

REVIEW PAPER

Nurse Competence Scale: a systematic and psychometric review

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Abstract

Aim. The aim of this study was to report a systematic and psychometric review.

Background. The Nurse Competence Scale is currently the most widely used generic instrument to measure Registered Nurses' competence in different phases of their careers. Based on a decade of research, this review provides a summary of the existing evidence.

Design. A systematic literature review of research evidence and psychometric properties.

Data sources. Nine databases from 2004 - October 2015.

Review methods. We retrieved scientific publications in English and Finnish. Two researchers performed data selection and appraised the methodological quality using the COnsensus-based Standards for the selection of health status Measurement INstruments checklist.

Results. A total of 30 studies reported in 43 publications were included. These consisted of over 11,000 competence assessments. Twenty studies were from Europe and 10 from outside Europe. In addition to experienced nurses, the Nurse Competence Scale has been used for the competence assessment of newly graduated nurses and nursing students, mainly in hospital settings. Length of work experience, age, higher education, permanent employment and participation in educational programmes correlated positively with competence. Variables including empowerment, commitment, practice environment, quality of care and critical thinking were also associated with higher competence. The Nurse Competence Scale has demonstrated good content validity and appropriate internal consistency.

Conclusion. The value of Nurse Competence Scale has been confirmed in determining relationships between background variables and competence. The instrument has been widely used with experienced and newly graduated nurses and their managers. Cross-cultural validation must be continued using rigorous methods.

Keywords: assessment, competence, instrument validation studies, instruments, Nurse Competence Scale, nursing, nursing workforce, professional competence, psychometric testing, registered nurses, systematic review

Why is this research or review needed?

- Competence is a critical attribute for safe, ethical and high-quality care. Competence assessment is thus needed.
- The Nurse Competence Scale is currently the most widely used generic competence assessment instrument across settings and samples.
- Based on a decade of international research, this review synthesizes the existing evidence concerning the Nurse Competence Scale instrument.

What are the key findings?

- The Nurse Competence Scale has been widely used in assessing the competence of experienced and newly graduated nurses. Several studies have included managers' assessments of nurses' competence.
- Sociodemographic, organizational, practice environment related and nurse related variables have been associated with a higher degree of competence.
- The Finnish Nurse Competence Scale is the most widely analysed regarding its measurement properties and was found to be a well-validated. Less psychometric information is available on the translated instruments.

How should the findings be used to influence policy/practice/research/education?

- The Nurse Competence Scale research findings can be used to continuously evaluate nurses' competence for managerial, educational and health policy purposes.
- Our systematic review indicates the need for high-quality language translations and methodologically rigorous cross-cultural studies.

Introduction

Competence is a crucial attribute for assuring high-quality, ethical and safe nursing care (Kendall-Gallagher & Blegen 2009, World Health Organization (WHO) 2013). Defined as 'functional adequacy and capacity to integrate knowledge and skills to attitudes and values into specific contextual situations of practice' (Meretoja *et al.* 2004b, pp. 330-331), competence has been recognized as a core component of professional standards (WHO 2013). The modernized directive (European Commission 2013/55/EU) and professional standards (American Nurses Association (ANA) 2015, Australian Nursing & Midwifery Council (ANMC) 2016) define competence requirements for registered nurses (hereinafter 'nurses').

Valid and reliable instruments are needed in the assessment of competence. The most appropriate instrument

should be selected based on cumulative knowledge of its use and measurement properties produced by studies of high methodological quality and thorough systematic reviews (Mokkink *et al.* 2010a). The Nurse Competence Scale (NCS) (Meretoja *et al.* 2004a) is the most widely used instrument for assessing nurses' generic competence. After a decade of international research, there is a need to synthesize the current state of knowledge concerning the NCS, its use, research findings and psychometric evidence.

Background

Competence development has been described as a process occurring over time (Benner 1984, Smith 2012). Therefore, competence assessment should start already during nursing education (Kajander-Unkuri *et al.* 2013) and continue throughout the nursing career (Schub 2014). This knowledge can be used when developing organizations' competence interventions, quality assurance processes and recruitment of employees (Salonen *et al.* 2007, Meretoja & Koponen 2012, Chen & Lou 2014).

The amount of competence research has increased during the past 20 years (Blažun *et al.* 2015). According to researchers, competence is a highly abstract phenomenon that is complicated to assess and measure. Therefore, a clear and unambiguous operational definition of the concept is crucial for creating valid competence assessment instruments (Smith 2012). The number of concept analyses from the last decade demonstrates the complexity of the concept (Axley 2008, Scott Tilley 2008, Valloze 2009, Gar-side & Nhemachena 2013). Consequently, there continues to be no consensus on the definition of competence (Watson *et al.* 2002, Cowan *et al.* 2005a, Scott Tilley 2008), although in their literature review, Yanhua and Watson (2011) noted that 'progress towards consensus and clarity of the concept is emerging' (p. 832).

Many instruments have been developed to measure nursing students' competence during education (Ličen & Plazarand 2015) and newly graduated nurses' (hereinafter 'NGNs') entry level competence (Watson *et al.* 2002). In the last decade, more instruments have also been released for practicing nurses. Both specific and generic instruments have been identified (Meretoja & Leino-Kilpi 2001, Watson *et al.* 2002, Walsh *et al.* 2009, Yanhua & Watson 2011, Franklin & Melville 2015). Specific instruments have been developed for particular fields, e.g. community health care (Bing-Jonsson *et al.* 2013) or for measuring certain, narrowly circumscribed competence, such as cultural competence (Loftin *et al.* 2013).

