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**REVIEW ARTICLE**

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# Systematic review: Association between the patient–nurse ratio and nurse outcomes in acute care hospitals

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**Abstract****Aims:** To evaluate and summarize current evidence on the relationship between the patient–nurse ratio staffing method and nurse employee outcomes.**Background:** Evidence-based decision-making linking nurse staffing with staff-related outcomes is a much needed research area. Although multiple studies have investigated this phenomenon, the evidence is mixed and fragmented.**Evaluation:** A systematic literature search was conducted using PubMed, Embase, Web of Science, Cinahl, Cochrane Library and the ERIC databases. Thirty studies were identified, analysing eight selected key nurse outcomes.**Key issue(s):** Future research should focus on unit-level data, incorporate other methodologies and aim for comparability between different types of clinical settings as well as different health care systems.**Conclusion:** A relationship between the patient–nurse ratio and specific staff-related outcomes is confirmed by various studies. However, apart from the patient–nurse ratio other variables have to be taken into consideration to ensure quality of care (e.g., skill mix, the work environment and patient acuity).**Implications for Nursing Management:** Hospital management should pursue the access and use of reliable data so that the validity and generalizability of evidence-based research can be assessed, which in turn can be converted into policy guidelines.**KEYWORDS**

health care, nurse outcome, patient–nurse ratio, staffing, work environment

## 1 | BACKGROUND

Over the past two decades, the health care sector has been in the midst of changes. Increased pressure on health care expenditure, rising patient expectations and new technologies are just a few challenges hospital management has been facing (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Aiken, Sloane, Bruyneel, Heede, & Sermeus, 2013; Sermeus et al., 2011). Finding the perfect balance between patients' needs and the right number of nursing staff is essential, especially given the fact that cost-saving measures have led to less available qualified staff (Duffield, Kearin,

Johnston, & Leonard, 2007). This shortage makes nursing in most countries a much sought-after resource and, consequently, causes an increased burden for these nurses (Aiken et al., 2013). In addition, research has shown that a considerable number of nurses experience high levels of job stress, which increases sickness absence and puts pressure on the remaining nurses causing a vicious circle of absenteeism (Van den Heede et al., 2013; Trybou et al., 2014). Evidence-based decision-making linking nurse staffing with constantly changing patients' care needs is therefore a much needed area of expertise (Squires, Jylha, Jun, Ensio, & Kinnunen, 2017).

Staffing research can be described as an incoherent field of research since there is no methodological consensus on how nurses' workload should be measured (Aiken, Clarke, Sloane, et al., 2002; Min & Scott, 2016; Sermeus et al., 2011). The patient–nurse ratio (P/N ratio) is a widely used method and refers to the total number of patients that are assigned to one nurse during his or her most recent shift (Aiken, Clarke, Sloane, et al., 2002). The use of a specific P/N ratio, such as a 4:1 ratio in medical or surgical units, has been suggested in earlier research (Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Aiken, Clarke, Sloane, et al., 2002). Furthermore, a decision to introduce legislation mandating unit-based minimum P/N ratios in acute care hospitals has already been introduced in some countries. However, concerns are expressed about these fixed staffing ratios, as they do not take into account the normal variability of the work environment across hospitals or even within similar units at the same hospital (Lake & Friese, 2006). Additionally, they do not take into account the workload variation during the day. Because of these reasons, hospital management continues to struggle with defining the right number of nurses.

Previous reviews mainly focused on a selection of nurse outcomes (Lang, Hodge, Olson, Romano, & Kravitz, 2004; Shin, Park, & Bae, 2018), adverse nurse outcomes (Butler et al., 2011; Shin et al., 2018) or only outcomes that were considered to be an objective measurement (Butler et al., 2011). None of the reviews have systematically explored the relationship between a wide range of nurse outcomes and the P/N ratio staffing method. Hence, there is a need for a systematic review.

This systematic review aims to assess and to summarize the current evidence on the relationship between the P/N ratio and nurse outcomes.

## 2 | METHODS

### 2.1 | Search strategy and study selection

A systematic literature search was conducted using PubMed, Embase, Web of Science, Cinahl, Cochrane Library and the ERIC databases in February 2018 (week 7). Via PubMed, we first identified potential MeSH terms and then added non-MeSH entry terms and synonyms meeting the inclusion criteria to complete the search string. Table 1 gives an overview of the inclusion and exclusion criteria. Appendix S1 provides the full details of the search strategy.

### 2.2 | Screening

First, duplicates were removed and two independent reviewers (H.W. and R.W.) screened the studies by title and abstract. In case of non-corresponding results, a third reviewer (J.T.) was consulted to reach a consensus. Next, the remaining articles were selected for full-text retrieval and underwent a quality appraisal. In addition, the reference lists of all the publications were screened and a forward citation track was applied.

