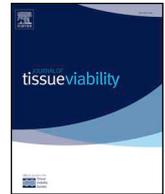




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Knowledge of nurses and nursing assistants about pressure ulcer prevention: A survey in 16 Belgian hospitals using the PUKAT 2.0 tool



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ABSTRACT

Background: Pressure ulcers have a high impact on patients and their families. Profound and up-to-date knowledge among nurses is important given the effect on attitudes and preventative behaviour. To gain insight into educational needs and priorities, regular knowledge assessments are needed.

Objective: To gain insight into the knowledge of nurses and nursing assistants about pressure ulcer prevention.

Design: Cross-sectional multicentre study.

Methods: 474 nurses and nursing assistants recruited at 29 wards in 16 hospitals completed individually the PUKAT 2.0, a valid and reliable questionnaire to measure nurses knowledge about pressure ulcer prevention. Data were collected between February 2016 and December 2017. Independent sample t-tests, one-way analyses of variance and Kruskal-wallis tests were performed to analyse the results.

Results: The mean total score was 50.7%. The lowest scores were found in the themes knowledge about prevention (42.7%), aetiology (45.6%) and prevention for specific patient groups (46.6%). Higher educational level ($H = 40.43$, $p < 0.001$) and attending additional training about pressure ulcers or wound care in general ($t = 2.93$, $p = 0.004$) resulted in significant higher total knowledge scores.

Conclusion: The results of this study highlight an important knowledge deficit about pressure ulcer prevention. The PUKAT 2.0 knowledge assessment tool made it possible to differentiate between a variety of cognitive process levels. This allowed to identify knowledge gaps and focus areas for continuing professional education. Education curricula for nurses and associated healthcare professionals are to be screened thoroughly and the identified knowledge gaps should be covered. Besides, multifaceted strategies are needed to improve clinical practice.

1. Introduction

The primary cause of pressure ulcers (PU) is a sustained mechanical load that is applied to soft tissues, usually near a bony prominence, causing deformation of skin and sub-dermal tissues [1]. Common locations for PU are elbows, heels, hips, shoulders, back and occiput. PU can be classified according to the International NPUAP/EPUAP Pressure Ulcer Classification System in four categories (I to IV including Unstageable and Suspected Deep Tissue Injury) [1] and have a high impact

on patients and their families. They can be associated with severe pain [2–4], increased mortality [5], reduced quality of life [6], reduced engagement in social activities [7], changed body image and loss of control [8]. Proper management and the use of protective devices contribute to PU prevention [9].

In 2014, the clinical practice guideline for the prevention and treatment of PU was developed [1], presenting clinical recommendations and summarizing the evidence. It is recommended to regularly assess the health professionals' knowledge and attitudes related to PU

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prevention and management, to facilitate compliance to clinical guidelines and to identify potential barriers and facilitators when introducing quality improvement initiatives [1]. Assessing knowledge and attitudes contributes to insight into educational needs and priorities and can assist in the development of organization-specific interventions [10]. Besides, knowledge assessment can be used as a basis for the development of evidence based training and education [10]. The provision of regular mandatory training for health professionals by organizations is an important quality indicator at structural level [1]. It is assumed that providing education has a positive effect on knowledge and skills and contributes to a positive change in the behaviour of healthcare professionals [11]. This is based on behavioural or social science theories and conceptual models such as the Knowledge-Attitude-Behaviour (KAB) model [12] and the Social Cognitive Theory [13]. Previous studies showed that nurses' knowledge has an impact on the attitude towards PU prevention [14,15], which in turn is significantly correlated with preventative behaviour [14,16,17]. This is in line with the Theory of Planned Behaviour [18,19], stating that attitudes, subjective norms and perceived behavioural control and beliefs (affected by education, knowledge and experience) have an impact on behaviour.

1.1. Background

A valid and reliable assessment tool should be used to assess nurses' knowledge about PU prevention [1]. The Pressure Ulcer Knowledge Assessment Tool (PUKAT) was developed by Beeckman et al. [20] since previously developed instruments lacked information about psychometric properties [20]. The PUKAT has proven content validity (CVI = 0.78–1.00) and good test-retest reliability (ICC = 0.88) [20]. In 2017, a revision and update took place (i.e. PUKAT 2.0) considering recent national and international guidelines. Content validity and face validity were assessed by experts from NPUAP and EPUAP and by pilot testing involving one nursing student, three nurses with different profiles and a wound care nurse. Validity of the multiple-choice test items, construct validity and stability of the PUKAT 2.0 were evaluated in 228 nurses and 114 nursing students of an undergraduate and vocational level. The PUKAT 2.0 showed good psychometric properties. The tool consists of 25 multiple-choice items, categorized into following six themes: 'Aetiology', 'Classification and observation', 'Risk assessment', 'Nutrition', 'Prevention of PU' and 'Specific patient groups'. Evaluation of different levels of knowledge is enhanced, for example by the inclusion of cases. Cognitive skills can be divided into lower-order skills requiring less cognitive processing, and higher order skills needing deeper learning and a greater degree of cognitive processing [21]. Benjamin Bloom created in 1956 a classification of cognitive skills, called Bloom's taxonomy [22]. In 2001, the taxonomy was revised by Anderson et al. [23] including following six hierarchical levels: remembering (level 1), understanding (level 2), applying (level 3), analyzing (level 4), evaluating (level 5) and creating (level 6).

