

Review

Associations between characteristics of the nurse work environment and five nurse-sensitive patient outcomes in hospitals: A systematic review of literature



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ARTICLE INFO

Article history:

Received 30 December 2013

Received in revised form 19 December 2014

Accepted 7 January 2015

Keywords:

Hospitals

Nurse-sensitive patient outcomes

Quality of care

Review

Work environment

ABSTRACT

Objective: To systematically review the literature on relationships between characteristics of the nurse work environment and five nurse-sensitive patient outcomes in hospitals.
Data sources: The search was performed in Medline (PubMed), Cochrane, Embase, and CINAHL.

Review methods: Included were quantitative studies published from 2004 to 2012 that examined associations between work environment and the following patient outcomes: delirium, malnutrition, pain, patient falls and pressure ulcers. The Dutch version of Cochrane's critical appraisal instrument was used to assess the methodological quality of the included studies.

Results: Of the initial 1120 studies, 29 were included in the review. Nurse staffing was inversely related to patient falls; more favorable staffing hours were associated with fewer fall incidents. Mixed results were shown for nurse staffing in relation to pressure ulcers. Characteristics of work environment other than nurse staffing that showed significant effects were: (i) collaborative relationships; positively perceived communication between nurses and physicians was associated with fewer patient falls and lower rates of pressure ulcers, (ii) nurse education; higher levels of education were related to fewer patient falls and (iii) nursing experience; lower levels of experience were related to more patient falls and higher rates of pressure ulcers. No eligible studies were found regarding delirium and malnutrition, and only one study found that favorable staffing was related to better pain management.

Conclusions: Our findings show that there is evidence on associations between work environment and nurse-sensitive patient outcomes. However, the results are equivocal and studies often do not provide clear conclusions. A quantitative meta-analysis was not feasible due to methodological issues in the primary studies (for example, poorly described samples). The diversity in outcome measures and the majority of cross-sectional designs make quantitative analysis even more difficult. In the future, well-described research designs of a longitudinal character will be needed in this field of work environment and nursing quality.

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What is already known about the topic?

- Nurse work environment is an important contributor for nurse outcomes, such as job satisfaction and burnout.
- Previous research showed associations between nurse staffing and patient outcomes, such as mortality and length of stay.
- High quality systematic reviews in this research area indicate methodological issues of primary studies.

What this paper adds

- Focusing on a limited set of five nurse-sensitive patient outcomes revealed that there were no eligible studies on delirium and malnutrition.
- Shows more favorable nurse staffing is associated with fewer patient falls and better pain management and conflicting results in relation to pressure ulcers.
- Finds that higher levels of experience and education and good collaborative relationships of professionals have favorable effects on the nurse-sensitive patient outcomes of falls and pressure ulcers.

1. Introduction

In 2004, the Institute of Medicine (IOM) published the report *Keeping Patients Safe: Transforming the Work Environment of Nurses*, emphasizing the importance of work environment in relation to the quality of nursing care (Institute of Medicine, 2004). Nurses constitute the largest group of employees in hospitals and deliver most of bedside patient care. Therefore, research on work environment factors influencing nursing quality is highly relevant to the healthcare field. McClure et al. (1983) were the first to explicitly identify some of the major characteristics of the nursing work environment, such as nurse staffing, nurse autonomy and collaboration with physicians (McClure and Hinshaw, 2002). Since then, several studies have focused on the measurement of nursing work environments, for example the Nursing Work Index (Kramer and Hafner, 1989), the Practice Environment Scale (Lake, 2002) and the Essentials of Magnetism (Kramer and Schmalenberg, 2004). A healthy work environment is defined as ‘one in which leaders provide the structures, practices, systems and policies that enable clinical nurses to engage in the work processes and relationships essential to safe and quality patient care outcomes’ (Schmalenberg and Kramer, 2008).

Donabedian’s Structure–Process–Outcome paradigm is often used as a framework for assessing work environments in relation to quality of care (Donabedian, 2003). Structural variables refer to those characteristics affecting the ability of hospital units to meet health care needs and include organizational characteristics (e.g., staffing, skill mix), nurses’ characteristics (e.g., education, experience) and patients’ characteristics (e.g., age, complexity). Process variables refer to activities of nurses in providing care and include nurses’ perception and nursing interventions. Outcome variables are the results of provided care. To date, the relationship between characteristics of nurse work environment and quality of nursing care has been the

subject of many studies that have been summarized in several reviews (e.g., Butler et al., 2011; Kane et al., 2007; Lake and Cheung, 2006; Lang et al., 2004; Lankshear et al., 2005; Shekelle, 2013). Yet, previous reviews have almost exclusively focused on structural characteristics regarding staffing levels, such as nurse staffing and skill mix. For example, the review of Lang et al. (2004) showed that higher levels of nurse staffing are associated with lower failure-to-rescue rates, lower inpatient mortality rates, and shorter hospital stays. Kane et al. (2007) performed a meta-analysis on staffing ratios between 1990 and 2006 and found that increased ratios of registered nurses were associated with decreased mortality rates, decreased length of stay and fewer adverse events. Although these reviews greatly contributed to insight in the effects of nurse staffing on patient outcomes, there is a need for information about characteristics other than nurse staffing. Therefore, in the present review, in addition to nurse staffing, we will focus on a broader set of characteristics of work environment and their effect on patient outcomes.

We aim to accumulate knowledge in addition to previous research referring to outcome measures such as mortality, length of stay and healthcare-associated infections (i.e., Aiken et al., 2003; Needleman et al., 2011; Stone et al., 2008). The main objective of the present study is to systematically review the literature and to provide an overview of associations between characteristics of the nurse work environment (e.g., nurse staffing, nurse–physician collaboration) and five nurse-sensitive patient outcomes (i.e., delirium, malnutrition, pain, patient falls, and pressure ulcers). Nurse-sensitive patient outcomes are defined as ‘those outcomes that are relevant, based on nurses’ scope and domain of practice, and for which there is empirical evidence linking nursing inputs and interventions to the outcome for patients’ (Doran, 2003; Maas et al., 1996). Focusing on a limited set of outcomes enables the opportunity for closer scrutiny on these five nurse-sensitive patient outcomes. Pain, patient falls and pressure ulcers are among the most commonly used nurse-sensitive outcome measures for benchmarking purposes in many countries (e.g., Canada, UK, and USA) (Doran et al., 2011). Additionally, delirium and malnutrition are less used in this context; however, their relevance is acknowledged, as in for example, the Netherlands it is mandatory for hospitals to publicly report these formal indicators of nursing quality (Dutch Health Care Inspectorate, 2012). We focus on articles published since 2004, which coincides with the release of the IOM-report mentioning the importance of quality of nursing care and the role of nurse work environments (Institute of Medicine, 2004).