Generic instruments should be designed to allow comparison of competence across a variety of settings, organizations and countries. Examples of generic instruments include the Nurse Competence Scale (NCS, Meretoja *et al.* 2004a), the Competency Inventory for Registered Nurses (CIRN, Liu *et al.* 2007), the European Questionnaire Tool (EQT1 and EQT2, Cowan *et al.* 2005b, 2007, 2008) and the Holistic Nursing Competence Scale (Takase & Teraoka 2011). Out of these generic instruments, the NCS is the most widely used.

The NCS measures nurses' generic competence defined as functional adequacy and capacity to integrate knowledge, skills, attitudes and values in specific contextual situations (Meretoja *et al.* 2004b). It was developed to overcome competence instruments' shortcomings, i.e. their lack of a strong theoretical background and rigorous psychometric testing (Meretoja & Leino-Kilpi 2001, Robb *et al.* 2002, Watson *et al.* 2002). Theoretical framework of the NCS is based on Benner's (1984) From Novice to Expert framework and its theoretical categories: helping role (seven items); teaching-coaching (16 items); diagnostic functions (seven items); managing situations (eight items); therapeutic interventions (10 items); ensuring quality (six items) and work role (19 items).

The instrument was developed in Finland by nursing experts defining indicators for competent nursing practice. The items were reduced from a large pool ($n = 1\ 308$) of competence indicators by deductive content analysis. Consecutive reductions led to a total of 73 items, resulting in very low item-to-item correlations. Two assessment scales are used. The level of competence is measured with a visual analogue scale (VAS) (0-100). Based on the empirical evidence of data distribution (Meretoja *et al.* 2004a), the VAS is divided into four parts for descriptive purposes: scores ≤ 25 indicate 'a low competence'; scores $> 25-50$ 'quite good competence'; scores $> 50-75$ 'good competence' and scores $> 75-100$ 'very good competence'. The relevance of the competences across settings is measured by the frequency of use: 0 = 'not applicable in my work'; 1 = 'used very seldom'; 2 = 'used occasionally'; and 3 = 'used very often in my work'. Time needed to complete the NCS assessment has been reported to range from 20-30 minutes (Dellai *et al.* 2009, Kawther *et al.* 2011).

The development and psychometric properties have been reported in full (Meretoja *et al.* 2002, 2004a, Meretoja 2003, Meretoja & Leino-Kilpi 2003). The NCS instrument may not be duplicated or reproduced in any publications because of publishing rights owned by the journal and university series.

The review

Aims

The aim of this review were twofold:

- to provide an overview of empirical studies using the NCS and to summarize research findings,
- to provide evidence concerning psychometric properties of the NCS.

Design

We formulated the research questions, chose databases and keywords, defined inclusion and exclusion criteria, searched the databases, identified studies using the NCS, selected and extracted data and assessed the methodological quality of studies on measurement properties. Then, we analysed, synthesized and interpreted the data and lastly presented the findings. We applied the COnsensus-based Standards for the selection of health status Measurement INstruments (COSMIN) reporting standards (Mokkink *et al.* 2010a, Terwee *et al.* 2012) and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines (Moher *et al.* 2009) as applicable.

Search methods

We developed our search strategy with a medical library information specialist. We performed searches from January 2004 - October 2015 in PubMed, CINAHL, PsycINFO, British Nursing Index, ERIC, Web of Science, Scopus, Medline (Ovid) and in ProQuest Dissertations and Theses databases. The year 2004, when NCS was published internationally, was chosen as the start of our search. We also conducted manual search of the references in included studies and retrieved and organized hits from all the searches using RefWorks®. To be included in the review, empirical studies were required to meet all following inclusion criteria: (1) published in English or Finnish; (2) using completed copyrighted NCS; (3) published in a peer-reviewed journal, as a dissertation or a university report and (4) available as a full text. A complete overview of the search strategy is presented in Table S1.

Search outcome

Overall, 1,830 references to publications were identified. First and the last author independently screening the title and abstract of each publication, assessed full texts for

eligibility and, finally, decided on inclusion. Consensus was reached through discussion. Duplicates in databases were searched in RefWorks© and between databases by manual search. In the end, 30 studies reported in 43 scientific publications (36 articles, six dissertations and one university research report) were included. Figure 1 contains a COSMIN flow chart of the search process.

Quality appraisal

The methodological quality of each study on measurement properties was assessed according to the COSMIN checklist (Mokkink *et al.* 2010b). Two reviewers (MF, YJ) independently rated the methodological quality. Consensus was reached through discussion.

The methodological quality of studies on measurement properties was mostly rated as fair (Table S2). The main reason for these ratings was that none of the studies described how missing items were handled. Excellent ratings ($n = 6$) were given for content analysis testing. Cross-cultural validity testing received the highest number ($n = 4$) of poor ratings.

Data abstraction

We tabulated study characteristics and empirical findings (Table 1, Tables S3-S6). One researcher (MF) extracted key descriptive details from the publications. Second researcher (YJ) verified the extracted data.