Literature on nurses' knowledge towards PU prevention is inconsistent [1]. Some studies reveal appropriate knowledge levels [24–29], while others show that knowledge is inadequate [14,17,30–34]. Comparison of findings is complicated by the use of different instruments and methodological limitations such as selection bias and single site data collection [1,35].

2. Methods

2.1. Aims

This study aimed to assess the knowledge of nurses and nursing assistants about PU prevention in Belgian hospitals.

2.2. Design

A cross-sectional multicentre study was performed. Data were collected between February 2016 and December 2017. The knowledge assessment was part of a broader study (i.e. a cluster three-arm RCT) wherein the effect of a quality improvement intervention was studied [59,60].

2.3. Sample

A convenience sample of 29 wards (8 intensive care units, 13 geriatric wards and 8 rehabilitation wards) in 16 Belgian hospitals (1 university hospital, 4 general hospitals with university character and 11 general hospitals) was involved in this study. Nurses and nursing assistants who attended a study specific training in the context of the RCT participated in this study [59,60].

2.4. Instrument

The pre-final version of the PUKAT 2.0 was used, containing 28 multiple-choice items. Items were formulated according to the Multiple-choice Item-writing Guideline [36] and consisted of a stem and five response alternatives, including the option 'I do not know the answer' (see Table 1). The items were categorized into six relevant themes: (1) 'Aetiology' (7 items); (2) 'Classification and observation' (4 items); (3) 'Risk assessment' (2 items); (4) 'Nutrition' (3 items); (5) 'Prevention of PU' (8 items) and (6) 'Specific patient groups' (4 items). The instrument was reviewed for face and content validity by a panel of eight experts from the National Pressure Ulcer Advisory Panel (NPUAP) in a Delphi procedure and adapted based on their feedback. More information about the development process of the PUKAT 2.0 can be found in the publication of Manderlier et al. [37]. According to the revised version of Bloom's taxonomy [23], following levels could be determined: remembering (level 1), understanding (level 2), analyzing (level 4) and evaluating (level 5). An overview of the cognitive levels of the 28 multiple-choice items can also be found in Table 1.

2.5. Procedure

Nurses and nursing assistants were invited to complete individually the pre-final printed version of the PUKAT 2.0. Completion occurred at the start of the study specific training in the context of the RCT. Time to complete the instrument was 20–30 min.

2.6. Data analysis

Statistical analyses were performed using the software package SPSS Statistics 24 (SPSS, Inc. Chicago, IL, USA). The answers on the knowledge assessment were recoded as correct vs. incorrect. Items scored as 'I don't know the answer' and multiple answers were considered incorrect. Consequently, sum scores were calculated in order to obtain a total score. In order to determine if there were differences between groups, independent sample t-tests and ANOVA tests with post-hoc Scheffe analysis were used when the Levene's test was non-significant. Kruskal-wallis tests and post-hoc Mann-Whitney U-tests were performed in case of a significant Levene's test. A significance level of 0.05 was applied.

2.7. Ethical considerations

The study was approved by the leading ethics review committee (February 2016-B670201526791) and each of the participating hospitals ethics review committee. Participants received written information on the aim, procedure, anonymity and confidentiality of the study. Written informed consent was obtained from all participants.

Table 1
PUKAT 2.0 pre-final version.