2. Methods

2.1. Search strategy and inclusion criteria

The following electronic databases were used to extract relevant studies: Medline (PubMed), Cochrane Library, Embase and CINAHL. First, search terms were determined by screening abstracts and reference lists of reviews on nurse work environment. Fig. 1 shows the final search strings. Second, two reviewers who are experts in the

PubMed

(((((patient[tiab] OR patients[tiab] OR patient's[tiab]) AND outcome*[tiab]) AND ("Hospitals"[Mesh] OR hospital*[tiab] OR inpatient*[tiab] OR hospitali*[tiab]) AND ("Nursing"[Mesh] OR "Nurses"[Mesh] OR "Nursing Staff, hospital"[Mesh] OR "nursing"[Subheading] OR ((nurse[tiab] OR nurses[tiab] OR nursing[tiab]) AND (characteristic*[tiab] OR practice*[tiab] OR staffing[tiab] OR quality[tiab] OR ((work[tiab] OR working[tiab]) AND (environment[tiab]))) OR (skills mix[tiab] OR skill mix[tiab])))) AND (((("Pressure Ulcer"[Mesh] OR pressure ulcer*[tiab] OR bedsore*[tiab] OR pressure sore*[tiab] OR decubitus[tiab]) OR ("Delirium"[Mesh] OR delirium*[tiab]) OR ("Pain Measurement"[Mesh] OR pain measur*[tiab] OR pain assess*[tiab]) OR ("Accidental Falls"[Mesh] OR fall*[tiab]) OR ("Malnutrition"[Mesh] OR malnutrition[tiab] OR undernutrition[tiab] OR nutritional deficienc*[tiab])) OR ((adverse event*[tiab] OR adverse occurrenc*[tiab]))) OR (nurse sensitive[tiab] OR nursing sensitive[tiab]) OR ("Restraint, Physical"[Mesh] OR restraint*[tiab]))

Embase

((patient* and outcome*).ti,ab. and (exp Hospital/ or hospital*.ti,ab. or inpatient*.ti,ab. or hospitali*.ti,ab.) and (exp Nurse/ or exp Nursing Staff/ or ((nurse or nurses or nursing) and (characteristic* or practice* or staffing or quality or ((work or working) and environment) or (skills mix or skill mix))).ti,ab.) and (exp decubitus/ or pressure ulcer*.ti,ab. or bedsore*.ti,ab. or pressure sore*.ti,ab. or decubitus.ti,ab. or (exp Delirium/ or delirium*.ti,ab.) or (exp Pain assessment/ or pain measur*.ti,ab. or pain assess*.ti,ab.) or (exp Falling/ or fall*.ti,ab.) or (exp Malnutrition/ or malnutrition.ti,ab. or undernutrition.ti,ab. or nutritional deficienc*.ti,ab.) or ((adverse event* or adverse occurrenc*).ti,ab.)) or (nurse sensitive or nursing sensitive).ti,ab or (restraint*).ti,ab

Cinahl

((patient* and outcome*) AND (MH "Hospitals+" or hospital* or inpatient* or hospitali*) AND ((MH "Nurses+" OR (MH "Nursing Staff, Hospital") OR (MH "Nursing Practice+") OR ((nurse or nurses or nursing) and (characteristic* or practice* or staffing or quality or ((work or working) and environment) or (skills mix or skill mix)))) AND (MH "Pressure Ulcer+" OR pressure ulcer* or bedsore* or pressure sore* or decubitus OR MH "Delirium+" OR delirium* OR MH "Pain Measurement" OR pain measur* or pain assess* OR MH "Accidental Falls+" OR fall* OR MH "Malnutrition+" OR malnutrition or undernutrition or nutritional deficienc* OR MH "Adverse Health Care Event+" OR adverse event* or adverse occurrenc*) OR "nurse sensitive" or "nursing sensitive" OR (MH "Restraint, Chemical" OR MH "Restraint, Physical" OR restraint*))

Fig. 1. Search query.

nursing field independently screened titles and abstracts of studies on their relevance. The final sample was established after full text reading by the same reviewers using inclusion and exclusion criteria, which are described in detail below. In case of discrepancies, there was discussion until consensus was reached. The MOOSE guidelines were used to structure this systematic review (Stroup et al., 2000).

We included studies that examined associations between work environment and nurse-sensitive patient outcomes in hospitals, had a quantitative study design, were written in English and were published from 2004 to 2012. In the literature search, we focused on delirium, malnutrition, pain, patient falls and pressure ulcers. These outcome measures are internationally used and acknowledged as benchmark indicators, for example in Scotland (NHS), UK (NHS), Sweden (CALNOC), Australia (CALNOC), Canada (C-HOBIC), USA (NDNQI), USA military (Milnod), USA veterans (VANOD), Belgium (B-NMDS), and the Netherlands (IGZ) (Doran et al., 2011). Two well-recognized indicator datasets of the Agency for Healthcare

Research and Quality (AHRQ) and the National Database of Nursing Quality Indicators (NDNQI) allow these nurse-sensitive patient outcomes to be available and clearly defined (Montalvo, 2007).

To find as many applicable studies for work environment characteristics, we used broad definitions regarding the nurse work environment (see Fig. 1). Then, to categorize the results we divided structural and process characteristics. For the structural characteristic of nurse staffing, we included the frequently used measures: (i) total nursing hours defined as 'total number of productive hours worked by all nursing staff with direct care responsibilities per number of days a patient stays in the hospital', (ii) registered nurses' hours (RN hours) defined as 'number of productive hours worked by a registered nurse (a nurse who holds a specific license with at least a three-year training certificate and holding post graduate qualifications) with direct care responsibilities per patient day', (iii) proportion of registered nurses (% RN) defined as 'proportion of productive hours worked by a registered nurse', (iv) temporary nurses defined as 'any

licensed nurse who is providing service at the facility as an employee of another entity' and (v) turnover defined as 'the process whereby nursing staff leave or patients transfer within the hospital environment' (Institute of Medicine, 2004; Kane et al., 2007; Van den Heede et al., 2007). In addition to nurse staffing, the structural characteristics of nurse experience and nurse education were added to the review, because these characteristics are potential influential factors (Schmalenberg and Kramer, 2008; West et al., 2009).

To categorize process characteristics of the work environment, we used the items of the *Essentials of Magnetism* (Schmalenberg and Kramer, 2008), including the eight factors which, according to nurses and experts in the field are essential for a healthy work environment and necessary for the provision of quality of care: (i) clinically competent peers, (ii) collaborative nurse–physician relationships, (iii) clinical autonomy, (iv) support for education, (v) adequacy of staffing, (vi) nurse manager support, (vii) control of nursing practice and (viii) patient-centered cultural values. These items have shown to be reliable and valid indicators regarding the quality of the nurse work environment (Kramer et al., 2010).

2.2. Exclusion criteria

This review concerns hospital care; studies examining healthcare settings other than hospitals (e.g., nursing homes, homecare, and rehabilitation clinics) were excluded. Initially, we wanted to perform a quantitative evaluation of previous research by presenting a meta-analysis of studies using objective outcome measures (e.g., clinical reported medical records from hospital databases). Therefore, study designs in which analysis was limited to only subjective perception measures (e.g., surveys) and articles on staff-related or organization-related outcomes (e.g., nurse satisfaction studies, economic evaluations) were excluded. An exception was made for the outcome measure of pain; ratings of pain express a subjective measure as pain is experienced by patients. Dissertations, reviews and studies initiated in developing or non-Western countries were excluded to enable valid comparison.

