additionally, authorization was secured from the Ministry of Health (MoH), with reference number 16065. Furthermore, permission from the primary author to utilize a previous study data was obtained (Akhu-Zaheya & Etoom, 2024). Comprehensive information regarding the study's objectives, the anticipated time commitment for completing questionnaires, as well as potential risks and benefits associated with participation, were provided to participants. Anonymity was maintained, and participants were explicitly informed of their voluntary participation rights, including the option to decline or withdraw without justification or adverse consequences. All participants provided written informed consent and rigorous measures to ensure confidentiality were implemented. Finally, formal permission was secured for instrument utilization.

2.4 Measures

The study employed a two-part questionnaire comprising demographic characteristics, and the Self-assessment Nursing Informatics Competencies Scale (SANICS). The initial section of the questionnaire captured demographic information, including hospital (current workplace), age, gender, educational level, years of experience in the profession, having studied a formal coursework of nursing informatics at the university, and working shift.

The second section of the questionnaire utilized in this study was the Self-assessment Nursing Informatics Competencies Scale (SANICS), which was developed by Yoon et al. (2009). The SANICS comprises 30 items, with respondents providing ratings on a 5-point Likert scale. The scale ranges from '1' (representing 'not competent') to '5' (representing 'expert') (Yoon et al., 2009). The mean score was calculated for each of the sub-scales. According to Yoon et al. (2009), a minimum score of three on the SANICS indicates informatics competence.

The SANICS items consist of five sub-scales: five items for clinical informatics roles (1-5), 15 items for basic computer knowledge and skills (6-20), four items for applied computer skills (21-24), four items for clinical informatics attitude (25-28), and two items for wireless device skills (29-30) (Table 1). Within these sub-scales, "basic computer knowledge and skills" and "wireless device skills" specifically assess computer skills, while "clinical informatics roles" and "clinical informatics attitude" specifically assess informatics knowledge. Lastly, the sub-scale "applied computer skills" specifically assesses informatics skills (Yoon et al., 2009).

Table 1. Self-assessment nursing informatics competencies scale (SANICS)

	Number of Items	Total Score
Informatics Knowledge	9	45
- Clinical Informatics Roles	5	5-25
- Clinical Informatics Attitude	4	4-20
Computer Skills	17	85
- Basic Computer Knowledge and Skills	15	15-75
- Wireless device Skills	2	2-10
Informatics Skills	4	20
- Applied Computer Skills	4	4-20
Total	30	150

The psychometric properties of the SANICS were rigorously established through several key analyses. First, factorial validity was confirmed, demonstrating that the scale items effectively measured the intended constructs. Second, internal consistency reliabilities were notably high. Specifically, the Cronbach's α coefficients for the SANICS sub-scales were as follows: clinical informatics role ($\alpha = 0.91$), basic computer knowledge and skills combined with clinical informatics attitude ($\alpha = 0.94$), applied computer skills in the context of clinical informatics ($\alpha = 0.89$), and wireless device skills ($\alpha = 0.90$). Additionally, the scale demonstrated responsiveness by capturing 63.7% of the observed variance across five distinct factors (Yoon et al., 2009). Additionally, previous studies have rigorously examined the psychometric properties of the SANICS, and these studies consistently affirmed the validity and reliability of the instrument for assessing nursing informatics competency among both practicing nurses and nursing students (Choi & Bakken, 2013; Godsey, 2015; Seo et al., 2019).

2.5 Translation Process of the SANICS Instrument (A-SANICS)

The SANICS instrument underwent a rigorous translation process to ensure its validity and semantic equivalence in Arabic. Following the methodology proposed by Brislin (1970), both forward and back-translation procedures were employed. The original English SANICS questionnaire, consisting of 30 items across five distinct domains, was initially translated into Arabic by two proficient translators. Subsequently, two additional qualified translators conducted the back-translation. The resulting Arabic version of SANICS (A-SANICS) underwent meticulous review and approval to ensure alignment with the original content and format. No language or semantic issues were identified in the scale. Lastly, pilot testing was performed among 30 nurses (excluded from the final analysis), using internal consistency Cronbach alpha (C. α), to ensure the readability of the translated instrument. The piloting revealed that the C. α for the overall instrument was above 0.80.

2.6 Data Collection

Data collection began following the Institutional Review Board (IRB) approval from the Jordan University of Science and Technology (JUST) and the Ministry of Health. Subsequently, the researchers sought permission from hospital administrators at the selected facilities to distribute the questionnaire to available nurses during data collection periods. The directors of nursing departments and quality assurance units were briefed on the study's purpose and significance. Nurses were approached at various times and shifts, spanning from November 25, 2021 to December 7, 2021. Participants were informed that completing the questionnaire would take approximately 5-10 minutes. The researchers initiated data collection at 7 a.m., distributing questionnaire forms between 8 a.m. and 12 midnight, accounting for different working shifts. This process continued for four consecutive days at each hospital. Nurses received the study questionnaire, accompanied by a cover letter outlining the study's objectives and anticipated outcomes. The researchers remained available to address any inquiries. Finally, the completed questionnaire forms were promptly collected from participating nurses.

