Received: 15 July 2020 | Revised: 11 August 2020 | Accepted: 12 August 2020

DOI: 10.1111/iwj.13495

ORIGINAL ARTICLE

IWJ WILEY

The development and testing of the C/WoundComp instrument for assessing chronic wound-care competence in student nurses and podiatrists

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Funding information
Finnish Wound Care Society; Mölnlycke Health Care AB; University of Turku

Abstract

The purpose of this study was to describe the level of chronic wound-care competence among graduating student nurses and student podiatrists in comparison with that of professionals and to develop and test a new instrument (the C/WoundComp) that assesses both theoretical and practical competence in chronic wound care as well as attitudes towards wound care. The data (N = 135) were collected in 2019 from four groups (1): graduating student nurses (n = 44) (2); graduating student podiatrists (n = 28) (3); registered nurses (n = 54); and (4) podiatrists (n = 9). The data were analysed using statistical analysis. According to the results, the students' total mean competence score was 62%. Their mean score for theoretical competence was 67%, and for practical competence, it was 52%. The students' competence level was statistically significantly lower than that of the professionals ($P < .0001$), but the students showed a positive attitude towards chronic wound care. The instrument demonstrated preliminary validity and reliability, but this warrants further testing. This study provides new knowledge about student nurses' and student podiatrists' competence in chronic wound care, suggesting that their theoretical and practical competence is limited. In addition, it provides information on different methods of assessing competence and how they can be combined.

KEYWORDS

clinical competence, nurses, podiatry, students, wounds and injuries

1 | INTRODUCTION

Competence is a multidimensional concept in health care, and its assessment as part of health-care professionals' education and clinical practice is essential for improving patient safety and quality of care.[1,2] According to Lejonqvist et al,[3] developing clinical competence in practice is a continuous process of encountering, knowing, performing, maturing, and improving. The number of patients suffering from chronic wounds is rising due to

the ageing population.[4] Therefore, it is essential to assess graduating health-care professionals' wound-care competence in order to determine whether the education being provided in wound care is meeting the current competence requirements.

Previous research has shown that wound-care competence is limited among both nursing professionals and students.[5,6] This research has focused mainly on knowledge or attitudes towards providing care or on preventing specific types of wounds, such as pressure ulcers[7-9] or leg/foot ulcers.[10,11] Only a few studies have investigated registered nurses' and student nurses' overall competence in wound care.[12,13] Studies assessing podiatrists' and student podiatrists' wound-care competence are scarce; however, the few studies that have been conducted have indicated that competence in this area is limited among both professional and student podiatrists.[14,15]

Registered nurses' and student nurses' wound-care competence has been assessed with various instruments that measure subjective and objective competence. Instruments that measure subjective competence assess a person's own perception of their competence in providing wound care and/or preventing wounds.[16,17] On the other hand, instruments that measure objective competence assess a person's true competence according to specific criteria. These objective competence instruments are usually knowledge tests that focus on wounds, wound care, or wound prevention.[18,19] Instruments that measure practical skills in wound management are lacking. In addition, only a handful of instruments have been validated through psychometric testing.[20]

There are some wound-care competence requirements for specialised wound-care nurses and postgraduate nurses,[21-23] but there are no international, general, or standardised requirements in this type of care for registered nurses at the graduation stage. However, Kielo et al[24] have identified general competence areas for registered nurses and podiatrists who provide chronic wound care, and these could be used as a framework for basic wound-care education and assessment in bachelor level courses.

Wound care, especially for chronic wounds, is multiprofessional work in which registered nurses and podiatrists play important roles. This study focuses on chronic wounds not only because of the multi-professional nature of care but also because of the continuously increasing number of patients who are suffering from these wounds. In addition, chronic wound care is seen as more demanding and complex than acute wound care by graduating student nurses.[15] In this study, "chronic wounds" refers to the most common chronic wounds, which are leg ulcers (including venous and arterial leg ulcers in addition to diabetic foot ulcers) and pressure ulcers,[25] which are also the wounds most frequently seen in general nursing and podiatry practice.

Key Messages

- nurses and podiatrists who provide care for patients with chronic wounds are expected to have adequate competence, but little is known about their competence in wound care when they graduate
- the purpose of this study was to describe the level of chronic wound-care competence among graduating student nurses and student podiatrists compared with the professionals and to develop and test a new instrument (the C/WoundComp) that assesses both theoretical and practical competence as well as attitudes towards wound care
- graduating student nurses' and podiatrists' theoretical and practical competence in wound care was limited, but they demonstrated positive attitudes towards chronic wound care. The C/WoundComp proved to be valid and reliable for measuring students' level of wound-care competence, but further testing is needed

This study focuses on graduating student nurses' and podiatrists' competence in chronic wound care. The purpose is to describe the level of competence among graduating student nurses and podiatrists in Finland compared with that of the professionals and to develop and test a new instrument (the C/WoundComp) that assesses both theoretical and practical competence in chronic wound care. Graduating student podiatrists are studied as a comparison group alongside student nurses because their roles and competence requirements are similar to those of nurses providing chronic wound care,[24] but there are substantially fewer podiatry students and professionals than nursing students and professionals in Finland, which makes reliable comparisons difficult. Registered nurses and podiatrists are studied as the "gold standard" groups in the psychometric testing of the developed instrument.

The research questions are as follows: (1) How do the theoretical and practical chronic wound-care competence levels of graduating student nurses and podiatrists compare with those of professionals? (2) How valid, reliable, and sensitive is the developed instrument (C/WoundComp) for assessing graduating student nurses' and student podiatrists' competence in chronic wound

care? The main goal of this study is to provide new knowledge about student nurses' and podiatrists' theoretical and practical competence in chronic wound care, and how that competence can be assessed, for use in the development and assessment of wound-care education in nursing and podiatry.

In this study, a graduating student nurse or student podiatrist is a bachelor level student who is in their final (seventh) semester in a university of applied sciences. A registered nurse or a podiatrist is a health-care professional who has graduated with a bachelor's degree in nursing or podiatry, which in Finland involves 3.5 years of full-time study (210 ECTS). The concept of competence is defined as a combination of knowledge, performance, skills, values, and attitudes.[26]

2 | METHODS

2.1 | Design

This study used a descriptive, comparative, and methodological design. It included six phases of instrument development adapted from DeVellis[27]: (1) construct development based on focus-group interviews, (2) item generation, (3) face validity, (4) expert panel and content validity, (5) pilot testing, and (6) psychometric testing (Figure 1). The instrument that was developed was intended to measure competence in chronic wound care among nursing and podiatry professionals as well as graduating student nurses and podiatrists.