**TABLE 1** Inclusion and exclusion criteria

- (1) The studies reported a P/N staffing ratio. In addition to the P/N ratio, this article also includes the “hours of care per patient day” (HPPD) method for calculating the nurses workload since conversion to the P/N ratio is possible. This method has shown to have a high inter-rater reliability (Min & Scott, 2016);
- (2) The studies had to assess nurse outcomes. Since there is no established subdivision of nurse outcomes, we included the most extensively studied outcomes: job (dis)satisfaction, emotional exhaustion or burnout, job stress, intent to leave and needle stick injuries. In addition, we included nurse reported measures of quality of care and safety of patients. Finally, nurses' perception of care left undone was also included given the potential negative impact on nurse outcomes. Studies focusing exclusively on patient and hospital outcomes were excluded;
- (3) The nurses (registered nurse or licensed practical nurse) needed to work in an acute, teaching or non-teaching, public or private hospital. Studies had to at least include the conventional medical-surgical nursing wards. Studies focusing solely on speciality units such as intensive care wards were excluded since staffing on these units is commonly different (Aiken, Clarke, & Sloane, 2002). Apart from this, studies focusing exclusively on nursing homes, skilled nursing facilities or long-term care facilities were also excluded;
- (4) Only empirical quantitative studies were included. Qualitative research, systematic reviews, meta-analyses, theoretical analysis and case studies were excluded;
- (5) Studies written in English, Dutch and French were considered. Studies conducted in developing countries were excluded

### 2.3 | Quality appraisal

Following Duhoux, Menear, Charron, Lavoie-Tremblay, and Alderson (2017), we used the Mixed Methods Appraisal Tool (MMAT) version 2011 (Pace et al., 2012). This instrument has been verified to be a reliable and valid tool for assessing quality of studies with diverse designs. This led to an overall methodological score.

## 3 | RESULTS

### 3.1 | Results of the search strategy

The initial database searches resulted in a total of 3,146 studies. After adjusting for duplicates, 2,834 articles remained. Subsequently, screening on title and abstract was completed and 2,754 articles were excluded because they did not meet the predefined inclusion criteria. After reading the full text of the papers, 28 studies remained eligible for inclusion. In addition, two additional articles were included via forward citation track (Figure 1).

### 3.2 | Study characteristics

All studies were published between 2002 and 2018. The articles originated in Europe (43%), North America (40%), Asia (10%) or a combination of North America and Europe (7%). With the exception of two studies, all samples were drawn from more than one hospital, with a maximum of 1,105 sites included.

According to the quality appraisal, two studies (7%) were rated strong, twelve studies (40%) were rated moderate, thirteen studies (43%) were rated weak, and three studies (10%) were rated very weak. The quality appraisal of these 30 articles is listed in Table 2.

Studies differed in a number of characteristics. First, nurse staffing was mostly measured by the P/N ratio (93%) and otherwise by the “hours per patient day” (HPPD) (7%). This P/N ratio was defined as the number of patients for whom each nurse was responsible during his or her last shift. It was measured by a self-reported nurse survey (83%), using administrative data (10%) or a fixed ratio due to change in regulation or policy (7%). Second, several study designs have been used: 25 articles (83%) used a cross-sectional design and five articles (17%) used a longitudinal design. Third, logistic regression was the most frequently used statistical methodology (52%). The presence of adjustments for confounding factors varied across the included studies. Most frequently used nurse characteristics were gender, experience, nursing speciality, age and education. In contrast, job status (part-time vs. full-time), the roles taken by nurses, the number of shifts worked and the last worked shift (e.g., day vs. night) are seldom taken into account. When studies accounted for hospital characteristics, they primarily included size, teaching status, technology and location.

The characteristics of the 30 studies and the results per outcome are listed in Tables 3 and 4.

### 3.3 | Reported outcomes

This section first provides an overview of the findings per outcome for the 30 included articles. Subsequently, the use of an additional explanatory variable, the work environment, is briefly described.

#### 3.3.1 | Job (dis)satisfaction

Ten studies (67%) described job dissatisfaction versus five studies (33%) job satisfaction. Eleven studies reported a significant association between staffing and job (dis)satisfaction. The remaining four studies that could not identify a significant relationship also received a lower quality appraisal. Each additional patient per nurse increased the odds of dissatisfaction by a factor between 1.07 and 1.15 (Aiken et al., 2008, 2012; Tellez, 2012). According to Aiken, Clarke, Sloane, et al. (2002), nurses in hospitals with 8:1 P/N ratio would be 1.75 times as likely as nurses with 4:1 P/N ratio to be dissatisfied with their jobs. This was confirmed by Rafferty et al. (2007), who reported that nurses with the heaviest workloads were 71% more likely to show job dissatisfaction.