Synthesis

Due to the heterogeneity of study data, we primarily reported the synthesis of data as a descriptive and narrative summary. We tabulated the COSMIN quality ratings per study (Table S2) to illustrate the methodological quality of each study on measurement properties. The COSMIN checklist consists of nine boxes (A-J) with methodological criteria for how each measurement property should be assessed. The following measurement properties are addressed: A) internal consistency, B) reliability (test-retest, inter-rater and intra-rater), C) measurement error, D) content validity, E) structural validity, F) hypotheses testing, G) cross-cultural validity, I) criterion validity and J) responsiveness. Each box contains 5-18 items to be assessed (Mokkink *et al.* 2010b). Each item was scored on a 4-point Likert scale (excellent, good, fair, poor). Methodological quality score was obtained for each measurement property based on the lowest rating of any box ('worst-score counts') (Terwee *et al.* 2012). Reliability has been defined as 'the

degree to which the measurement is free from measurement error' (Mokkink *et al.* 2016, p. 108). Validity refers to how well an instrument measures the construct(s) it purports to measure (Mokkink *et al.* 2016). Responsiveness indicates the instruments' suitability for detecting change occurring over time (Terwee *et al.* 2007, Mokkink *et al.* 2010a).

Results

Study characteristics

The systematic review included 30 studies. International use of the NCS has increased since 2010 (Table 1). Seventy per cent of the studies were published within the last 5 years. The studies included over 11,000 competence assessments conducted on four continents (Europe $n = 20$; Asia $n = 5$; North America $n = 3$; Australia $n = 2$). Sample sizes exceeding 200 were reported in 12 studies.

The studies were mainly cross-sectional ($n = 27$) and conducted in hospitals ($n = 27$), municipal care ($n = 1$) and all healthcare settings ($n = 2$). Response rates averaged 68 ($n = 24$, range 30-100%). Power calculations were reported in six studies. Rejection rate due to incompletely filled out NCS averaged 8% ($n = 6$, range 2-21%) (Table S3).

The primary aim of the studies was to investigate the level of nurse competence ($n = 26$) (Table S3), cross-cultural validation of the NCS ($n = 2$) (Dellai *et al.* 2009, Müller 2013), concurrent validity testing of a new competence instrument ($n = 1$) (Kamel *et al.* 2011) or to develop a systematic model to define nurses' optimal competence level (Meretoja & Koponen 2012).

Competence levels were analysed in all studies. Practicing nurses' competence assessments were investigated in 21 studies (Table 1), NGNs' competence in seven (Cowin *et al.* 2006, 2008, Salonen *et al.* 2007, Hengstberger-Sims *et al.* 2008, Wangensteen 2010, Wangensteen *et al.* 2012, 2015, Delaney 2013, Lima *et al.* 2014, Delaney *et al.* 2015, Numminen *et al.* 2015a, 2015c, 2016a, b) and that of students in two (Kajander-Unkuri *et al.* 2014, 2016, Kajander-Unkuri 2015).

Nurses' self-assessments were reported in nearly all studies ($n = 28$). Self-assessment was combined with managers' assessments in five studies (Meretoja & Leino-Kilpi 2003, Bahreini *et al.* 2011b, Meretoja & Koponen 2012, Koskinen *et al.* 2014, Numminen *et al.* 2015b) and students' assessments with mentors' assessments in one study (Kajander-Unkuri 2015, Kajander-Unkuri *et al.* 2016). Moreover, educators' and managers' assessments of NGNs' competence were combined without NGNs' self-assessments in one study (Numminen *et al.* 2014) (Table S3).

