

## Nurse students' competences in interprofessional pharmaceutical care in Europe: Cross-sectional evaluation

Elyne De Baetselier<sup>a,\*</sup>, Nienke E. Dijkstra<sup>b,2,3</sup>, Luis M. Batalha<sup>c,4</sup>, Paulo A. Carvalho Ferreira<sup>c</sup>, Izabela Filov<sup>d</sup>, Vigdis A. Grøndahl<sup>e</sup>, Jana Heczkova<sup>f</sup>, Ann K. Helgesen<sup>e</sup>, Jo Hirdle<sup>g</sup>, Sue Jordan<sup>h</sup>, Petros Kolovos<sup>i</sup>, Gero Langer<sup>j</sup>, Sabina Ličen<sup>k</sup>, Manuel Lillo-Crespo<sup>l,5</sup>, Alba Malara<sup>m</sup>, Hana Padyšáková<sup>n</sup>, Mirko Prosen<sup>k,6</sup>, Dorina Pusztai<sup>o</sup>, Bence Raposa<sup>o</sup>, Jorge Riquelme-Galindo<sup>l,7</sup>, Jana Rottková<sup>n</sup>, Carolien G.M. Sino<sup>b,8</sup>, Francesco Talarico<sup>m</sup>, Styliani Tziaferi<sup>i</sup>, Bart Van Rompaey<sup>a,9</sup>, Tinne Dilles<sup>a,10</sup>

<sup>a</sup> Faculty of Medicine and Health Sciences, University of Antwerp, Antwerp, Belgium

<sup>b</sup> University of Applied Sciences Utrecht, Research Centre Healthy and Sustainable Living, Utrecht, the Netherlands

<sup>c</sup> Higher School of Nursing of Coimbra, Health Sciences Research Unit: Nursing, Coimbra, Portugal

<sup>d</sup> University "St.Kliment Ohridski" Bitola, Republic of North Macedonia

<sup>e</sup> Østfold University College, Faculty of Health and Welfare, Halden, Norway

<sup>f</sup> Institute of Nursing Theory and Practice, First Faculty of Medicine, Charles University, Prague, Czech Republic

<sup>g</sup> Faculty of Health and Social Sciences, Bournemouth University, England, UK

<sup>h</sup> Faculty of Medicine, Health and Life Science, Swansea University, Wales, UK

<sup>i</sup> Department of Nursing, Laboratory of Integrated Health Care, University of Peloponnese, Tripolis, Greece

<sup>j</sup> Medical Faculty, Institute of Health and Nursing Sciences, Martin-Luther-Universität Halle-Wittenberg, Halle (Saale), Germany

<sup>k</sup> University of Primorska, Faculty of Health Sciences, Department of Nursing, Izola, Slovenia

<sup>l</sup> Department of Nursing, Alicante University, Alicante, Spain

<sup>m</sup> ANASTE-Humanitas Foundation, Rome, Italy

<sup>n</sup> Faculty of Nursing and Professional Health Studies, Slovak Medical University in Bratislava, Bratislava, Slovakia

<sup>o</sup> Institute of Nursing Sciences, Basic Health Sciences and Health Visiting, University of Pecs Faculty of Health Sciences, Pecs, Hungary

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### ABSTRACT

**Background:** Safe pharmaceutical care requires competent nurses with specific knowledge, skills and attitudes. It is unclear whether nursing students are adequately prepared to perform pharmaceutical care in practice.

\* Corresponding author.

*E-mail addresses:* [elyne.debaetselier@uantwerpen.be](mailto:elyne.debaetselier@uantwerpen.be) (E. De Baetselier), [nienke.dijkstra@hu.nl](mailto:nienke.dijkstra@hu.nl) (N.E. Dijkstra), [batalha@esenfc.pt](mailto:batalha@esenfc.pt) (L.M. Batalha), [palex@esenfc.pt](mailto:palex@esenfc.pt) (P.A.C. Ferreira), [belafilov@gmail.com](mailto:belafilov@gmail.com) (I. Filov), [vigdis.a.grondahl@hiof.no](mailto:vigdis.a.grondahl@hiof.no) (V.A. Grøndahl), [jana.heczkova@lf1.cuni.cz](mailto:jana.heczkova@lf1.cuni.cz) (J. Heczkova), [ann.k.helgesen@hiof.no](mailto:ann.k.helgesen@hiof.no) (A.K. Helgesen), [jhirdle@bournemouth.ac.uk](mailto:jhirdle@bournemouth.ac.uk) (J. Hirdle), [s.e.jordan@swansea.ac.uk](mailto:s.e.jordan@swansea.ac.uk) (S. Jordan), [petroskolovos@yahoo.gr](mailto:petroskolovos@yahoo.gr) (P. Kolovos), [gero.langer@medizin.uni-halle.de](mailto:gero.langer@medizin.uni-halle.de) (G. Langer), [sabina.licen@fvz.upr.si](mailto:sabina.licen@fvz.upr.si) (S. Ličen), [manuelillocrespo@gmail.com](mailto:manuelillocrespo@gmail.com) (M. Lillo-Crespo), [albamalara@gmail.com](mailto:albamalara@gmail.com) (A. Malara), [hana.padysakova@szu.sk](mailto:hana.padysakova@szu.sk) (H. Padyšáková), [mirko.prosen@fvz.upr.si](mailto:mirko.prosen@fvz.upr.si) (M. Prosen), [dorina.pusztai@etk.pte.hu](mailto:dorina.pusztai@etk.pte.hu) (D. Pusztai), [bence.raposa@etk.pte.hu](mailto:bence.raposa@etk.pte.hu) (B. Raposa), [jrgrqlm@gmail.com](mailto:jrgrqlm@gmail.com) (J. Riquelme-Galindo), [jana.rottkova@szu.sk](mailto:jana.rottkova@szu.sk) (J. Rottková), [c.m.g.Sino-2@umcutrecht.nl](mailto:c.m.g.Sino-2@umcutrecht.nl) (C.G.M. Sino), [france.talarico12@gmail.com](mailto:france.talarico12@gmail.com) (F. Talarico), [stylianitziaferi216@gmail.com](mailto:stylianitziaferi216@gmail.com) (S. Tziaferi), [bart.vanrompaey@uantwerpen.be](mailto:bart.vanrompaey@uantwerpen.be) (B. Van Rompaey), [tinne.dilles@uantwerpen.be](mailto:tinne.dilles@uantwerpen.be) (T. Dilles).