2.2 | Instrument development

Phase 1: Focus-group interviews

In phase 1, the construct of the instrument was developed on the basis of six focus-group interviews. The interviews were carried out in 2018 to create the theoretical base and competence areas for the instrument. A qualitative design was used. In total, 23 health-care professionals and experts in wound care were interviewed. According to the analysis, competence in chronic wound care was divided into two main categories: (1) knowledge, skills, and performance, and (2) values and attitudes, as defined by Cowan et al.[26] The first main category was divided into three areas of competence: (1) anatomy and physiology, (2) aetiology, care and prevention, and (3) wound management and assessment. These areas were further divided into specific competences, such as asepsis, wound dressings, and nutrition. Values and attitudes were divided into care, prevention, evidence-based practice, holistic care, respect, and economics.[24]

Phase 2: Item generation

In phase 2, the authors created the items for the instrument. The items were generated on the basis of an earlier version of the instrument,[15] the findings of the focus-group interviews, scientific literature about wound care, and care guidelines. The instrument was designed to include four parts: (1) demographic data, (2) a knowledge test to assess theoretical wound-care competence, with a focus on chronic wounds, (3) a simulation to observe and assess practical wound-care competence, and (4) a self-assessment of attitudes and values relating to wound care (see Cowan et al[26]; Table 1).

Since the aim was to compare the wound-care competence of graduating student nurses and podiatrists with the competence of professionals, the items for collecting demographic data had to be different for professionals and students. For students, the background questions (six items) included items on the education in wound care that they had received during their current studies and any earlier degree course in health care. For the professionals, the background questions (11 items) instead included questions about their workplace, field, professional experience, and any post-degree training they had received in wound care.

The second and third parts of the instrument included both theoretical and practical components of the competence areas defined by Cowan et al[26]: knowledge, performance, and skills. Knowledge was defined as the "facts, information, and skills acquired through experience or education", performance as "the action or process of performing a task or function", and skills as "the ability to do something well".[28] A total of 52 items were included in the second and third parts of the instrument. The first 38 items tested theoretical competence using a knowledge test with three response options ("Yes", "No", and "Do not know"). The remaining 14 items tested practical competence using a simulation in which an observer indicated whether or not the participant performed specific wound-care actions correctly. The simulation was based on an imaginary case in which a patient had a diabetic foot ulcer. The wound used in the simulation was a false ulcer in an anatomic wound model made by VATA Inc. (US, OR). The other equipment, such as wound dressings and instruments, was real. In the simulation, the participants were asked to assess the wound and perform wound care on it. The content of the second and third parts of the instrument was structured according to the competence areas identified in phase 1 (Table 1).

Items for measuring participants' attitudes and values in relation to wound care were planned for inclusion in the fourth part of the instrument, meaning that they had to be operationalised and measured. Attitudes were defined as "a settled way of thinking or feeling about

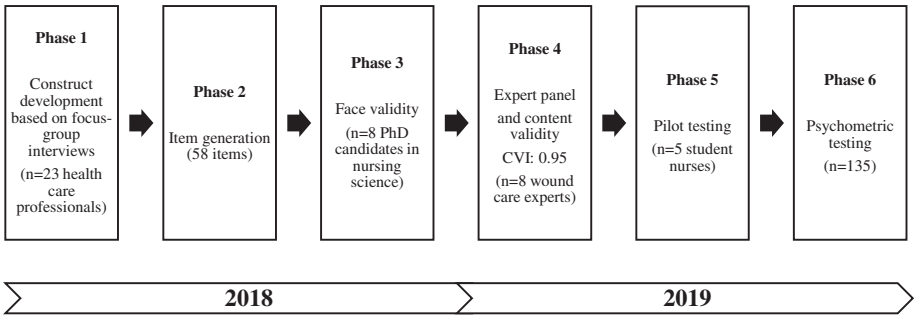

FIGURE 1 The development process of the C/WoundComp instrument

something" and values as "the principles or standards of behaviour".[28] However, it is difficult to operationalise or measure values, so the items included in the final part of the instrument focused on participants' attitudes only. Six items were included, using a 5-point Likert-scale: 1 = totally disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = totally agree. The items were structured according to the competence areas identified in phase 1. (Table 1)

Phase 3: Face validity

In phase 3, an evaluation of the face validity of the instrument was carried out to find out if the new instrument seemed to be measuring the things it was designed to measure.[29] In a face-to-face meeting, a group of PhD candidates (n = 8) in nursing science evaluated the face validity, the general look of the instrument, and especially its structure. On the basis of the qualitative feedback provided by the evaluators, some changes to the wording and order of the items were made before the instrument was passed to the expert panel for review.

Phase 4: Expert panel and content validity

The fourth phase of the development process consisted of an expert panel reviewing the instrument. In total, eight experienced experts in wound care in different fields of healthcare were recruited to review the instrument individually. The panel was made up of two registered nurses who worked in a field of wound care, an authorised wound-care nurse, two wound-care researchers, a podiatrist, a vascular surgeon, and a plastic surgeon with a specialisation in wound care. The experts evaluated each item for its relevance, clarity, and importance using a four-point scale (1 = not relevant/clear/important, 2 = somewhat relevant/clear/important, 3 = quite relevant/clear/important, and 4 = highly relevant/clear/important). The experts were also asked to prioritise the items according to their opinion on which ones are crucial to knowledge or performance and to suggest an acceptable competence level (a passing score). Only three experts suggested a passing score. The average passing score according to these three experts was 24/38 (63%) for the knowledge test and 10/14 (71%) for the simulation. Only one expert highlighted the items that they thought were essential. These included all the items in the aetiology, care, and prevention sub-scale, three items in the anatomy and physiology sub-scale, six items in the wound assessment and management sub-scale, and nine items in the simulation.

The content validity index (CVI) for theoretical competence, practical competence, and attitudes (parts two, three, and four of the instrument) was calculated as follows: an item-CVI (I-CVI) was calculated as the number of experts giving a rating of either 3 or 4, divided by the number of experts for each item. The I-CVIs varied between 0.625 and 1. After the I-CVI calculation, the average I-CVIs for relevance, clarity, and importance were computed. Finally, an average of the average I-CVIs (S-CVI/Ave) was computed, giving a CVI of 0.95 for the developed C/WoundComp instrument.[30,31] After the expert review, some changes and clarifications were made to the items. Most of these were amendments to the wording to increase clarity. All of the items were assessed as relevant and important according to the experts.

Phase 5: Pilot testing

The developed instrument was pilot tested with five graduating student nurses at one Finnish university of applied sciences in order to test its usability. The students responded to the background data questions, the knowledge test, and the self-assessment of attitudes towards wound care. After that, the practical part of the instrument – the simulation – was performed individually with each student. The students read the patient case and familiarised themselves with the simulated situation and the equipment. They were then asked to perform wound care while thinking aloud[32] about what they were doing and why. The researcher asked questions during the simulation to understand what the participants were thinking. After the pilot testing, five items in the knowledge test were edited, and some minor changes and corrections were made to the wording of some of the items. No changes were made to the simulation or to the attitudes section.