2.7 Data Analysis

The data analysis process employed the Statistical Package for the Social Sciences (SPSS, version 27) for Windows. Descriptive statistics, including mean, standard deviation, frequency, and percentage, were employed to characterize and summarize the demographic characteristics according to their level of measurement. Also, skewness and kurtosis values were employed to assess the normality of the scores for each item. The content validity was assessed by a single panel of five experts. Exploratory factor analysis (EFA) was conducted to determine construct validity. Before EFA conduction, the appropriateness of the data will be evaluated using the Kaiser-Mayer-Olkin (KMO) sampling sufficiency measure and Bartlett's test for sphericity. Additionally, IBM AMOS 24.0 was utilized to develop the confirmatory factor analysis (CFA) model using the maximum likelihood method. Convergent validity and divergent validity were determined by the average variance extracted (AVE), and the heterotrait-monotrait ratio of correlations (HTMT). Moreover, the corrected item-total correlation coefficients for each item, Cronbach's alpha, McDonald's omega, composite reliability, and split-half reliability were evaluated to determine the instrument's reliability.

3. Results

3.1 Participants' Demographic Characteristics

The study questionnaire was distributed to 195 nurses. Of this group, 176 nurses actively participated by completing the questionnaire, resulting in a response rate of (90.2%). The highest percentage of participants worked in the Irbid Field Hospital intensive care unit (ICU) (n= 55, 31.25%) (Table 2). The mean age of the participating nurses was (M= 27.99, SD = 4.00). Also, the mean years of experience in the profession of the participating nurses were (M= 5.03, SD = 3.41). Additionally, among the study participants, 88 (50%) were females. Furthermore, more than two-thirds of the study participants held a bachelor's degree in nursing (n= 160, 90.9%) and studied a formal coursework of nursing informatics at the university (n= 128, 72.7%). Moreover, more than a half of the study participants worked on the BC shift (n=96, 54.5%).

Table 2. Participants' demographic characteristics (N= 176)

Variable	Categories	N	%	M	SD
Hospital (Current Workplace)	Irbid Field Hospital ICU Al-Basheer Hospital Medical ICU Al-Basheer Hospital Surgical ICU Al-Basheer Hospital CCU Al-Zarqa Governmental Hospital ICU	55 51 35 15 20	31.25 29.0 19.9 8.5 11.4		
Age				27.99	4.00
Gender	Male Female	88 88	50 50		
Educational Level	Bachelor's Degree Master's Degree	160 16	90.9 9.1		
Studied a Formal Coursework of Nursing Informatics at the University	Yes No	128 48	72.7 27.3		
Years of Experience in the Profession				5.03	3.41
Shift	A BC	80 96	45.5 54.5		

Note: M: mean; SD: standard deviation; ICU: intensive care unit; CCU: critical care unit.

3.2 Item Characteristics and Content Validity

The mean item scores ranged between 1.84 (*SD* = 0.924) and 2.99 (*SD* = 1.10), while skewness ranged from −0.20 to .937, and kurtosis ranged from – 0.835 to 0.419) (Table 3). Non-normality can be inferred when skewness values exceed two and kurtosis values surpass seven (Kim, 2013). The skewness and kurtosis values for the scale items didn't exceed these limits. Therefore, the scale items were considered normally distributed and met the normality assumption for factor analysis.

Table 3. Item characteristics and content validity (N= 176)

Item	M	SD	S	K	I-CVI
1. As a clinician (nurse), participate in the selection process, design, implementation and evaluation of systems	1.84	.924	.937	.419	0.8
2. Market self, system, or application to others	2.03	1.00	.625	-.437	0.8
3. Promote the integrity of and access to information to include, but not limited to, confidentiality, legal, ethical, and security issues	2.33	1.00	.479	-.208	1
4. Seek available resources to help formulate ethical decisions in computing	2.03	.967	.736	.128	1
5. Act as an advocate of leaders for incorporating innovations and informatics concepts into their area of specialty	2.01	.953	.469	-.721	1
6. Use different options for connecting to the Internet (phone line, mobile phone, cable, wireless, satellite) to communicate with other systems (e.g. access data, upload, download)	2.13	1.01	.549	-.505	1
7. Use the Internet to locate (e-learning, teleworking), download items of interest	2.49	1.06	.304	-.434	1
8. Use a database management program to develop a simple database and/or table	2.19	1.05	.722	.002	0.8
9. Use database applications to enter and retrieve information	2.28	1.04	.587	-.140	0.8
10. Conduct online literature searches	2.82	1.12	.193	-.585	1
11. Use presentation graphics (e.g. PowerPoint) to create slides, displays	2.75	1.16	.152	-.815	1
12. Use multi-media presentations	2.66	1.12	.242	-.712	0.8
13. Use word processing	2.81	1.09	.273	-.556	1