2.3. Quality appraisal

To determine methodological quality of selected studies we used the Dutch version of Cochrane's critical appraisal instrument, addressing randomized controlled trials (RCTs), cohort studies, and cross-sectional studies (Dutch Institute for Healthcare Improvement, 2007). The criteria of validity (e.g., well-described design, appropriate methods, definition of research participants, and selection bias), reliability (e.g., follow up, confounders, outcome data, and statistical methods) and applicability (e.g., generalizability, relevance within health care) were assessed for each study. The criteria were scored as the following: fully met (1 point), partly met (1/2 point) or not met (0 point). The total scores give an indication of study quality. Specifically, studies of low quality scored 1/2–1 point, studies of moderate quality 1½–2 points and studies of high quality 2½–3 points. Subsequently, the levels of

evidence, ranging from A2 to D status, were determined. The A2-level constitutes RCTs and prospective cohort studies with sufficient sample sizes and follow-up. Observational studies (i.e., cohort and patient control) that did not meet the criteria of A2-level were labeled level B. Level C includes studies with a descriptive design (i.e., cross-sectional studies) and level D includes experts' opinion.

3. Results

3.1. Description of studies

The initial search yielded 1120 references of which 989 remained after removing duplicates (Fig. 2). After screening the titles, 298 studies were selected for further examination. Based on the abstracts, the two reviewers independently decided that 57 studies met the inclusion criteria. After full text reading, the final sample included 29 studies (Kappa's coefficient: .74). Table 1 represents the

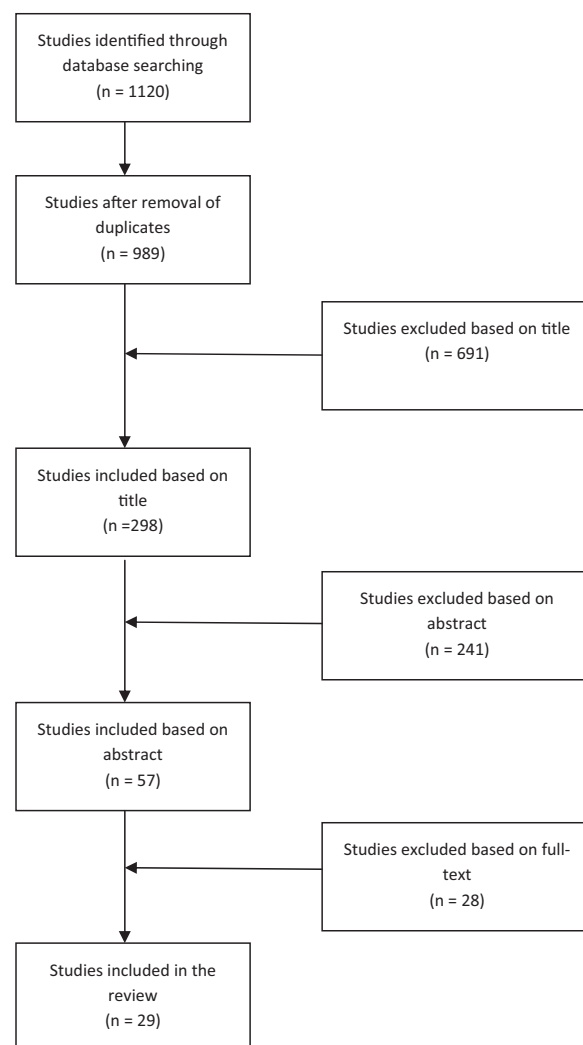


Fig. 2. Flowchart of the inclusion process.

Table 1
Characteristics of included studies.

Author, year, and country	Design	Sample	Independent variables	Outcome variables	Factors controlled for	Key findings
Bae et al., 2010a, USA	Cross-sectional Retrospective 2003–2004	N = 277 medical/surgical units of 142 hospitals	Skill mix % External temporary nurse hours/RN % Internal temporary nurse hours/RN % Total temporary nurse hours/RN	Patient falls Incidence/1000 patient days	Work complexity Support services Nurse age Educational level	Significant more falls in units with high levels of total temporary nurse hours RR = 1.188, $p = .05$
	Staff nurse survey	N nurses = 4954 N patients = not described			Unit tenure RN hours Unit size Magnet certification	No significance for external or internal temporary nurse hours
Bae et al., 2010b, USA	Cross-sectional Retrospective 2003–2004	N = 268 medical/surgical and general units of 141 hospitals	Nurse staffing Turnover rates/six months	Falls Patient falls/1000 patient days	Work complexity Unit size and tenure Hospital size	Significant fewer falls in units with low levels of turnover compared to units without turnover $\beta = -.297$, $p = .02$
	RN survey	N nurses = not described N patients = not described	Mediating variables Workgroup process (cohesion, learning, relational coordination)		Technological status Teaching status Nurse education level Care hours Patient age Patient health status Prior hospitalizations	No significant mediating effect of workgroup process on falls
Breckenridge- Sproat et al., 2012, USA	Longitudinal cohort Retrospective 2003–2006	N = 23 medical/surgical, step-down and critical care units of 4 Military hospitals	Nurse staffing NHPPD Reserve nurses (temporary nurses)	Falls Incident reporting	Unit type Acuity Staff category Study duration	No significant associations nurse staffing and falls
	Staff nurse survey	N nurses = 506 N patients = not described	Skill mix % RN/total nursing hours % LPN/total nursing hours % Nurse aid/total nursing hours Mediating variables Daily patient acuity			Significant increase of falls in step down units associated with increase of reserve nurses $\beta = 4.921$, $p < .05$ Significant positive effect acuity in medical/surgical units on falls $\beta = .328$, $p < .05$

Table 1 (Continued)

Author, year, and country	Design	Sample	Independent variables	Outcome variables	Factors controlled for	Key findings
Burnes Bolton et al., 2007, USA	Longitudinal cohort Prospective Predata 2002 Postdata 2004/2006	<i>N</i> = 187 medical/surgical units <i>N</i> = 65 step down units of 108 hospitals	Nurse staffing RN hours/patient day LPN hours/patient day Unlicensed hours/patient day	Falls Incidence falls/1000 patient days Falls with injury/1000 days	Hospital size	Significant increases in staffing hours and ratios pre/post
		<i>N</i> patients = 11,740	Total hours/patient day Skill mix % RN hours/skill mix % LPN hours/skill mix % Unlicensed hours/skill mix % Contracted hours/skill mix	Pressure ulcers Prevalence pressure ulcers Prevalence HAPU		Significant inverse relation falls and %RN step down units $\beta = -.029, p = .008$ Significant positive relation total hours of care on > stage 2 pressure ulcers in stepdown units $\beta = .928, p = .004$ Significant inverse effect contracted staff on falls with injury in medical/surgical units $\beta = -.003, p = .006$
Chang et al., 2006, USA	Cross-sectional Retrospective RN survey Patient survey	<i>N</i> = 222 medical/surgical units of 126 hospitals	Other variables Workgroup diversity (e.g. education, RN experience) Workgroup performance (e.g. team-work) Intervening process variables (workgroup cohesion, workgroup initiative)	Falls Patient falls/total patient days	Patient age Unit size	Significant inverse effect of workgroup initiative on falls $\beta = -.18, p < .01$ No significant effect of intervening process variables, workgroup diversity and performance on falls
		<i>N</i> nurses = not described <i>N</i> patients = not described				
Donaldson et al., 2005, USA	Longitudinal cohort Retrospective Predata 2002 Postdata 2004	For patient falls <i>N</i> = 200 medical/surgical units <i>N</i> = 68 stepdown units of 68 hospitals	Nurse staffing NHPPD RN Hours/patient day	Falls Incidence/1000 patient days	Hospital size Hospital system	Increases nurse-patient ratios of staffing and skill mix in medical/surgical units NHPPD increased with 7.4% $p = .0024$
		For pressure ulcers <i>N</i> = 119 medical/surgical units	LVN Hours/patient day Non RN + LVN caregiver hours/patient day	Pressure ulcers Prevalence pressure ulcers Prevalence HAPU		No significant changes of nurse-patient ratios of staffing and skill mix in step down units

