

ORIGINAL ARTICLE

A systematic and psychometric review of tests measuring nurses' wound care knowledge

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Abstract

Wound care is an important realm of nurses' clinical responsibilities, and a broad knowledge and range of skills are needed to perform efficient and safe patient care. Nurses' knowledge on this matter can be measured using knowledge tests. This study aims to identify, define, and analyse the knowledge tests developed for the measurement of nurses' wound care knowledge, and to evaluate the psychometric properties of the tests. This study was a systematic literature review. A total of 52 studies and 18 instruments were found. Of the 18 instruments, only 5 had been used more than once and were successful in a psychometric evaluation. These five instruments were analysed on the basis of their psychometric properties by using Zwakhlen et al.'s (2006) psychometric testing framework. According to the analysis, the Pressure Ulcer Knowledge Test (PUKT) and the Pressure Ulcer Knowledge Assessment Tool (PUKAT) were the most valid and reliable instruments for measuring nurses' wound care knowledge. Most of the instruments identified and analysed focused on pressure ulcers, indicating that future instruments could focus more on other types of wounds or on wound care in general in order to receive a broader understanding of nurses' wound care knowledge.

KEYWORDS

knowledge, nurses, psychometrics, wounds and injuries

1 | INTRODUCTION

The number of patients with wounds, especially chronic wounds, is predicted to rise in the near future due to the ageing population.¹ Wound care is an important realm of nurses' clinical responsibilities. Provision of wound care demands thorough knowledge and competence, and the care should be based on the evidence available² and up-to-date knowledge.³ With sufficient knowledge, both quality of care and patient safety can

be improved; and when evidence-based interventions are implemented in clinical practice, it is possible to reduce the costs of care.^{4,5} However, strong evidence is not available for all types of wounds and clinical scenarios, and healthcare professionals often have to rely on practical advice given in consensus guidelines.² Furthermore, nurses have been found to prefer experience, clinical practice, and learning from colleagues; that is, they lean on lower-level evidence⁶ instead of using evidence-based guidelines.^{7,8}

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Knowledge influences people's behaviour. Knowledge of something may, for example, affect safety and effectiveness, and it encourages orderliness.⁹ This indicates that in order to perform evidence-based care, nurses should have sufficient knowledge of wounds and wound care. However, previous studies have shown that nurses' wound care knowledge, such as pressure ulcer knowledge, is limited and that education on wound care is unstructured at the undergraduate level and in continuing education.⁶

The Oxford English Dictionary¹⁰ defines knowledge as "Facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject" and "Awareness or familiarity gained by experience of a fact or situation". This suggests that knowledge has both objective and subjective dimensions. One's knowledge can be measured using knowledge tests (objective knowledge) or self-assessment (subjective knowledge),⁹ and previous studies.^{11,12} have found that both aspects of nurses' knowledge of wound care practice and wound prevention is limited. However, the methods and instruments that are used to measure one's knowledge play a significant role when it comes to the reliability of the results. In addition, the instruments may vary in their stage of development and in their psychometric properties that could affect the validity and generalisation of the results. For example, self-assessment instruments have been criticised for ceiling effects and for responses that favour ideal situations, rather than factual knowledge and competence.^{13,14} Thus, objective measures are important in revealing professionals' knowledge. Still, these measures have to be accurate, reliable, and valid to be able to make any worthwhile conclusions.

The instrument-development process begins with determining the purpose of the instrument, followed by generating an item pool and determining the measurement format.¹⁵ The items of the instrument must operationalise the key concepts of the subject reliably, be relevant and acceptable to the study's target group, and be suitable for research purposes and able to answer the research questions.¹⁶

According to DeVellis,¹⁵ the development process usually continues with expert reviews and consideration of the inclusion of the validation items. At this point, the face validity and content validity of the instrument are measured, which involves listening to experts' opinions about the potential instrument and its items. The content validity index (CVI) can then be calculated, and the instrument and its items can be adjusted on the basis of feedback from the experts before it is administered to a larger sample.^{16,17}

The final stages of the development process according to DeVellis¹⁵ are administering the items to a development sample, evaluating the items and optimising the scale length. At this stage, the instrument will be pilot-tested and then tested with a larger sample in order to perform

Key Messages

- nurses' objective wound care knowledge can be measured using valid and reliable knowledge tests. The validity and reliability of the tests can be assessed by evaluating the psychometric properties of the instruments
- this study is a systematic and psychometric literature review aiming to identify, define, and analyse the focus and content of the knowledge tests developed for the objective measurement of nurses' wound care knowledge, and to evaluate the psychometric properties of the knowledge tests
- the most valid and reliable instruments for measuring nurses' wound care knowledge, according to the review, were the PUKT and the PUKAT instruments

psychometric tests and describe the instrument's validity and reliability. Finally, the final form of the instrument will be formulated.^{16,17}

Reliability, and especially validity, are incremental, and the development process is endless because instruments are constantly being used in different circumstances and with different groups, and no single study can prove the reliability or validity of a given instrument.¹⁸ However, proper reporting of the development process and the psychometric properties of the instrument are essential in order to understand what has been carried out and what has been found.¹⁸

Nurses' competence and knowledge have become increasingly important and topical issues, because of new knowledge, emerging interventions, and the need for continuing education and updated information.¹⁹ For example, in the wound care field, new evidence and new care guidelines are constantly appearing, which means that nurses need to update their knowledge regularly. Measuring knowledge can provide information about nurses' objective competence and possible educational needs that could help to ensure that they have sufficient and updated knowledge of wounds and their care. To achieve this, valid and reliable instruments for measuring and comparing wound care knowledge are needed.