14. Use networks to navigate systems (e.g. LAM, WLAN, WAN)	2.58	1.08	.381	-.474	0.8
15. Use operating systems (e.g. copy, delete, change directories)	2.89	1.06	.258	-.361	1
16. Use existing external storage devices (e.g. network drive, CD, DVD, USB flash drive, memory card, online file storage)	2.72	1.09	.206	-.576	1
17. Use computer technology safely	2.82	1.00	.030	-.493	1
18. Navigate Windows (e.g. manipulate files using file manager, determine active printer, access installed applications, create and delete directories)	2.84	1.00	-.020	-.472	1
19. Identify the basic components of the computer system (e.g. features of a PC, workstation)	2.68	1.07	.211	-.415	1
20. Perform basic troubleshooting in applications	2.19	1.05	.620	-.205	0.8
21. Use applications for diagnostic coding	2.10	1.00	.807	.370	0.8
22. Use applications to develop testing materials (e.g. e-learning)	2.08	1.02	.748	.007	1
23. Access shared datasets (e.g. Clinical Log Database, Minimum Dataset)	2.31	1.07	.508	-.394	0.8
24. Extract data from clinical datasets (e.g. Clinical Log Database, Minimum Dataset)	2.43	1.09	.437	-.533	0.8
25. Recognize that health computing will become more common	2.99	1.10	.164	-.608	1
26. Recognize that the computer is only a tool to provide better nursing care and that there are human functions that cannot be performed by a computer	2.93	1.15	.078	-.653	1
27. Recognize that one does not have to be a computer programmer to make effective use of the computer in nursing	2.77	1.15	.164	-.745	1
28. Recognize the value of clinician involvement in the design, selection, implementation, and evaluation of applications and systems in healthcare	2.80	1.12	.130	-.644	1
29. Use a wireless device (PDA or cellular telephone) to locate and download resources for patient safety and quality care	2.56	1.17	.370	-.698	1
30. Use a wireless device (PDA or cellular telephone) to enter data	2.54	1.22	.376	-.835	0.8
					S-CVI= 0.93

Note: M: mean; SD: standard deviation; S: Skewness; K: kurtosis; I-CVI: item content validity index; S-CVI: scale content validity index.

The content validity of the 30 items of the A-SANICS was evaluated by a single panel of five experts. In this study, an expert reviewer is a registered nurse holding a minimum qualification of a master's degree in nursing science, possessing at least ten years of professional experience (at least five years of them in hospital implemented electronic health system), and having published relevant work in local or international journals. A panel of five experts evaluated the translated scale independently in terms of clarity and relevancy. The questionnaire items were rated on a four-point Likert scale, ranging from 1 ('not relevant') to 4 ('very relevant'). The item content validity index (I-CVI) for each A-SANICS item was from 0.80 to 1.0, and the total scale content validity index (S-CVI) was 0.93.

3.3 Exploratory Factor Analysis

The Kaiser-Mayer-Olkin (KMO) measure for sampling adequacy was high (0.923), and Bartlett's test of sphericity was significant ($\chi2$ = 4493.934, df = 435, $p < 0.001$). Therefore, the study data was appropriate for the factor analysis. Principal Component Analysis (PCA) and Principal Axis Factoring (PAF) methodologies were utilized, incorporating a range of rotational configurations and retaining factors with Eigenvalues greater than 1 (Table 4). The selection criteria for the best exploratory factor analysis (EFA) model included factors with high item loadings, clean loadings (where the difference between two loadings on the same factor exceeds 0.20), high communalities, at least two items in a factor, and overall model variance (Liao et al., 2023; Warner, 2013). Therefore, in this study, we have chosen model nine in Table 3. Model nine was conducted through PCA with Promax rotation and Kaiser normalization.

Table 4. Descriptive statistics for 12 models in EFA

Model	Extraction and rotation	Number of factors	Item communalities range	Total amount of variance explained	Number of items with unclean loadings*
1	PCA, unrotated	5	(.634 – .829)	71.62	5
2	PAF, unrotated	5	(.521 – .819)	66.06	5
3	PCA, Varimax	5	Communalities for all items = 1	71.62	2
4	PAF Varimax	5	(.539 – .845)	66.06	2
5	PCA, Quartimax	5	Communalities for all items = 1	71.62	12
6	PAF Quartimax	5	(.539 – .845)	66.06	10
7	PCA, Equamax	5	Communalities for all items = 1	71.62	4
8	PAF, Equamax	5	(.539 – .845)	66.06	4
9	PCA, Promax	5	Communalities for all items = 1	71.62	1
10	PAF, Promax	5	(.539 – .845)	71.62	1
11	PCA, Oblimin	5	Communalities for all items = 1	71.62	2
12	PAF, Oblimin	5	(.539 – .845)	71.62	1

Note: PCA: Principal Component Analysis; PFA: Principle Axis Factoring; Eigenvalue ≥ 1
* Unclean loading means that the difference between factor loadings for the same item in different factors is less than 0.20.

The results of PCA with Promax rotation and Kaiser normalization revealed that there were five factors with eigenvalues greater than 1.00. This model is the best modified model accounting for 71.62% of the total variance (Table 5). There are 30 items on a Likert scale in the model. The five factors include factor 1, which accounted for 47.19% of the variance, factor 2 for 8.83%, factor 3 for 6.62%, factor 4 for 4.74%, and factor 5 for 4.22%. In (Figure 1), the descending tendency became weakened after the fifth point, providing further confirmation of the five-factor structure inherent in the original scale.