<sup>1</sup> Twitter @ebaetselier.

<sup>2</sup> Shared first author.

<sup>3</sup> Twitter @dijkstrane.

<sup>4</sup> Twitter @lusbatalha5.

<sup>5</sup> Twitter @manuelilloc.

<sup>6</sup> Twitter @mirkoproosen.

<sup>7</sup> Twitter @riquelmejg.

<sup>8</sup> Twitter @caroliensino.

<sup>9</sup> Twitter @bartrompaey.

<sup>10</sup> Twitter @tinnedilles.

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Skills  
Attitudes  
Education  
Pharmaceutical care

Mapping their pharmaceutical care competences can lead to a better understanding of the extent to which curricula fit expectations of the labour market.

**Objectives:** To assess pharmaceutical care competences of final-year nursing students of different educational levels.

**Design:** A cross-sectional survey design.

**Settings:** In 14 European countries, nursing schools who offer curricula for level 4 to 7 students were approached.

**Participants:** Through convenience sampling 1741 final-year student nurses of level 4 to 7 were included. Sampling strategies were country-specific.

**Methods:** A web-platform was developed with an assessment of the level in which students mastered pharmaceutical care competences. Knowledge questions, case studies (basic/advanced level), self-reported practical skills and attitudes were evaluated.

**Results:** Mean scores for knowledge questions differed significantly ( $p < 0.001$ ) between level 5 (56/100), level 6 (68/100) and level 7 students (72/100). For basic cases level 5 students reached lower scores (64/100) compared with level 6 (71/100) and level 7 (72/100) students ( $p = 0.002$  and  $p = 0.005$ ). For more advanced cases no difference between levels was observed (overall mean 61/100). Most students (63–90 %) considered themselves skilled to perform pharmaceutical care and had positive attitudes towards their participation in pharmaceutical care (65–97 %).

**Conclusions:** Relatively low knowledge scores were calculated for final-year student nurses. In some domains, lower levels of students might be insufficiently prepared to take up responsibilities in pharmaceutical care. Our assessment can be used as a tool for educators to evaluate how prepared nursing students are for pharmaceutical care. Its further implementation for students of different educational levels will allow benchmarking between the levels, both within and between countries.

## 1. Introduction

Nurses are one of the healthcare professionals with an important contribution to pharmaceutical care. Pharmaceutical care has been defined by Hepler and Strand (1990) as “the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient’s quality of life” and “it involves the process through which a pharmacist co-operates with a patient and other professionals in designing, implementing and monitoring a therapeutic plan that will produce specific therapeutic outcomes”. The collaboration of pharmacists with other health professionals involves mainly nurses and physicians and has been acknowledged as key to optimise this care aspect (Choo et al., 2010; Council of Europe, 2020).

Nurses work in a variety of settings and have different qualification levels ranging from level 4 to 7 according to the European Qualification Framework (EQF) (European Centre for the Development of Vocational Training, 2021). The national policies on nurses’ role differ throughout Europe and affect nurses’ pharmaceutical care activities. In some countries these activities are also dependent on their educational level and not all levels exist for nurses in every country. From a historical viewpoint, nurse activities have been shifted from preparing and administering medicines under supervision of physicians to multiple pharmaceutical care activities and even task shifting from physicians to nurses (Maier and Aiken, 2016). A study about nurses’ role in inter-professional pharmaceutical care presented a framework describing up to 26 nursing activities, such as, recognising and preventing risks, complications and medication errors, communication and discussion with patients or family, ensuring transitional care collaboration and communication, and inter/intraprofessional collaboration (De Baetselier et al., 2021). For each of these activities, nurses need competences. A competence can be defined as “a coherent cluster of knowledge, skills, and attitudes which can be utilised in real performance contexts” (Mulder, 2014, (page 3)). The acquisition of professional competences is an ongoing process of developing knowledge, skills, and attitudes, starting during nurse education and continuing in practice. According to Dijkstra et al. (2021) 60 competences are necessary to perform nurse activities in pharmaceutical care. For example, nurses need to be aware of the role of each healthcare professional and they need knowledge about which professional should be contacted. Besides, the nurses need skills to communicate clearly and they need self-confidence to communicate. It is, however, unclear to what extent student nurses are prepared to apply these competences in clinical practice. These competences are essential to providing safe and effective care. In addition,