A systematic and psychometric review of the existing instruments for measuring objective wound care knowledge is beneficial for those who are willing to use these instruments in clinical practice and for research purposes. The aim of this study was to identify, define, and

analyse the focus and content of the knowledge tests (instruments) developed for the objective measurement of nurses' wound care knowledge, and to evaluate the psychometric properties of the knowledge tests. The knowledge tests were limited to those measuring only nurses' or student nurses' wound care knowledge because nurses' responsibilities in wound care are usually similar despite the country or sector. Other healthcare professionals', like physicians', roles and responsibilities in wound care can be different from those of nurses. The research questions were:

- What do knowledge tests (instruments) measuring nurses' wound care knowledge focus on and contain?
- What are the psychometric properties of these knowledge tests?

2 | MATERIALS AND METHODS

This study was a systematic literature review of the research evidence and psychometric properties of the knowledge tests (instruments) available for measuring knowledge of nurses' wound care. A methodological design was applied in order to highlight the strengths and weaknesses of these instruments and to explore how they limit or open up opportunities for measuring nurses' objective wound care knowledge using knowledge tests.

2.1 | Literature search and retrieval

The literature search was conducted systematically by a single researcher in December 2018 using Medline/PubMed, CINAHL, the Cochrane Library, Embase, Web of Science and Scopus. The search terms used were as follows: *knowledge test*, *wound*, *ulcer*, *pressure ulcer*, *decubitus*, *leg ulcer*, *wound care*, *wound management*, *wound assessment*, *tissue viability*, *nursing*, and *nurse* with their combinations using Boolean operators.

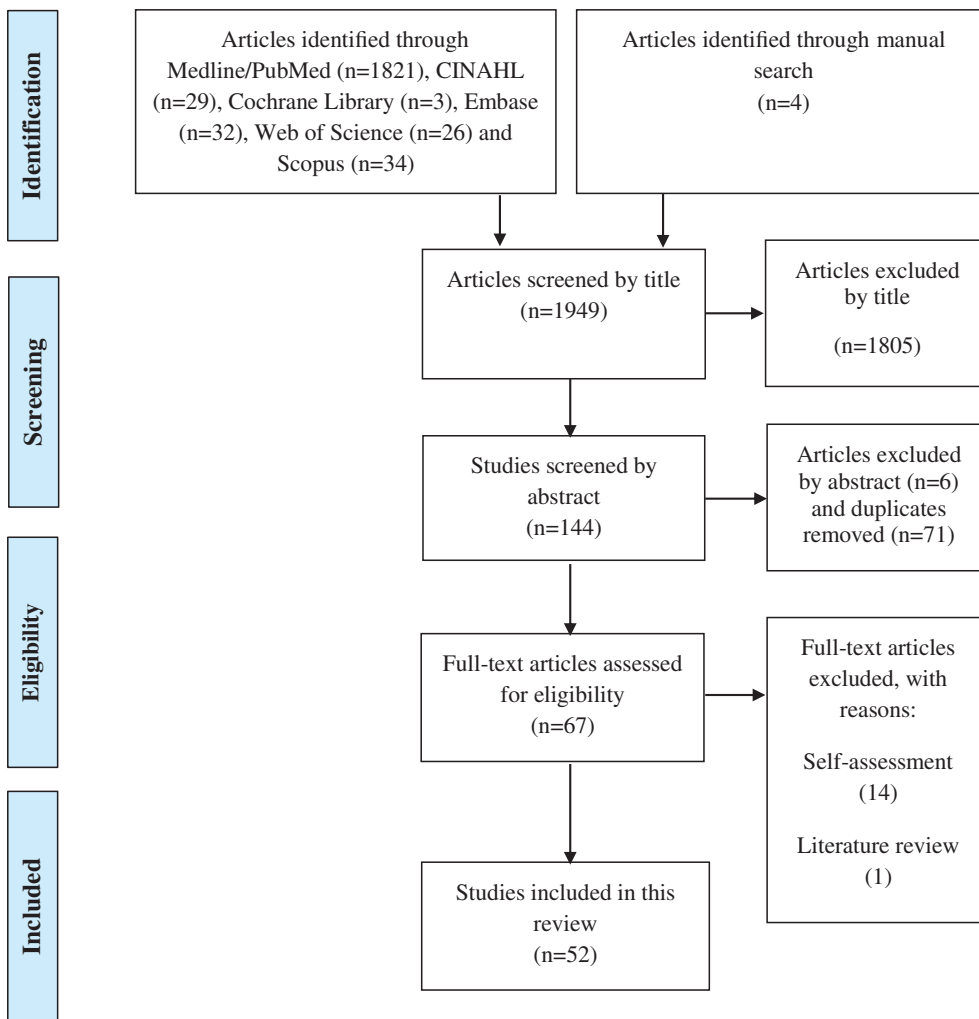
Original studies that used a knowledge test as an instrument to assess nurses' or student nurses' objective knowledge of wound care were included in this study. The knowledge tests had to provide evidence of a stable instrument format, which means that the instrument had to be used more than once, and it had to be psychometrically tested. Knowledge tests that were used to assess nurses' objective knowledge of wound care for all types of wounds were included. The studies had to be written in English and include an abstract. Self-assessment instruments were excluded because they do not measure one's objective knowledge. No time limits were set in order to find all developed instruments. In addition, the reference lists of