Table 5. Exploratory factor analysis of the Arabic version of SANICS

Item	Item description						
		C^2	F1	F2	F3	F4	F5
Basic computer knowledge and skills							
13	Use word processing	1	.969				
16	Use existing external storage devices (e.g. network drive, CD, DVD, USB flash drive, memory card, online file storage)	1	.921				
11	Use presentation graphics (e.g. PowerPoint) to create slides, displays	1	.911				
12	Use multi-media presentations	1	.849				
18	Navigate Windows (e.g. manipulate files using file manager, determine active printer, access installed applications, create and delete directories)	1	.801				
17	Use computer technology safely	1	.698				
14	Use networks to navigate systems (e.g. LAM, WLAN, WAN)	1	.664				
15	Use operating systems (e.g. copy, delete, change directories)	1	.650				

19	Identify the basic components of the computer system (e.g. features of a PC, workstation)	1	.643				
10	Conduct online literature searches	1	.622				
Clinical informatics attitude							
26	Recognize that the computer is only a tool to provide better nursing care and that there are human functions that cannot be performed by a computer	1		.866			
27	Recognize that one does not have to be a computer programmer to make effective use of the computer in nursing	1		.858			
28	Recognize the value of clinician involvement in the design, selection, implementation, and evaluation of applications and systems in healthcare	1		.855			
25	Recognize that health computing will become more common	1		.705			
29	Use a wireless device (PDA or cellular telephone) to locate and download resources for patient safety and quality care	1		.695			
30	Use wireless device (PDA or cellular telephone) to enter data	1		.612			
Applied computer skills							
23	Access shared datasets (e.g. Clinical Log Database, Minimum Dataset)	1			.894		
21	Use applications for diagnostic coding	1			.886		
24	Extract data from clinical data sets (e.g. Clinical Log Database, Minimum Dataset)	1			.863		
22	Use applications to develop testing materials (e.g. e-learning)	1			.711		
20	Perform basic troubleshooting in applications	1			.690		
Clinical informatics roles							
1	As a clinician (nurse), participate in the selection process, design, implementation, and evaluation of systems	1				.838	
4	Seek available resources to help formulate ethical decisions in computing	1				.829	
2	Market self, system, or application to others	1				.813	
5	Act as an advocate of leaders for incorporating innovations and informatics concepts into their area of specialty	1				.712	
3	Promote the integrity of and access to information to include, but not limited to, confidentiality, legal, ethical, and security issues	1				.690	
Advanced computer knowledge and skills							
6	Use different options for connecting to the Internet (phone line, mobile phone, cable, wireless, satellite) to communicate with other systems (e.g. access data, upload, download)	1					.788
7	Use the Internet to locate (e-learning, teleworking), download items of interest	1					.778
8	Use a database management program to develop a simple database and/or table	1					.707
9	Use database applications to enter and retrieve information	1					.479
Eigenvalues			14.15	2.65	1.98	1.42	1.26
Percentage of variance (total: 71.62%)			47.19%	8.83%	6.62%	4.74	4.22

Note: C^2: commonalities. The extraction method was exploratory factor analysis, principal components method, and Promax rotation with Kaiser Normalization. F1, F2, F3, F4, and F5 are factor loadings for the rotated solution. Eigenvalues ≥ 1.0; KMO =0.923.

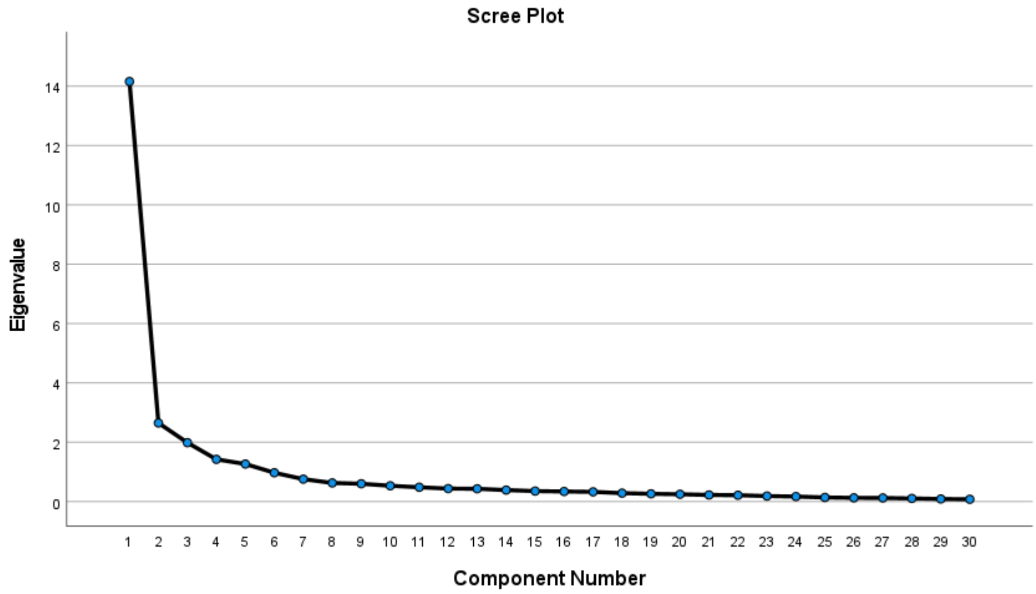

Figure 1. Scree plot of exploratory factor analysis for A-SANICS

Factor one "basic computer knowledge and skills" comprised ten items (13, 16, 11, 12, 18, 17, 14, 15, 19, and 10). Factor two "clinical informatics attitude" included six items (26, 27, 28, 25, 29, and 30). Factor three "applied computer skills" consisted of five items (23, 21, 24, 22, and 20). Factor four "clinical informatics roles" encompassed five items (1, 4, 2, 5, and 3). Factor five "advanced computer knowledge and skills" comprised four items: (6, 7, 8, and 9). Item nine, "Use database applications to enter and retrieve information", was uncleanly loaded. Consequently, assigned to factor five, based on the theoretical rationale (Duale et al., 2023), factor loadings of the items were all above 0.4, indicating that they are measuring the same underlying construct.