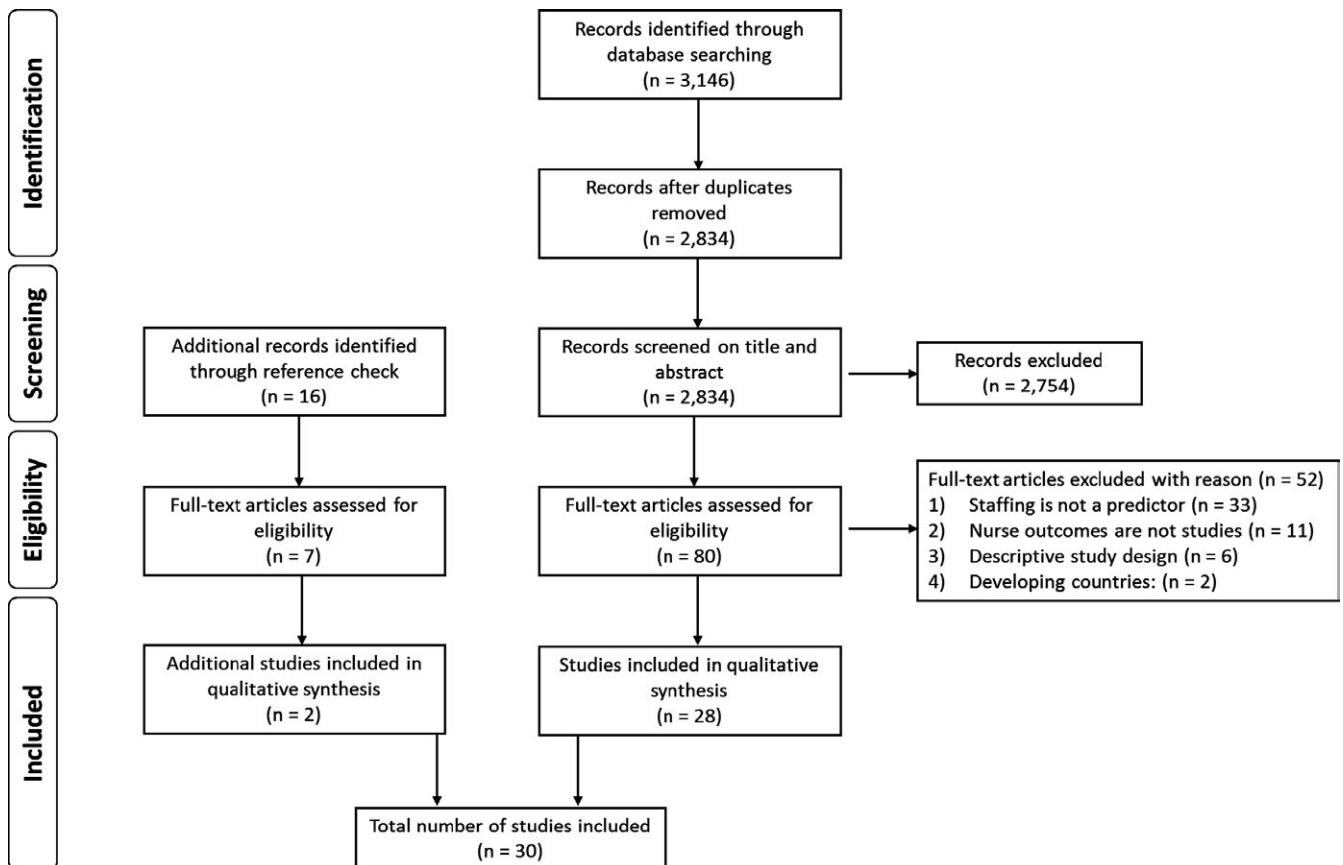


FIGURE 1 Search strategy flow chart

**TABLE 2** Quality of the studies according to the Mied Methods Appraisal Tool (MMAT)

Reference	Screening questions		Quantitative nonrandomized				Overall quality <sup>a</sup>
	Are there clear qualitative and quantitative research questions (or objectives*), or a clear mixed methods question (or objective*)?	Do the collected data allow address the research question (objective)? E.g., consider whether the follow-up period is long enough for the outcome to occur (for longitudinal studies or study components)	Are participants (organizations) recruited in a way that minimizes selection bias?	Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention and outcomes?	In the groups being compared, are the participants comparable, or do researchers take into account (control for) the difference between these groups?	Are there complete outcome data (80% or above), and an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies?	
Aiken et al. (2008) USA	Yes	Yes	Yes	Can't tell	Yes	No	***
Aiken LH, et al. (2012) USA, Europe (12)	Yes	Yes	Yes	Yes	Can't tell	Yes	***
Ball, Murrells, Rafferty, Morrow, and Griffiths (2014) England	Yes	Yes	Yes	Yes	Can't tell	No	**
Hair, Salisbury, Johannsson, and Redfern-Vance (2014) USA	Yes	Yes	Yes	No	No	No	*
Hinno, Partanen, and Vehviläinen-Julkunen. (2012) Finland, The Netherlands	Yes	Yes	Yes	Can't tell	Can't tell	No	**
MacPhee, Dahinten, and Havaei. (2017) Canada	Yes	Yes	Yes	Can't tell	Can't tell	No	**
McHugh, and Ma (2014) USA	Yes	Yes	Yes	Yes	Yes	No	***
Sochalaki (2004) USA	Yes	Yes	Yes	Can't tell	No	Yes	**
Tellez (2012) USA	Yes	Yes	Can't tell	No	No	Can't tell	*
Casalicchio, Lesaffre, Küchenhoff, and Bruyneel (2017) Europe (12)	Yes	Yes	Yes	Yes	Can't tell	Yes	***
Fujimura, Tanii, and Saijoh (2011) Japan	Yes	Yes	No	Can't tell	No	Can't tell	*
Schubert et al. (2013) Switzerland	Yes	Yes	Yes	Yes	Yes	Can't tell	***
Louch, O'Hara, Gardner, and O'Connor (2016) UK	Yes	Yes	No	Yes	Yes	No	**
Van den Heede et al. (2013) Belgium	Yes	Yes	Yes	Yes	Yes	Yes	****
Sheward, Hunt, Hagen, Macleod, and Ball (2005) England, Scotland	Yes	Yes	Can't tell	Can't tell	Yes	No	**