the articles that were found were searched manually. In total, 1945 articles were screened by title, of which 144 were chosen for abstract screening. Of these, 67 studies were chosen for full-text screening. Fifteen studies were excluded: 14 of these had used a self-assessment instrument, and one was a literature review. Four studies were found through the manual search. The remaining 52 studies were included in this review (Figure 1) and grouped according to the instruments that had been used.

The focus in this review was the instruments used in the original articles. Descriptive data from each study and the used instrument were collected in a table. This consisted of information about the author, year, country, aim, and instrument name. This served as an identification table for the instruments. Once the instruments had been identified, a final table (Table 1) was constructed, which included detailed information about each instrument: name, focus, number of items, scoring, and a list of studies that have used the given instrument. In the final table, the authors' original expressions of their instrument were used without any interpretation.

2.2 | Data analysis and quality appraisal

The knowledge tests (instruments) used to measure nurses' or student nurses' objective knowledge of wound care were identified from the original articles. The instruments were listed and grouped according to their original instrument, because some of the instruments had been used and revised also in later studies. The articles were categorised as original instrument-development studies, further validation studies (e.g. language or cultural validation), or studies where the instrument was only used in clinical or research settings, without any validation or psychometric testing. Once the selected studies had been grouped by instruments, it was possible to identify 18 tests on wound care knowledge. Five of these instruments were standardised and had been used more than once, and the analysis was targeted at these instruments. The analysis was conducted using the 10 point framework for evaluation of psychometric properties of the instruments provided by Zwakhalen et al,⁷¹ which required the following items of each instrument: (a) known origin of the items, (b) sufficient sample for testing (number of participants), (c) analysis of and justification for content validity, (d) level of criterion validity achieved using correlation, (e) construct validity in relation to other appropriate knowledge tests, (f) construct validity of differentiation, (g) homogeneity, (h) inter-rater reliability (confirmed with observation or shown in activity), (i) intra-rater or test-retest reliability, and (j) feasibility (Table 2). Each of these items was scored either 0, 1, or 2 by the researchers in accordance with Zwakhalen et al,⁷¹

FIGURE 1 Selection process

giving a maximum score of 20. The higher the score, the higher the psychometric properties. This framework was chosen because it has been developed and used as a quality judgement criterion for instruments and their psychometric properties in nursing research.

The remaining 13 instruments were tests that measured nurses' or student nurses' wound care knowledge. These instruments had been developed for study purposes and used only once. The psychometric evaluation of these instruments was lacking, which is why they were not included in the analysis of psychometric properties.

3 | RESULTS

3.1 | Focus and content of the knowledge tests

Across 52 studies, 18 different instruments measuring nurses' or student nurses' wound care knowledge were found. Five of these instruments were standardised

knowledge tests that were included in the analysis of psychometric properties.^{20,21,40,44,55,56}

In four of these analysed instruments, the focus was on nurses' pressure ulcer knowledge (PUKT),^{20,21} PZ-PUKT,⁴⁰ PUKAT,⁴⁴ PUKAT 2.0,⁵⁵ and in one instrument⁵⁶ it was on nurses' knowledge of diabetic foot ulcer care. The number of items in the instruments analysed varied between 15 and 72, and all the instruments were divided into three or more sub-categories or themes.

Most of the knowledge tests used true/false or multiple-choice questions (or both) to measure nurses' wound care knowledge. In the majority, the scoring in most items was calculated as the number or percentage of correct answers. However, a cut-off or pass score was reported for only two of the instruments.^{20,56}

3.2 | Description of the analysed instruments

The Pressure Ulcer Knowledge Test (PUKT) developed by Pieper and Mattern^{20,21} has 47 items divided into the