3.4 Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) was employed to ascertain the construct validity of the five-factor model. In the present study, various model fit indices and their criteria were utilized, to evaluate the goodness-of-fit of the model with the given dataset: Chi-square/Degrees of Freedom (χ^2/df) of < 5, Standardized root mean square residual (SRMR) of <0.80, Tucker-Lewis Index (TLI) of >0.90, comparative fit index (CFI) of >0.90, Incremental Fit Index (IFI) of > 0.90, and root mean square error of approximation (RMSEA) of <0.80 (Hair et al., 2014; Hu & Bentler, 1999).

The CFA results, based on 30 items, indicated that the five-factor model derived from the exploratory factor analysis (EFA) was deemed acceptable (χ2/df = 1.994, p <0.001, RMSEA = 0.075, CFI = 0.916, SRMR= 0.070, TLI= 0.901, IFI = 0.917). The fit indices fell within acceptable ranges, indicating that the model adequately fits the data (Table 6). Standardized CFA for the five factor 30-item structure model is depicted in Figure 2.

Table 6. Fitting indices for the five-factor model

Index	Acceptable Value	The Scale
Chi-square/degree of freedom (χ^2/df)	<5	1.944
Standardized Root Mean Square Residual (SRMR)	<0.80	0.070
Tucker-Lewis Index (TLI)	>0.90	0.901
Comparative Fit Index (CFI)	>0.90	0.916
Incremental Fit Index (IFI)	>0.90	0.917
Root Mean Square Error of Approximation (RMSEA)	<0.08	0.075

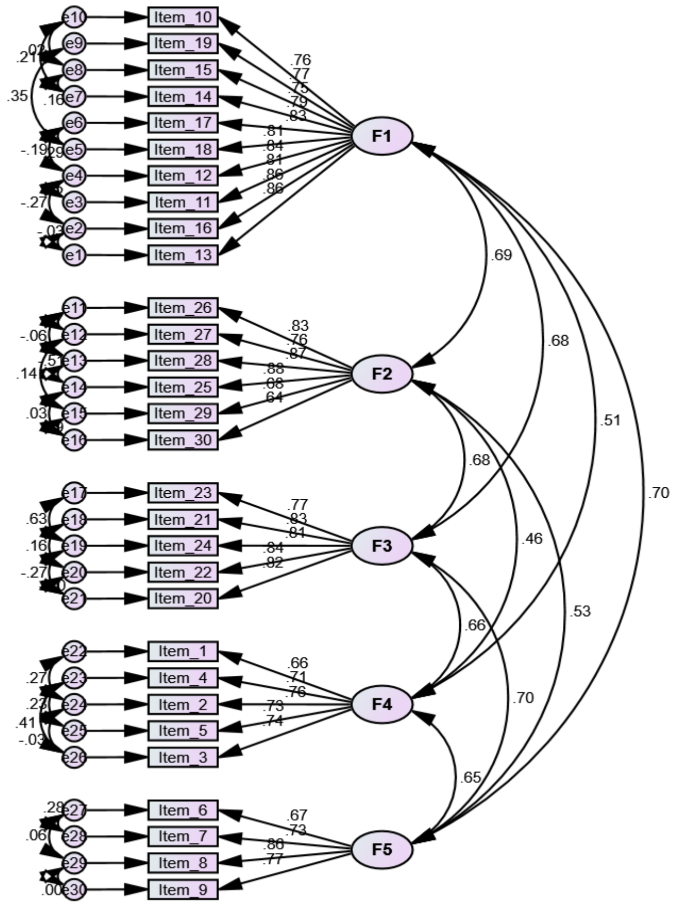

Figure 2. Confirmatory factor analysis for the A-SANICS

3.5 Convergent Validity and Divergent Validity

The convergent validity was evaluated based on an average variance extracted (AVE) of ≥ 0.5 (Ta'an et al., 2024). Also, the square root of the AVE for every construct (factor) was computed and compared to the correlations between the constructs to evaluate divergent validity. The divergent validity was affirmed when the square roots of AVE were greater than the correlations between the constructs (Shrestha, 2021). The results showed that the AVE values for all five factors of the SANICS scale exceeded the established cut-off point, supporting convergent validity (Table 7). Additionally, the square roots of AVE were higher than the correlations between constructs, supporting divergent validity. Furthermore, the divergent validity was ensured by using the heterotrait-monotrait ratio (HTMT). Normally, the threshold for acceptable divergent validity using the HTMT is set at 0.90 (Henseler et al., 2015). However, in the present study, a more conservative criterion of 0.85 was employed to ensure heightened sensitivity (Henseler et al., 2015). Therefore, if the value of HTMT is lower than 0.85, then the divergent validity is acceptable, which is as (Table 8) shows.

Table 7. Convergent validity and divergent validity

	AVE	F1	F2	F3	F4	F5
F1	.650	**.807**				
F2	.609	.690	**.780**			
F3	.665	.676	.697	**.816**		
F4	.521	.515	.463	.660	**.722**	
F5	.580	.704	.533	.702	.647	**.762**

Note: F1: Basic computer knowledge and skills; F2: Clinical informatics attitude; F3: Applied computer skills; F4: Clinical informatics roles; F5: Advanced computer knowledge and skills; AVE: Average Variance Extracted.