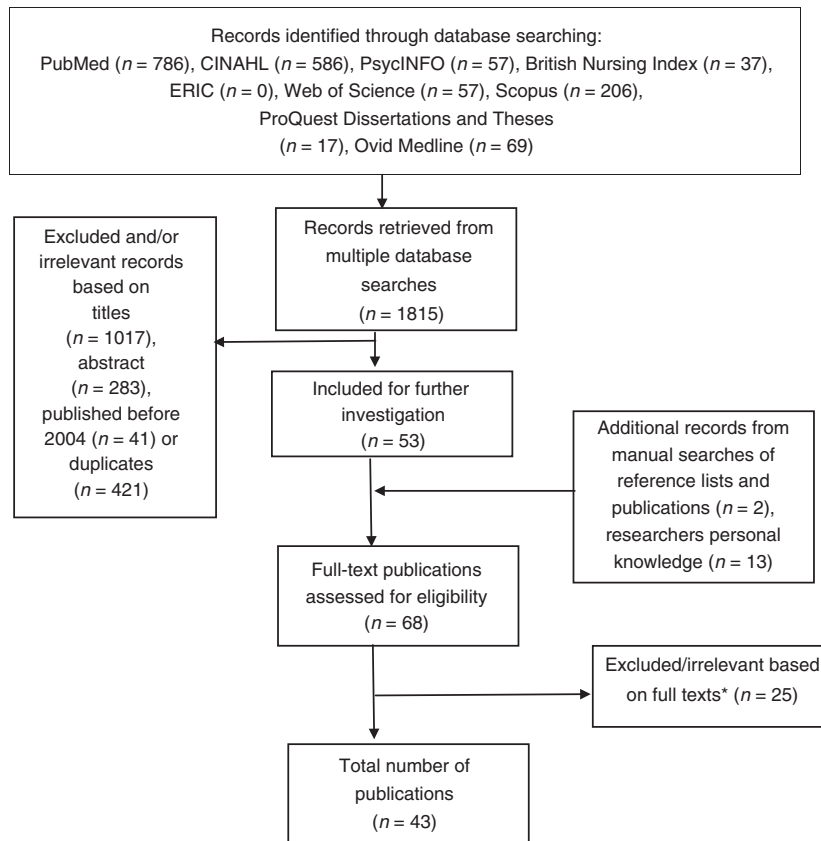


Figure 1 COSMIN flow chart of the search process. *Excluded for the following reasons: Complete copyrighted NCS instrument was not used ($n = 5$): McCurry 2006, McCarthy *et al.* 2013, Donilon 2013, Greenfield *et al.* 2014, Kampelman 2015), NCS used, but publication's language other than English or Finnish ($n = 10$): Dellai 2006 (Italian), Finotto & Cantarelli 2009 (Italian), Martin *et al.* 2010 (German), Pantelidou 2010 (Greek), Girbig & Bauer 2011 (German), Kudoh *et al.* 2011 (Japanese), Castillo Martínez 2011 (Spanish), Lili (2013) (Chinese), Sponton *et al.* (2013) (Italian), Scavone *et al.* 2014 (Italian), other instrument than NCS used ($n = 10$).

Research findings

Level of competence

Practicing nurses assessed their overall competence from good to very good (VAS mean 69.3, range 57.2-82.8) in 18 studies. NGNs reported their competence as somewhat lower, from moderate to good (VAS mean 54.0, range 40.1-62.5) in seven studies. Graduating nurse students' perceptions of their overall competence were good (VAS mean 66.2) (Table S4).

One-year educational interventions were analysed in three studies. Iranian nurses reported an increase in their competence scores from mean VAS score of 75.7 to 85.7 after a 1-year programme ($P < 0.001$), while the change was not statistically significant in a control group (Bahreini *et al.* 2013). Finnish forensic nurses reported higher competence scores (VAS mean 72.4 increased to 84.9, $P < 0.05$) after the intervention. A smaller increase (VAS mean 67.1 increased to 74.8, statistically significant in one category)

was assessed by their managers (Koskinen *et al.* 2014). In the United States, NGNs' overall competence scores increased only slightly after a critical care education programme (VAS mean 60.5 increased to 64.1, not statistically significant) (Delaney 2013, Delaney *et al.* 2015).

Managers assessed nurses' competence somewhat higher than nurses themselves in three studies (Meretoja & Leino-Kilpi 2003, Meretoja & Koponen 2012, Numminen *et al.* 2015b), while in two, nurses assessed their competence higher than their managers (Bahreini *et al.* 2011b, Koskinen *et al.* 2014) (Table S4). Educators evaluated NGNs' competence higher (VAS mean 60.1) than their managers (VAS mean 43.7) (Numminen *et al.* 2014) and nurse students' assessments of their competence were, very optimistically, higher (VAS mean 66.2) than the assessments by their mentors (VAS mean 56.6) (Kajander-Unkuri *et al.* 2016).

Studies showed that if one group of raters (RNs, managers, educators or nursing students) assessed any competence category higher than another group, the higher

Table 1 Characteristics of included studies ($n = 30$) and variables associated with competence.

Author, year	Country	NCS language version	No. of participants	Sample	Setting	Variables associated with competence (available information presented)
Meretoja (2003), Meretoja <i>et al.</i> (2004a,b)	Finland	Finnish	498	Registered nurses (RNs)	University hospital	Age ($r = 0.339$, $P < 0.001$), years in current environment ($r = 0.336$, $P < 0.001$), years as RN ($r = 0.303$, $P < 0.001$), years in health care ($r = 0.337$, $P < 0.001$). Frequency of using competencies ($P < 0.05$). Frequency of using competencies
Meretoja and Leino-Kilpi (2003)	Finland	Finnish	162	RNs	University hospital	Frequency of using competencies ($P = 0.03$).
Cowin <i>et al.</i> (2006), Hengstberger-Sims <i>et al.</i> (2008), Cowin <i>et al.</i> (2008)	Australia	English	116	Newly graduated RNs	Acute care public hospitals	Frequency of using competencies ($P = 0.03$).
Heikkilä <i>et al.</i> (2007)	Finland	Finnish	296	RNs, assistant ward managers	University hospital	Being assistant ward manager ($P = 0.000$), having permanent employment ($P = 0.025$), work experience ($P = 0.021$).
Mäkipaura <i>et al.</i> (2007)	Finland	Finnish	49	RNs	University hospital	Having permanent employment. Frequency of using competencies ($P < 0.001$).
Salonen <i>et al.</i> (2007)	Finland	Finnish	147	Newly graduated RNs	University hospital	Age ($r = 0.129$, $P = 0.001$), current work experience ($r = 0.272$, $P = 0.001$). Frequency of using competencies.
Dellai <i>et al.</i> (2009)	Italy	Italian	10	RNs	Hospital	Age ($R^2 = 0.227$, $P = 0.027$), healthcare experience ($P = 0.007$).
Wangensteen (2010), Wangenstein <i>et al.</i> (2012, 2015)	Norway	Norwegian	600	Newly graduated RNs	All healthcare settings	Helping role and gender ($R^2 = 0.218$, $P = 0.042$), Teaching-coaching and work area ($R^2 = 0.146$, $P = 0.028$), Diagnostic functions and research use in daily practice ($R^2 = 0.170$, $P = 0.041$), Managing situations and healthcare experience ($R^2 = 0.101$, $P = 0.005$), Therapeutic interventions and healthcare experience ($R^2 = 0.185$, $P = 0.018$), Ensuring quality and attitude towards research ($R^2 = 0.242$, $P = 0.032$), work role and availability and support for research use for daily practice ($R^2 = 0.190$, $P = 0.041$).
Bahreini <i>et al.</i> (2011a)	Iran	Persian	266	RNs	University hospital	Frequency of using competencies.
Bahreini <i>et al.</i> (2011b)	Iran	Persian	224	RNs, nurse managers	University hospital	Frequency of using competencies.