Frith et al., 2010, USA	Cross-sectional Retrospective 2005–2007	N = 43 stepdown units of 38 hospitals	Skill mix % RN/total nursing hours % LVN/total nursing hours % Non RN/total nursing hours Contracted hours/ patient day	Adverse events One of them: pressure ulcers Prevalence/1000 patient days	Patient age Complication index	No significant changes of falls and pressure ulcers after mandated staff ratios
		N patient days = ±196,000				
Goode et al., 2011, USA	Cross-sectional Retrospective 2005	N = 11 medical/surgical units of 4 hospitals	Nurse staffing RN hours/patient day LPN hours/patient day	Pressure ulcers Rate observed and expected risk	Patient age Complication index	No significant relationships between nurse staffing and adverse events
		N patients = 34,838	Skill mix % RN/skill mix % LPN/skill mix			Significant relation between %RN in skill mix and adverse events An increase of RN by 1% reduced adverse events with 3.4%
		General and intensive care units	RN/patient day LPN/patient day		Patient characteristics Patient condition Hospital casemix	Significantly less NHPPD in general units of Magnet hospitals
		N patients = not described	CNA/patient day Skill mix % RN/staffing mix			Significantly lower %RN in general and intensive care units of Magnet hospitals Less pressure ulcers Magnet hospitals Significant inverse association pressure ulcers and NHPPD in intensive care units $\beta = -.022, p < .10$
Gunningberg et al., 2012, USA, Sweden	Cross-sectional Retrospective 2009	N = 33 medical/surgical units of a university hospital in Sweden N patients = 630	Nurse staffing NHPPD % Patient (bed) turnover % Voluntary turnover	Pressure ulcers Prevalence pressure ulcer Prevalence HAPU	Hospital size	In USA higher total staff and %RN
		N = 14 medical/surgical units of a general hospital in Sweden N patients = 253	Skill mix % RN/staff mix			In USA higher patient (bed) turnover In USA less patients/RN
		N = 1100 medical/surgical units of 207 hospitals in the USA N patients = 16,427	Mediating variables Patients per RN			In USA lower prevalence pressure ulcers and HAPU

Table 1 (Continued)

Author, year, and country	Design	Sample	Independent variables	Outcome variables	Factors controlled for	Key findings
Jiang et al., 2006, USA	Cross-sectional Retrospective 2001	<i>N</i> = 372 acute hospitals	Nurse staffing and skill mix AHA: FTE/adjusted patient day Ratio of FTE to average daily census	Decubitus ulcers Risk adjusted rates	Casemix Severity illness Hospital ownership Size Teaching status	Significant inverse relation RN hours/patient days and decubitus ulcers ANA: $\beta = -.001$, $p < .001$ OSHDP: $\beta = -.002$, $p < .001$
		<i>N</i> patients = not described	OSHDP: Paid hours RN/adjusted patient day Paid hours LPN/adjusted patient day % RN/licensed nurses Total paid hours/adjusted patient day % RN % LPN, % nurse aid/total nurses		Urban vs. Rural	Significant inverse relation %RN/licensed nurses and decubitus ulcers ANA: $\beta = -.044$, $p < .01$ OSHDP: $\beta = -.053$, $p < .001$
Kendall-Gallagher and Blegen, 2009, USA	Cross-sectional Retrospective 2000	<i>N</i> = 48 intensive care units of 29 hospitals	Nurse staffing NHPPD	Falls Rate of falls/1000 patient days	Patient risk	No significant effects of staffing and skill mix
		<i>N</i> patients = not described	Skill mix % RN/skill mix			Inverse association between unit proportion of certified staff nurses and rate of falls $\beta = -.06$ $p = .04$
			Other variables % Staff nurses with speciality certification % Staff nurses with at least a Bachelor degree Mean years of experience Organizational characteristics			No significant effects of experience, bachelor degree or organizational characteristics
Krapohl et al., 2010, USA	Cross-sectional Retrospective	<i>N</i> = 25 intensive care units of 8 hospitals	Other variables % Certified nurses Workplace empowerment (opportunity, information, support, resources)	Pressure ulcers Prevalence	Not described	No significant effect of proportion certified nurses or workplace empowerment on pressure ulcers

	Staff nurse survey	N nurses = 450 N patients = not described				Significant positive association nurses' perception of workplace empowerment and certification ($r = .397, p = .05$)
Mallidou et al., 2011, Canada	Cross-sectional Retrospective 1998–1999	N = 12 hospitals (medical, surgical, emergency, intensive care units)	Other variables Informal practices (autonomy, control over practice nurse–physician relationships)	Falls Adverse event	Not described	Inversed effect of experience on adverse events in medical units $\beta = -.104$ and emergency departments $\beta = -.136$
	RN survey	N nurses = 1937 N patients = not described	Formal practice (satisfactory salary, education, quality assurance program, preceptorship, experience)			Significant inverse effect RN/physician relationship on adverse events in medical units $\beta = -.115$ Significant inverse effect of fulltime/parttime on adverse events in surgical units ($\beta = -.104$) and emergency units ($\beta = -.178$) Significant inverse effect preceptorship on adverse events in intensive care units $\beta = -.164$ No significance regarding education, autonomy and control over practice
Manojlovich et al., 2009, USA	Cross-sectional Retrospective 2005	N = 25 intensive care units of 8 hospitals	Other variable Perception of communications Characteristics of the Practice environment	Pressure ulcers Prevalence > stage 2	Patient severity	No significant relation communication on any adverse events
	Staff nurse survey	N nurses = 462 N patients = 1090				No significant effect of Practice Environment as mediator
Manojlovich et al., 2011, Canada, USA	Cross-sectional Retrospective 2007	N = 14 medical/surgical units of 1 hospital in Canada N = 12 medical/surgical units of 1 hospital in USA N patients = not described	Other variables Level of RN needed to provide care (Active ingredient: skill mix, education, experience) (Intensity: FTE's, RN-Patient Ratio, RN worked hours/patient day)	Falls Rate of falls/1000 patient days	Not described	Significant inverse effect of active ingredient on falls $r = -.44, p = .03$ Significant inverse effect of intensity on falls $r = -.44, p = .03$

Table 1 (Continued)