Note: Bold diagonals are the squared root of AVE, and off-diagonals are correlations.

Table 8. Divergent validity results (HTMT)

	F1	F2	F3	F4	F5
F1					
F2	.743				
F3	.686	.712			
F4	.485	.468	.614		
F5	.709	.590	.700	.602	

Note: HTMT: heterotrait-monotrait ratio. F1: Basic computer knowledge and skills; F2: Clinical informatics attitude; F3: Applied computer skills; F4: Clinical informatics roles; F5: Advanced computer knowledge and skills.

3.6 Reliability

The corrected item-total correlation coefficients for each item ranged from 0.421 to 0.772 (Table 9). The internal consistency reliability results for the five sub-scales demonstrate robust internal consistency for each sub-scale and for the overall scale. Cronbach's α coefficients ranged from 0.856 to 0.949, and was 0.961 for the overall scale. McDonald's omega ranged from 0.856 to 0.949, and was 0.959 for the overall scale. Composite reliability ranged from 0.845 to 0.949, and was 0.977 for the overall scale. Moreover, split-half reliability was evaluated by dividing the translated scale items into two halves according to odd and even numbers. The result of the current study showed a split-half reliability of 0.984.

Table 9. Reliability analysis

Item		CITC	C. α	M. ω	CR	Split-half reliability
						.984
Basic computer knowledge and skills			.949	.949	.949	
13	Use word processing	.726				
16	Use existing external storage devices (e.g. network drive, CD, DVD, USB flash drive, memory card, online file storage)	.721				
11	Use presentation graphics (e.g. PowerPoint) to create slides, displays	.696				
12	Use multi-media presentations	.716				
18	Navigate Windows (e.g. manipulate files using file manager, determine active printer, access installed applications, create and delete directories)	.730				
17	Use computer technology safely	.772				
14	Use networks to navigate systems (e.g. LAM, WLAN, WAN)	.750				
15	Use operating systems (e.g. copy, delete, change directories)	.676				
19	Identify the basic components of the computer system (e.g. features of a PC, workstation)	.743				
10	Conduct online literature searches	.708				
Clinical informatics attitude			.907	.899	.902	
26	Recognize that the computer is only a tool to provide better nursing care and that there are human functions that cannot be performed by a computer	.641				
27	Recognize that one does not have to be a computer programmer to make effective use of the computer in nursing	.601				
28	Recognize the value of clinician involvement in the design, selection, implementation, and evaluation of applications and systems in healthcare	.667				
25	Recognize that health computing will become more common	.701				

29	Use a wireless device (PDA or cellular telephone) to locate and download resources for patient safety and quality care	.685				
30	Use wireless device (PDA or cellular telephone) to enter data	.663				
Applied computer skills			.912	.910	.908	
23	Access shared datasets (e.g. Clinical Log Database, Minimum Datasets)	.653				
21	Use applications for diagnostic coding	.657				
24	Extract data from clinical datasets (e.g. Clinical Log Database, Minimum Dataset)	.690				
22	Use applications to develop testing materials (e.g. e-learning)	.725				
20	Perform basic troubleshooting in applications	.702				
Clinical informatics roles			.867	.866	.845	
1	As a clinician (nurse), participate in the selection process, design, implementation, and evaluation of systems	.421				
4	Seek available resources to help formulate ethical decisions in computing	.489				
2	Market self, system, or application to others	.501				
5	Act as an advocate of leaders for incorporating innovations and informatics concepts into their area of specialty	.532				
3	Promote the integrity of and access to information to include but not limited to confidentiality, legal, ethical, and security issues	.571				
Advanced computer knowledge and skills			.856	.856	.846	
6	Use different options for connecting to the Internet (phone line, mobile phone, cable, wireless, satellite) to communicate with other systems (e.g. access data, upload, download)	.539				
7	Use the Internet to locate (e-learning, teleworking), download items of interest	.645				
8	Use a database management program to develop a simple database and/or table	.650				
9	Use database applications to enter and retrieve information	.648				
Overall			.961	.959	.977	

Note: CITC: Corrected item-total correlation; C.α: Cronbach's alpha; M.ω: McDonald's omega; CR: Composite reliability.

4. Discussion

Nurses hold a pivotal position within clinical practice as essential members of the healthcare team, and their informatics competencies significantly influence the outcomes of interventions (Khezri & Abdekhoda, 2019). The availability of the Arabic version of the self-assessment nursing informatics competency scale is limited. Therefore, this study aims to evaluate the psychometric proprieties of the Arabic version of the Self-assessment Nursing informatics competency scale among Arabic-speaking nurses.

Validity refers to the extent to which a tool or measurement instrument can precisely measure the object to be measured (Ahmed & Ishtiaq, 2021). This study evaluates the validity of the A-SANICS from two perspectives: content validity, and construct validity. Specifically, data was analyzed using exploratory factor analysis, confirmatory factor analysis, convergent validity, and divergent validity.