TABLE 1 Description of selected instruments

Instrument	Knowledge focus	Items, scales/themes and scoring	Studies using the instrument
Instruments used more than once			
PUKT	Pressure ulcers	Number of items: 47 Sub-scales/themes: Prevention/risk (33), Pressure ulcer staging (7), Wound description (7) Scoring: “True”, “False” and “Do not know”; Each correct answer scored 1 point (“Do not know” was counted as an incorrect answer); Pass mark: 90%	Instrument development and validation ^{20,21} Instrument adaptation for Portuguese, ²² Farsi, ²³ Nigeria, ²⁴ Australia, ²⁵ Turkey, ²⁶ Cyprus ²⁷ Reliability testing ²⁸⁻³⁰ Use only ³¹⁻³⁹
PZ-PUKT	Pressure ulcers	Number of items: 72 Sub-scales/themes: Prevention/risk (20), Pressure ulcer staging (25), Wound description (27) Scoring: “True”, “False” and “Do not know”; Number of correct items and a percentage score are used to calculate an overall scale	Instrument development and validation ⁴⁰ Translation and cultural adaptation for Brazilian Portuguese ^{41,42} Use only ⁴³
PUKAT	Pressure ulcers	Number of items: 26 Sub-scales/themes: Aetiology and development (6), Classification and observation (5), Nutrition (1), Risk assessment (2), Prevention: reducing pressure/shear (7), Prevention: reducing the duration of pressure/shear (5) Scoring: Multiple-choice questions with 3 answer options and “Do not know”; “Do not know” was recorded as “not correct”	Instrument development and validation ⁴⁴ Instrument validation for Swedish, ⁴⁵ Italy, ⁴⁶ China, ⁴⁷ Turkey, ⁴⁸ Farsi ¹² Reliability testing ⁴⁹ Use only ⁵⁰⁻⁵⁴
PUKAT 2.0	Pressure ulcers	Number of items: 25 Sub-scales/themes: Aetiology (6), Classification and observation (4), Risk assessment (2), Nutrition (3), Prevention of pressure ulcers (8), Specific patient groups (2) Scoring: Multiple-choice items; Respondent’s total score was calculated as the sum of their correct answers (“Do not know” counted as incorrect)	Instrument development and validation ⁵⁵
(No name)	Diabetic foot ulcers	Number of items: 15 Sub-scales/themes: Predisposing factors for ulcers (3), Characteristics of ulcers (3), Complications of ulcers (3), Diabetic ulcer care (6) Scoring: Multiple-choice questions with “True”, “False” and “Do not know” answer options; Correct answers scored 1 point each, incorrect answers and “Do not know” scored zero; A knowledge score \geq mean was considered as “good knowledge” and a knowledge score $<$ mean was considered as “poor knowledge”	Instrument development and validation ⁵⁶ Instrument validation in Pakistan ⁵⁷
Instruments used only once			
(No name)	Wound irrigation	Number of items: 18	Instrument development ⁵⁸

(Continues)

TABLE 1 (Continued)

Instrument	Knowledge focus	Items, scales/themes and scoring	Studies using the instrument
(No name)	Various wounds	Sub-scales/themes: General knowledge of wound irrigation (9), Knowledge about wound irrigation techniques (9) Scoring: True or false; Number and percentage of correct answers calculated	Instrument development ⁵⁹
(No name)	Pressure ulcers	Number of items: 23 (of which 10 measure knowledge) Sub-scales/themes: None Scoring: True or false; Percentage of correct answers	Instrument development and validation ⁶⁰
(No name)	Pressure ulcers	Number of items: 37 Sub-scales/themes: Prevention (16), Treatment (21) Scoring: "Yes", "Sometimes", and "No"; Percentage of correct answers	Instrument development and validation ⁶¹
(No name)	Pressure ulcers	Number of items: 11 Sub-scales/themes: None Scoring: Multiple-choice and short-answer questions; Number and percentage of correct answers; Pass mark: 76%	Instrument development and validation ⁶¹
(No name)	Various wounds	Number of items: 10 Sub-scales/themes: None Scoring: Multiple-choice and "true or false" questions; Each correct answer scored 10 points; Maximum score: 100	Instrument development ⁶²
(No name)	Surgical wounds	Number of items: 9 Sub-scales/themes: None Scoring: Multiple-choice questions; one correct answer, 2 distractors, and "Do not know"; Percentage of correct answers	Instrument development and validation ⁶³
Determination of the Practices of Nurses Regarding DTI and Stage I PU	Pressure ulcers	Number of items: 24 Sub-scales/themes: 8 case studies and 3 questions each Scoring: Each correct answer scored 4.17; Maximum score: 100	Instrument development ⁶⁴
(No name)	Pressure ulcers	Number of items: 21 Sub-scales/themes: None Scoring: Multiple-choice questions; Number of correct answers	Use only ⁶⁵
(No name)	Pressure ulcers	Number of items: 27 Sub-scales/themes: Category 1 (15), Category 2 (12) Scoring: Each correct answer scored 1 point; each incorrect answer scored zero; Pass mark: 70%	Instrument development ⁶⁶
(No name)	Pressure ulcers	Number of items: 45 Sub-scales/themes: Prevention interventions (16), Treatment interventions (29) Scoring: Total score and percentage of correct answers	Instrument development ⁶⁷
(No name)	Pressure ulcers	Number of items: 23	Instrument development ⁶⁸

TABLE 1 (Continued)

Instrument	Knowledge focus	Items, scales/themes and scoring	Studies using the instrument
(No name)	Various wounds	Sub-scales/themes: Facts about pressure ulcers (8), Risk factors for developing pressure ulcers (8), Strategies used in prevention (7) Scoring: Closed-ended questions; Percentage of correct answers	Instrument development ⁶⁹
(No name)	Pressure ulcers	Number of items: 26 Sub-scales/themes: Basic knowledge/symptom recognition (6), Clinical investigation (4), Treatment (16) Scoring: Multiple-choice questions with 5 answer options; Number and percentage of correct answers	Instrument development and validation ⁷⁰
(No name)	Pressure ulcers	Number of items: 25 (of which 11 are knowledge test items) Sub-scales/themes: None Scoring: Single- and multiple-choice questions; Number and percentage of correct answers; Each correct answer scored 1 point; Maximum score: 11	Instrument development and validation ⁷⁰

following themes: prevention/risk (33 items), pressure ulcer staging (7 items), and wound description (7 items). The answer options to these items were “Yes”, “No” and “Do not know”. The PUKT has been translated into several languages and some versions of the test have been slightly modified.