international labour mobility also increases the importance of evaluating the fit of nurse education and competences with expectations from the labour market. The Bologna Declaration of 1999 promoted the mobility of students and academics between institutions and European countries, requiring comparable, compatible and coherent systems (The European higher education area, 1999). Yet, differences in the content of nurse education may hinder adequate education and labour mobility of European nurses, which could impact care quality. The content of curricula regarding nurse competences in pharmaceutical care differs between levels of education (Sulosaari et al., 2014), and current education offers insufficient opportunities to gain an acceptable level of pharmaceutical care knowledge (Jordan et al., 1999; Manias and Bullock, 2002). Improvements in nurse education have been recommended (Dilles et al., 2011; Jordan et al., 1999; Simonsen et al., 2014; Sino et al., 2013). Comparing nursing students’ pharmacological knowledge and calculation skills between EQF levels (specifically level 5 and 6 students), showed level 5 students scored statistically significantly lower (57 %) than level 6 students (61 %) (Dilles et al., 2011). The clinical relevance of this 4 % difference is uncertain, yet it is an indication to further investigate the differences in competences between educational levels. In this way also the strengths of each educational level, can help us to deploy nursing staff aligned with their competences.

Research on the impact of deficient pharmaceutical care education is scarce. When reviewing research beyond pharmaceutical care, more evidence is available. Several studies suggest nurse education having a significant influence on patient outcomes, such as in-hospital mortality (Aiken et al., 2014; Haegdorens et al., 2019; Kane et al., 2007).

This study is the last part of the European Commission funded DeMoPhaC project, an international collaboration to investigate nurses’ roles and competences in Europe. The aim of this study was to assess pharmaceutical care competences of final-year student nurses, who are expected to be optimally prepared to function as qualified nurses in pharmaceutical care practice in the near future.

## 2. Methods

### 2.1. Study design

A cross-sectional survey was used to assess pharmaceutical care competences in final-year nurses of different educational levels.

## 2.2. Participants and setting

In fourteen European countries pharmaceutical care competences in student nurses were evaluated: Belgium, Czech Republic, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Portugal, the Republic of North Macedonia, Slovakia, Slovenia, Spain, and the United Kingdom (Wales and England only). Convenience sampling was performed in 112 nursing schools, who offered an educational programme for EQF level 4 (only in the Netherlands), level 5, level 6 or level 7 students (European Centre for the Development of Vocational Training, 2021). Institutions were approached based on their proximity to the researchers in the different countries. Final-year students were selected based on their willingness to participate after having been informed about the study by a researcher and/or a teacher. Students were assessed during the final year, assuming (almost) the entire curriculum had been covered.

## 2.3. The digital survey

The CHERRIES statement, a checklist for reporting web-based surveys (Eysenbach, 2004), was used to describe the survey development and application. The questions were developed in consultation with all DeMoPhaC-partners. The survey consisted of an introductory part with questions about demographics, educational level and the combination of studying and working in healthcare, followed by the main part of the survey: an assessment of student nurses' competences in pharmaceutical care (Supplementary material Fig. 1 and Supplementary material appendix 1).

### 2.3.1. Nurses' competences in pharmaceutical care

Nurses' competences included pharmaceutical care knowledge, skills, and attitudes derived from the pharmaceutical care competence framework of Dijkstra et al. (2021). To assess these competences, a broad item pool of 82 knowledge questions, 42 skills questions and 32 attitude questions was developed based on literature search (Jordan and Torrance, 1996; Moloney et al., 2020; Rosenberg, 1965; Rosenthal and Burchum, 2020). Most competence questions were formulated as examples of pharmaceutical care situations in practice. Knowledge was assessed by multiple choice questions with four answering options, including 'I don't know'. Self-reported skills and attitudes had to be indicated on a 4-point Likert scale from strongly disagree to strongly agree. An education specialist from the Netherlands evaluated (face validity) the questions and advised about further validation and pilot testing. Afterwards, all questions were presented to fourteen experts in clinical practice, nurse education and research. They were asked to rate the relevance of all questions on a 4-point Likert scale from not relevant to highly relevant (Lynn, 1986). The 'item content validity index' (I-CVI), corresponded to the number of experts scoring quite or highly relevant divided by the number of participating experts ( $n = 14$ ). Items with an I-CVI  $< 0.80$  were removed from the item pool, resulting in the removal of 30 knowledge questions, 26 skills questions and 17 attitudes questions. In addition, the experts were asked to advise about the level of difficulty of each knowledge question. A basic or advanced level of difficulty could be assigned. The mode of all expert assessments determined the final level per question. Advanced level questions were only offered to students with at least 75 % correct basic questions. The final assessment comprised 18 knowledge questions about pharmaceutical care; 34 knowledge questions relating to clinical cases (one mental health patient, one internal medicine/elderly care patient, and one surgical patient); 16 questions about pharmaceutical care skills and 12 about pharmaceutical care attitudes (Supplementary material Fig. 1).

Finally, the survey was translated by the members of the national research teams into 13 languages for use in local languages. A pilot test was performed by six Belgian, Dutch and Italian students to perform face validity of the measuring instrument. No major adaptations were requested. Data of these pilot students were not used in the data analysis of this study.

## 2.4. Data collection

Between January and April 2021 data were collected. Overall, 112 institutions were asked to encourage their students to take part. The online survey was available on a website, especially developed to support this study. The online platform design improved the attractiveness of the assessment and students were able to select case studies that best matched their own practice experiences. Additionally, the website offered possibilities to compare results with other students through benchmarking graphs. The user-friendliness of the survey was enhanced by giving the students pausing and restarting options. In each country local data collection strategies were considered to maximise data collection, taking into account restrictive measures and online education, due to the COVID pandemic.