TABLE 1 Structure of the C/WoundComp instrument (number of items in brackets)

Part I	Background items: Students (6), Professionals (11)		
Part II	Knowledge test (38) (theoretical competence)	Competence areas	Anatomy and physiology (6) Aetiology, care, and prevention (12) Wound assessment and management (20)
Part III	Simulation (14) (practical competence)		Aetiology, care, and prevention (1) Wound assessment and management (13)
Part IV	Attitude assessment (6)		Care (1) Prevention (1) Evidence-based practice (1) Holistic care (1) Respect (1) Economics (1)

Phase 6: Psychometric testing

Psychometric testing was conducted to evaluate the validity, reliability, and sensitivity of the instrument. The theoretical part and the practical part were tested separately and together, in order to find out how the two parts worked individually and in combination. The estimated sample needed to calculate the confidence interval (CI) for the mean score in the theoretical part (the knowledge test) was 100, and for the time-consuming practical part (the simulation) it was 50. Therefore, the target sample was a total of 100 participants across four groups (student nurses, student podiatrists, registered nurses, and podiatrists), of which 50 would participate in both the theoretical and the practical assessment, and the remaining 50 would participate in the theoretical part only. However, given that the number of graduating student podiatrists and professional podiatrists is relatively low in comparison with the number of student and registered nurses, it was known that the number of participants in each of the four groups would not be equal.

The main target groups were graduating student nurses and student podiatrists at Finnish universities of applied sciences. The other target groups were registered nurses and podiatrists. The student participants had to be graduating students in their final semester, and the professionals had to have at least a bachelor's degree in either nursing or podiatry and be involved in wound care as part of their work. The student nurses were recruited using a cluster sample from two universities of applied sciences, and the student podiatrists were recruited as a total sample from the two universities of applied sciences that educate podiatrists in Finland. The registered nurses and podiatrists were recruited using a cluster sample from primary and specialised care in three hospital districts.

2.3 | Data collection

The data for the final, psychometric testing phase were collected between September and December 2019 from the student participants at their universities of applied sciences or training places, and from the professionals at their workplaces or at educational events. The data for the theoretical and attitudes parts of the instrument were collected using paper-and-pencil questionnaires. The data for the practical part was collected using observations during a simulated wound-care situation, and the simulations were videotaped to increase the validity of the study. All the simulation data were collected by the corresponding author. The corresponding author also collected the data for the theoretical part, with the exception of one student group whose teacher collected the data. All the eligible participants who were present during the data collection took part in the theoretical part of the instrument. The data collection for the simulations was arranged separately, either immediately after the theoretical part or on another day, until the target sample had been met.

2.4 | Ethical considerations

The study followed the guidelines for responsible research conduct published by the Finnish Advisory on Research Integrity by the appointment of the Ministry of Education and Culture.[33] Ethical approval was obtained from the university ethics committee (code: 4/2018). Research permissions were sought and received from the organisations representing the study participants. Participation was voluntary, and the participants received information about the study and the data-processing and data protection according to the European Union general data

privacy regulation.[34] After receiving the information and being given the opportunity to ask questions, the participants signed an informed consent form.

2.5 | Statistical analysis

The categorical variables were described using counts (n) and percentages. The continuous variables, which did not follow a normal distribution, were summarised with the median and lower quartile (Q1) and the upper quartile (Q3), and the groups were compared using the Wilcoxon rank-sum test. The comparisons of the groups' mean scores in the knowledge test and simulation were performed using a one-way analysis of variance (ANOVA). Comparisons of attitudes towards wound care between the groups were performed using the Kruskal-Wallis test. The correlation between participants' theoretical and practical competence was examined using Spearman's correlation coefficient. The inter-rater reliability for the observations in the simulation was evaluated by calculating Cohen's Kappa coefficient; the internal consistency of the knowledge test and simulation was evaluated using the Kuder–Richardson (KR) formula. Discriminant analysis was used to find out which knowledge test sub-scales indicated differences in students' and professionals' knowledge. All the tests were performed as two-sided, with a significance level set at 0.05. The analyses were carried out using SAS System, version 9.4 for Windows (SAS Institute Inc., Cary, North Carolina).

3 | RESULTS

3.1 | Sample characteristics

A total of 135 participants participated in the final phase (psychometric testing) of the instrument development. This total included 44 student nurses, 28 student podiatrists, 54 registered nurses, and nine podiatrists. Of these, 50 participated in the whole test, including theoretical and practical assessments. This group included 19 student nurses, 20 registered nurses, six student podiatrists, and five podiatrists. The remaining 85 participants answered the knowledge test and attitudes section only.

Nearly two-thirds (61%) of the students were graduating nurses. Of those, less than one-quarter (23%) had a previous degree in health care; most of those who did (70%) had a previous degree in nursing, and the rest (30%) had some other previous degree in health care. The rest of the students (39%) were graduating podiatrists, of which one-quarter (25%) had some previous degree in health care.

Most of the student nurses (82%) answered that they had received either little or very little theoretical and practical wound-care education during their studies. In addition, nearly half (48%) of the student nurses answered that they had received either little or very little practical training in wounds during their clinical training. On the other hand, more than two thirds (68%) of the graduating student podiatrists answered that they had received theoretical wound-care education to some extent, but more than one-third (36%) said that they had not received any practical wound-care education. (Table 2) According to the participants' estimates, the student podiatrists had received a statistically significantly higher amount of theoretical wound-care education than the student nurses ($P < .0001$). Apart from this, there was no statistically significant difference between the student groups in terms of how much wound-care education they had received.

Eighty-six percent of the professionals were registered nurses and the rest (14%) were podiatrists. Approximately half of the registered nurses (52%) and podiatrists (44%) worked in primary care. Most of the professionals worked on wards or in outpatient clinics. They were allowed to choose more than one unit if they were working in multiple units. The amount of professional experience varied between the groups ($P = .009$): the median among the registered nurses was 15 years (Q1 9, Q3 23), but for the podiatrists, it was 4 years (Q1 2, Q3 14). In addition, the amount of experience in wound care varied greatly between the two groups ($P = .005$): 10 years (Q1 6, Q3 19) for the registered nurses, and 2 years (Q1 2, Q3 9) for the podiatrists. Most of the registered nurses and podiatrists had also updated their wound-care education in the past two years and had studied wound care independently. (Table 2)

3.2 | Level of competence

3.2.1 | Theoretical competence (knowledge test)

The participants' mean score for correct answers in the knowledge test was 28/38 (73%, 95% CI 27.1-28.6). The mean score for all students was 25/38 (67%, 95% CI 24.3-26.2), and the mean score for all professionals was 31/38 (81%, 95% CI 30.0-31.4). The difference between the students' and professionals' mean scores was statistically significant ($P < .0001$). The mean scores for correct answers were 25/38 (65%, 95% CI 23.2-25.8) for the student nurses, 27/38 (70%, 95% CI 25.1-27.9) for the student