The Pieper-Zulkowski Pressure Ulcer Knowledge Test (PZ-PUKT)⁴⁰ is a revised version of the earlier PUKT and includes 72 items in the following themes: prevention/risk (20 items), pressure ulcer staging (25 items), and wound description (27 items). It offers the same answer options: “Yes”, “No”, and “Do not know”. The PZ-PUKT is available in several languages as well.

The third knowledge test, the Pressure Ulcer Knowledge Assessment Tool (PUKAT) developed by Beeckman et al⁴⁴ has 26 items under 6 themes: (a) aetiology and development (6 items), (b) classification and observation (5 items), (c) nutrition (1 item), (d) risk assessment (2 items), (e) prevention: reduction of the magnitude of pressure/shear (7 items), and (f) prevention: reduction of the duration of pressure/shear (5 items). There are three answer options in each item including “I do not know the answer” option. The PUKAT has also been translated to several languages.

The PUKAT 2.0⁵⁵ is an updated version of the original PUKAT test that includes 25 multiple-choice items divided into six themes: aetiology (6 items), classification and observation (4 items), risk assessment (2 items), nutrition (3 items), prevention of pressure ulcers (8 items), and specific patient groups (2 items).

The fifth knowledge test is an instrument for assessing nurses' knowledge of (and attitudes towards) diabetic foot ulcers developed by Kumarasinghe et al⁵⁶ It has three sections: covariates, knowledge test, and attitudes. The knowledge test has 15 multiple-choice questions within four themes: predisposing factors for ulcers (3 items), characteristics of ulcers (3 items), complications of ulcers (3 items), and diabetic ulcer care (6 items). The answer options are “True”, “False”, and “Do not know”.

3.3 | Psychometrics (and comparison)

Our assessment found that the knowledge tests had varied psychometric properties. Validity in terms of content, criterion, construct, and differentiation was explored using many methods. Among the methods used to establish content validity was a panel of experts,^{26,40} who evaluated the clarity of the items,^{20,21} the clarity of the instrument as a whole,²² the readability of the items,^{20,21} or the logic of the test structure.^{20,21} The CVI was used to demonstrate the agreement between experts.^{26,44,47,48} The item difficulty and discrimination indexes^{44,46-48,55} were used to ensure validity. In addition, the quality of the response options^{44,55} was assessed. For instruments that had been translated, a panel of experts evaluated the conceptual, semantic, and idiomatic equivalence.⁴² Face validity was assessed in only one study.²⁵

TABLE 2 Psychometric assessment of five instruments according to Zwakhalen et al⁷¹

Instrument	Validity				Reliability			Overall score (0–20)			
	Item origin (0–2)	Number of participants (0–2)	Content (0–2)	Criterion (0–2)	Construct I: in relation to other tests (0–2)	Construct II: differentiates (0–2)	Homogeneity (0–2)		Inter-rater (0–2)	Intra-rater or test–retest (0–2)	Feasibility (0–2)
Original study ^{20,21} PUKT	AHCPR's Pressure Ulcers in Adult Prevention (1992) guideline → 2 points	n = 228 registered nurses (1995), n = 75 critical care nurses (1997) → 2 points	Content validity: 4 enterostomal nurses (clarity and ease of understanding the items), Structure of the test statements was tested by 10 nurses → 2 points	N/A	N/A	N/A	Coefficient alpha values for all nurses were 0.85, for the total score: 0.80 for the prevention, 0.49 for the staging, and 0.59 for the wound. The coefficient alpha values for critical care nurses were 0.91 total, 0.88 prevention, 0.62 staging, and 0.73 wound → 2 points	N/A	N/A	Short, manageable with instructions, scoring interpretation → 2 points	10
Adaptation of PUKT to Portuguese ²²	Forward-back translation process	n = 83 third- and fourth-year students	Examination of the instrument for clarity and comprehension, 8 students	N/A	N/A	N/A	Coefficient alpha value for the total score of all students was 0.63	N/A	N/A	N/A	N/A
Use of the adapted version of PUKT in Portuguese ²⁹	N/A	n = 106 nurses	N/A	N/A	N/A	N/A	Coefficient alpha value for the total score of all nurses was 0.83	N/A	N/A	N/A	N/A
Instrument validation: PUKT in Farsi ²³	Forward-back translation process	n = 126 critical care nurses	Pilot testing, factor analysis	N/A	N/A	N/A	Alpha coefficient: 0.88	N/A	3 weeks test–retest coefficient stability: 0.73	N/A	N/A
Instrument validation: PUKT in Nigeria ²⁴	N/A	n = 111 nurses	N/A	N/A	N/A	N/A	Split-half reliability: 0.861	N/A	N/A	N/A	N/A
Use of PUKT in Iran ²⁸	N/A	n = 159 nurses	N/A	N/A	N/A	N/A	Alpha coefficient for internal consistency: 0.85; test–retest coefficient: 0.81	N/A	N/A	N/A	N/A
Adaptation of PUKT to Australian healthcare ²⁵	Modified for application in Australian acute care facilities, and items were	n = 827	Face and content validity with 5 experts	N/A	N/A	N/A	Cronbach's alpha: 0.35	N/A	N/A	N/A	N/A