Aiken et al. (2002) USA	Yes	Yes	Yes	Can't tell	Yes	No	***

(Continues)

TABLE 2 (Continued)

Reference	Screening questions			Quantitative nonrandomized			Overall quality <sup>a</sup>
	Are there clear qualitative and quantitative research questions (or objectives*), or a clear mixed methods question (or objective*)?	Do the collected data allow address the research question (objective)? E.g., consider whether the follow-up period is long enough for the outcome to occur (for longitudinal studies or study components)	Are participants (organizations) recruited in a way that minimizes selection bias?	Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention and outcomes?	In the groups being compared, are the participants comparable, or do researchers take into account (control for) the difference between these groups?	Are there complete outcome data (80% or above), and an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies?	
Clarke, Rockett, Sloane, and Aiken (2002) USA	Yes	Yes	No	Can't tell	Can't tell	No	**
Kalisch, Tschannen, and Lee (2011) USA	Yes	Yes	No	Yes	Can't tell	Yes	**
Cho et al. (2016) South Korea	Yes	Yes	Yes	Yes	Yes	Yes	****
Clarke, Sloane, and Aiken (2002) USA	Yes	Yes	No	Can't tell	Yes	Can't tell	**
Kutney-Lee, Wu, Sloane, and Aiken (2013) USA	Yes	Yes	No	Can't tell	Yes	No	**
Aiken et al. (2010) USA	Yes	Yes	Yes	Can't tell	Yes	No	**
Tervo-Heikkinen, Kiviniemi, Partanen, and Vehviläinen-Julkunen (2009) Finland	Yes	Yes	No	Can't tell	Can't tell	Yes	**
Ball et al., (2016) Sweden	Yes	Yes	Yes	Can't tell	Yes	Yes	***
Rafferty et al. (2007) England	Yes	Yes	Yes	Can't tell	Yes	No	***
Aiken et al. (2002) USA, Canada, England, Scotland	Yes	Yes	Yes	Yes	Can't tell	No	***
Heinen et al. (2013) Europe (10)	Yes	Yes	Yes	Yes	Can't tell	Yes	***
Cho et al. (2016) South Korea	Yes	Yes	No	Yes	Can't tell	Can't tell	**
Aiken et al. (2012) England	Yes	Yes	Yes	Yes	Yes	No	***
Lindqvist et al. (2014) Finland, Norway, Sweden	Yes	Yes	Yes	Can't tell	Yes	Can't tell	***

<sup>a</sup>Overall quality is based only on the four quality criteria for quantitative nonrandomized studies