	THEME AETIOLOGY
Level 1 Remembering	<p>1. What is a cause of pressure ulcers?</p> <p>a) Diabetes. b) The use of corticosteroids. c) Hypertension. d) Tissue oxygenation.^a e) I don't know the answer.</p>
Level 2 Understanding	<p>2. A patient sits with the head of bed elevated to 60 degrees. What happens when his skin sticks to the underlying surface when he slides down in bed?</p> <p>a) The pressure increases. b) Rubbing increases. c) Shear increases.^a d) Friction increases. e) I don't know the answer.</p>
Level 1 Remembering	<p>3. What is the international prevalence of pressure ulcers in hospitals?</p> <p>a) Between 10% and 20%.^a b) Between 20% and 30%. c) Between 30% and 40%. d) Between 40% and 50%. e) I don't know the answer.</p>
Level 2 Understanding	<p>4. Excessively moist skin (due to e.g. incontinence or wound exudate) combined with increased body temperature are associated with pressure ulcer development. This statement is ...</p> <p>a) Correct. Excessive skin moisture and raised temperature are causal factors for the development of pressure ulcers. b) Correct. Excessive skin moisture and raised temperature are risk factors for the development of pressure ulcers.^a c) Incorrect. Wounds that occur in a moist and warm environment are always defined as incontinence-associated dermatitis (IAD). d) Incorrect. An increased temperature results in better blood flow and thus decreases the risk of pressure ulcers. e) I don't know the answer.</p>
Level 4 Analyzing	<p>5. CASE: A patient is sitting in a chair in the morning (1 h) and in the afternoon (1 h). The rest of the day he spends in bed. He can't mobilize himself. When does this patient have the highest risk to develop a pressure ulcer (if no prevention is applied)?</p> <p>a) There is no higher risk to develop a pressure ulcer if a seated position is combined with a lying position (e.g. resting in bed). b) The risk to develop a pressure ulcer is highest when he is seated because high pressure is applied during a short period of time. c) The risk to develop a pressure ulcer is highest when he is lying in bed because lower pressure is applied during a longer period of time. d) The risk to develop a pressure ulcer is high in this specific case, both when seated in a chair and lying in bed. A short-term high pressure can have the same effect as a long-term low pressure.^a e) I don't know the answer.</p>
Level 4 Analyzing	<p>6. Individual patient characteristics are associated with how the skin and underlying tissues react to pressure and shear. Which statement is correct?</p> <p>a) Skin and tissue stiffness have an influence on how the skin reacts to pressure and shear.^a b) Older patients always have a higher risk to develop pressure ulcers than younger patients. c) Only lifestyle and pathology have an influence on how the skin reacts to pressure and shear. d) Only the time and the amount of pressure and shear have an influence on how the skin reacts to pressure and shear. e) I don't know the answer.</p>
Level 4 Analyzing	<p>7. Which statement is correct?</p> <p>a) The use of moisture absorbing pads decrease the risk of pressure ulcers. b) The use of soap can erode the skin barrier, thereby increasing the risk of superficial skin damage.^a c) Massaging the skin (during washing and drying) is effective to prevent pressure ulcers. d) After washing the feet, dress the heels (with a bandage) will decrease the risk of heel pressure ulcer development. e) I don't know the answer. THEME CLASSIFICATION AND OBSERVATION</p>
Level 4 Analyzing	<p>8. CASE: You observe a new blister on the heel of a bedbound patient. Neither non-blanchable erythema or an ulcer has been previously documented. Which statement is correct? The blister is ...</p> <p>a) Not a pressure ulcer. b) A Category II pressure ulcer. c) A Category I pressure ulcer as long as the blister remains intact. d) There is insufficient information to know if this is a pressure ulcer or not.^a e) I don't know the answer.</p>
Level 1 Remembering	<p>9. What is referred to as a pressure ulcer category I?</p> <p>a) Blanchable erythema. b) Non-blanchable erythema. c) Intact blister. d) Open blister. e) I don't know the answer.</p>
Level 2 Understanding	<p>10. Which of these stages of pressure ulcers may require debridement?</p> <p>a) Category I, II, III, and IV. b) Category II, III, and IV. c) Category III and IV.^a d) Category IV only. e) I don't know the answer.</p>
Level 1 Remembering	<p>11. CASE: The nurse observes a bony structure in a wound. This pressure ulcer would be classified as a stage:</p> <p>a) IV pressure ulcer.^a b) IV pressure ulcer if there are signs of undermining. c) IV pressure ulcer if there is necrosis. d) IV pressure ulcer if there are signs of a reduction of the supply of blood to the tissue. e) I don't know the answer. THEME RISK ASSESSMENT</p>

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Table 1 (continued)