Content validity refers to the extent to which a test incorporates all essential items necessary to adequately represent the concept being measured (Souza et al., 2017). The content validity of the A-SANICS was evaluated by a single panel of five experts. The results showed that the S-CVI was 0.93, and the I-CVI was between 0.8 and 1, demonstrating excellent content validity. Additionally, these findings indicated that the instrument's items were highly relevant and useful for measuring the desired construct. However, to be deemed as having excellent content validity, the evaluation criteria state that the I-CVI must be higher than 0.78 and the S-CVI must approach 0.80 (Li et al., 2022). This result is similar to that of a previous study, which found that the S-CVI was 0.99, and the I-CVI was between 0.88 and 1 (Seo et al., 2019).

Construct validity refers to the extent to which a set of variables accurately represents the underlying construct that was intended to be measured (Souza et al., 2017). In the present study, exploratory factor analysis (EFA) was conducted. However, before EFA conduction, the appropriateness of the data for factor analysis was assessed through the Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy and the Bartlett test of sphericity. The KMO result was 0.923, indicating an adequate sample size for factor analysis. However, the recommended value for factor analysis was above 0.6 (Jassim & Alansari, 2020), and a KMO value between 0.8 and 1 indicates an adequate sample (Etoom & Alnjadat, 2024). The Bartlett test of sphericity was significant. Therefore, this indicates that the matrix is not an identity matrix and can be utilized for factor extraction (Ahmad et al., 2023).

In this study, factor loadings and eigenvalues were determined using cut-off values of 0.4 and 1, respectively. Factor loadings elucidate the relationships between variables, contributing to construct clarification (Şimşek et al., 2023). Notably, items with loading values exceeding 0.40 are indicative of their representation of the factors (Shrestha, 2021). Therefore, in this study, all scale items are related to the construct, as the factor loadings ranged from 0.479 to 0.969. This result is similar to that of previous studies, which found that the factor loadings for all items are above 0.4 (Seo et al., 2019; Yoon et al., 2009).

EFA was conducted using the principal components approach and Promax rotation. In this study, EFA identified five sub-scales with eigenvalues ≥ 1.0, collectively accounting for 71.62% of the scale’s overall variance, indicating that the items demonstrated robust explanatory power concerning nursing informatics competency. However, EFA guidelines suggest that factors should explain at least 50% of the total variation (Shrestha, 2021). Additionally, robust construct validity is achieved when the factors identified through EFA account for at least 50% of the total variation (Weziak-Bialowolska et al., 2021). Therefore, this finding validates the suitability of the scale within this context. The amount of variance explained by factors in this study is higher than the original scale, which consists of five sub-scales accounting for 63.7% of the total variance (Yoon et al., 2009), similar to the Korean version of SANICS, which found six factors accounting for 71.0% of the total variance (Seo et al., 2019). However, there is a difference in the order of items between the two studies.

The A-SANICS approved as a five-factor model includes basic computer knowledge and skills comprising ten items, clinical informatics attitude with six items, applied computer skills with five items, clinical informatics roles with five items, and advanced computer knowledge and skills comprising four items. In contrast, the original scale consisted of five sub-scales including basic computer knowledge and skills comprising 15 items, clinical informatics attitude with four items, applied computer skills with four items, clinical informatics roles with five items, and wireless device skills comprising two items (Yoon et al., 2009). Also, the Korean version of SANICS consisted of six sub-scales including advanced skills for clinical informatics comprising nine items, basic application skills with six items, basic computer skills with six items, roles in nursing informatics with five items, skills for using clinical applications comprising two items, and attitude about using computer in nursing with two items (Seo et al., 2019). These variations may be attributed to differences in nurses’ knowledge levels, skills, language proficiency, and cultural backgrounds. Additionally, variations in study populations exist. Notably, the Korean version of the SANICS scale was assessed among nursing students, while the original and Arabic versions were evaluated among practicing nurses.

The EFA analysis also revealed that wireless device skills are a component of clinical informatics attitude factor rather than an independent one. Also, a new factor named “advanced computer knowledge and skills”, comprises four items related to internet and database utilization. These results could be explained by the growing use of technology in healthcare. In addition, the selected hospitals in this study implemented the electronic health system “Hakeem”. Furthermore, the items were categorized under advanced computer knowledge and skills, due to the necessity for profound comprehension and mastery of computer knowledge, problem-solving skills, and the practical application of computer-related concepts. Therefore, the factor-five name was "advanced computer knowledge and skills". This result is similar to that a previous study, which found that the wireless device skills' items are components of another factor, rather than a separate factor (Seo et al., 2019).

Nursing informatics competency factually was classified into three major domains: computer skills, informatics knowledge, and informatics skills (Kleib et al., 2022). Therefore, according to the results of the current study, factors one and five assess computer skills, factors two and four assess informatics knowledge, and factor three assess informatics skills.

Confirmatory factor analysis (CFA) was employed to assess the validity of the identified structure, using the same dataset. The scale's structure underwent evaluation using goodness-of-fit indices, including $\chi2$/df, SRMR, TLI, CFI, IFI, and RMSEA. Notably, all fit indices met the acceptability criteria, affirming that the A-SANICS exhibits an overall acceptable fit. Consequently, the five-factor structure derived from the EFA was found to be generally compatible and confirmed.