Table 1 (Continued).

Author, year	Country	NCS language version	No. of participants	Sample	Setting	Variables associated with competence (available information presented)
Istromina (2011), Istromina <i>et al.</i> (2011)	Lithuania	Lithuanian	218	RNs	Hospital	Higher education ($r = 0.176$, $P < 0.05$), completed additional educational courses based on professional development ($r = -0.276$, $P < 0.01$), high level of independence at work ($r = -0.251$, $P < 0.01$), job satisfaction ($r = -0.217$, $P < 0.01$), quality of abdominal perioperative nursing ($r = 0.249-0.351$, $P < 0.01$).
Kamel <i>et al.</i> (2011)	Egypt	Not described	50	RNs	University hospital, hospital	
Kawther <i>et al.</i> (2011)	Egypt	Not described	116	Nurse managers	University hospital	
Stobinski (2011)	USA	English	162	RNs	US Navy, civilian hospitals	Practice Environment Scale of the Nursing Work Index (PES-NWI) mean ($r = 0.236$, $P = 0.01$). Age ($P = 0.046$, with navy nurses), length of work experience ($P = 0.025$), working in navy ($P = 0.004$).
Hamström <i>et al.</i> (2012)	Finland	Finnish	84	RNs	University hospital	Frequency of using competencies. Age and Managing situations ($P < 0.01$), Ensuring quality ($P < 0.05$), Work role ($P < 0.05$), Diagnostic functions ($P < 0.05$). Work experience and Managing situations ($P < 0.05$), Ensuring quality ($P < 0.05$), Work role ($P < 0.05$), Helping role ($P < 0.01$). Work rotation and Managing situations ($P < 0.05$), Ensuring quality ($P < 0.05$). Permanent position and Ensuring quality ($P < 0.05$), Therapeutic interventions ($P < 0.05$). Frequency of using competencies.
Meretoja and Koponen (2012)	Finland	Finnish	199	RNs, nurse managers	University hospital	
O'Leary (2012)	USA	English	101	RNs	Tertiary care hospital	Age ($r = 0.30$, $P < 0.01$), years of nursing experience ($r = 0.27$, $P < 0.01$). Frequency of using competencies.
Silvennoinen <i>et al.</i> (2012)	Finland	Finnish	166	RNs	University hospital	Age ($P = 0.003$), educational level ($P = 0.044$), following professional literature ($P = 0.028$) experiencing professional development as important ($P = 0.044$). Frequency of using competencies.
Bahreini <i>et al.</i> (2013)	Iran	Persian	73	RNs	University hospital	
Delaney (2013), Delaney <i>et al.</i> (2015)	USA	English	82	Newly graduated RNs	Hospitals	

Table 1 (Continued).

Author, year	Country	NCS language version	No. of participants	Sample	Setting	Variables associated with competence (available information presented)
Müller (2013)	Switzerland	German	621	RNs	University hospital	
Numminen et al. (2013), Meretoja et al. (2015)	Finland	Finnish	2038	RNs	University hospital	Age, length of work experience in health care, length of work experience in current work unit ($r = 0.144$ - 0.353 , $P = 0.000$ - 0.030).
Kajander-Unkuri et al. (2014), Kajander-Unkuri (2015)	Finland	Finnish	154	Nurse students	University hospitals	Frequency of using competencies ($r = 0.450$ - 0.733 , $P = 0.000$). Pedagogical atmosphere ($r = 0.203$, $P = 0.012$), qualifications provided by education to practice as a nurse ($r = 0.341$, $P < 0.001$).
Koskinen et al. (2014)	Finland	Finnish	34	RNs, nurse managers	Forensic hospital	Age and the ability to critically evaluate own nursing philosophy ($r = 0.507$, $P = 0.038$), age and developing documentation of patient care ($r = -0.663$, $P = 0.003$), work experience and the ability to provide expertise for the care team ($r = 0.499$, $P = 0.041$).
Lima et al. (2014)	Australia	English	47	Newly graduated RNs	Tertiary hospital	Frequency of using competencies.
Numminen et al. (2014)	Finland	Finnish	227	Nurse managers, educators	University hospital, universities of applied sciences	
Numminen et al. (2015a,c), (2016a,b)	Finland	Finnish	218	Newly graduate nurses	All health care settings	Perceptions of the ethical climate ($r = 0.307$, $P < 0.001$), perception of practice environment ($r = 0.241$, $P < 0.001$), affective occupational commitment (< 0.005).
Karlstedt et al. (2015)	Sweden	Swedish	344	RNs	Municipal care	
Numminen et al. (2015b)	Finland	Finnish	1781	RNs, nurse managers	University hospital	
Kajander-Unkuri et al. (2016)	Finland	Finnish	84	Nurse students, mentors	University hospital	