Level 5 Evaluating	<p>12. CASE: A patient is recently admitted to your nursing unit. The patient has no signs of skin redness (blanchable/non-blanchable). When completing the risk assessment tool, the score indicates that there is no risk for pressure ulcer development. No prevention is needed. However, you are very surprised because your clinical experience tells you that this patient is at risk. What are you going to do now?</p> <p>a) You don't implement a prevention plan because both the skin assessment and the scoring tool indicated that there is no increased risk. b) You don't implement a prevention plan because risk assessment instruments are developed to replace clinical judgment. c) You ignore the result of the risk assessment tool and take preventive measures because your clinical judgment is as important as the result of the risk screening using the tool.^a d) You decide to reassess the patient on a daily basis (using the instrument) and to start prevention if the risk assessment instrument indicates an increased risk to develop a pressure ulcer. e) I don't know the answer.</p>
Level 1 Remembering	<p>13. Which of these statements about the frequency of skin assessment in hospitals is correct?</p> <p>a) The frequency of skin assessment is a medical decision (made by a medical doctor). b) Skin areas with an increased risk for pressure ulcer development should be inspected at least once a week. c) The skin of patients at risk should be inspected twice a week. d) The skin of all patients should be inspected daily.^a e) I don't know the answer. THEME NUTRITION</p>
Level 5 Evaluating	<p>14. CASE: A 23 year old previously healthy male was recently admitted to the hospital with a spinal cord injury (car accident). He is immobile and has no problems eating or drinking. Is nutritional supplementation needed to reduce the risk for pressure ulcers?</p> <p>a) Yes, I will provide nutritional supplementations (vitamin tablets) primarily to prevent pressure ulcers. b) Yes, I will provide nutritional supplementations (arginine enriched drinks) primarily to prevent pressure ulcers. c) No, I will not change the nutrition of this patient as long as no signs of pressure ulcers are observed (redness or skin breakdown). d) No, I will not change the nutrition of this patient as long as nutritional intake is adequate.^a e) I don't know the answer.</p>
Level 1 Remembering	<p>15. Indicate the nutritional elements that are most essential to prevent pressure ulcers.</p> <p>a) Carbohydrates, fats and proteins. b) Calories, proteins and fluids.^a c) Calories, carbohydrates and proteins. d) Fat, fluids and proteins. e) I don't know the answer.</p>
Level 1 Remembering	<p>16. What type of patients (in terms of body weight) have an increased risk to develop pressure ulcers?</p> <p>a) Only cachectic patients. b) Only obese patients. c) Both cachectic and obese patients.^a d) Body weight and BMI are not associated with pressure ulcer risk. e) I don't know the answer. THEME PREVENTION OF PRESSURE ULCERS</p>
Level 1 Remembering	<p>17. What percent of patients with an increased risk to develop pressure ulcers receive adequate prevention in hospitals?</p> <p>a) 20%.^a b) Between 20 and 50%. c) Between 50 and 70%. d) 70%. e) I don't know the answer.</p>
Level 1 Remembering	<p>18. CASE: Your colleague informs you that she positioned a patient in bed in a semi Fowler position. What does this mean?</p> <p>a) The patient lies on his side in an angle of 30°. b) The patient lies on his side in an angle of 90°. c) The patient lies in a supine position, with both head of bed and upper legs elevated up to an angle of 30°.^a d) The patient lies in a supine position, with the head of bed elevated up to an angle of 45°. e) I don't know the answer.</p>
Level 1 Remembering	<p>19. Which repositioning protocol is most effective to prevent pressure ulcers? Starting with the patient supine, then ...</p> <p>a) Lateral 30° left – supine - lateral 30° right - supine - lateral 30° left – ...^a b) Lateral 90° left – supine - lateral 90° right - supine - lateral 90° left – ... c) Lateral 30° left – supine - lateral 30° right - supine - lateral 90° left - supine - lateral 90° right - ... d) Lateral 30° left - lateral 90° left – supine - lateral 30° right - lateral 90° right - supine - ... e) I don't know the answer.</p>
Level 4 Analyzing	<p>20. The use of a ring cushion (donuts) is effective to prevent pressure ulcers when patients are seated. This statement is ...</p> <p>a) Correct because the pressure near the bony prominence is reduced. b) Correct because it redistributes pressure and shear effectively around the area at risk. c) Incorrect because the contact surface between the patient's skin and the surface is smaller, thus the pressure will be higher.^a d) Incorrect as it is only effective if a patient had a pressure ulcer in the past. e) I don't know the answer.</p>
Level 2 Understanding	<p>21. How should bed linen be used to prevent pressure ulcers?</p> <p>a) Don't secure the bottom sheets under the mattress, so they can move along with the patient. b) Don't secure the blanket of the patient, so it can move along with the patient.^a c) Make sure bottom sheets are stretched tight, to avoid wrinkles. d) Put moisture- absorbing pads under the patient to protect his skin. e) I don't know the answer.</p>
Level 2 Understanding	<p>22. Indicate the most effective technique to position a patient when seated.</p> <p>a) In an upright position with the knees in a 90° angle and the feet not touching the ground. b) In an upright position with the legs being supported so that an angle of more than 90° is created at the knees. c) In a semi-reclined position with the knees in a 90° angle with the feet not touching the ground. d) In a semi-reclined position with the legs being supported so that an angle of more than 90° is created at the knees.^a e) I don't know the answer.</p>
Level 2 Understanding	<p>23. CASE: Your patient is lying on a pressure redistributing foam mattress. Do you take other measures to prevent pressure ulcers on the heels?</p> <p>a) No. A pressure redistributing foam mattress is sufficient. b) No. A pressure redistributing foam mattress combined with repositioning is sufficient. c) Yes. I will place a pillow under the calves to off-load the heels.^a d) Yes. I will place IV bags under the heels to off-load the heels. e) I don't know the answer.</p>

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Table 1 (continued)

Level 2 Understanding	24. How does repositioning prevent pressure ulcers? a)The amount of pressure and shear will be reduced. b)The amount and duration of pressure and shear will be reduced. c)The duration of pressure and shear will be reduced. ^a d)It reduces friction at the bony prominences. e)I don't know the answer. THEME SPECIFIC PATIENT GROUPS
Level 5 Evaluating	25. CASE: When repositioning your ICU patient from supine to lateral on the right side at 30 degrees, the PCO2 decreases and the heart rate increases, which triggers the alarms to ring. What are you going to do? a)You turn the patient quickly to a supine position to avoid further instability and you try again later. b)You turn the patient quickly to a supine position to avoid further instability and you document in the chart that the patient cannot be repositioned. c)You leave the patient on the right side, check the vital signs and give the patient 5–10 min to stabilize. ^a d)You leave the patient on the right side, check the vital signs and give the patient 20–30 min to stabilize. e)I don't know the answer.
Level 4 Analyzing	26. Which of these statements is true about the development of pressure ulcers in the operating room? a)Pressure ulcers are not likely to occur during surgery. If redness is observed just after surgery, it is most likely to be a burn wound. b)Immobilization after surgery causes pressure ulcers to develop, not the immobilization during the surgery itself. c)When pressure ulcers develop during surgery the first visible signs appear a few days later; making people think they developed after surgery. ^a d)A pressure ulcer appearing postoperatively is always the result of immobilization during surgery. e)I don't know the answer.
Level 4 Analyzing	27. Which factor has the lowest priority (when it comes to pressure ulcer prevention) when installing a patient on the surgical table? a)Pressure on the Achilles tendon. b)The body weight of the patient. ^a c)Overstretching of the joints. d)Positioning of the medical equipment. e)I don't know the answer.
Level 1 Remembering	28. Indicate the location on the body where babies have the highest risk to develop a pressure ulcer. a)Occiput. ^a b)Heels. c)Shoulders. d)Sacrum. e)I don't know the answer.

^a Incidates the correct answer.

2.8. Validity and reliability/rigour

The data collection document was designed using the software program Teleform (HP, California, USA). Data were scanned and automatically transferred to an SPSS database. Supervision by the researcher during the assessment made it impossible for participants to discuss possible answers or to search for extra information. For assignment of the multiple-choice items to the Bloom's taxonomy consensus between the researchers was obtained.