TABLE 2 (Continued)

Instrument	Item origin (0-2)	Number of participants (0-2)	Validity			Reliability			Overall score (0-20)	
			Content (0-2)	Criterion in relation to other tests (0-2)	Construct I: differentiates (0-2)	Homogeneity (0-2)	Inter-rater (0-2)	Intra-rater or test-retest (0-2)		Feasibility (0-2)
	updated to ensure consistency with current clinical practice guidelines									
Use of PUKT in Turkey ²⁶	Forward-back translation process	n = 308 nurses	CVI 0.918 with 6 experts	N/A	N/A	N/A	N/A	Inter-rater reliability (kappa): 0.646 → 1 point	The level of consistency between test-retest mean scores was not statistically significantly different. The correlation coefficient was 0.926, and the relationship between the 2 test scores was determined to be highly significant. The internal consistency reliability Cronbach's alpha was 0.814 for all items. → 1 point	2 new points
Instrument validation: PUKT in Cyprus ²⁷	Forward-back translation process	n = 102 nurses	N/A	N/A	The knowledge test after the adjustments and modifications in its final form had 21 questions (Kaiser-Meyer-Olkin = 0.680) compared with 44 in the original (Kaiser-Meyer-Olkin 0.463), producing good-quality data (Bartlett 767.041, P < 0.001) → 2 points	N/A	N/A	Internal validity: Kuder-Richardson = 0.82	N/A	2 new points
Total: 14										
Original study ⁴⁰ PZ-PUKT	Examination of the original test and	Test 1 (2012) n = 108	Examination of the original test.	N/A	N/A	N/A	N/A	N/A	Takes 20 to 30 minutes to complete.	12

(Continues)

TABLE 2 (Continued)

Instrument	Item origin (0-2)	Number of participants (0-2)	Validity			Reliability			Overall score (0-20)	
			Content (0-2)	Criterion in relation to other tests (0-2)	Construct I: differentiates (0-2)	Inter-rater (0-2)	Intra-rater or test-retest (0-2)	Feasibility (0-2)		
	a literature review of the last 5 years and content/recommendations in the National Pressure Ulcer Advisory Panel/European Pressure Ulcer Advisory Panel (NPUAP)/EPUAP → 2 points	Test 2 (2013) n = 95 → 2 points	literature/guideline review, establishment of sub-scales. Rabeh et al 2018: expert panel agreement 80% → 2 points	N/A	Construct I: differentiates (0-2)	Homogeneity (0-2) Cronbach's alpha was 0.80 for the overall test. Cronbach's alpha values for the sub-scales were as follows: staging, 0.67; wound description, 0.64; and prevention/risk, 0.56 → 2 points	Inter-rater (0-2) Retest (n = 95) Cronbach's alpha: 0.80. The PZ-PUKT reliability coefficient alpha value compared with the PUKT is higher for staging and wound description (PUKT, 0.49 and 0.59, respectively) but lower for prevention/risk (PUKT, 0.80) → 2 points	Feasibility (0-2) Scale is manageable with instructions, scoring interpretation. → 2 points		
Translation and cultural adaptation of PZ-PUKT for use in Brazilian Portuguese ^{41,42}	Forward-back translation process	n = 54 nurses	The translation was analysed in terms of its conceptual, semantic, and idiomatic equivalence by a panel of 5 nurses. Changes were approved when agreement among the panel was 80%. Pre-testing.	N/A	N/A	Cronbach's alpha for the 72 items was 0.825; but for the sub-scales, it was: 0.379 for prevention; 0.421 for staging, and 0.349 for wound description. The overall value was higher than 0.70.	N/A	N/A	N/A	
Total: 12										
Original study ⁴⁴ PUKAT	Literature review of guidelines about pressure ulcer classification and 2 Delphi rounds → 2 points	Delphi: 9 trustees from EPUAP; empirical data: n = 312 nurses and n = 296 nursing students → 2 points	CVI = 0.78-1.00. Validity of the items: item difficulty (0.27-0.87), discrimination index (0.10-0.65), quality of response alternatives (0.03-0.58) → 2 points	N/A	N/A	Internal consistency 0.77 for total scale (0.40-0.78 in themes) → 2 points	Known groups technique: significant differences between experts and non-experts → 2 points	Stability ICC: 0.88 → 2 points	Takes 30 minutes to complete → 2 points	14

TABLE 2 (Continued)