TABLE 2 Demographic data of participants

Students	**SN (n=44)**	**SP (n=28)**
Previous degree in health care [n (%)]	10 (23)	7 (25)
The amount of received wound care education [%] (not at all / very little / a little / to some extent / a lot / to a great extent)		
Theoretical education	0 / 43 / 39 / 9 / 9 / 0	0 / 7 / 18 / 68 / 7 / 0
Practical education	4 / 57 / 25 / 14 / 0 / 0	36 / 28 /18 / 11 / 7 / 0
Practical training	5 / 27 / 20 / 43 / 5 / 0	0 / 14 / 14 / 43 / 22 / 7
Self-studying	9 / 14 / 38 / 32 / 7 / 0	11 / 25 / 32 / 28 / 4 / 0
Professionals	**RN (n=54)**	**P (n=9)**
Sector [n (%)]		
Primary health care	28 (52)	4 (44)
Specialised health care	26 (48)	5 (56)
Place of work [n (%)]		
Ward	26 (48)	4 (44)
Outpatient clinic/care	16 (30)	7 (78)
Service housing	1 (2)	2 (22)
Home care	11 (20)	0 (0)
Own business	0 (0)	0 (0)
Other	6 (11)	0 (0)
Speciality (if working at specialised health care) [n (%)]		
Internal medicine	9 (17)	6 (67)
Surgery	14 (26)	1 (11)
Acute or intensive care	1 (2)	0 (0)
Other	6 (11)	0 (0)
Working experience [years: median (Q1, Q3)]	15 (9, 23)	4 (2, 14)
Experience in wound care [years: median (Q1, Q3)]	10 (6, 19)	2 (2, 9)
How often the person is caring wounds [n (%)]		
Daily	23 (42)	5 (56)
Weekly	22 (41)	1 (11)
Monthly	7 (13)	2 (22)
More rarely	0 (0)	1 (11)
Not at all	2 (4)	0 (0)
Authorised wound-care nurse [n (%)]	2 (4)	0 (0)
Completed training in special competence in wound care [n (%)]	26 (49)	2 (25)
Taken part in post-degree wound-care training over the past 2 y [n (%)]	37 (70)	6 (75)
Studied wound care on their own over the past 2 y, e.g. by reading care recommendations or research articles? [n (%)]	44 (83)	8 (100)

Abbreviations: SN, student nurses; SP, student podiatrists; RN, registered nurses; P, podiatrists.

podiatrists, 31/38 (81%, 95% CI 30.0-31.5) for the registered nurses, and 30/38 (80%, 95% CI 28.5-32.0) for the podiatrists. (Table 3) In the knowledge test, the registered nurses' mean score was statistically significantly higher than that of the student nurses ($P < .0001$), and the podiatrists' mean score was statistically significantly higher

TABLE 3 Mean scores in the knowledge test and simulation

Part	Participants	Mean score (%)	SD	Min	Max	CI (95%)	P^a
Knowledge test (38)	All (n=135)	27.8 (73%)	4.43	12	36	27.1-28.6	<.0001
	Student nurses (n=44)	24.5 (65%)	4.24	12	31	23.2-25.8	
	Student podiatrists (n= 28)	26.5 (70%)	3.66	18	33	25.1-27.9	
	Registered nurses (n=54)	30.8 (81%)	2.74	24	36	30.0-31.5	
	Podiatrists (n=9)	30.2 (80%)	2.28	25	32	28.5-32.0	
Sub-scales of the knowledge test							
Anatomy and physiology (6)	All (n=135)	4.8 (80%)	0.83	2	6	4.6-4.9	.4184
	Student nurses (n=44)	4.6 (77%)	0.94	2	6	4.4-4.9	
	Student podiatrists (n= 28)	5.0 (83%)	0.74	4	6	4.7-5.3	
	Registered nurses (n=54)	4.8 (80%)	0.79	3	6	4.6-5.0	
	Podiatrists (n=9)	4.9 (81%)	0.78	4	6	4.3-5.4	
Aetiology, care and prevention (12)	All (n=135)	8.6 (71%)	1.95	3	12	8.2-8.9	<.0001
	Student nurses (n=44)	7.2 (60%)	1.83	3	10	6.7-7.7	
	Student podiatrists (n= 28)	8.6 (71%)	1.97	4	12	8.0-9.2	
	Registered nurses (n=54)	9.1 (80%)	1.32	6	12	9.2-10.1	
	Podiatrists (n=9)	8.9 (74%)	1.62	5	10	7.8-10.0	
Wound assessment and management (20)	All (n=135)	14.5 (72%)	2.77	4	19	14.0-15.0	<.0001
	Student nurses (n=44)	12.7 (64%)	2.54	4	16	12.1-13.4	
	Student podiatrists (n= 28)	12.9 (65%)	2.42	9	18	12.1-13.7	
	Registered nurses (n=54)	16.4 (82%)	1.74	12	19	15.8-17.0	
	Podiatrists (n=9)	16.4 (82%)	0.73	15	17	15.0-17.9	
Simulation (14)	All (n=50)	8.4 (60%)	2.53	3	13	7.7-9.2	.0009
	Student nurses (n=19)	7.2 (52%)	2.55	3	12	6.2-8.2	
	Student podiatrists (n= 6)	6.7 (48%)	1.86	5	10	4.9-8.5	
	Registered nurses (n=20)	9.9 (70%)	1.93	6	13	8.9-10.8	
	Podiatrists (n=5)	9.6 (69%)	1.95	7	12	7.6-11.5	

Abbreviations: SD, standard deviation; CI, confidence interval.
[a]ANOVA.

than that of the student podiatrists ($P = .005$). In addition, the student podiatrists' scores in the knowledge test were statistically significantly higher than those of the student nurses ($P = .022$). However, the difference between the scores of the professionals (registered nurses and podiatrists) was not statistically significant ($P = .657$). (Table 3)

The graduating student nurses received the highest mean scores in the items related to signs of a wound infection (100%) and venous insufficiency (98%). Their lowest mean scores were related to pain assessment (0%) and pressure ulcer prevention (16%). The graduating student podiatrists received the highest mean scores in the items related to venous insufficiency (100%) and diabetic foot ulcer care (100%). Their lowest mean scores were in pain assessment (0%) and pressure ulcer prevention (18%). The registered nurses gained the highest mean scores in the items related to pressure ulcer care (100%), signs of an infection (100%), and pain management (100%). Their lowest mean scores were in pain assessment (7%) and pressure ulcer prevention (17%). Finally, the podiatrists received the highest mean scores in arterial insufficiency, venous insufficiency, diabetic foot ulcer prevention, pressure ulcer care, signs of an infection, debridement techniques, nutrition assessment, nutrients, procedure description, motivation and self-care, information-giving and consultation (all 100%). Their lowest mean scores were in pain assessment (0%) and pressure ulcer prevention (0%). (Figure 2.)