3. Results

3.1. Characteristics of the participants

In total, 474 participants completed the questionnaire. 90.9% were nurses, 9.1% were nursing assistants. More than half of the participants were over the age of 35 and had more than 10 years work experience. 60.5% of the participants had a bachelor degree. An overview of the demographic data of all participants is shown in Table 2.

3.2. Knowledge of participants

The mean total score was 50.7%. The lowest scores were found in the themes 'Prevention' (42.7%), 'Aetiology' (45.6%) and 'Specific patient groups' (46.6%). The highest scored themes were 'Risk assessment' (83.8%) and 'Nutrition' (59.6%). An overview of the knowledge scores in total and per theme is reported in Tables 3 and 4. The mean knowledge score decreased when the cognitive level of the questions increased (level 1 = 57.9%, level 2 = 44.2%, level 4 = 38.1%), except for questions assigned to level 5 (66.8%) (see Table 5).

There were no statistical significant differences in mean scores between male and female participants. Nurses scored significant higher than nursing assistants on the complete questionnaire (52.1% versus 35.4%, $p < 0.001$), on all different themes and on questions assessing

Table 2

Demographic data of the participants.

	Participants (n = 474) n (%)
Ward	
ICU	168 (35.4)
Geriatrics	188 (39.7)
Rehabilitation	118 (24.9)
Gender	
Female	403 (88.0)
Male	55 (12.0)
Age category	
< 25 years	40 (8.5)
25–34 years	153 (32.6)
35–50 years	159 (33.9)
> 50 years	117 (24.9)
Work experience	
< 5 years	125 (27.4)
5–10 years	77 (16.9)
11–20 years	85 (18.6)
> 20 years	169 (37.1)
Education	
Secondary school	39 (8.5)
Higher professional education	124 (27.1)
Bachelor degree	277 (60.5)
Master degree	14 (3.1)
Function	
Nurse	430 (90.9)
Nursing assistant	43 (9.1)
Additional training in PU/Wound care	
Yes	19 (4.0)

the possibility to reproduce (level 1) (59.3% versus 39.3%, $p < 0.001$) or understand/interpret (level 2) (45.6% versus 28.6%, $p < 0.001$) knowledge or to evaluate patient cases (level 5) (69.6% versus 39.0%, $p < 0.001$). Participants who attended additional training in PU or wound care had significant higher scores in total than nurses who did not attend any additional training (61.0% versus 50.2%, $p = 0.004$) and on the themes 'Aetiology' (62.9% versus 44.9%, $p < 0.001$), 'Risk

Table 3
Knowledge of participants - Total score and themes 'Aetiology', 'Classification & observation' and 'Risk assessment'.

	Total score mean % (SD)		Aetiology mean % (SD)		Classification and observation mean % (SD)		Risk assessment mean % (SD)	
	N	Difference	N	Difference	N	Difference	N	Difference
Overall	256		392		423		434	
Ward		F = 5.66, p = 0.004		F = 2.34, p = 0.098		F = 0.01, p = 0.986		H = 6.73, p = 0.035
ICU	87		135		150		149	
Geriatrics	100		159		167		173	
Rehabilitation	69		98		106		112	
Gender		t = 1.19, p = 0.235		t = 0.42, p = 0.673		t = 1.86, p = 0.064		t = -0.23, p = 0.815
Female	222		338		363		371	
Male	32		46		50		53	
Age category		F = 0.99, p = 0.400		F = 0.46, p = 0.713		F = 5.84, p = 0.001		H = 9.96, p = 0.019
< 25 years	27		33		37		38	
25–34 years	86		130		141		143	
35–50 years	83		131		144		148	
> 50 years	60		95		98		102	
Work experience		F = 2.11, p = 0.099		F = 2.53, p = 0.057		F = 1.46, p = 0.224		F = 0.07, p = 0.974
< 5 years	75		107		117		119	
5–10 years	44		68		71		71	
11–20 years	46		68		74		77	
> 20 years	87		138		150		153	
Education		H = 40.43, p < 0.001		F = 7.31, p < 0.001		F = 9.05, p < 0.001		H = 6.95, p = 0.074
Secondary school	20		30		34		34	
Higher prof. education	63		103		111		118	
Bachelor degree	160		234		250		256	
Master degree	7		12		11		10	
Function		t = 4.74, p < 0.001		t = 2.93, p = 0.004		t = 4.84, p < 0.001		t = 2.44, p = 0.019
Nurse ^a	235		359		384		395	
Nursing assistant	21		32		38		38	
Additional training in PU/		t = 2.93, p = 0.004		t = 4.04, p < 0.001		t = 1.84, p = 0.066		t = 4.55, p < 0.001
Wound care								
Yes	11		15		17		18	
No	245		377		406		416	

^a Bachelor degree or higher professional education (= fourth grade of secondary school).

Table 4
Knowledge of participants - themes 'Nutrition', 'Prevention' and 'Specific patient groups'.