Author, year, and country	Design	Sample	Independent variables	Outcome variables	Factors controlled for	Key findings
Mark et al., 2004, USA	Longitudinal cohort Retrospective 1990–1995	N = 422 hospitals	Nurse staffing RN FTE/1000 inpatient days	Decubitus ulcers Risk-adjusted observed and expected decubitus ulcers	Hospital heterogeneity Historical circumstances	Significant inverse effect of RN FTE on decubitus ulcers $\beta = -.017, p = .01$
		N patients = not described	LPN FTE/1000 inpatient days Non-nurse FTE/1000 inpatient days			Significant inverse marginal effect of RN FTE on decubitus in all quartiles 25th: $\beta = -.050, p = .001$ 50th: $\beta = -.045, p = .001$ 75th: $\beta = -.040, p = .01$ After controlling for hospital-specific effects, results are insignificant
McCloskey and Diers, 2005, New Zealand	Longitudinal cohort Retrospective 1993–2000	N = medical and surgical units of 85 hospitals	Nurse staffing FTE/1000 patient days FTE/1000 discharges Total nursing hours/1000 patient days Total nursing hours/1000 discharges	Decubitus ulcers Rate of decubitus ulcers	No risk adjustment, other than cohort	After mandated staffing ratios 36% decrease of total nursing hours and FTE/1000 discharges and 18% increase of %RN skill mix
		N nurses RN and EN = 65,221 N patients = ± 3.3 million				After mandated ratios increase of decubitus ulcers 88%(medical units) and 258%(surgical units)
	Staff nurse survey		Skill mix % RN/total FTE			Significant correlations between decubitus ulcers and total nursing Hours, %RN and FTE ($p < .05$)
McGillis Hall et al., 2004, Canada	Cross-sectional Retrospective Year = not described	N = 77 medical, surgical and obstetric units of 19 hospitals	Nurse staffing % Professional staffing	Falls Rate of falls	Patient complexity Age	No significant effects of nurse staffing on falls
		N patients = not described	Other variables Average nurse experience			No significant relations between level of experience and patient outcomes
Patrician et al., 2011, USA	Longitudinal cohort Prospective 2003–2006	N = 31 medical/surgical units N = 8 step-down units N = 18 critical care units of 13 Military Hospitals	Nurse staffing NCHPPS	Falls Incidence reporting	Patient census Patient acuity Hospital size Shift time	With every 1 h decrease of NCHPPS significant increase of falls (with injury) in all units (15–51%)
		N patients = 111,522	Skill mix % RN/skill mix per shift	Falls with injury Incidence reporting		With every 10% decrease in %RN increase of falls with injury critical care (36%) and medical/surgical units (30%)

			Other variables Worked hours by staff category (civilian vs. military)			Every 10% decrease of civilian nurses associated with 36% (critical care) and 48% (medical/surgical units) increase of falls
						Significant positive association between patient acuity/census and falls in medical/surgical and stepdown units
Purdy et al., 2010, Canada	Cross-sectional Retrospective	N = 61 medical/surgical units of 21 hospitals	Other variables <i>Group level:</i> Group processes (teamwork)	Falls Falls/1000 patient days	Length of stay Nursing experience Nursing care hours	Significant inverse effects on falls on the group level: group processes $\beta = -.19, p = .05$ and structural empowerment $\beta = -.12, p = .05$
	Staff nurse survey Patient survey	N nurses = 679 N patients = 1005	Structural empowerment (workplace factors)			No significant effects of nurse empowerment on the individual level
			<i>Individual level:</i> Psychological empowerment Empowerment behavior			
Seago et al., 2006, USA	Longitudinal cohort Retrospective 1999–2002	N = 3 medical/surgical units of 1 university hospital	Nurse staffing Total RN Hours/patient day Non-RN Hours/patient day NHPPD	Falls Incidence/1000 patient days	Casemix Work intensity	Significant positive effect NHPPD on perception pain management $\beta = 2.44, p < .01$
	Patient survey	N patients = not described		Decubitus ulcers Incidence/1000 patient days		Significant positive effect %RN on perception pain management $\beta = 13.63, p < .01$
			Skill mix % RN/total nursing hours	Pain management Patient satisfaction		No significant effect of RN or non-RN hours on pain, falls or decubitus
Shuldham et al., 2009, UK	Cross-sectional Retrospective 2006–2007	N = 2 hospitals Low dependency units: wards (cardiology, cardio-thoracic surgery, respiratory)	Nurse staffing NHPPD	Pressure sores Prevalence	Not described	No significant effects of NHPPD on falls and pressure ulcers

Table 1 (Continued)

Author, year, and country	Design	Sample	Independent variables	Outcome variables	Factors controlled for	Key findings
Stone et al., 2007, USA	Cross-sectional Retrospective 2002	High dependency units: critical and intensive care unit	Skill mix % Permanent hours/total hours % Permanent hours/permanent and temporary internal hours	Patient falls Incidence reporting		Significant positive effect %permanent hours/permanent and temporary hours on pressure sores in low dependency units OR = 1.092 $p = .026$
		N adult patients = 23,192 N child patients = 2315				Significant positive effect %permanent hours/total hours on pressure sores in low dependency units OR = 1.070, $p = .019$ No significant effects %permanent hours in high dependency units
	Staff nurse survey	N = 51 intensive care units of 31 hospitals	Nurse staffing RN hours/patient day Ratio overtime/regular RN hours	Decubiti Incidence	Patient severity Patient co-morbidity Patient demographics Patient socio-economics Hospital size	Significant inverse effect of RN hours on decubiti OR = .69 $p < .001$ (third quartile vs. first quartile)
		N nurses = 1095 N patients = 15,902	Other variables Average RN wage Organizational climate		Teaching status Nurse casemix ICU-type	Significant positive effect of overtime on decubiti OR = 1.91 $p < .001$ (fourth quartile vs. first quartile) No significant relations decubiti and wages or organizational climate
Taylor et al., 2012, USA	Cross-sectional Retrospective 2004–2005	N = 29 medical/surgical and rehabilitation units of 1 trauma hospital	Nurse staffing RNHPPD Unit turnover rate	Falls Incidence Decubitus ulcers	Patient complexity	Every additional hour RNHPPD associated with 9% decrease odds patient falls Significant association teamwork and decubitus ulcers OR = .56 $p < .001$
	Staff nurse survey	N nurses = 723 N patient discharges = 28,876	Other variables	Incidence		No significant association of unit turnover on decubitus ulcers or falls
Titler et al., 2011, USA	Longitudinal cohort Retrospective 1998–2002	N = 1 hospital	Nurse Staffing Average RN/hour	Falls Incident reporting	Patient characteristics Clinical conditions	Fall group N = 481 Non-fall group N = 9706
		N patients = 7851 N hospitalizations = 10,187	Skill mix % RN/skill mix		Co-morbidities Interventions	With every 10% increase of %RN odds of falling decreased with 18.8%