The professionals (both nurses and podiatrists) achieved statistically significantly higher scores than the students in the following items: venous leg ulcers (prevention) ($P = .0096$), venous leg ulcers (care) ($P < .0001$), arterial ulcers (prevention) ($P < .0001$), arterial ulcers (care) ($P < .0001$), diabetic foot ulcers (care) ($P = .016$), aseptic working and order ($P = .008$), wound bed ($P = .0004$), colour and tissue type ($P = .007$), bacteria sample ($P < .0001$), debridement ($P = .0001$), dressings (use and function) ($P = .0003$), dressings (generic names) ($P < .0001$), nutrition assessment ($P = .037$), pain management ($P < .0001$), documentation of care ($P = .010$), multi-professional working ($P = .0003$), and consultation ($P = .002$). However, the students (both student nurses and student podiatrists) achieved statistically significantly higher scores than those of the professionals in one item: skin layers ($P = .022$).

The mean score for correct answers in the anatomy and physiology sub-scale for all study participants was 5/6 (80%). The difference between the students' and the professionals' scores was not statistically significant ($P = .752$). In the aetiology, care, and prevention subscale, the mean score for all participants was 9/12 (71%), and the mean score of the professionals was statistically significantly higher than that of the students ($P < .0001$). In addition, the student podiatrists' mean score was statistically significantly higher than those of the student nurses ($P = .001$), but the difference in the mean scores of the professionals was not statistically significant

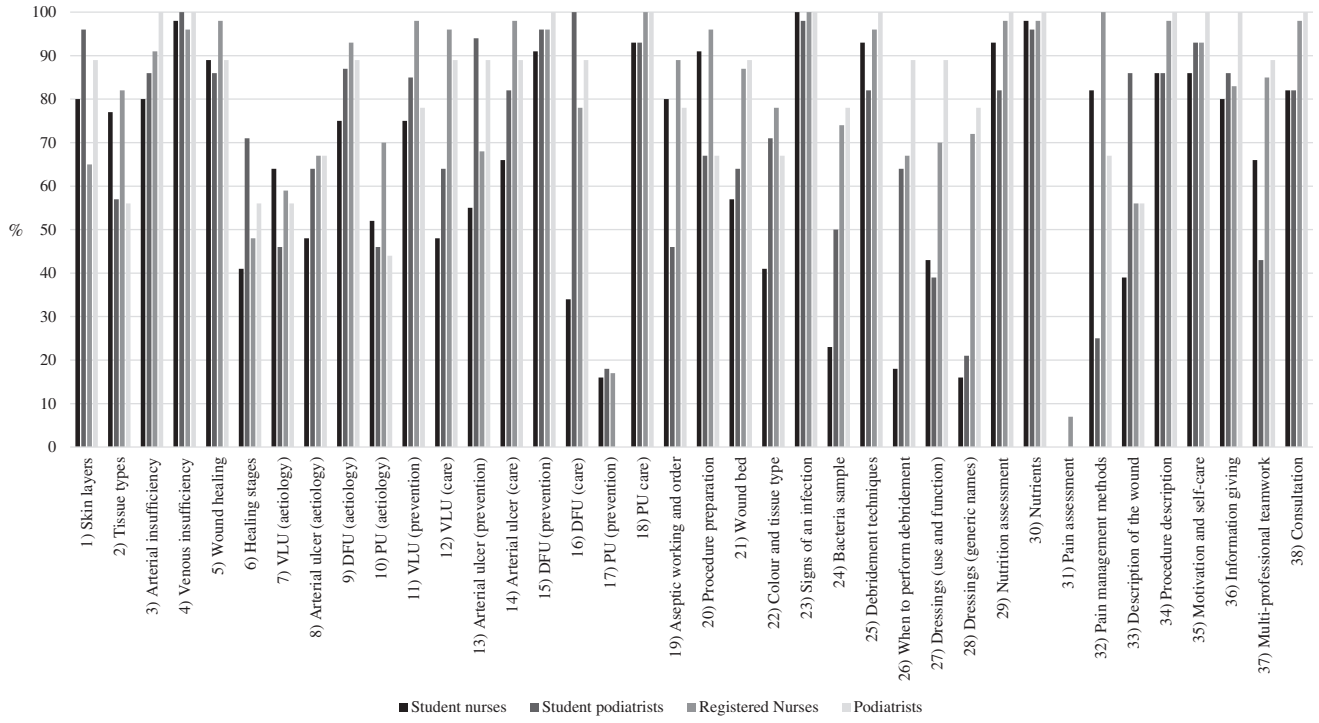

FIGURE 2 Percentages of correct answers in the knowledge test per group

($P = .230$). Finally, in the wound assessment and management sub-scale, the mean score for all participants was 15/20 (72%). The professionals achieved statistically significantly higher scores than the students ($P < .0001$); however, the difference in mean scores between the student nurses and the student podiatrists ($P = .698$) and between the registered nurses and the podiatrists ($P = .924$) was not statistically significant. (Table 3)

Those students who had practised wound care often or to a great extent during their practical training achieved significantly higher scores in the knowledge test than those who had practised less ($P = .0224$). Otherwise, there was no statistically significant relation between the education received and theoretical competence.

3.2.2 | Practical competence (simulation)

In the simulation, the mean score for all participants was 9/14 (60%, 95% CI 7.7-9.2). The mean score for all students was 7/14 (51%, CI 95% 6.1-8.1), and for all professionals, it was 10/14 (70%, CI 95% 9.0-10.6). The mean scores were 7/14 (52%, 95% CI 6.0-8.4) for the student nurses, 7/14 (48%, 95% CI 4.7-8.6) for the student podiatrists, 10/14 (70%, 95% CI 9.0-10.8) for the registered nurses, and 10/14 (69%, 95% CI 7.2-12.0) for the podiatrists. The professionals' practical competence was statistically significantly higher than that of the students ($P < .0001$). However, there was no statistically significant difference between the student nurses' and student podiatrists' scores or between the registered nurses' and podiatrists' scores ($P = .820$). (Table 3) In addition, there was no statistically significant relation between the students' practical competence and the amount of wound-care education they had received.

The graduating student nurses received their highest scores in colour and tissue type (100%), debridement (95%), pain management (74%), and consultation (74%). Their lowest scores were in diabetic foot ulcer care (11%) and procedure description (16%). The graduating student podiatrists received the highest scores in colour and tissue type (100%), debridement (100%), diabetic foot ulcer care (83%), and consultation (83%). The lowest scores for the student podiatrists were in pain assessment (0%) and pain management (0%). The registered nurses achieved their highest scores in colour and tissue type (95%), debridement (95%), and consultation (95%). Their lowest scores were received in the bacterial sample (30%) and aseptic working and order (40%). The podiatrists gained their highest scores in colour and tissue type (100%), signs of infection (100%), debridement (100%), diabetic foot ulcer care (100%), and consultation (100%). Their lowest scores were in pain management (20%), pain assessment (40%), aseptic working and order (40%), and procedure description (40%). (Figure 3.) The mean scores of the professionals were statistically significantly higher than those of the students in the following simulation items: wound products (use and function) ($P = .0322$), diabetic foot ulcer (care) ($P = .0001$), and motivation and self-care ($P = .0041$).