## 2.5. Data analysis

Only students who completed at least all 18 knowledge questions were included in the analysis. Data were analysed using IBM SPSS Statistics v.28.0®. A two-sided level of significance of 0.05 was used. Discontinuous data were described using frequency distributions; continuous data were described using a descriptive analysis (median, minimum, maximum (demographical data) or mean value and standard deviation (knowledge scores)). Normality of the distributions was tested with absolute values of skewness and kurtosis or with Z-scores depending on the (sub)sample size (Kim, 2013). To evaluate student nurses' knowledge, sum scores were calculated for knowledge questions and case questions and presented as percentages to compare scores. Differences in competences between levels 4–7 student nurses were explored. In the Netherlands, Norway, Wales and Portugal there are no level 5 students. Level 4 students were only included in the Netherlands. To evaluate the statistical significance of the differences between the educational levels, one-way ANOVA (with Bonferroni post hoc tests) for normally distributed scale variables (knowledge scores) and Kruskal-Wallis for ordinal variables (skills and attitudes) or not normally distributed scale variables were used.

## 2.6. Ethical considerations

The Ethics Committee for Social Sciences and Humanities of the University of Antwerp approved the study design (Reference SHW\_20\_63). Depending on local regulations, in some countries additional approval was obtained: College of Human and Health Sciences Research Ethics Committee, Swansea University (reference 301120a); Comissão de Ética da UICISA-E da ESEnFC, Coimbra (Reference P747/01); Medical Ethics Committee of the Republic of Slovenia (Reference 0120-516/2018/6). All respondents received information on the purpose, design and execution of the study. At the start of the digital questionnaire, all respondents had to indicate they had read the study information and consented to participate. Without any obligation, students could create a personal account on the website. The registration enabled the provision of certificates after the assessment, and created the possibility for participants to pause the survey and continue later. The data collection in students without personal accounts was completely anonymous. Personal data of students with an account were pseudonymized to ensure privacy. Finally, in Italy, one ECTS credit (European Credit Transfer and Accumulation System) was offered to each student that completed the assessment, in order to enhance data collection.

## 3. Results

### 3.1. Research population

A total of 3262 students consented to participate, of which 47 % quitted before having answered the first 18 knowledge questions. These

students ( $n = 1521$ ) were excluded from analyses. Excluded students were mostly Italian (21 %), Belgian (16 %), or Dutch (11 %). Age, work experience and weekly working hours did not differ between excluded and included students. Women had more incomplete questionnaires (29 %) than men (21 %,  $p < 0.001$ ). Also, students, combining their studies with a job broke off the survey more often early (34 %), then fulltime students (23 %,  $p < 0.001$ ).

In total, 1741 students from 14 European countries participated in the study, although predominantly Italians (d70 %). The mainly female (77 %) sample consisted of 1 % level 4 students, 6 % level 5, 81 % level 6, and 12 % level 7. Median age was 23 years (range 18–62). More than one quarter of the students were combining their studies with a job in healthcare, with a median of 36 (range 3–55) weekly working hours, if they both worked and studied (Table 1). A comparison between the Italian sample and other European students showed more male students were included (25 %) than in the rest of Europe (17 %,  $p < 0.001$ ). Italians were younger (22 vs 24 years,  $p < 0.001$ ), had less experience in healthcare (0 vs 3 years,  $p < 0.001$ ) and they combined their studies less often (20 %) with a job in healthcare than their student colleagues in other countries (48%,  $p < 0.001$ , Supplementary material appendix 2).

### 3.2. Pharmaceutical care competences in nurse education

On a self-report scale from 0 to 5, the mean competence score in pharmaceutical care was 2.9 (SD 1.3), without difference between Italian and non-Italian students ( $p = 0.949$ ). In the next paragraphs, we elaborate on the assessment of student nurses' pharmaceutical care knowledge and their self-reported pharmaceutical care skills and attitudes.

#### 3.2.1. Pharmaceutical care knowledge of student nurses

Mean scores for knowledge questions were 9.9/18 (or 55 %) for level 4 students, 10/18 (or 56 %) for level 5, 12/18 (or 68 %) for level 6 and 13/18 (or 72 %) for level 7, without difference between level 4–5, but a significant difference between all other groups (all  $p < 0.001$ , Table 2).