						No significant effect average RN/hour
Twigg et al., 2011, Australia	Longitudinal cohort Retrospective 2000–2004 2 time series pre/post mandated staffing in 2002	N = 52 units of 3 hospitals N patients = 236,454	Nurse staffing NHPPD	Pressure ulcers Incidence rate	Time period Season Patient group	No significant increase of RN hours and NHPPD pre/post (58420–69327) No significant relation between staffing and pressure ulcers Significant decrease of pressure ulcers in individual hospitals pre/post
Unruh and Zhang, 2012, USA	Longitudinal cohort 1996–2004 Staff nurse survey	N = 124 hospitals N nurses = not described N patients = not described	Nurse staffing RN FTE RN FTE/adjusted patient day	Decubitus ulcers Incidence/1000 patients Patient safety indicators (decubitus ulcers, infections, sepsis)	Patient turnover Hospital size Hospital casemix Urban vs. rural Payer mix Ownership	Significant positive effect of initial levels of RN FTE/adjusted on initial level of decubitus $\beta = .996$, $p = .05$ Significant inverse effect of initial levels of RN FTE/adjusted on decubitus over time $\beta = -.001$, $p = .05$ No significance regarding RN FTE and decubitus
Van den Heede et al., 2009, Belgium	Cross-sectional Retrospective 2003	N = 1403 general acute care and intensive care units of 115 hospitals N patients = 260,923	Nurse staffing NHPPD Standardized NHPPD Other variables % Nurses with Bachelor's degree	Pressure ulcers Incidence	Co-morbidity Patient age Patient gender Admission type Hospital size Technology status	No significant associations between nurse staffing and patient outcomes No significant effect Bachelor's degree
Wolf et al., 2008, USA	Randomized Controlled trial 2006–2007 Patient survey	N = 1 unit of a Bariatric Center N control group = 58 N intervention group = 58	Other variables Nurses trained in patient-centered care vs. usual care	Falls Absence of falls	Demographics nurse Demographics patient Co-morbidity	No significant differences between control and intervention groups regarding falls

AHA, American Hospital Association; CNA, certified nurses assistant; EN, enrolled nurses; FTE, fulltime equivalent; HAPU, hospital-acquired pressure ulcers; LPN, licensed practical nurse; LVN, licensed vocational nurse; NCHPPS, Total Nursing Care Hours per Patient per Shift; NHPPD, Nursing Hours of Care per Patient Day; OSHPD, Office for Statewide Health Planning and Development; RCT, randomized controlled trial; RN, registered nurse; RNHPPD, Registered Nursing Hours of Care per Patient Day.

Table 2a

Quality appraisal of included studies (exclusively nurse staffing).

Author/date	Validity	Reliability	Applicability	Total	Level of evidence
Seago 2006	1	1	1/2	2½	A2
Burnes Bolton 2007	1	1	0	2	A2
Mark 2004	1/2	1	1	2½	B
Titler 2011	1	1	0	2	B
Mc Closkey 2005	1/2	1/2	1	2	B
Unruh 2012	0	1/2	1	1½	B
Breckenridge-Sproat 2012	1	1/2	0	1½	B
Twigg 2011	1/2	1/2	0	1	B
Donaldson 2005	1/2	1/2	0	1	B
Bae 2010a	1	1	1	3	C
Bae 2010b	1	1/2	1	2½	C
Stone 2007	1/2	1	1	2½	C
Jiang 2006	1	1	0	2	C
Frith 2010	1/2	1/2	1	2	C
Goode 2011	1/2	1/2	1/2	1½	C
Gunningberg 2012	1/2	1/2	0	1	C
Shuldham 2009	1	0	0	1	C

characteristics of these studies. Most studies originated from North-America (20 from the USA and three from Canada). Two studies were conducted in Australia and New-Zealand, one in the UK and one in Belgium. Two studies compared data from the USA with data from other countries (Sweden and Canada). The studies differed in their level of analysis; five studies described results at the hospital-level and 24 studies at the unit-level. The unit-level analysis mainly focused on intensive care, surgical and medical/surgical units.

In terms of the nurse-sensitive outcomes, 12 studies examined pressure ulcers and 11 examined patient falls. Six studies analyzed both pressure ulcers and patient falls, among which one also elaborated on pain management. The search did not yield any applicable studies referring to delirium or malnutrition. Regarding work environment characteristics, 17 studies exclusively focused on nurse staffing; five of these studies were appraised as high quality studies, eight studies as moderate quality studies and four studies were rated low quality (Table 2a). A total of 12 studies also reported on characteristics other than nurse staffing; three of these studies were appraised as high quality studies, seven studies as moderate quality studies and two studies were rated low quality (Table 2b).

3.2. Patient falls

3.2.1. Nurse staffing

Only one of the six studies on patient falls and total nursing hours reported significant relationships. In this study, [Patrician et al. \(2011\)](#) found that significantly more falls occurred in various units of military hospitals if total nursing hours were lower. However, the study provided no description of the width of confidence intervals. Another cohort study on military hospitals ([Breckenridge-Sproat et al., 2012](#)) did not find any significant associations between nursing hours and patient falls. Additionally, [Burnes Bolton et al. \(2007\)](#), [Kendall-Gallagher and Blegen \(2009\)](#), [McGillis Hall et al. \(2004\)](#) and [Shuldham et al. \(2009\)](#) did not find evidence regarding total nursing hours. A similar trend occurred for RN hours; one of six studies found small and inversed associations with patient falls. The cross-sectional study of [Taylor et al. \(2012\)](#) showed significant inversed effects, as an additional hour of care by RNs was associated with a 9% decrease in the odds to fall. Yet, five other studies did not find any significant associations ([Burnes Bolton et al., 2007](#); [Donaldson et al., 2005](#); [Frith et al., 2010](#); [Seago et al., 2006](#); [Titler et al., 2011](#)). Three of four studies on the proportion of RNs

Table 2b

Quality appraisal of included studies (nurse staffing and other characteristics).

Author/date	Validity	Reliability	Applicability	Total	Level of evidence
Wolf 2008	1/2	0	1	1½	A2
Patrician 2011 ^a	1/2	1/2	1/2	1½	B
Kendall-Gallagher 2009 ^a	1	1	1/2	2½	C
Chang 2006	1/2	1	1	2½	C
Van den Heede 2009 ^a	1	1	1/2	2½	C
Purdy 2010	1/2	1/2	1	2	C
Krapohl 2010	1/2	1/2	1	2	C
Manojlovich 2009	1/2	1/2	1	2	C
Mallidou 2011	1/2	0	1	1½	C
Taylor 2012 ^a	1	1/2	0	1½	C
Manojlovich 2011	1/2	1/2	0	1	C
McGillis Hall 2004 ^a	1	0	0	1	C

^a Studies which also analyzed nurse staffing and/or skill mix.

reported significant effects. The three cohort studies showed that higher proportions of RNs were significantly related to lower numbers of patient falls. More specifically, small effect sizes were reported for medical/surgical and critical care units (Patrician et al., 2011) and for step down units (Burnes Bolton et al., 2007). Titler et al. (2011) evaluated the reported fall incidences in one hospital and found that with every 10% increase in the proportion of RNs, the odds of falling decreased by approximately 19%. There was one cross-sectional study showing no significant associations with patient falls (Kendall-Gallagher and Blegen, 2009). Regarding temporary nurses, Burnes Bolton et al. (2007), Bae et al. (2010a) and Breckenridge-Sproat et al. (2012) all showed significant positive associations between patient falls and temporary nurses (i.e., more patients fall in units with higher levels of temporary nurses). Two studies reported nurse turnover; Bae et al. (2010b) found that, compared to units without nurse turnover, fall rates in medical/surgical units with low turnover rates (< 3.3%) were significantly lower. Taylor et al. (2012) did not find any significant associations between falls and unit turnover.