**TABLE 3** Study characteristics

Reference	Sample (hospitals, nurses)	Design	Quality	Staffing level	Analysis
Aiken et al. (2008) USA	168 hospitals, 10,184 nurses	Quantitative; cross-sectional	***	Nurse survey: mean number of patients assigned to staff nurses on the last shift (min 1, max 20)	Logistic regression
Aiken et al. (2012) USA, Europe (12)	1,105 hospitals, 61,168 nurses	Quantitative; cross-sectional	***	Nurse survey: ratio of patients to nurses on the ward on the last shift	Logistic regression
Ball et al. (2014) England	46 hospitals, 2,917 nurses	Quantitative; cross-sectional	**	Nurse survey: numbers of staff giving direct patient care and the numbers of patients on the ward on the last shift	Logistic regression
Hairr et al. (2014) USA	70 nurses	Quantitative; cross-sectional	*	Nurse survey: number of patients assigned to at the beginning of the last shift	Correlational analyses
Hinno et al. (2012) Finland, The Netherlands	869 nurses	Quantitative; cross-sectional	**	Nurse survey: number of patients for whom each nurse was directly responsible	Analysis of variance t tests Chi-squares
MacPhee et al. (2017) Canada	472 nurses	Quantitative; cross-sectional	**	Nurse survey: number of patients and number of direct care nursing staff on the unit during the last shift	Logistic regression Multiple regression
McHugh and Ma (2014) USA	534 hospitals, 26,005 nurses	Quantitative; cross-sectional	***	Nurse survey: average number of patients reported by the nurses on the units on their last shift divided by the average number of nurses on that unit	Logistic regression
Sochalski (2004) USA	8,670 nurses	Quantitative; cross-sectional	**	Nurse survey: number of patients for whom direct patient care was provided on the last shift	Multivariate linear regression
Tellez (2012) USA	12,149 nurses	Quantitative; longitudinal	*	RN hours per patient day (HPPD)	Analysis of variance Bonferroni post hoc Independent t tests Pearson chi-squares
Casaliccio et al. (2017) Europe (12)	488 hospitals, 23,589 nurses	Quantitative; cross-sectional	***	Nurse survey: number of patients per nurse	Semiparametric latent variable model
Fujimura et al. (2011) Japan	1 hospital, 14 nurses	Quantitative; longitudinal	*	Change in regulation/policy; patient/nurse ratio (1st survey: 10:1; 2nd survey: 7:1)	Student's t test Analysis of variance Fisher's exact test
Schubert et al. (2013) Switzerland	35 hospitals, 1,633 nurses	Quantitative; cross-sectional	***	Nurse survey: number of patients on the unit on the last shift, divided by the number of RNs on the unit on the last shift	Multilevel regression analysis
Louch et al. (2016) UK	3 hospitals, 83 nurses	Quantitative; longitudinal	**	Nurse survey: number of patients that were allocated under the direct care of the nurse	Hierarchical linear modelling
Van den Heede et al. (2013) Belgium	56 hospitals, 186 nurses	Quantitative; cross-sectional & qualitative	****	Nurse survey: number of nurses and patients that were present on their unit on their last shift	(Generalized Estimation Equation) logistic regression

(Continues)

TABLE 3 (Continued)

Reference	Sample (hospitals, nurses)	Design	Quality	Staffing level	Analysis
Sheward et al. (2005) England, Scotland	59 hospitals, 8,779	Quantitative; cross-sectional	**	Nurse survey: questions on staffing figures on the last shift, size of ward, patient numbers on the last shift (occupancy) and the number of patients cared for by the respondent	Logistic regression
Aiken et al. (2002) USA	168 hospitals, 10,184 nurses	Quantitative; cross-sectional	***	Nurse survey: mean patient load across all nurses on the last shift they worked, regardless of the speciality or shift (day, evening, night) worked (min 1, max 20)	Logistic regression
Clarke et al. (2002) USA	22 hospitals, 2,287	Quantitative; cross-sectional	**	Nurse survey: number of patients cared for on the last shift they worked	Logistic regression
Kalisch et al. (2011) USA	10 hospitals, 4,288 nurses	Quantitative; cross-sectional	**	Hours per patient day (HPPD)	Multiple regression
Cho et al. (2016) South Korea	51 hospitals, 3,037 nurses	Quantitative; cross-sectional	****	Nurse survey: number of patients assigned to them on their last shift	Multilevel logistic regression
Clarke et al. (2002) USA	20 hospitals, 732 nurses	Quantitative; longitudinal	**	Administrative data: number of full-time equivalent registered nurse positions and the average daily patient census on each of the units for each day of the first month of the study period	Logistic regression modelling employing generalized estimating equations
Kutney-Lee et al. (2013) USA	137 hospitals, 7,651 nurses	Quantitative; longitudinal	**	Nurse survey: number of patients cared for on the last shift (min 1, max 20)	General linear model
Aiken, Clarke, Sloane, et al. (2010) USA	604 hospitals, 22,336 nurses	Quantitative; cross-sectional	**	Nurse survey: numbers of nurses and patients on the unit on the last shift	Logistic regression
Tervo-Heikkinen et al. (2009) Finland	5 hospitals, 854 nurses	Quantitative; cross-sectional	**	Nurse survey: mean number of reported patients assigned to the RN during the last working shift	Bayesian network Causal data analysis
Ball et al. (2016) Sweden	79 hospitals, 10,174 nurses	Quantitative; cross-sectional	***	Nurse survey: number of staff providing direct patient care and the number of patients on the ward on the last shift they worked	Multilevel logistic regression
Rafferty et al. (2007) England	30 hospitals, 3,984 nurses	Quantitative; cross-sectional	***	Nurse survey: number of patients on the nurses' ward during the last shift worked and the total number of nurses covering these patients (as well as the number of patients specifically assigned to the nurse)	Logistic regression
Aiken, Clarke and Sloane (2002) USA, Canada, England, Scotland	303 hospitals, 10,319 nurses	Quantitative; cross-sectional	***	Nurse survey: number of patients assigned to the nurse on their last shift	Logistic regression
Heinen et al. (2013) Europe (10)	385 hospitals, 23,159 nurses	Quantitative; cross-sectional	***	Dividing the number of patients by the number of nurses during the nurses' last shift, which could have been any possible shift	Multilevel regression