Instrument	Item origin (0-2)	Number of participants (0-2)	Validity			Reliability			Overall score (0-20)		
			Content (0-2)	Criterion in relation to other tests (0-2)	Construct II: differentiates (0-2)	Homogeneity (0-2)	Inter-rater (0-2)	Intra-rater or test-retest (0-2)		Feasibility (0-2)	
Turkish version of PUKAT (PUPKAI-T) ⁴⁸	Forward-back translation process	Linguistic validity (n = 10) experts, empirical data: nurses (n = 150), stability: nurses (n = 46)	CVI = 0.94, discrimination indices (0.20-0.78), item difficulty (0.21-0.88)	N/A	N/A	N/A	Kuder-Richardson: 0.803	N/A	Test-retest ICC: 0.37-0.80	N/A	
Chinese version of PUKAT (IAKPUP) ⁴⁷	Forward-back translation process. Based on an extensive literature review and the experts' opinions; 2 items were added, resulting in an instrument with 28 items	Test-retest: nurses (n = 20), empirical data: nurses (n = 186)	Expert panel (n = 6) evaluated the content validity (CVI = 0.79-0.97) and the overall score was calculated (CVI = 0.91). The item difficulty (0.46-0.93) and discrimination values (0.28-0.55).	N/A	N/A	N/A	Cronbach's alpha was 0.792 for the overall instrument (subthemes: 0.426-0.804)	N/A	Test-retest: the overall ICC was 0.826 (range: 0.671-0.892)	N/A	
Italian version of PUKAT ⁴⁶	Forward-backward translation, semantic and conceptual equivalence with Italian context was ensured	Pilot study: nursing students (n = 219), empirical data: nursing students (n = 742)	Difficulty index (0.3-0.8), discrimination index (0.29-0.60)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Total: 14											
Original study ⁴⁵ PUKAT 2.0	Review of new guidelines + Delphi → 2 points	Delphi: NPUAP + EPUAP experts n = 15, pilot: 1 nursing student and 3 nurses, empirical data: n = 228 nurses, n = 114 nursing students. → 2 points	Item difficulty (0.12-0.91), discriminating power (0.02-0.34), quality of response options (0.01-0.70) → 2 points	N/A	N/A	N/A	Known groups technique: significant differences between groups → 2 points	N/A	Stability ICC: 0.69 → 1 point	N/A	9
Total: 9											
Original study ⁴⁶ Nurses' knowledge (and attitudes) on diabetic foot ulcer disease	Relevant literature in wound management and by obtaining inputs from	n = 200 registered nurses in surgical wards and outpatient department	Expert team including a physiologist, a general surgeon who manages	N/A	N/A	N/A	Cronbach's alpha values of 0.704 for the knowledge section	N/A	N/A	Pre-test with 10 wound care nurses → 2 points	10

(Continues)

TABLE 2 (Continued)

Instrument	Validity				Reliability			Overall score (0-20)	
	Item origin (0-2)	Number of participants (0-2)	Content (0-2)	Criterion in relation to other tests (0-2)	Construct I: differentiates (0-2)	Construct II: Homogeneity (0-2)	Inter-rater (0-2)		Intra-rater or test-retest (0-2)
	wound care experts → 2 points	→ 2 points	patients with diabetic ulcers, and a nursing practitioner who specialises in wound care management → 2 points			→ 2 points			
Instrument validation of Kumarasinghe's instrument in Pakistan ⁵⁷	N/A	n = 250 nurses working in tertiary hospitals	Faculty experts reviewed the content	N/A	N/A	Cronbach's alpha: 0.73	N/A	N/A	Pilot-test with 30 nurses
Total: 10									

The construct validity in relation to other instruments was tested during the PUKT validation in the Cypriot language.²⁷ The differentiation of the instrument was assessed using the known groups technique between experts and non-experts.^{44,55} The criterion validity was not assessed in any of the instruments.

Most of the studies (n = 13) evaluated homogeneity with Cronbach's coefficient alpha or the Kuder-Richardson formula. Cronbach's coefficient alpha ranged from 0.35 (PUKT²⁵) to 0.91 (PUKT^{20,21}), and the Kuder-Richardson formula ranged from 0.80 (PUKAT⁴⁸) to 0.83 (PUKT²⁷). Test-retest was assessed in six studies (PUKT,²³ PUKT,²⁸ PUKT,²⁶ PZ-PUKT,⁴⁰ PUKAT,⁴⁸ and PUKAT.⁴⁷ Stability was assessed using intraclass correlation while evaluating the reliability of the PUKAT.^{44,55} Inter-rater reliability was assessed in one study.²⁶

Feasibility was assessed infrequently, with only four studies mentioning aspects related to this. The PUKT was considered to be short and manageable with instructions.^{20,21} The PZ-PUKT took 20 to 30 minutes to administer and was reported to be manageable with instructions.⁴⁰ The PUKAT took approximately 30 minutes.^{44,56} Kumarasinghe's⁵⁶ instrument was pilot-tested and considered to be feasible.^{56,57}

The overall score for psychometrics ranged from 9 to 14. All the instruments provided evidence of validity. On the single instrument level, the PUKT was most comprehensively assessed in terms of psychometrics; namely, content and construct validity, homogeneity, inter-rater reliability, test-retest, and feasibility. The PUKAT also provided evidence of content validity, differentiating validity, homogeneity, test-retest, and feasibility. The PZ-PUKT instead demonstrated evidence of content validity, homogeneity, test-retest and feasibility, and the PUKAT 2.0 demonstrated evidence of content and construct validity and stability. Kumarasinghe's⁵⁶ instrument focused on content validity, homogeneity, and feasibility.