3.2.3 | Total competence (knowledge test and simulation)

When combining theoretical and practical competence in the sample that participated in both parts of the instrument (n = 50), the students scored 32/52 (62%, 95% CI 30.2-34.5) and the professionals scored 40/52 (77%, 95% CI 38.4-41.3). Therefore, professionals' competence was statistically significantly higher ($P < .0001$). The student nurses scored 32/52 (62%, 95% CI 29.5–34.7), the student

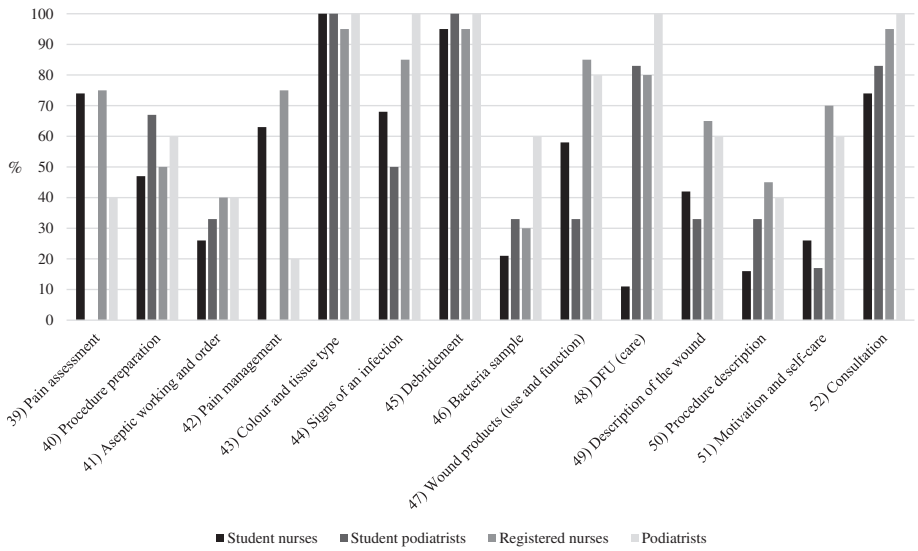

FIGURE 3 Percentages of correct actions in the simulation per group

TABLE 4 Percentages of participants' attitudes towards wound care (translated item in brackets; the positive attitude in grey)

Participants	Completely disagree (n/%)	Disagree (n/%)	Neither agree nor disagree (n/%)	Agree (n/%)	Completely agree (n/%)	*P*[a]
Wound care (nurses and podiatrists should be able to care for wounds)						.8222
Student nurses (n=44)	0 / 0	0 / 0	2 / 5	14 / 32	27 / 63	
Student podiatrists (n=28)	0 / 0	0 / 0	0 / 0	14 / 50	14 / 50	
Registered nurses (n=54)	6 / 11	0 / 0	1 / 2	15 / 28	32 / 59	
Podiatrists (n=9)	1 / 11	0 / 0	0 / 0	2 / 22	6 / 67	
Wound prevention (wound prevention is futile because wounds cannot be wholly prevented anyway)						.0621
Student nurses (n=44)	29 / 68	13 / 30	0 / 0	0 / 0	1 / 2	
Student podiatrists (n=28)	21 / 75	7 / 25	0 / 0	0 / 0	0 / 0	
Registered nurses (n=54)	48 / 89	5 / 9	0 / 0	0 / 0	1 / 2	
Podiatrists (n=9)	6 / 67	1 / 11	0 / 0	0 / 0	2 / 22	
Evidence-based practice (EBP is the responsibility of doctors, not nurses/podiatrists)						.3229
Student nurses (n=44)	26 / 60	15 / 35	2 / 5	0 / 0	0 / 0	
Student podiatrists (n=28)	16 / 57	9 / 32	3 / 11	0 / 0	0 / 0	
Registered nurses (n=54)	41 / 76	10 / 18	0 / 0	1 / 2	2 / 4	
Podiatrists (n=9)	6 / 67	2 / 22	0 / 0	0 / 0	1 / 11	
Holistic care (wound care is basically dressing changing)						.0205
Student nurses (n=44)	11 / 26	17 / 39	7 / 16	8 / 19	0 / 0	
Student podiatrists (n=28)	10 /36	15 / 54	1 / 3	2 / 7	0 / 0	
Registered nurses (n=54)	27 / 50	21 / 39	1 / 2	4 / 7	1 / 2	
Podiatrists (n=9)	5 / 56	3 / 33	0 / 0	0 / 0	1 / 11	
Respect (A patient has the autonomy to their treatment even if the patient and the nurse/podiatrist disagree on the treatment)						.3436
Student nurses (n=44)	0 / 0	0 / 0	7 /16	23 / 54	13 / 30	
Student podiatrists (n=28)	0 / 0	2 / 7	9 / 32	10 / 36	7 / 25	
Registered nurses (n=54)	2 / 4	4 / 7	5 / 9	30 /55	13 / 25	
Podiatrists (n=9)	0 / 0	0 / 0	1 / 11	5 / 56	3 / 33	
Economics (The price of the wound care product does not matter when choosing a care product)						.0033
Student nurses (n=44)	1 / 3	10 / 23	9 / 21	16 / 37	7 / 16	
Student podiatrists (n=28)	1 / 4	5 / 18	5 / 18	11 / 39	6 / 21	
Registered nurses (n=54)	10 / 19	20 / 37	8 / 15	11 / 20	5 / 9	
Podiatrists (n=9)	2 / 23	1 / 11	0 / 0	3 / 33	3 / 33	

Note: © Kielo 2019.
[a]Kruskal-Wallis Test.

podiatrists scored 33/52 (64%, 95% CI 28.1-37.9), the registered nurses scored 40/52 (77%, 95% CI 38.4-41.6), and the podiatrists scored 39/52 (75%, 95% CI 34.6-43.8). Again, the registered nurses' scores were statistically significantly higher than those of the student nurses ($P < .0001$), and the podiatrists' scores were statistically significantly higher than those of the student podiatrists ($P = .028$). However, there was no statistically significant difference between the student groups ($P = .674$) or the professional groups ($P = .724$).

Whether the student participants had received previous education in health care had no relation to their competence level. Neither did the professionals' post-degree training, experience, place of work, sector, or speciality. However, those professionals who provided wound care every day achieved statistically significantly higher scores than those who did not provide wound care at all ($P = .028$). Higher scores that were nearly or barely statistically significant were also found among those professionals who provided wound care every week ($P = .053$) or every month ($P = .048$) compared with those who did not provide wound care at all.