(Continues)

TABLE 3 (Continued)

Reference	Sample (hospitals, nurses)	Design	Quality	Staffing level	Analysis
Cho et al. (2016) South Korea	1 hospital, 116 nurses	Quantitative; cross-sectional	**	Change in regulation/policy (high staffing (7 patients per RN) and low staffing (17 patients per RN))	Multiple regression analysis with multilevel modelling
Aiken et al. (2018) England	46 hospitals, 2,963 nurses	Quantitative; cross-sectional	***	Nurse survey: number of patients they cared for on the last shift. Responses are averaged across all nurses in each hospital working the day shift	Least-squares regression
Lindqvist et al. (2014) Finland, Norway, Sweden	138 hospitals, 15,900 nurses	Quantitative; cross-sectional	***	Nurse survey: number of patients they were directly responsible for on the most recent shift? (& three additional questions)	Logistic regression

Moreover, direct patient care is characterized by higher levels of involvement, which is related to job satisfaction.

### 3.3.2 | Emotional exhaustion

Emotional exhaustion or burnout emerged as a frequently studied topic. We identified eleven articles focusing on this outcome and all articles reported a significant association between the P/N ratio and burnout: an increase in the P/N ratio is associated with an increase in emotional exhaustion.

### 3.3.3 | Job stress

Job stress was studied in two articles and both could not find a statistically significant correlation between P/N ratio and stress. However, these results should be interpreted with caution given that the quality of the studies is weak to very weak.

### 3.3.4 | Intent to leave

Our review identified nine articles addressing intent to leave as an outcome. Four reported that higher P/N ratio was significantly associated with higher rates of intent to leave (Aiken et al., 2012; Van den Heede et al., 2013; McHugh & Ma, 2014). Another four articles described that they could not find a significant relationship between staffing and intent to leave (Aiken et al., 2008; Heinen et al., 2013; Kutney-Lee, Wu, Sloane, & Aiken, 2013; Tervo-Heikkinen et al., 2009).

### 3.3.5 | Needle stick injuries

The two identified studies (Clarke et al., 2002; Clarke et al., 2002) described a significant relationship between nurse staffing and injury due to needle sticks. Nurses working on units with lower staffing were significantly more likely to report risk factors associated with needle stick injuries.

### 3.3.6 | Nurses' perception of quality of care

Nurses reported quality of care was studied in eight articles. Only one study reported no significant association between staffing and the perceived quality of care (Tervo-Heikkinen et al., 2009). The other seven studies reported that a higher P/N ratio increased the odds of negative nurses' perception on quality of care. However, one study highlighted that although better staffing is positively associated with higher quality of care, its effect is not as clear as the effect of better organisation (Aiken, Clarke, & Sloane, 2002).

### 3.3.7 | Nurses' perception of patient safety

Three studies described significant associations between staffing and safety perception outcomes: lower P/N ratios indicated more favourable perceptions of patient safety.