Convergent validity refers to the extent to which responses on a measurement instrument demonstrate a robust association with responses on conceptually similar instruments or tests (APA, 2018a). In the present study, the convergent validity is evaluated by using an average variance extracted (AVE) $\geq$ 0.5. The results revealed that all factors exceeded the cut-off point, indicating that the A-SANICS is convergently valid, indicating that the items in a particular factor converge to represent that factor. On the other hand, divergent validity pertains to the degree to which a test or measure diverges from another measure the underlying construct of which is conceptually unrelated (APA, 2018b). The divergent validity was evaluated by square roots of AVE, and heterotrait-monotrait ratio (HTMT) using a cut-off value of 0.85. The findings revealed that the square roots of AVE were higher than the correlations between constructs, and the HTMT values for all factors below the cut-off point, indicating that each factor is a distinct construct, and independent from other constructs. Therefore, according to these results, the A-SANICS is divergently valid. However, it's difficult to compare the results of CFA, convergent validity, and divergent validity with those of previous studies, since this is the first study that assesses such types of validity regarding informatics competency.

Reliability pertains to the consistency, stability, and accuracy of data obtained, as well as the extent to which a measuring instrument mitigates random error (Ahmed & Ishtiaq, 2021; Bao et al., 2022). In the current study, reliability was evaluated by corrected item-total correlation (CITC), and internal consistency, The CITC coefficient is the correlation between each item on the scale and the total of the other items (Chang et al., 2018). Items related to the full scale were identified based on CITC using a criterion of 0.3 or higher (Chang et al., 2018). The current study revealed that CITC for each item ranged from 0.421 to 0.772, indicating a moderate-to-high relationship between each item and the total of other items. Also, these results suggest that the participants comprehended the statements accurately and provided objective responses (Şimşek et al., 2023).

Internal consistency pertains to the degree to which the items of a test yield consistent scores (Anselmi et al., 2019). The A-SANICS demonstrated excellent internal consistency, with Cronbach's α coefficients ranging from 0.856 to 0.949, and being 0.961 for the total scale. In addition, the McDonald's omega ranged from 0.856 to 0.949, and was 0.959 for the total scale. Furthermore, the Composite reliability ranged from 0.845 to 0.949, and was 0.977 for the total scale. Moreover, the split-half reliability was 0.984. These coefficients suggest that the A-SANICS items effectively measure a single underlying construct related to informatics competency among Arabic-speaking nurses. However, the established threshold for acceptable internal consistency is 0.7, which is widely regarded as indicative of a reliable level of consistency (Trabelsi et al., 2024). This result is similar to the internal consistency result of the original scale, which was between 0.89 and 0.94 (Yoon et al., 2009), and higher than the internal consistency result of the Korean version of SANICS, which was 0.64-0.93 (Seo et al., 2019).

5. Implications for Nursing

Nursing informatics plays a significant role in the areas of practice, education, research, and administration. Nurses must be evaluated for their level of nursing informatics competency to guarantee that they have the knowledge and abilities needed to reducing medical errors, promoting electronic health documentation, advancing evidence-based practice, and ensuring maximum safety and high-quality patient care. Healthcare facilities can accurately assess a nurse's informatics competency by using this tool. This makes it possible to assess nursing staff more effectively, highlight areas in need of improvement, and design specialized training programs.

Utilizing this tool could increase nursing educators' awareness of the requirements to improve the level of nursing informatics competency among nursing students and determine which areas of informatics competency need greater focus in designing better educational programs. Additionally, educational institutions may employ this tool to identify students requiring further training in specific informatics competencies, thereby ensuring that they meet the workforce demands in a technology-driven healthcare environment. Furthermore, the presented tool can serve as a valuable resource for designing educational strategies aimed at enhancing nursing students' informatics competencies within the dynamic healthcare information technology environment. Moreover, this tool can be used by researchers and healthcare administrators to conduct studies across various healthcare facilities. This may result in identifying the best practices and bringing scientifically supported strategies into practice to improve nursing care.

6. Limitations and Recommendation

Although this study is the first to assess the psychometric properties of A-SANICS among nurses, it is important to acknowledge that certain limitations may restrict the generalizability of the findings. First, a cross-sectional study design was used to gather the data, which may not always ensure accuracy. This is due to the possibility that survey respondents may not have answered every question or may not have remembered answering certain questions correctly. Second, the selection of study participants in this study was carried out by convenience sampling techniques, which might not represent NI competency in other hospitals, and limit the generalization of the findings. Future studies should involve nurses, and nursing students drawn from diverse geographic regions, as well as different healthcare settings. This approach would enhance the external validity of the study findings. Also, studies should be conducted to assess the tool effectiveness in improving nurse competencies over time and across different healthcare systems. In addition, a longitudinal strategy, and probability sampling techniques should be used in future research to more precisely identify changes and trends across time, and limit bias in sample selection. Furthermore, future interventional studies should be conducted to assess how the A-SANICS could improve informatics competency when incorporated into continuous professional development or pre-service education programs. Moreover, future studies should explore the new factors that emerged in this study to determine whether they are specific to Arabic-speaking nurses or pertinent to a more general shift in informatics competency.

7. Conclusion

The psychometric proprieties of the A-SANICS were examined using content validity, EFA, CFA, convergent validity, divergent validity, as well as with internal consistency methodologies. It was concluded that the Arabic version of SANICS is valid and reliable. This scale can be used to assess the nursing informatics competency level among nurses and nursing students. Further studies should involve a more extensive and diverse sample of participants to rigorously evaluate the psychometric properties of the Arabic version of SANICS.

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Conflict of Interests

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