3.2.4 | Attitudes

Six items measured the participants' attitudes towards chronic wound care. A Likert scale was used in these items. There were statistically significant differences among the four participant groups in the responses to two items: holistic care ($P = .021$) and economics ($P = .003$) (Table 4). In addition, when comparing the student groups with the professional groups, there was a statistically significant difference in the same two items ($P = .008$ and $P = .001$).

The majority of the participants demonstrated a positive attitude towards wound care, wound prevention, evidence-based practice, holistic care, and respect. However, in relation to the economics item, there was more variation among the groups, and only the registered nurses showed a positive attitude towards economics in wound care. The attitude of the professionals was more positive overall (all items) ($P = .0117$) and towards economics in particular ($P = .001$). However, the students had a more positive attitude than the professionals towards wound care ($P = .030$). (Table 4) The participants' attitudes were related to their theoretical competence in holistic care ($P = .040$) and in economics ($P = .002$), meaning that attitudes that were more positive attitudes in these items were related to higher scores in the knowledge test. However, the participants' attitudes were not related to their simulation scores. (Table 4)

3.3 | Psychometric testing

The construct validity and sensitivity of the developed instrument were assessed using the known-groups method, in which the professionals were considered to represent the gold standard. The professionals' competence was statistically significantly higher than the students' competence in both the theoretical and practical parts of the instrument ($P < .0001$); this indicates that the instrument as a whole is sensitive because it was able to segregate students and professionals. In addition, the professionals demonstrated statistically significantly higher knowledge levels than the students in the aetiology, care, and prevention sub-scale and in the wound assessment and management sub-scale (both $P < .001$). No statistically significant difference was found between the professionals' and the students' knowledge in the anatomy and physiology sub-scale ($P = .752$).

The internal consistency reliability, calculated using the KR formula, was acceptable for both the theoretical part (knowledge test 0.71) and the practical part (simulation 0.94) of the instrument. The inter-item correlation to the whole knowledge test was 0.06, and to the simulation, it was 0.53. The inter-item correlations to the subsales of the knowledge test were 0.0 (anatomy and physiology), 0.21 (aetiology, care, and prevention), and 0.17 (wound assessment and management). These results indicate that the inter-item reliability was low for the knowledge test but optimal for the simulation. The reliability of the simulation was calculated using inter-rater reliability since two researchers watched the simulation videos and assessed the participants' competence. The agreement between the two researchers according to Cohen's Kappa was 0.96, meaning that the inter-rater agreement was excellent in the practical competence part of the instrument.

The correlation between the participants' theoretical competence and their practical competence was assessed to examine if the different parts of the instrument were able to give similar co-directional results for a person's competence. There was a moderate correlation between participants' theoretical and practical competence (Spearman rho r = 0.57, $P < .0001$) (Figure 4). In addition, most of the items in the simulation measured the same competence areas as the wound assessment and management sub-scale in the knowledge test. The correlation between the simulation and the wound assessment and management sub-scale was found to be 0.61 ($P < .0001$), indicating that the participants' theoretical competence in wound assessment and management also had a moderate correlation with their practical skills.

Finally, the cut-off point for an acceptable level of competence for both the knowledge test and the

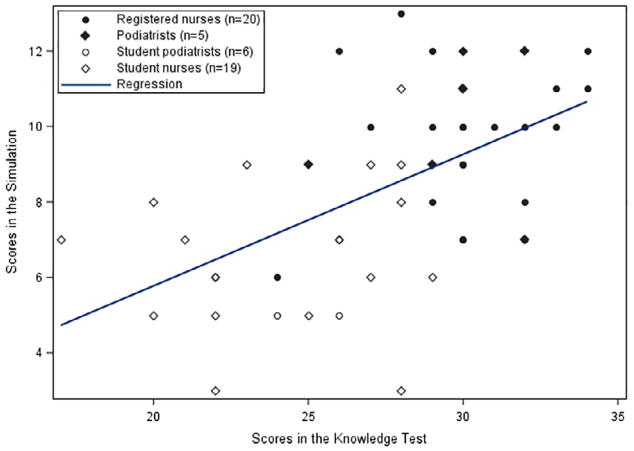

FIGURE 4 Correlation between practical and theoretical competence

simulation was assessed using a contrasting groups method,[35] in which the initial cut-off score for the instrument is the intersection of masters' (professionals') and non-masters' (students') competence. This gave a cut-off score of 29/38 (76%) for the knowledge test and 8/14 (57%) for the simulation. However, in order to avoid false-positive results, the cut-off scores could also be set according to the professionals' (gold standard) mean competences, which would be 31/38 (81%) for the knowledge test and 10/14 (70%) for the simulation.

4 | DISCUSSION

4.1 | Discussion of the results

The purpose of this study was to describe graduating student nurses' and student podiatrists' competence in chronic wound care in comparison with that of professional nurses and podiatrists and to develop and test a new instrument for assessing competence in chronic wound care (C/WoundComp). According to the results, the students had limited competence in chronic wound care but demonstrated positive attitudes towards this area of care. In addition, the developed instrument showed preliminary validity and reliability.

The students' theoretical competence in chronic wounds was lower than that of the professionals. This was to be expected, given that most of the professionals were experienced in wound care and were regularly providing this care. In addition, the student podiatrists' theoretical competence was higher than that of the student nurses. Some previous studies have also compared students and professionals, in addition to comparing different groups of students. For example, in the study by Beeckman et al,[19] registered nurses received higher scores than students in a pressure ulcer knowledge test, but in the study by Gunningberg et al[36] the difference between students' and professionals' knowledge was not statistically significant. Student podiatrists have also been reported as achieving higher scores than student nurses in theoretical wound-care competence in a previous study by the research group.[15] The difference between student nurses' and student podiatrists' competences may be explained by the variations in the wound-care education provided in these two degree programmes. Differences in educational emphases were also seen in the knowledge test items, such as pain management (for student nurses) and diabetic foot ulcer care (for student podiatrists).

In the practical part of the instrument, the students' competence was again lower than that of the professionals, which can certainly be explained by the professionals' experience. In addition, differences in the registered nurses' and podiatrists' education and practices were observed during the simulation. For example, pain assessment and management seemed to be an area that student nurses and registered nurses were more familiar with. This may be explained by the fact that diabetic foot ulcers are usually considered not to be painful due to neuropathy,[37,38] and diabetic foot ulcers are the main form of ulcer that podiatrists deal with. However, in this simulation, the participants were informed that the ulcer was painful. Even though simulation has been used a lot in health-care education,[39] its use in nursing research, especially in wound-care research, is limited. In a previous study by Moura and Larcher Caliri,[40] the simulation was used in an evaluation of student nurses' competence in pressure ulcer risk assessment, with promising results; and in the study by Redmond et al,[41] a virtual patient was used in wound-care education for student nurses. Nevertheless, no previous studies using a similar type of wound-care simulation as a research method were found for comparison, which can be explained by the complexity of simulation as a method.