TABLE 4 Results per nurse outcome

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
<i>Job (dis)satisfaction</i>				
Aiken et al. (2008) USA	—	Work environment	Nurse: sex, experience, education, nursing specialty Hospital: size, teaching status, technology	Each additional patient per nurse increased the odds of dissatisfaction with roughly one-tenth.
Aiken et al. (2012) USA, Europe (12)	How satisfied are you with your current job? (4-point Likert-type scale)	Work environment	Nurse: age, sex, full-time employment status, specialty Hospital: size, teaching status, technology	Each additional patient per nurse increased the odds of job dissatisfaction. Staffing and the quality of the work environment were significantly associated with nurse outcomes.
Johannsson, and Redfern-Vance (2014) USA	Control Over Practice subscale of the NWI-R & additional question: Has the number of patients you have been assigned resulted in job dissatisfaction?	—	—	There is a weak positive relationship between job satisfaction and nurse staffing.
MacPhee, Dahinten, and Havaei (2017) Canada	Sum of three variables; derived from the validated Canadian National Survey on the Work and Health of Nurses	(1) Nurse reports: patient acuity (2) Nurse reports: patient dependency (3) Nurse perceptions of heavy workloads (4) Nursing tasks left undone and compromised standards (5) Task-level interruptions to work flow	Can't tell	P/N ratio is correlated with job satisfaction (weak negative correlation). Staffing level is a non-significant predictor in logistic regression. Perceptions of heavy perceived nurse workload and frequent interruptions were independently associated with lower levels of job satisfaction.
McHugh and Ma (2014) USA	How satisfied are you with your current job? (4-point Likert-type scale)	(1) Wage (2) Work environment	Nurse: gender, education level, unit type, years of experience Hospital: market competition with the Herfindahl–Hirschman index, teaching status, number of beds, technology level, ownership, state, urban–rural location	Higher P/N ratio is positively related to job dissatisfaction. Hospitals with better work environments and better staffing have lower odds of job dissatisfaction. Magnet recognition was associated with lower odds of job dissatisfaction.
Sheward et al. (2005) England, Scotland	How satisfied are you with your current job? (4-point Likert-type scale)	—	Nurse: age, sex, years as an RN, qualification, speciality Hospital: Number of beds in hospital, teaching status, technology status	Significant relationship between staffing and dissatisfaction: fewer number of patients per nurse is related to a decrease in job dissatisfaction.

(Continues)

TABLE 4 (Continued)

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
Aiken et al. (2002) USA	How satisfied are you with your current job? (4-point Likert-type scale)	—	Nurse: sex, experience, type of degree, type of unit Hospital: high technology, teaching status, size (number of beds)	Strong and significant association: an increase of one patient per nurse increased job dissatisfaction by 15%. Nurses in hospitals with 8:1 P/N ratio would be 1.75 times as likely as nurses with 4:1 P/N ratio to be dissatisfied with their jobs.
Aiken et al. (2010) USA	—	Work environment	Nurse: age, sex, race, degree, experience, type of unit assigned to Hospital: location (state), teaching status, technology status, bed size	Poorer staffed hospitals have significantly higher odds on reporting job dissatisfaction. Outcomes are better for nurses in hospitals that meet a benchmark based on California staffing mandates.
Rafferty et al. (2007) England	How satisfied are you with your current job? (4-point Likert-type scale)	—	Nurse: age, sex, enrolled (vs. registered) nurse, degree, dependents, clinical speciality Hospital: hospital size, teaching status, technology status	Nurses with the heaviest workloads were 71% more likely to show job dissatisfaction. Heavy patient workload is related to greater job dissatisfaction.
Aiken et al. (2002) USA, Canada, England, Scotland	How satisfied are you with your current job? (4-point Likert-type scale)	Organisational support (staffing adequacy, managerial support for nurses' decisions)	Controlled for country/site (limited info)	Poorer staffed hospitals have significantly higher odds on reporting dissatisfaction. When staffing and organisational support simultaneously are taken into account, no significant association could be found.
Fujimura et al. (2011) Japan	Physicians' and nurses' estimation of their Working Hours, Income, Number of Physicians and Nurses in the Ward	—	—	The 7:1 system (instead of 10:1) not always showed advantages for the quality of life of the medical staff.
Tervo-Heikkinen et al. (2009) Finland	RN-WCBI: job satisfaction is 1 item (4-point Likert-type scale)	Work environment (control of own practice, adequacy of material resources, attitudes towards technical equipment)	Can't tell	P/N ratio did not correlate significantly with job satisfaction.
Kutney-Lee et al. (2013) USA	A single item on the survey that asked to rate how satisfied they were with their job	Work environment	Nurse: age, sex, education, full-time status, unit type Hospital: teaching status, size, technology status Baseline staffing and work environment values (in 1999)	Improvements in nurse staffing were not found to be significantly associated with job dissatisfaction, in contrast to work environments (where an association with lower rates of job dissatisfaction were found).
Tellez (2012) USA	Satisfaction with work environment was measured by 30 questions, one questions asked the overall job satisfaction (5-point Likert-type scale)	—	—	No significant difference in staffing between the satisfied and dissatisfied nurses.