In sum, most studies on nurse staffing and patient falls did not show significant associations. However, the studies that did report significant effects were labeled as moderate to high quality and found inversed effects, indicating that a more favorable staffing is associated with a lower number of patient falls.

3.2.2. Education

Two of four studies found significant associations between patient falls and education. Manojlovich et al. (2011) showed that higher levels of education were related to lower rates of patient falls. Another study found that a higher proportion of certified nurses were associated with fewer patient falls (Kendall-Gallagher and Blegen, 2009). However, this study did not find evidence in regard to nurses with at least a Bachelor's degree. Two studies (Chang et al., 2006; Mallidou et al., 2011) did not find effects of nursing education.

3.2.3. Experience

Three of six studies on experience found significant associations with patient outcomes. Patrician et al. (2011) found that decreasing the numbers of civilian nurses, who on average have more experience, was associated with more fall incidences. Similar inversed associations were reported by Mallidou et al. (2011) and Manojlovich et al. (2011). Chang et al. (2006), Kendall-Gallagher and Blegen (2009) and McGillis Hall et al. (2004) did not find significant effects of experience.

3.2.4. Collaborative nurse–physician relationships

Two out of three studies on collaboration with physicians in relation to patient falls reported significant associations. Specifically, positively appreciated communication was associated with fewer adverse events (i.e., patient falls, medical errors, and nosocomial infections) (Mallidou et al., 2011) and lower number of patient falls (Purdy et al., 2010). Chang et al. (2006) did not find significant associations.

3.2.5. Patient-centered values

The only randomized controlled trial that was available addressed the relationship between patient-centered care (PCC) and the absence of falls. No significant differences were found between 58 patients who received care from PCC trained nurses and 58 patients who received usual care (Wolf et al., 2008).

3.3. Pressure ulcers

3.3.1. Nurse staffing

Regarding total nursing hours of care, three of nine studies found significant effects on pressure ulcers. In their New-Zealand study, McCloskey and Diers (2005) reported a 36% decrease in total nursing hours after health care reengineering policies between 1993 and 2000. During these years, the rates of pressure ulcers increased and associations with staffing hours were significant. Goode et al. (2011), using a significance level of $p < .10$, found the following significant inversed associations: higher total nursing hours and fewer pressure ulcers in intensive care units in the USA. Burnes Bolton et al. (2007) unexpectedly found that in 65 step-down units, higher levels of nursing hours were significantly related to higher prevalence of pressure ulcers between 2002 and 2006 ($\beta = .928, p = .004$). These types of associations were, however, not found for the same study sample in the period from 2002 to 2004 (Donaldson et al., 2005). Five studies in different countries (i.e., England, Australia, Belgium, and USA) did not find significant associations with pressure ulcers (Gunningberg et al., 2012; Kendall-Gallagher and Blegen, 2009; Shulldham et al., 2009; Twigg et al., 2011; Van den Heede et al., 2009). Regarding the hours of care performed by registered nurses (RN hours), four of six studies reported significant relationships. Jiang et al. (2006) compared two databases, the American Hospital Association (AHA) and the Office of State-wide Health Planning and Development (OSHPD). Both databases agreed on the small inversed effects of higher numbers of RN hours on pressure ulcers. Stone et al. (2007) and Mark et al. (2004) found similar significant inverse relationships between RN hours and pressure ulcers. In the study by Mark et al. (2004), associations were no longer significant after controlling for hospital-specific effects (e.g., patient case mix and hospital size). Stone et al. (2007) also found that higher rates of pressure ulcers were significantly related to more overtime hours by RNs. Unruh and Zhang (2012) found contrasting results regarding pressure ulcers; higher levels of RN hours were associated with higher incidences of pressure ulcers ($\beta = .996, p = .05$). Two studies did not find any associations between RN hours and pressure ulcers (Frith et al., 2010; Taylor et al., 2012). Regarding the proportion of registered nurses (%RN) in relation to pressure ulcers, three of six studies found significant associations. One cohort study reported counterintuitive, yet significant positive associations; higher proportion of RNs in the skill mix related to higher rates of pressure ulcers (McCloskey and Diers, 2005). However, two cross-sectional studies that used retrospective analysis found significant inversed associations (Frith et al., 2010; Jiang et al., 2006). It is important to note that the results of Frith et al. (2010) are difficult to interpret as they

used a large category of adverse events as the outcome variable, which included pressure ulcers, but they did not differentiate the effects of each adverse event. Three cross-sectional designs did not find any significant associations (Goode et al., 2011; Gunningberg et al., 2012; Kendall-Gallagher and Blegen, 2009). One study examined pressure ulcers in relation to temporary and non-temporary nurses and found that higher levels of permanent nurses (i.e., non-temporary nurses) led to higher pressure ulcers rates (Shulldham et al., 2009). The two studies on turnover did not find significant associations; Taylor et al. (2012) investigated unit turnover and Gunningberg et al. (2012) investigated several variables, such as patient turnover, staff voluntary turnover and patients per registered nurse.

In sum, contradicting results were shown for measures of nurse staffing in relation to pressure ulcers. Most studies found inversed effects; more favorable staffing was associated with fewer pressure ulcers. However, these effect sizes were small in contrast to the large effect sizes of the three cohort studies that revealed high staff numbers were related to high levels of pressure ulcers.

3.3.2. Education

Both studies on education in relation to pressure ulcers did not find significant associations; Van den Heede et al. (2009) with regard to nurses with at least a Bachelor's degree and Krapohl et al. (2010) did not show significant effects in relation to certified nurses.

3.3.3. Collaborative nurse–physician relationships

Positively appreciated communication was associated with a lower number of pressure ulcers in the study by Taylor et al. (2012). However, Manojlovich et al. (2009) did not find significant associations.

3.3.4. Pain

The only study to report on the outcome measure of pain showed that patients were more satisfied with pain management if favorable staffing existed. Moreover, a higher number of total nursing hours and higher proportion of RNs in the skill mix improved pain management (Seago et al., 2006).

4. Discussion

The aim of the present study was to systematically review the literature on the relationship between characteristics of nurse work environment and five nurse-sensitive patient outcomes (i.e., delirium, malnutrition, pain, patient falls, and pressure ulcers) in hospitals. We considered a broad set of work environment characteristics, thereby potentially adding to existing knowledge in this area. Regarding the articles in this study, we originally intended to report on five nurse-sensitive patient outcomes; however, the literature search revealed that there were only eligible studies on pressure ulcers and patient falls and one study on pain assessment. This finding is informative, because it suggests that future work should be conducted to identify relationships between work environment and outcome measures such as malnutrition and delirium. Otherwise, one may want to reconsider whether

or not these patient outcomes should be used as indicators of nursing quality. For example, in the Netherlands malnutrition and delirium are part of a mandatory set of quality indicators, determined by the Health Care Inspectorate. Health care policy makers should ask whether these types of data are useful as benchmark indicators for nursing quality.