assessment applied to all competence categories ($p < 0.01$) (Meretoja & Leino-Kilpi 2003, Bahreini *et al.* 2011b, Koskinen *et al.* 2014, Numminen *et al.* 2014, 2015b, Kajander-Unkuri *et al.* 2016) (Table S5). We used Pearson's correlation analysis to examine how closely the pairs of raters followed a similar pattern of competence assessment for the seven categories. This correlation was statistically significant ($P = 0.042-0.001$) in four studies (Meretoja & Leino-Kilpi 2003, Koskinen *et al.* 2014, Numminen *et al.* 2014, 2015b), while in two studies, this correlation did not reach a significant level ($P = 0.057-0.266$) (Bahreini *et al.* 2011b, Kajander-Unkuri *et al.* 2016) (Table S5).

Nurses reporting higher competence also reported a higher frequency of using competence in twelve studies (Meretoja 2003, Meretoja & Leino-Kilpi 2003, Meretoja *et al.* 2004a,b, 2015, Cowin *et al.* 2006, 2008, Mäkipeura *et al.* 2007, Salonen *et al.* 2007, Hengstberger-Sims *et al.* 2008, Wangensteen 2010, Bahreini *et al.* 2011a, Stobinski 2011, Hamström *et al.* 2012, O'Leary 2012, Silvennoinen *et al.* 2012, Wangensteen *et al.* 2012, Numminen *et al.* 2013, Koskinen *et al.* 2014). The NCS competence scores increased, for example, from a VAS mean of 33 to 59 and to 84 when the frequency of using the competences increased from 'very seldom' to 'occasionally' and 'to very often' respectively (Meretoja *et al.* 2004a).

Variables associated with competence

Several variables were associated with higher competence (Table 1). All correlations were statistically significant, although the correlations were mainly moderate or low ($r < 0.600$).

Sociodemographic variables, such as older age in eight studies (Meretoja 2003, Meretoja *et al.* 2004a,b, 2015, Salonen *et al.* 2007, Stobinski 2011, Hamström *et al.* 2012, Silvennoinen *et al.* 2012, Numminen *et al.* 2013, Karlstedt *et al.* 2015), higher education in three studies (Istomina 2011, Istomina *et al.* 2011, Silvennoinen *et al.* 2012, Karlstedt *et al.* 2015), additional educational training in two studies (Heikkilä *et al.* 2007, Istomina 2011, Istomina *et al.* 2011), healthcare experience prior to nursing education in one study (Wangensteen 2010, Wangensteen *et al.* 2012) and having previous professional qualifications in one study (Kajander-Unkuri *et al.* 2014, Kajander-Unkuri 2015), were associated with higher competence. Expected correlation between the length of work experience and higher self-assessed competence was found in 11 studies (Meretoja 2003, Meretoja & Leino-Kilpi 2003, Meretoja *et al.* 2004a,b, Heikkilä *et al.* 2007, Salonen *et al.* 2007, Dellai *et al.* 2009, Istomina 2011, Istomina *et al.* 2011, Stobinski 2011, Hamström *et al.* 2012, O'Leary 2012,

Numminen *et al.* 2013, Karlstedt *et al.* 2015). Such a correlation was not found in three studies investigating experienced practicing nurses (Mäkipeura *et al.* 2007, Bahreini *et al.* 2011a, Silvennoinen *et al.* 2012).

Organizational variables, such as permanent employment in three studies (Heikkilä *et al.* 2007, Mäkipeura *et al.* 2007, Hamström *et al.* 2012), work rotation in one study (Hamström *et al.* 2012) and higher level of independence at work in one study (Istomina 2011, Istomina *et al.* 2011) were reported by nurses with higher competence levels.

Practice environment related variables, such as quality of care in two studies (Istomina 2011, Istomina *et al.* 2011, Stobinski 2011), learning environment in two studies (Kajander-Unkuri *et al.* 2014, Kajander-Unkuri 2015), ethical climate in one study (Numminen *et al.* 2015a,c) and positive perceptions of practice environment in one study (Numminen *et al.* 2015b,c) were all associated with higher competence.

Nurse related variables, such as occupational commitment in one study (Numminen *et al.* 2016b), empowerment in one study (Numminen *et al.* 2015c), critical thinking in one study (Wangensteen 2010, Wangensteen *et al.* 2012) and willingness for professional development in two studies (Heikkilä *et al.* 2007, Silvennoinen *et al.* 2012) were reported by nurses with higher competence levels (Table 1).

Psychometric properties of the NCS

Out of the measurement properties, internal consistency (in 22 studies), content validity (in nine studies), structural validity (in seven studies), hypothesis testing (in three studies), cross-cultural validity (in five studies) and responsiveness (in three studies) were evaluated. None of the studies reported test-retest-, inter-rater- or intra-rater reliability or measurement error testing. Criterion validity was not applicable, as no gold standard instrument exists. The key findings of psychometric testing are presented in Table S3.

Internal consistency

In 22 studies, Cronbach's alpha values varied from 0.61-0.97 at the category level (Table S6). Average alpha values of each category ranged from 0.83-0.92 and 90% of the alpha values exceeded 0.80, indicating appropriate internal consistency.