4 | DISCUSSION

The aim of this study was to identify, define, and analyse the focus and content of the knowledge tests developed for the objective measurement of nurses' wound care knowledge, and to evaluate the psychometric properties of the knowledge tests. Several instruments for measuring nurses' wound care knowledge were identified, but only a few of them had been thoroughly psychometrically tested and proven to be reliable.^{20,21,40,44,55,56}

Based on the findings of this review, the PUKT^{20,21} and the PUKAT⁴⁴ were the most used, valid, and reliable of the instruments. They had also been translated into various languages. The new versions of these two instruments (PZ-PUKT⁴⁰ and PUKAT 2.0⁵⁵) have also been

validated, indicating that they have obtained a strong position as instruments for measuring nurses' knowledge on pressure ulcers. The instrument developed by Kumarasinghe et al⁵⁶ was the only one that measured nurses' knowledge of diabetic foot ulcers.

Many of the knowledge tests that have been developed recently have a theoretical and evidence-based background, and their testing is still underway. The most commonly used method to test the validity of the instruments was content validity with panels of experts. Other validity measurements were rare, but construct validity was tested in two studies.^{27,44} The most common test of homogeneity was coefficient alpha testing, and this was followed by test-retest reliability. Inter-rater reliability²⁶ and split-half reliability²⁴ were each used in one study. The feasibility of the instruments was discussed in most of the studies reviewed.^{20,21,40,44} The instruments that had been used only once were also found to have potential for use in assessing nurses' wound care knowledge, but further research would need to be carried out on their psychometric testing.

Several evidence-based care guidelines have been developed for nurses working with patients with various wounds that could be used as structures for knowledge tests too. However, the existing knowledge tests focus mostly on pressure ulcers, and there is a lack of valid and reliable tests for wounds of other aetiologies. The reason for this might be that efforts to develop knowledge tests have focused on nurse-sensitive outcomes, such as pressure ulcer prevention, and the prevalence of pressure ulcers has been identified as one such outcome for a long time, as well as being one of the quality indicators of nursing care.⁷²⁻⁷⁴ Given the commonality of wound care activity, the lack of instruments that provide an extensive measure of nurses' knowledge of this area should be a professional concern, because neither employers nor nurses have instruments that can reliably verify the level of nurses' knowledge of specific wounds, such as venous or arterial leg ulcers. According to this review, only a few of the knowledge tests that were identified through the literature search could measure the respondents' general knowledge about wounds, but none of the analysed instruments. Instruments that measure general knowledge of wounds could be beneficial when charting nurses' and student nurses' knowledge about the care of various types of wounds. In a recently published study about graduating student nurses' and student podiatrists' knowledge of wound care,⁷⁵ a general knowledge test was developed and tested. The results indicated that these instruments could also be used in multiprofessional communities where the clinical duties and responsibilities are similar.

Nurses need to have a comprehensive knowledge of wounds, because patients with wounds of different

aetiologies receive care in various environments⁷⁶ and by nurses with different levels of education.⁷⁷ In Finland, for example, employers are required to monitor nurses' professional development⁷⁸ and the nurses themselves are responsible for their professional development in many countries.⁷⁹⁻⁸¹ Knowledge tests could help employers and nurses to plan continuing education activities and allocate educational resources to those who need them most. In addition, the knowledge tests could be used in undergraduate nursing programmes, for example, in their final exams. Testing students' and professionals' knowledge may also help educators to develop standardised courses on wound care in both basic and further education. Knowledge tests could also help nurses to recognise possible gaps in their learning. Of the instruments analysed in this review, the PUKT and the PUKAT were used the most in research and clinical contexts.

As stated in the introduction, the development of an instrument is an ongoing process. It begins with determining the purpose of the instrument, continues with formulating the instrument, and is followed by testing the instrument for validity and reliability. Instruments need constant testing when they are used in new settings and situations. Even the most valid and reliable instruments need to be updated and constantly evaluated.

4.1 | Strengths and limitations of the review

The literature search was performed in six widely used scientific databases with comprehensive coverage in the field of healthcare.⁸² The number of duplicate hits was high, indicating that there was overlap between the six databases. The research team approved the search terms, but only one researcher conducted the systematic search, which might decrease the validity of the study. The data retrieval and analysis were conducted by four members of the research team, and after each step, a consensus was reached through a discussion. Sharing the responsibilities increased the robustness of this review. The review focused only on those knowledge tests, which had been used more than once for the purpose of data collection. This might have restricted the number of knowledge tests in the English language that were reviewed.

4.2 | Conclusions

Several knowledge tests measuring nurses' knowledge of wound care have been developed, the majority of which focus on pressure ulcer care. However, only a few of the developed instruments have been used more than once and

validated through psychometric testing. Two instruments (the PUKT and the PUKAT) were the most used and tested in measuring nurses' knowledge of pressure ulcers because they were the most used and most tested of all the instruments. Newer instruments that have been used only once may also have potential, but more testing is needed in order to prove their validity and reliability. Knowledge tests have been used widely in the context of healthcare in general, and they seem to be popular also in wound care. Given that most of the instruments reviewed focused on care of pressure ulcers, new instruments for measuring professionals' knowledge of other wounds are needed.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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