The study participants' attitudes towards chronic wound care were found to be positive in general. However, the professionals' attitudes were more positive for most of the items, which can also be explained by their experience and expertise in wound care (e.g. [42,43]). It was also found that having a more positive attitude towards holistic care and economics was related to a participant's theoretical competence. However, the participants' attitudes were not related to their practical competence. Positive attitudes in general could be explained by

understanding the importance of preventive and holistic wound care. Previous studies of attitudes towards wound care among student nurses and registered nurses have also indicated some mixed results. In a study by Kim and Lee,[44] registered nurses showed positive attitudes towards pressure ulcer prevention, and in the study by Usher et al,[45] student nurses demonstrated a positive attitude towards this area of wound care. However, in the study by Khojastehfar et al,[46] registered nurses' attitude scores in pressure ulcer prevention were unsatisfactory, and in the study by Garrigues et al,[47] student nurses stated a range of attitudes towards pressure ulcer prevention. Yet, it is worth noting that most of the previous studies on student or registered nurses' attitudes towards wound care have focused on pressure ulcer prevention. Studies assessing general attitudes towards wound care are scarce. Some previous studies have also found a positive relation between knowledge and attitudes (e.g. [43,48]).

The empirical data used in this study was also used in the final phase of developing the C/WoundComp instrument: psychometric testing. The psychometric testing proved that the instrument was valid because it was able to measure the phenomena that it was supposed to measure.[49,50] It also indicated an acceptable internal consistency (criterion; alpha >0.70; [50,51]). In addition, the instrument was demonstrated to be sensitive, as most parts of the instrument were able to segregate the students and professionals.[52] However, some of the items in the knowledge test could be modified to increase the reliability of the instrument for future use, given that the inter-item correlations in the knowledge test were not optimal.[53] In addition, some of the items seemed to be too easy, too difficult or unclear, since either all or none of the participants knew the correct answer. In addition, the pressure ulcer prevention item in the knowledge test seemed to be demanding for most of the participants. The wording might have been a bit unclear. Still, it is also possible that there was a real knowledge gap among participants because it was asked how soon a pressure ulcer risk assessment should be conducted from hospitalised patients. Furthermore, the cut-off scores calculated for the instrument represented relatively low passing scores, especially for practical competence. However, human judgement is also needed when setting desirable passing scores for competence assessments, as the professionals and the experts are always the best judges.[35] Still, it is worth noting that the instrument is new, and instrument development is a continuous process.[54] This instrument is also novel and unique because it combines both theoretical and practical competencies, which had not been done previously when measuring health-care professionals' and students' wound-care competence.

4.2 | Strengths and limitations

This study used a descriptive comparative methodological design, and the data were collected at one specific time from four different groups. The participants of this study were recruited as a cluster sample, which may decrease the validity of the study.[55] However, the study participants were recruited from different organisations. The sample size was not relatively large, and the sizes of the groups varied widely due to an unequal number of graduating students and professionals within the two professions, which may also decrease the validity of the study. Nevertheless, the data from this sample were diverse, including the knowledge test results and the simulation observations. The simulations were carried out by the corresponding researcher, meaning that it would not have been possible to test a larger sample due to limited economic resources. However, because the simulations were carried out by one researcher only, they were conducted consistently, which may increase the validity of the study.

The instrument development process was systematic and adapted from DeVellis.[27] The structure of the developed instrument was designed on the basis of the previous focus-group interviews, increasing the validity of the instrument. The items of the instrument were formulated on the basis of the previous instrument, the focus-group interviews, and the literature. The instrument went through an evaluation of face validity and content validity, in addition to pilot testing, before psychometric testing was conducted with a larger sample, which increases its validity. In the psychometric testing phase, various validity and reliability tests were conducted, with mainly acceptable results, increasing the validity of the instrument. However, some of the items in the knowledge test were found to be too easy, too demanding, or unclear, so those items should be edited for future use. In addition, the inter-item correlation of the knowledge test was low. The data were analysed by two statisticians in cooperation with the research team, which increases the validity of the study.

It is also worth noting that the practical competence part of the instrument was simulated; even though the case and the situation were designed to be as real as possible, some things (for example, debridement) could not be actualised as reliably as they would have been in a real situation.[56] In this simulation a false wound was used, so a real debridement could not be performed and assessed. The participants received one point if they took the correct instrument and demonstrated the debridement. In addition, no real care documentation programme was used in the simulation, and the participants were only asked to tell the researcher what they would document

about the wound and the care they provided. This might have been difficult for some participants. However, real wounds and real patients could not be used, as real situations could not have been made similar and standardised for 50 participants.

The C/WoundComp instrument that was developed measures wider competence than knowledge alone, as it also measures skills, performance, and attitudes in an objective way, which increases the validity of the instrument. Still, providing an objective assessment of attitudes is always demanding.[57] In addition, this instrument did not directly measure values, even though values are one of the competence attributes according to Cowan et al.[26] The instrument was developed with assistance from many wound-care professionals, and it was found to be suitable for graduating student nurses and student podiatrists as well as nursing and podiatry professionals.

This study was conducted in Finland, so the results cannot be fully generalised to other countries. However, the nursing education provided in Finland is based on the European Union Directive,[58] and the framework for professional qualifications is based on the European Higher Education Area[59] guidelines, indicating that at least some of the results could be utilised in other European countries. Still, there are no general guidelines on the content or amount of wound-care education that should be provided in a bachelor level nursing programme.[60] Further studies in this field could focus on the validation of the instrument in other countries and languages. It is also worth noting that new evidence is constantly appearing and the items should be checked and updated if necessary before using the instrument for research or clinical purposes in the future.

CONCLUSIONS

The findings of this study suggest that graduating student nurses' and student podiatrists' competence in chronic wound care was limited, especially their practical competence. In addition, the students reported that they had not received enough wound-care education during their studies. Nevertheless, the students' attitudes towards wound care were mainly positive. This study also presented the process of developing the C/WoundComp instrument. Psychometric testing suggested that the instrument is valid, reliable, and sensitive, but in future, more international and multicentre testing is needed, as well as validation in other languages and cultures. The developed instrument can be used to measure both the theoretical and practical wound-care competence of students or professionals in nursing and podiatry. Different parts of the instrument can be also used separately, in undergraduate and postgraduate competence assessments, in order to determine whether the competence levels of students and professionals meet current requirements.

ACKNOWLEDGEMENTS

We want to thank all the participants of this study as well as the wound care experts who gave their best opinion and helped to develop the instrument. We want to thank also the Finnish Wound Care Society and the University of Turku for financial support, as well as Mölnlycke Health Care AB for sponsoring some of the wound care products used in the simulations.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

DATA AVAILABILITY STATEMENT

Data available on request due to privacy/ethical restrictions

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How to cite this article: Kielo-Viljamaa E, Suhonen R, Ahtiala M, et al. The development and testing of the C/WoundComp instrument for assessing chronic wound-care competence in student nurses and podiatrists. *Int Wound J*. 2020; 1–17. https://doi.org/10.1111/iwj.13495