Content validity

When developing the NCS, six expert groups, nurses and nurse managers confirmed the content validity (Meretoja *et al.* 2004a). Moreover, content validity was confirmed in two studies performing pilot tests in Finland (Meretoja &

Leino-Kilpi 2003, Kajander-Unkuri *et al.* 2014). High frequency of using competences across settings and populations indicates the relevance of the NCS items in 15 studies (Table S4).

Content Validity Index (CVI) was calculated to evaluate the content validity of the Persian NCS (Bahreini *et al.* 2011a). The index was 0.83, based on experts' ratings concerning item relevance. Acceptable range of CVI depends on the number of experts evaluating the scale (DeVon *et al.* 2007). However, this information or the method used to calculate the index was not reported.

Structural validity

Three Finnish studies confirmed the seven-category structure of the NCS. When testing the NCS with a sample of 498 nurses, principal component analysis confirmed the structure and the total variance explained was 52.7% (Meretoja *et al.* 2004a). In Heikkilä *et al.* (2007) study, using confirmatory factor analysis (CFA) ($n = 296$), the average variance extracted (AVE) was calculated and the explanatory power with the seven categories ranged between 45.7 and 62.6%. CFA was performed in a study using data from NGNs' ($n = 318$). RMSEA (0.073) indicated a fairly good fit, NFI (0.625) poor fit and CMIN/DF (2.706) fairly good fit. (Numminen *et al.* 2015c.)

When testing the structural validity of the English (Cowin *et al.* 2006), Lithuanian (Istomina 2011, Istomina *et al.* 2011), Norwegian (Wangensteen *et al.* 2015) and German (Müller 2013) translations, factor analysis results did not confirm Benner's original seven-category theoretical structure. No testing of structural validity of the Persian, Italian and Swedish translations has been performed.

Hypotheses testing

Hypothesis testing was reported in three studies. The NCS has a positive correlation with the 6-D performance instrument (Schwirian 1978) ($r = 0.829$, $P < 0.001$) (Meretoja *et al.* 2004b). The NCS has a positive correlation with the Australian National Competence Standards (ACNI) ($n = 116$) ($r = 0.75$, $P < 0.01$) (Cowin *et al.* 2008) and with the Egyptian newly developed competence assessment tool for critical care nurses ($n = 50$) ($r = 0.44$, $P < 0.01$) (Kamel *et al.* 2011). However, results should be interpreted with caution as neither of the two latter instruments has undergone rigorous psychometric testing.

Cross-cultural validity

The original Finnish NCS was used in 15 studies (Table 1). The NCS was forward- and back-translated with two

qualified English translators (Meretoja, personal communication) and published for international use in Meretoja *et al.* (2004a). Moreover, the Finnish NCS was translated to Norwegian (only forward translation) (Wangensteen 2010), Swedish using qualified translator (Meretoja, personal communication) and German (process not described in detail) (Müller 2013). The English NCS was forward- and back-translated into Italian (Dellai *et al.* 2009), Lithuanian (Istomina 2011) and Persian (Bahreini *et al.* 2011a). In two studies (Kamel *et al.* 2011, Kawther *et al.* 2011), the language version was not described.

For the English NCS, one informal pilot test using a convenience sample ($n = 10$) of nurses was performed in the USA (Stobinski 2011). Pilot tests have also been conducted with Italian ($n = 10$) (Dellai *et al.* 2009), Lithuanian ($n = 114$) (Istomina 2011), Swedish ($n = 6$) (Karlstedt *et al.* 2015) and Persian (sample size unknown (Bahreini *et al.* 2011a)) language versions.

Responsiveness

Responsiveness was reported in three studies (Bahreini *et al.* 2013, Delaney 2013, Koskinen *et al.* 2014, Delaney *et al.* 2015). These studies analysed the effect of a 1-year educational intervention on nurses' competence. Although two of the studies (Bahreini *et al.* 2013, Koskinen *et al.* 2014) showed a statistically significant increase in competence during the longitudinal follow-up, the results should be interpreted with caution due to small sample sizes.

Discussion

When selecting the most appropriate measurement instrument, comprehensive literature reviews are critically important for gathering research evidence (Kimberlin & Winterstein 2008). Therefore, we applied a systematic approach to review studies using the NCS. International use of the NCS is increasing, as two-thirds of the publications were published after 2010. The clinical use has been diversified; the instrument has been used to investigate competence levels, variables associated with competence and the effects of educational interventions. The NCS has been used most frequently in European countries, although there is also increase in using it on other continents.

The generic NCS instrument was originally developed for practicing nurses working in hospitals with highly specialized care. Research findings in this review indicate that the NCS is applicable across practice settings and nurse populations. Most practicing nurses from different countries have assessed their competence as good. This is in line with the results obtained with other generic instrument (Chang *et al.*

2011). It seems that nursing education and further training produce the kind of generic competence deemed good by both nurses and their managers. However, there has been variation in competence assessments across countries and settings. Many reasons may account for the variation in competence levels; differences in educational systems, practice environments, opportunities for further training or nurses' self-confidence. Cumulative research comparing larger nurse populations across settings is still limited and thus multi-country, multi-setting studies should be implemented.