**Table 1**  
Population characteristics ( $n = 1741$ ).

	All ( $n = 1741$ )	Level 4 students ( $n = 20$ )	Level 5 students ( $n = 100$ )	Level 6 students ( $n = 1417$ )	Level 7 students ( $n = 204$ )
<b>Country/State, %</b>					
Italy	69.8	0	0	78.1	53.4
Belgium	6.1	0	47.0	3.5	4.4
Spain	3.6	0	4.0	3.2	6.4
Republic of North Macedonia	3.4	0	15.0	1.8	9.3
Greece	3.1	0	5.0	3.1	2.5
The Netherlands	2.5	100	0	1.7	0
Portugal	2.2	0	0	2.0	4.9
Germany	1.7	0	16.0	0.8	1.0
Slovakia	1.4	0	0	1.4	2.5
Slovenia	1.4	0	2.0	0.8	5.4
Slovenia	1.3	0	8.0	0.8	2.3
UK – England	1.0	0	0	1.2	0
UK – Wales	1.0	0	2.0	0.6	3.9
Hungary	0.7	0	0	0.6	2.5
Norway	0.5	0	1.0	0.4	1.5
Czech Republic					
<b>Gender, %</b>					
Male	22.3	10.0	10.0	23.4	21.6
Female	76.9	90.0	88.0	75.9	77.5
Other <sup>a</sup>	0.8	0	2.0	0.7	1.0
<b>Age (years), median (min-max)</b>	23.0 (18–62)	22.0 (20–54)	27.0 (18–58)	22.0 (18–62)	30.0 (22–60)
<b>Experience HC (years), median (min-max)</b>	0 (0–40)	4 (1–34)	3 (0–38)	0 (0–36)	6 (0–40)
<b>Combining studies + job HC (yes), %</b>					
Working hours HC/week, median (min-max)	28.1 (3–55)	95.0 (8–40)	35.0 (5–48)	19.3 (3–55)	78.9 (6–50)

HC = healthcare. a transgender male, transgender female, gender nonbinary, self-defined, prefer not to say or 'other'.

Only 0.3 % of the students answered all questions correctly. Level 6–7 Italians had higher mean scores (69 %) than non-Italian level 6–7 students (64 %,  $p < 0.001$ , Supplementary material appendix 3). Taking into account non-Italian students only, differences between level 5–6 (56 % vs 63 %,  $p = 0.001$ ) and 5–7 (56 % vs 68 %,  $p < 0.001$ ) were observed.

For knowledge questions about specific practice cases, mean scores on 100 were respectively 74, 64, 71 and 72 ( $p = 0.002$  between level 5–6;  $p = 0.005$  between level 5–7) for the 'basic' questions and 71, 58, 60 and 61 ( $p = 0.099$ ) for the 'advanced' questions. Less than 1 % of the students reached maximum scores for basic (0.7 %) or advanced (0.3 %) cases (Table 2). Fig. 1 presents knowledge scores in each country, and a comparison between levels of education.

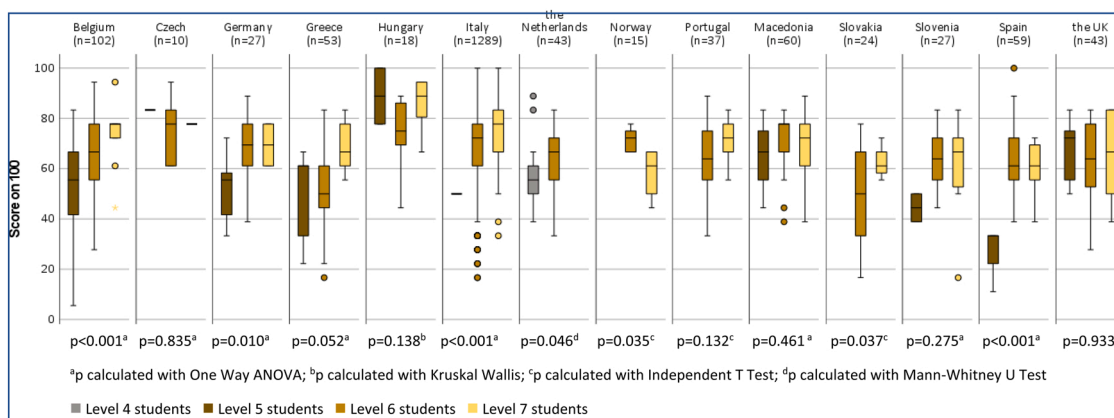
#### 3.2.2. Self-reported pharmaceutical care skills

Student nurses were asked to self-assess their current pharmaceutical care skills. The majority considered themselves sufficiently skilled to perform pharmaceutical care-related tasks: depending on the task, 10–37 % of the students reported limited skills. The task 'proposing initiation or discontinuation of certain medicines' was assessed by 37 % of the students as a task for which they felt insufficiently skilled. Also, a quarter of the students did not feel skilled enough to take follow-up steps for drug-related problems (28 %) and to take appropriate actions to avoid side effects (26 %). On the other hand, almost all students found they were able to motivate patients to continue their medication therapy (89 %), to empower patients to take medicines correctly (89 %) and to question patients' home medication (90 %) (Fig. 2). Some differences were seen in self-reported pharmaceutical care skills between level 4–7 students, however, for most skills no difference was detected (Supplementary material Fig. 2). Similarly, comparisons within countries showed hardly any differences between levels of education (Supplementary material appendix 4). Only in Italy significantly more level 7 students felt skilled compared to level 6 students for several self-assessed skills ( $p < 0.05$ , Supplementary material appendix 4). In contrast, comparisons between countries showed significant differences for all