	Nutrition mean % (SD)		Difference	Prevention mean % (SD)		Difference	Specific patient groups mean % (SD)		Difference
	N			N			N		
Overall	415	59.6 (29.5)		324	42.7 (17.5)		352	46.6 (24.4)	
Ward			H = 1.78, p = 0.411			F = 4.68, p = 0.010			H = 12.18, p = 0.002
ICU	148	61.3 (26.1)		112	43.3 (16.6)		124	52.8 (21.4)	
Geriatrics	163	60.3 (30.0)		128	45.3 (17.9)		137	43.1 (24.6)	
Rehabilitation	104	56.1 (32.9)		84	37.9 (17.4)		91	43.4 (26.3)	
Gender			t = -0.51, p = 0.610			t = 1.48, p = 0.141			t = 1.86, p = 0.064
Female	354	60.3 (29.6)		278	42.4 (17.4)		302	45.6 (24.0)	
Male	50	58.0 (27.6)		41	46.6 (17.0)		44	52.8 (24.8)	
Age category			H = 1.41, p = 0.703			F = 1.06, p = 0.366			F = 0.46, p = 0.710
< 25 years	37	59.5 (26.2)		34	44.5 (16.6)		36	48.6 (24.6)	
25–34 years	131	57.8 (29.2)		106	42.3 (17.1)		110	45.0 (24.4)	
35–50 years	144	61.6 (27.1)		109	44.4 (17.1)		122	48.2 (22.8)	
> 50 years	98	60.5 (33.6)		75	40.0 (18.9)		83	45.5 (26.8)	
Work experience			F = 0.83, p = 0.481			H = 2.77, p = 0.428			F = 6.49, p < 0.001
< 5 years	112	57.1 (28.4)		97	43.7 (16.4)		103	52.4 (23.4)	
5–10 years	67	57.7 (31.0)		55	39.3 (20.8)		58	35.8 (22.5)	
11–20 years	76	61.8 (29.7)		57	45.8 (15.4)		60	45.4 (23.2)	
> 20 years	146	62.1 (29.7)		108	42.7 (17.4)		123	48.4 (24.1)	
Education			F = 6.23, p < 0.001			F = 10.96, p < 0.001			F = 13.59, p < 0.001
Secondary school	34	41.2 (28.5)		26	29.8 (17.7)		24	21.9 (19.9)	
Higher prof. education	112	57.4 (30.1)		86	40.4 (16.1)		93	41.9 (23.9)	
Bachelor degree	242	62.8 (28.5)		197	44.7 (16.8)		215	51.3 (23.0)	
Master degree	11	69.7 (27.7)		8	64.1 (19.4)		8	50.0 (18.9)	
Function			t = 4.05, p < 0.001			t = 4.46, p < 0.001			t = 5.40, p < 0.001
Nurse ^a	377	61.5 (28.9)		297	44.0 (16.9)		324	48.5 (23.7)	
Nursing assistant	37	41.4 (27.7)		27	28.7 (18.3)		27	23.1 (20.7)	
Additional training in PU/ Wound care			t = -0.67, p = 0.503			t = 2.32, p = 0.021			t = -0.03, p = 0.980
Yes	17	54.9 (26.2)		12	54.2 (12.3)		14	46.4 (19.3)	
No	398	59.8 (29.6)		312	42.3 (17.6)		338	46.6 (24.6)	

^a Bachelor degree or higher professional education (=fourth grade of secondary school).

assessment' (97.2% versus 83.2%, $p < 0.001$) and 'Prevention' (54.2% versus 42.3%, $p = 0.021$). They also scored significant higher on questions for which understanding (level 2) (56.0% versus 43.8%, $p = 0.017$) or analysing (level 4) (54.3% versus 37.4%, $p = 0.001$) was necessary.

When comparing participating wards (geriatrics, rehabilitation and ICU), significant differences were found for the total score and the themes 'Prevention', 'Risk assessment' and 'Specific patient groups'. Higher total scores were obtained for participants working on geriatric wards (52.0%, $p = 0.017$) and ICU wards (52.5%, $p = 0.010$) compared to rehabilitation wards (46.6%). For the theme 'Prevention' participants from geriatric wards scored statistically significant higher than rehabilitation wards (45.3% versus 37.9%, $p = 0.011$). The same was for the theme 'Risk assessment' (87.9% versus 79.0%, $p = 0.011$). ICU wards scored significantly higher on the theme 'Specific patient groups' compared to geriatric wards (52.8% versus 43.1%, $p = 0.002$) and rehabilitation wards (52.8% versus 43.4%, $p = 0.005$).

For the themes 'Classification & observation' and 'Risk assessment' significant differences were found in relation to the age of participants. Participants aged under 25 obtained significant higher scores (67.6%) on the theme 'Classification & observation' compared to participants in the age category 25–34 years (52.7%, $p = 0.019$), 35–50 years (48.6%, $p = 0.001$) and > 50 years (49.5%, $p = 0.004$). Related to the theme 'Risk assessment' 25–34 year old participants scored significant lower than participants in the age category 35–50 year (82.2% versus 88.5%, $p = 0.038$). This last category scored consequently significant higher compared to participants > 50 years (88.5% versus 78.4%, $p = 0.002$).

For the theme 'Specific patient groups' a significant difference in knowledge scores was found between participants with less than 5 years of work experience and participants with 5–10 years of work experience (52.4% versus 35.8%, $p < 0.001$). Participants with 5–10 years of work experience scored significantly lower than participants with more than 20 years of work experience (35.8% versus 48.4%, $p = 0.011$).