All but one of the reviewed studies used self-assessments of competence. Self-assessment has been considered essential to competence measurement (Cowan *et al.* 2008), although the validity of self-assessment has been questioned (Baxter & Norman 2011) due to the lack of objectivity (Franklin & Melville 2015) and concerns with reporting low assessment (Alison Evans Consulting 2008).

Therefore, use of a multi-method approach using peer reviews, observations or knowledge tests has been recommended (Alison Evans Consulting 2008). This kind of research is likely to help achieving a more comprehensive understanding of competence and gaining evidence concerning the validity of the self-assessment instruments.

In nearly all of the NCS studies, there was a theoretically expected, systematic correlation between the length of experience and competence based on Benner's (1984) framework, with the exception of early career nurses. In addition, age and higher education correlated positively with competence. There is a complex relationship between competence and experience: competence does not increase linearly (Benner 1984, Takase 2013, Takase *et al.* 2014) and is associated with several variables, as seen in this review. Therefore, longitudinal research following competence development over time is required (Franklin & Melville 2015).

In addition to experienced nurses, the NCS has been used to evaluate the competence of newly graduated nurses and nursing students. Because the use of generic NCS items depends on one's work experience, beginner practitioners do not use all the competence items as often as experienced nurses (Wangensteen *et al.* 2012). However, the NCS has shown its value in assessing NGNs' competence (Theisen & Sandau 2013). Little is known about the antecedents of competence (Takase *et al.* 2015). The NCS studies have been among the first to investigate competence related variables. Several sociodemographic, organizational, practice environment related and nurse related variables were found to be associated with the level of competence. Thus, further cumulative research is warranted in this area. Nurse managers should recognize the multi-factorial background of nurse competence to maximise the outcomes of patient care.

The methodological quality of studies assessed with COSMIN criteria varied from excellent to poor, but was mostly rated as fair. This finding implies that more studies of higher methodological quality are needed. The NCS studies have been descriptive, many with small sample sizes collected from one hospital and used nonprobability sampling methods. This could lower the external validity and cross-cultural validation of findings (David & Sutton 2011). The NCS has mainly been validated among hospital nurses and should be further tested in non-hospital settings. Moreover, test-retest-, inter-rater- and intra-rater reliability as well as measurement errors should be investigated.

Appropriate psychometric properties were reported in the reviewed studies, especially in terms of content validity and internal consistency. Internationally, nurses indicated frequent use of the NCS competences in their current practice, which signals that the content validity of the NCS is up-to-date in the contemporary healthcare settings. The availability of a clear description of the concept of competence was identified as strength.

In the international studies implementing factorial validation in Australia, Lithuania, Switzerland and Norway, Benner's theoretical structure was not confirmed. There might be an explanation for this. The 73 items were reduced from a pool of 1308 competence indicators, resulting in very low item-to-item correlations. Therefore, factor analysis might not detect the theory-based category structure. Thus, the assessment of the theoretical structure should not be based solely on factor analysis. Due to the small sample sizes (<350) in two international studies (Cowin *et al.* 2006, Istomina 2011), factorial validation results must be interpreted with caution.

The instrument must always be pretested (Polit & Beck 2012) and the cultural relevance of the items must be evaluated, for example, with an expert panel, before the data collection to ensure the validity of research findings (Squires *et al.* 2013). The translation process should be accurate and rigorously documented to allow assessing the process and its quality (Hoben *et al.* 2013). In the future, cross-cultural studies should provide more detailed information about cultural validation. Proper methodological rigour and adequate sample sizes is needed when validating the NCS internationally.

Despite the availability of different types of reliability estimates, the authors exclusively reported internal consistency (Cronbach's alpha) values. High alpha values (>0.90) could be a sign that some items are redundant (Streiner 2003). Moreover, with a long scale (over 15 items), Cronbach's alpha could be supplemented with alternative reliability approaches; for example, with the average inter-item

correlation or mean item-partial total correlation (Streiner & Kottner 2014).

Strengths and limitations

As a thorough search was conducted in nine databases with the guidance of an information specialist, it can be assumed that the majority of the published studies that have used NCS were found. Only studies in the English and Finnish language were included and, therefore, language bias could be an issue. Ten studies using the NCS were excluded because of the language. Future reviews concerning the NCS should include studies published in other languages by employing an international team with linguistic expertise. The choice of databases and search terms, study inclusion and synthesis of results all required the subjective consideration of the researchers. The method of quality appraisal was based on the COSMIN criteria. Researchers determined quality based on their subjective understanding and caution is thus required when interpreting the quality assessments. However, to diminish the subjectivity of the assessment, each study publication was analysed by two researchers independently and discrepancies were resolved through discussion.

Conclusion

This review involved analysing 30 studies which covered over 11,000 independent competence assessments. The Nurse Competence Scale has confirmed its value in determining variables related to higher competence. These results suggest that managers and healthcare policy makers can significantly influence the level of competence and, therefore, patient outcomes. Several studies indicated that the instrument items were relevant in different work environments. The Nurse Competence Scale showed good content validity and appropriate internal consistency. Nevertheless, there continues to be a limited amount of psychometric evidence concerning the translated instruments, as some of the translated versions are only used in single studies. Cross-cultural validation must be continued using rigorous methods.

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Conflict of interest

No conflict of interest has been declared by the authors.

Author contributions

All authors have agreed on the final version and meet at least one of the following criteria [recommended by the ICMJE (<http://www.icmje.org/recommendations/>)]:

- substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site.

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