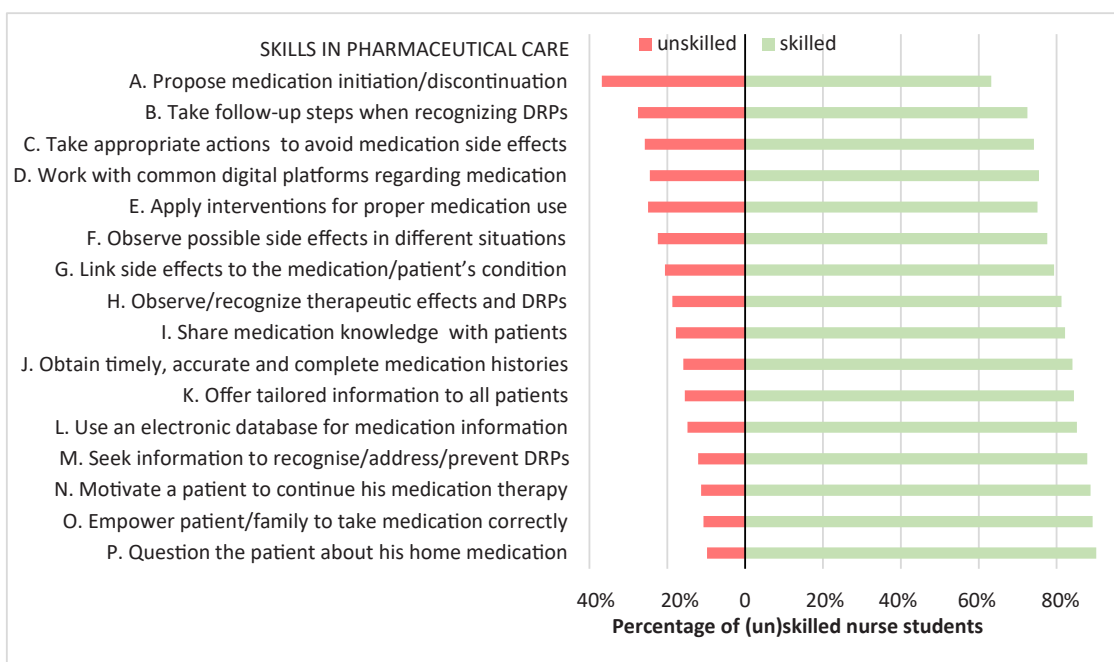
**Table 2**  
Mean pharmaceutical care knowledge scores of level 4–7 student nurses.

	All students Mean/100 (SD)	Level 4 Mean/100 (SD) n = 20	Level 5 Mean/100 (SD) n = 100	Level 6 Mean/100 (SD) n = 1417	Level 7 Mean/100 (SD) n = 204	p-value
Case 1: psychiatric ward	71.2 (18.7)	81.4 (26.6)	73.9 (25.0)	70.8 (18.5)	72.3 (16.3)	NS
Basic questions (n = 1584)	66.1 (23.1)	78.8 (22.5)	73.3 (24.1)	65.5 (23.1)	66.4 (22.4)	NS
Advanced questions (n = 1456)						
Case 2: internal medicine & geriatrics	69.7 (19.2)	58.3 (21.4)	59.9 (25.9)	69.8 (18.9)	73.6 (16.7)	< 0.001 <sup>b,c,d</sup>
Basic questions (n = 1562)	66.8 (24.0)	72.7 (26.1)	63.7 (25.3)	66.7 (24.1)	67.9 (22.4)	NS
Advanced questions (n = 1425)						
Case 3: surgical medicine	77.5 (18.7)	81.3 (16.1)	68.4 (24.9)	77.6 (18.5)	80.1 (16.8)	< 0.001 <sup>c,d</sup>
Basic questions (n = 1541)	61.3 (19.1)	72.5 (15.9)	63.6 (15.2)	60.7 (19.3)	64.5 (18.2)	NS
Advanced questions (n = 1431)						
Overall knowledge scores	71.2 (16.8)	74.1 (16.2)	64.0 (22.2)	71.4 (16.1)	71.9 (18.4)	0.003 <sup>c,d</sup>
Basic questions (n = 1605)	60.5 (18.5)	71.3 (12.3)	57.5 (21.1)	60.4 (18.5)	61.2 (17.8)	NS
Advanced questions (n = 1521)	67.3 (14.7)	55.0 (18.0)	55.6 (18.7)	67.5 (14.0)	72.2 (13.5)	< 0.001 <sup>a,b,c,d,e</sup>
General questions (n = 1718)						

p calculated with One-Way ANOVA + Bonferroni post hoc test (NS = not significant; <sup>a</sup>significant difference between level 4–6; <sup>b</sup>significant difference between level 4–7; <sup>c</sup>significant difference between level 5–6; <sup>d</sup>significant difference between level 5–7; <sup>e</sup>significant difference between level 6–7.



**Fig. 1.** Boxplots for scores (on 100) about general pharmaceutical care knowledge of different levels of student nurses split up for 14 European countries.



**Fig. 2.** Percentages of student nurses reporting to be unskilled (red bars) or skilled (green bars) to perform pharmaceutical care skills in 14 countries (n = 1401).

but two skills. Relatively fewer German and Greek students assessed themselves skilled in pharmaceutical care than other European students (Supplementary material appendix 4). Finally, significantly more non-Italian students reported to seek information and take follow-up steps when recognising drug-related problems (respectively 92 % vs 87 %;  $p = 0.019$  and 78 % vs 71 %;  $p = 0.017$ ), and to have the skills to work with common digital medication platforms (80 % vs 74 %;  $p = 0.037$ ).

### 3.2.3. Self-reported pharmaceutical care attitudes

All but one of the attitude-related statements were self-assessed as positive attitudes by more than 80 % (range 80–97 %) of the students. Indeed, most student nurses (80 %) were satisfied with the pharmaceutical care they provided, and they believed they could provide pharmaceutical care just as well as other final-year students (81 %). Students were confident to address drug-related problems (80 %), to provide therapeutic education (84 %), and to inform prescribers in case of required medication adjustments (92 %). Another positive attitude, indicated by 93 % of the students, was the attitude to contact a nurse mentor, physician, or pharmacist when searching for alternative treatments. Almost all students (95 %) considered ‘providing therapeutic education when starting new medication’ as their responsibility, and even more students (97 %) found it important to ask patients whether they understood medication-related information. Finally, the majority of the students would look up how to prepare medicines, if they did not know how to do so (96 %).