Initially, we wanted to perform a quantitative meta-analysis; however, comparing study results proved to be problematic due to the lack of relevant statistical information in many of the primary studies. For example, some articles missed clear information about sample sizes. In other articles the information on statistical analysis was incomplete (e.g., p-value or confidence interval not reported). Additionally, large differences in outcome measures compromised the possibility of conducting a meta-analysis. We consider it imperative to note these issues, because it may hinder the accumulation of knowledge about optimal nurse work environments. Based on the findings of this review, there are two overall conclusions. First, there were mixed results regarding the association between nurse staffing and the outcome measures of patient falls and pressure ulcers. Second, we found indications that specific work environment characteristics other than staffing are related to nurse-sensitive outcomes. We will discuss these findings in more detail in the following paragraphs.

4.1. Nurse staffing

Overall, regarding the structural characteristic of nurse staffing in relation to nurse-sensitive patient outcomes, we found that the studies that were labeled low quality were also the studies that were unable to show significant effects. Significance was found in studies of moderate or high quality, including the only study to report on pain, showing that patients were more satisfied with pain management if favorable staffing levels existed. Most studies were based on North American data and to prevent an underestimation of effects in other areas, it would be useful to examine nurse work environments and nursing quality in various continents (e.g., Europe, Australia).

Regarding nurse staffing in relation to patient falls, most studies did not report significant effects. However, the evidence is rather consistent and shows that higher staffing numbers are associated with fewer patient falls. This finding is consistent with previous reviews (e.g., Kane et al., 2007). Most studies that found significant effects used a longitudinal cohort design (i.e., level of evidence A2 or B). The major preponderance of cross-sectional designs (level C) in this research field, with a high risk of contamination of confounders and bias makes it difficult to generate explanatory results. Randomized controlled trials would be the preferred research design, yet as mentioned by Clarke and Donaldson (2008), it is almost impossible to use these designs in the present research area, because it requires randomization of interventions that cannot be controlled. In our review, one randomized controlled trial (Wolf et al., 2008) was included; the small sample size of 58 patients could be a possible explanation for the lack of significant effects. In future research on work

environment and nursing quality, longitudinal observational designs would be preferred. These types of designs allow for descriptions of trends over time and therefore provide more robust evidence on associations (Dunton et al., 2007).

For pressure ulcers, the findings indicate that there are mixed outcomes in this area. Most studies found that more favorable staffing, such as more nursing hours or higher proportions of registered nurses (RNs), is related to lower levels of pressure ulcers. However, there were a few cohort studies in the dataset that found contradictory results, in which higher staffing numbers were associated with higher levels of pressure ulcers. As a possible explanation for these counterintuitive effects, McCloskey and Diers (2005) referred to work prioritization; more emphasis on the importance of adverse events, such as pressure ulcers may have led to increased reporting on these adverse events. Furthermore, the influence of patient acuity might have played a role. It may be useful to systematically examine the possible role of this factor in future studies. According to Kramer et al. (2010), conflicting results may reflect methodological errors related to finding relationships between structure variables (e.g., staffing, skill mix) and outcomes (e.g., pressure ulcers) without including an analysis of process variables (i.e., nursing interventions) that mediate the relationship. The safest conclusion that can be drawn is that evidence on nurse staffing and pressure ulcers is inconclusive and more research is necessary.

4.2. Characteristics other than nurse staffing

Analysis of the 12 studies on characteristics of the work environment other than staffing showed significant effects for collaborative relationships, education and experience. To appreciate these findings several aspects need to be considered. We found evidence that positively appreciated nurse–physician collaboration and a more experienced and higher-educated staff were significantly associated with lower rates of pressure ulcers and fewer patient falls. Effective collaboration is already acknowledged to be an important work environment factor by the Institute of Medicine (2004). The findings of the present study support this view. Nevertheless, it was the only process characteristic that was linked to pressure ulcers and falls. This finding implicates a gap in literature concerning a lack of evidence regarding the relationship between process variables of the work environment and patient outcomes.

Regarding structural nurse characteristics, our findings regarding the favorable effects of higher nursing education are consistent with ongoing insights in the relevance of this work environment factor. For example, two recently published articles showed that higher levels of nurses with (at least) a Bachelor's degree are significantly associated with lower in-hospital mortality (Aiken et al., 2014) and with lower failure to rescue, shorter length of stay, and lower decubitus ulcer rates (Blegen et al., 2013). Additionally, experience is considered to be a highly relevant factor in work performance in general performance literature as well as in studies on nurse performance. For example, it is well known that experience is associated with the

accumulation of job knowledge and automation of procedures, which allow an employee to conduct the job more effectively and efficiently (Schmidt and Hunter, 2004). This factor is also true for nurses (DeLucia et al., 2009; McCloskey and McCain, 1988). The findings of the present review confirm that nursing experience and education (structure) are influential factors and play a role in determining nursing quality (outcome), potentially through knowledge and competencies on the job (process).

4.3. Quantitative analysis

We have discussed some fundamental problems with assessing and comparing data from primary studies that prevented us from conducting an adequate quantitative meta-analysis of the literature. There is an ongoing debate regarding the robustness of quantitative meta-analyses of observational studies. Previous reviews, including Lake and Cheung (2006) and Lankshear et al. (2005) suggested that improvements in measurements and methods in this research field have not been achieved. However, in the absence of evidence from randomized controlled trials, there is growing evidence from observational studies in this research area. Meta-analyses could provide a pooled summary of effects from individual studies and highlight topics in which findings are limited (Stroup et al., 2000). Therefore, in addition to increasing the number of studies in this area, future research should also consider that individual studies may eventually be data-points for quantitative reviews and therefore should provide sufficient levels of statistical information (e.g., clear description of sample and effect sizes).

4.4. Limitations

The present review reveals the relationship between nurse work environment and nurse-sensitive patient outcomes. Nevertheless, there are several limitations that should be considered in interpreting the results. First, due to methodological issues as described in the previous paragraph, we were unable to perform a quantitative meta-analysis on the study results. Second, our aim was to analyze patient outcomes that are specifically related to nursing quality. We focused on a limited set of nurse-sensitive patient outcomes, whereas other outcomes were excluded (e.g., medication errors, and nosocomial infections). Nevertheless, we emphasize that the present review gives us the opportunity to draw clear conclusions on the quality of nursing care regarding the five nurse-sensitive patient outcomes. Third, although a full description of study results is provided, there were primary studies that did not report on confounding factors (e.g., patient and organizational characteristics) which may have affected patient outcomes.

5. Conclusion

In the present systematic review scientific evidence was found on the effects of nurse staffing and other characteristics of the work environment (i.e., collaborative relationships, experience, and education) on falls, pain

management and pressure ulcers. These findings complement the knowledge from previous reviews on staffing in relation to patient outcomes such as mortality and length of stay, in providing evidence that more favorable work environments contribute to improved patient outcomes. Contemporary health care requires that the quality of nursing care is excellent, and therefore, understanding the relationship with nurse work environment is imperative. Our findings emphasize the need for longitudinal research with well-defined outcome measures and comparable samples of hospitals or hospital units.

Conflict of interest: None.

Funding: Not applicable.

Ethical approval: Not applicable.

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