The education level of participants resulted in statistical significant differences for the total score and all themes, except for the theme 'Risk assessment'. Generally, a higher education level was associated with higher knowledge scores, except for two themes (i.e. 'Risk assessment' and 'Specific patient groups'). No significant differences in scores on questions assessing reproduction (level 1) were found between higher professional education (55.7%), bachelor degree (60.9%) and master degree (62.3%), in contrast to level 2 questions. A higher education level resulted in higher scores on questions assessing the ability to evaluate (level 5).

4. Discussion

The aim of this study was to measure the knowledge of nurses and nursing assistants about PU prevention. The pre-final version of the valid, reliable and up-to-date PUKAT 2.0 instrument was used, consisting of 28 multiple-choice items (covering six relevant themes).

The results showed that the knowledge of nurses and nursing assistants was poor (50.7%), especially related to the themes 'Prevention', 'Aetiology' and 'Specific patient groups'. Inadequate theoretical knowledge was also found in previous research [14,17,30–35,38–42].

Table 5
Knowledge per question level.

	Level 1 ^b		Level 2 ^c		Level 4 ^d		Level 5 ^e		Difference
	mean % (SD)	N							
Overall	57.9 (15.2)	309	44.2 (18.2)	352	38.1 (18.6)	344	66.8 (29.7)	386	F = 1.19, p = 0.312
Age category									
< 25 years	61.4 (11.5)	32	44.4 (16.3)	36	40.1 (17.5)	31	73.1 (26.2)	36	F = 1.40, p = 0.244
25–34 years	57.5 (14.4)	97	43.7 (18.2)	118	36.4 (18.8)	110	65.3 (30.8)	119	
35–50 years	59.0 (16.1)	112	43.0 (17.3)	113	40.4 (18.4)	123	68.9 (29.5)	134	
> 50 years	54.8 (16.2)	68	46.5 (20.2)	83	36.1 (18.5)	78	63.9 (29.4)	95	F = 2.63, p = 0.050
Work experience									
< 5 years	60.4 (12.2)	90	43.1 (18.4)	105	39.6 (18.7)	96	71.0 (28.1)	108	F = 2.18, p = 0.090
5–10 years	56.2 (16.5)	50	43.1 (19.2)	57	32.9 (20.1)	62	58.9 (31.5)	60	
11–20 years	59.2 (16.8)	57	44.8 (16.2)	58	41.6 (16.3)	58	65.7 (31.0)	68	
> 20 years	56.3 (15.8)	105	46.3 (18.1)	122	37.5 (17.6)	120	68.6 (29.4)	137	F = 14.43, p < 0.001
Education									
Secondary school	39.8 (19.0)	21	29.6 (20.9)	28	32.6 (21.6)	25	38.7 (32.3)	31	F = 2.18, p = 0.090
Higher prof. education	55.7 (14.0)	78	40.4 (16.1)	93	35.3 (16.0)	95	62.7 (28.1)	100	
Bachelor degree	60.9 (13.8)	194	46.9 (17.3)	213	39.4 (18.6)	206	72.8 (27.9)	233	
Master degree	62.3 (12.2)	7	63.5 (10.4)	9	44.6 (17.8)	8	71.4 (23.0)	7	t = 1.45, p = 0.148
Function									
Nurse ^a	59.3 (14.0)	287	45.6 (17.3)	322	38.4 (18.3)	317	69.6 (28.1)	350	t = 6.08, p < 0.001
Nursing assistant	39.3 (18.7)	22	28.6 (21.3)	29	33.0 (21.3)	26	39.0 (30.8)	35	
Additional training in PU/Wound care									
Yes	62.1 (11.5)	12	56.0 (13.6)	13	54.3 (18.1)	15	60.0 (28.7)	15	t = 3.50, p = 0.001
No	57.7 (15.4)	297	43.8 (18.2)	339	37.4 (18.3)	329	67.0 (29.7)	371	t = -0.90, p = 0.369

^a Bachelor degree or higher professional education (= fourth grade of secondary school).

^b Remembering.

^c Understanding.

^d Analyzing.

^e Evaluating.

High knowledge scores on the theme 'Risk assessment' was in accordance with previous research [14,15,25,35].

Questions assigned to a higher cognitive level (> level 1) according to the revised version of Bloom's taxonomy [23], and thus requiring critical thinking skills based on knowledge generally resulted in lower mean knowledge scores. This was also found in the study of Kim et al. [43] and Tiemeier et al. [44]. This highlights the need to increase the basic understanding of nurses and nursing assistants related to PU, since the ability to succeed at higher levels of Bloom's taxonomy is due partially to success at lower levels [45].

In line with previous studies [14,28,30,42,46] higher scores were associated with higher levels of education and training. This is however in contrast with the study of Demarré et al. [17], by which knowledge was assessed using the PUKAT instrument [20] and no significant differences in knowledge were found between nurses and nursing assistants [17]. A possible explanation might be the rephrasing of questions and inclusion of patient cases in the PUKAT 2.0 instrument, creating the advantage of evaluating higher levels of knowledge. The fact that no statistical differences were found for level 4 questions when comparing the function (nurse vs. nursing assistant) and education levels of participants might possibly be explained by the nature of the question itself. Higher scores for wound care nurses compared to nurses who did not attend any additional training in wound care were also found in previous research [47]. As a result, organizational support on certification or higher education in wound care is recommended [48].