A more negative attitude was reported by 35 % of the future nurses: they did not believe that patients have as much to say in their medication therapy as physicians and nurses (Fig. 3). This attitude did not differ between level 4–7 students ( $p = 0.114$ ). Some differences were seen in self-reported pharmaceutical care attitudes between student levels, where more level 6 students reported negative attitudes compared with level 5 and 7 ( $p < 0.05$ ). However, for most attitudes no difference could be detected between educational levels (Supplementary material Fig. 3).

Intra-country comparisons between levels of education only showed differences in attitudes of Italian students. There, level 7 students reported significantly more positive attitudes toward performing pharmaceutical care than level 6 students. Cross-country comparisons showed less German students had positive attitudes in pharmaceutical care than other European students. Finally, more non-Italian students felt they could provide pharmaceutical care as well as other students (86 %) compared to Italian students (80 %,  $p = 0.021$ ) and also more non-Italians would look up medication preparation (99 % vs 96 %,  $p = 0.021$ ) (Supplementary material appendix 5).

## 4. Discussion

This study aimed to assess pharmaceutical care competences of final-year nursing students. Only 0.3 % of the students were able to answer all knowledge questions correctly. Also less than 1 % reached maximum scores for basic or advanced practice cases. Mean scores were 67 % for pharmaceutical care knowledge, 71 % for basic cases and 61 % for advanced cases. No significant difference existed between level 4 and 5 scores. Though, level 5 students reached lower scores than level 6 students, who in turn also scored lower than level 7 students. Most students considered themselves skilled to perform pharmaceutical care and reported positive attitudes towards their participation in pharmaceutical care.

Our study surveyed a large sample of European students, two-thirds of whom were Italian. The reason for this preponderance of Italians was the offer of one ECTS-credit per Italian student. This greatly boosted the Italian data collection but skewed our ‘European’ data. However, our analyses allowed to rule out the possibility that the results would be too much Italian and too little European. Reporting the results of our data-analysis from different perspectives to still draw transparent conclusions about the pharmaceutical care competences of European student nurses. Indeed, we always reported differences between Italian and non-Italian respondents. Also, we have shown both overall ‘European’ analyses, as well as intra-country and between-country analyses. In doing so, we found small, though not dominant, differences between Italians and other nationalities regarding self-reported skills and attitudes. For pharmaceutical care knowledge more clear differences were seen: Italian student nurses scored better for basic practice cases (73 % vs 67 %) and for non-case related pharmaceutical care knowledge (69 % vs 64 %). These higher Italian scores were seen in both level 6 and 7 students. As a result, the rather disappointing knowledge scores, that were calculated for final-year student nurses, were probably even an over-estimation of the current ‘European’ student’s knowledge.

Previous research already demonstrated that student nurses’ pharmacological knowledge and calculation skills are limited; comparing EQF levels, showed level 5 scored significantly lower (57 %) than level 6 (61 %) (Dilles et al., 2011). Several other studies have addressed deficiencies in registered nurses’ medication competences (Aitken et al., 2006; Cabilan et al., 2016), yet, studies about student nurses’ pharmaceutical care competences are scarce. Most studies investigate parts of pharmaceutical care, such as medication calculation skills, without looking at pharmaceutical care beyond medication preparation and administration (Ardahan-Akgül et al., 2019; Stolic, 2014). An older study among Finnish nurses and students did elaborate more broadly on

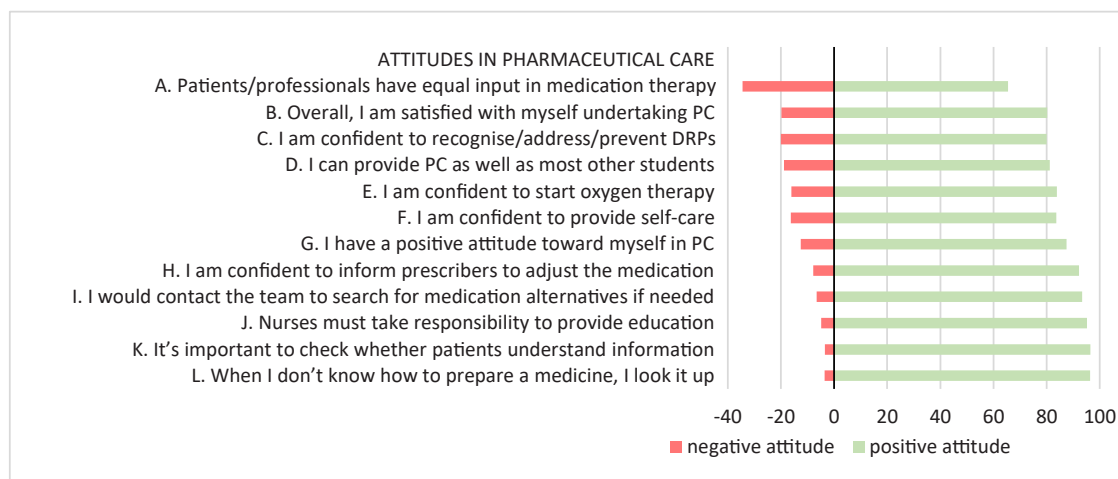


Fig. 3. Percentages of student nurses having negative (red bars) or positive (green bars) attitudes towards performing pharmaceutical care in 14 countries ( $n = 1389$ ).

pharmaceutical care skills. They found pharmacokinetics and pharmacodynamics were rated as least well known pharmaceutical care areas (Grandell-Niemi et al., 2005). More up-to-date research in more countries is needed to extend the current body of evidence about student nurses' pharmaceutical care competences. Also, the further implementation of our assessment will allow benchmarking between different EQF levels, both within and between countries. Most importantly, it will allow to detect mismatches between competences required in the labour market and those resulting from current curricula. Given the relatively low mean scores we calculated, we presume curricula gaps, indicating the need to reconsider current pharmaceutical care offers.