A difference in scores between the participating wards (geriatrics, rehabilitation and ICU) was found, indicating lower scores for rehabilitation wards (i.e. mean total score of 46.6%). This was not expected and is in contrast to the study of Kaddourah et al. [25] which assessed the knowledge of nurses and other health professionals towards PU prevention in a rehabilitation hospital using the Pressure Ulcer Knowledge Test (PUKT) [49]. A mean percentage score of 75.0% for nurses was found in this study.

The age group < 25 years had significantly higher mean scores on the theme 'Classification and observation' compared to the other age categories. Significant higher mean scores for younger age group participants were also found in the study of Kaddourah et al. [25]. This can be explained by the short time period between the time of graduation and starting to work as a nurse. However, related to the theme 'Risk assessment' participants in the age category 35–50 year had significant higher scores than 25–34 and > 50 year old participants.

Having 5–10 years of work experience resulted in significant lower scores on one theme (i.e. 'Specific patient groups') compared to less than 5 years or more than 20 years of work experience. The relationship between knowledge scores and clinical experience was assessed in the study of Kaddourah et al. [25], which was not significant. Pancorbo-Hidalgo et al. [28] analyzed the influence of professional experience on nurses' knowledge and found significant differences between professionals with 2–5 and 5–10 years experience compared to less experienced nurses, the latter having lower knowledge scores. Nurses with over 20 years of professional activity showed a statistical decrease in knowledge scores [28]. This can be explained by a possible imbalance between practical and theoretical knowledge. Based on the literature review of Suva et al. [50] it can be stated that the current evidence with respect to the impact of clinical experience on nurses' knowledge about PU is unclear.

The results of this study highlight important knowledge deficits related to PU prevention. Consequently, strategies need to be developed to improve nurses' and nursing assistants' knowledge in the first place and clinical practice in the second place. The Education Committee of the European Wound Management Association (EWMA) developed and disseminated a curricular framework that incorporates various aspects of wound management in a number of education models, including the module 'Prevention and Management of PU' [51]. A combination of intellectual and practical skills is recommended through the combination of lectures, workshops and learning practice. Varying methods of

education strategies should be used in order to meet diverse learning needs [52,53]. According to the EWMA an education module on the prevention and management of PU should include following themes: epidemiology, anatomy, pathophysiology, principles of patient care, assessment, risk factor management, prevention of PU, wound management of PU, management of infection, specialist interventions, systemic and local pharmacological management, rehabilitation service and psychosocial aspects of care [51]. However, those themes are perhaps currently not all included in the nursing curriculum, which should be considered further. Profound knowledge of theoretical frameworks and pathophysiological mechanisms is needed to gain insight in which preventive measures should be applied as well as the underlying reason. Therefore, evidence based training in PU prevention at the organizational level should be mandatory at orientation and on a yearly basis [48]. Based on the research of Ousey et al. [54] and in accordance to the Theory of Planned behaviour [18,19] it can be stated that training has a positive effect on confidence and competence in PU management. Also starting from the Social Cognitive Theory [13] where skills, self-efficacy and outcome expectancies are primary personal concepts for understanding behaviour, training and education is of utmost importance.

Since implementation of PU best practices is influenced by multiple factors [50] and higher knowledge does not necessarily result in better practice [14,25,26,31,32], also other influencing factors such as time management, staff shortages, absence of policy and guidelines [24,42,55,56] should be taken into account to obtain a higher quality of care. Facilitators to guideline implementation and thus clinical practice might be group interaction, positive attitudes and beliefs, leadership support, presence of champions, teamwork and (inter-organizational) collaboration and support from a professional association [57]. Next, evaluation of the availability, quality and standards for use of PU prevention and treatment equipment is recommended, together with regular evaluation of organizational performance in PU prevention and treatment and the provision of feedback to stakeholders. To gain insight in the quality of care being delivered, quality indicators need to be used. Consequently, improvement initiatives can be developed which can be again monitored [1]. Quality indicators can be categorized into structure (evaluation at the level of the care setting), process (evaluation at the level of care) and outcome (evaluation at the level of the individual patient) [58]. To improve clinical practice, a structured, tailored and multi-faceted strategy will need to be developed [1].

4.1. Limitations

The assessment of knowledge about PU prevention by using an instrument covering a wide range of relevant topics related to PU prevention can be seen as a strength since it facilitates the detection of bottlenecks. Consequently, educational needs can be highlighted. Despite the tool is easy to administer, the inclusion of 28 items can be seen as a possible disadvantage resulting in an instrument which is too time consuming to complete. For this study the pre-final version of the PUKAT 2.0 was used, given the fact that the validation process was still ongoing at the moment of study start-up. However, this version integrated the recent guidelines and was able to measure the knowledge of nurses and nursing assistants conform these recently published National and International guidelines. Differences between the pre-final version and the final version are minimal and can be found in reformulations of the stem (13 items), reformulations of the response alternatives (15 items) and the exclusion of items (1 in the theme 'Aetiology' and 2 in the theme 'Specific patient groups').

5. Conclusion

Knowledge about pressure ulcer prevention of nurses and nursing assistants was suboptimal. The PUKAT 2.0 knowledge assessment tool allowed to differentiate between a variety of cognitive process levels.

This allowed to identify knowledge gaps and focus areas for continuing professional education. Education curricula for nurses and associated healthcare professionals are to be screened thoroughly and the identified knowledge gaps should be covered. Besides, multifaceted strategies (including education) are needed to improve clinical practice.

Declarations of interest

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