Across Europe, levels of nurse education are embedded in different legal contexts. Our study showed room for improvement in pharmaceutical care knowledge in all education levels, and by far the most in level 5 nurses. These findings suggest that lower levels of student nurses might be insufficiently prepared to take up responsibilities in some domains of pharmaceutical care. This was also demonstrated by earlier, non-pharmaceutical care specific, research (Fauteux, 2013). Moreover, this recalls the Institute of Medicine's (IOM) report 'The Future of Nursing', that was released ten years ago. The report recommended that the proportion of level 6 nurses should increase from 50 % to 80 % by 2020 to provide safe care (Institute of Medicine, 2011). Unfortunately, recent figures show that this goal is still far from being achieved in all countries (Haegdorens et al., 2019). Although the IOM recommendation was written for safe care in general, we believe their advice is equally applicable on pharmaceutical care. Our call for higher-educated nurses does not mean lower-educated nurses cannot have a place in modern healthcare. In contrast, with current nurse shortages, the contribution of nurses of all educational levels is essential. However, the efficient use of available nurses is paramount. Since final-year students are soon expected to be sufficiently prepared to function as qualified nurses in pharmaceutical care, we suggest estimating the readiness to perform pharmaceutical care related tasks before they enter the 'real practice world'.

#### 4.1. Strengths and limitations

To our knowledge this is the first pan-European assessment providing useful insights in nursing students' competences related to interprofessional pharmaceutical care tasks. Another strength was the involvement of a relevant international expert panel with experience in practice, nurse education and research. Their expertise allowed thorough content validation of the item pool which assured representativity of the results.

Some limitations also have to be acknowledged. Regardless of the considerable number of students included in our study, we have to recognise a poor recruitment rate on a European level, given the large amount of nursing schools in Europe. At the start of the data collection the user-friendliness of the survey did not meet the research team's predetermined expectations. Some technical problems occurred causing many students to abort the survey before answering the knowledge questions. Also, this self-selected sample might have led to a distortion of the results due to only the most motivated students or those with a special interest in pharmaceutical care participating. Next, the much higher response rate of Italian students impedes a clear view on overall European student competences. To allow drawing intra-country conclusions, more students should be included in follow-up research. After all, the small numbers of students within some educational levels did not allow statistical tests to be conducted at country-levels. Also, comparing different curricula is challenging because of inconsistent use of terms between countries (Lahtinen et al., 2014). Even within sovereign states dissimilar healthcare systems exists, as this is the case for Wales and England in the UK (Bevan et al., 2014). We, however, have chosen not to split up regions within countries in order not to reduce subsample sizes even further. Yet, future research is suggested to investigate the need for cultural adaptations of the assessment and perform further testing. We

also recommend adding questions on the duration of training that students already completed, since this might differ substantially, resulting in an important impact on the ability to compare groups. Finally, we acknowledge that our findings about skills and attitudes represent perceptions and are not validated against direct observations. So, as with all self-reports, we cannot discount acquiescence response bias for the skills and attitudes assessed (Baron-Epel et al., 2010).

## 5. Conclusion

This study aimed to evaluate pharmaceutical care competences in student nurses of 14 European countries. Most students considered themselves skilled to perform pharmaceutical care and reported positive attitudes towards their participation in pharmaceutical care. However, our results showed low knowledge scores: 55 % for level 4, 56 % for level 5, 68 % for level 6 and 72 % for level 7 students. Our assessment can be used as a tool for nurse educators to evaluate pharmaceutical care preparedness of student nurses. Its further implementation for students of different EQF levels will allow benchmarking between the levels, both within and between countries.

### CRediT authorship contribution statement

**Elyne de Baetselier, Nienke E Dijkstra:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Visualization, Project administration, Funding acquisition. **Tinne Dilles, Bart van Rompaey, Carolien GM Sino:** Conceptualization, Methodology, Writing – review & editing, Supervision, Project administration, Funding acquisition, Final approval of the version to be submitted. **Luis M da Cunha Batalha, Paulo A Carvalho Ferreira, Izabela Filov, Vigiadis Abrahamson Grøndahl, Jana Heczkova, Ann Karin Helgesen, Joanne Hirdle, Sue Jordan, Petros Kolovos, Gero Langer, Sabina Ličen, Manuel Lillo-Crespo, Alba Malara, Hana Padyšáková, Mirko Prosen, Dorina Pusztai, Bence Raposa, Jorge Riquelme-Galindo, Jana Rottková, Francesco Talarico, Styliani Tziaferi:** Methodology, Writing – review & editing, Final approval of the version to be submitted.

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### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.nepr.2022.103485](https://doi.org/10.1016/j.nepr.2022.103485).

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