(Continues)

TABLE 4 (Continued)

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
Lindqvist et al. (2014) Finland, Norway, Sweden	How satisfied are you with your current job? & Would you recommend your hospital to a nurse colleague as a good place to work?	Involvement in direct patient care	Nurse: age, sex, experience, reported number of nursing staff Hospital	An increased number of patients is related to higher odds of work dissatisfaction (Finnish sample not significant)
<i>Burnout/emotional exhaustion</i>				
Aiken et al. (2008) USA	Maslach Burnout Inventory	Work environment	Nurse: sex, experience, education, nursing specialty Hospital: size, teaching status, technology	Each additional patient per nurse increased the odds of burnout with roughly one-fifth.
Aiken et al. (2012) USA, Europe (12)	Maslach Burnout Inventory	Work environment	Nurse: age, sex, full-time employment status, specialty Hospital: size, teaching status, technology	Each additional patient per nurse increased the odds of burnout. Staffing and the quality of the work environment were significantly associated with nurse outcomes.
MacPhee M, Dahinten VS, Havaei F. (2017) Canada	Maslach Burnout Inventory	(1) Nurse reports: patient acuity (2) Nurse reports: patient dependency (3) Nurse perceptions of heavy workloads (4) Nursing tasks left undone and compromised standards (5) Task-level interruptions to work flow	Can't tell	P/N ratio is correlated with emotional exhaustion (weak positive correlation). Staffing level is a non-significant predictor in logistic regression. Nurses who experienced heavy workloads on a daily basis were three and a half times more likely to report high emotional exhaustion.
McHugh and Ma (2014) USA	Maslach Burnout Inventory	(1) Wage (2) Work environment	Nurse: gender, education level, unit type, years of experience Hospital: market competition with the Herfindahl–Hirschman index, teaching status, number of beds, technology level, ownership, state, urban–rural location	Higher P/N ratio is positively related to burnout. Magnet recognition was associated with lower odds of burnout
Casaliccio et al. (2017) Europe (12)	Maslach Burnout Inventory	Work environment	Can't tell	An increase in the P/N ratio is associated with an increase in emotional exhaustion. At about 15 patients per nurse, no further increase in emotional exhaustion is seen

(Continues)

TABLE 4 (Continued)

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
Sheward, Hunt, Hagen, Macleod, and Ball (2005) England, Scotland	Maslach Burnout Inventory	—	Nurse: age, sex, years as an RN, qualification, speciality Hospital: number of beds in hospital, teaching status, technology status	Highly significant relationship between staffing and emotional exhaustion: fewer number of patients per nurse is related to a decrease in burnout.
Aiken et al. (2002) USA	Maslach Burnout Inventory	—	Nurse: sex, experience, type of degree, type of unit Hospital: high technology, teaching status, size (number of beds)	Higher emotional exhaustion was strongly and significantly associated with P/N ratio. An increase of 1 patient per nurse increased burnout by 23%. Nurses in hospitals with 8:1 P/N ratio would be 2,29 times as likely as nurses with 4:1 N/P ratio to show high emotional exhaustion
Kutney-Lee et al. (2013) USA	Maslach Burnout Inventory	Work environment	Nurse: age, sex, education, full-time status, unit type Hospital: teaching status, size, technology status Baseline staffing and work environment values (in 1999)	Improvements in nurse staffing (and improvements in work environments) were significantly associated with lowered burnout rates over time.
Aiken et al. (2010) USA	—	Work environment	Nurse: age, sex, race, degree, experience, type of unit assigned to Hospital: location (state), teaching status, technology status, bed size	Poorer staffed hospitals have significantly higher odds on reporting burnout (factor 1.5). Outcomes are better for nurses in hospitals that meet a benchmark based on California staffing mandates.
Rafferty et al. (2007) England	Maslach Burnout Inventory	—	Nurse: age, sex, enrolled (vs. registered) nurse, degree, dependents, clinical speciality Hospital: hospital size, teaching status, technology status	Nurses with the heaviest workloads were 78% more likely to show burnout. Heavy patient workload is related to greater emotional exhaustion.
Aiken et al. (2002) USA, Canada, England, Scotland	Maslach Burnout Inventory	Organisational support (staffing adequacy and managerial support for nurses' decisions)	Controlled for country/site (limited info)	Poorer staffed hospitals have significantly higher odds on reporting burnout. When staffing and organisational support simultaneously are taken into account, no significant association could be found.
<b>Stress</b>				
Fujimura, Tanii, and Saijoh (2010) Japan	Levels of mental and physical stress were examined using the Simplified Job Stressor Questionnaire (SJSQ)	—	—	Under the 7:1 system (compared with the 10:1 system), the rates for high physical stress were slightly reduced, but these differences were not statistically significant, whereas that for high mental stress remained unchanged

(Continues)

TABLE 4 (Continued)

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
Tervo-Heikkinen et al. (2009) Finland	RN-WCBI	Work environment (control of own practice, adequacy of material resources, attitudes towards technical equipment)	Can't tell	P/N ratio did not correlate statistically significantly with stress.
<i>Intent to leave</i>				
Aiken et al. (2012) USA, Europe (12)	Intent to leave their job within the next year	Work environment	Nurse: age, sex, full-time employment status, specialty Hospital: size, teaching status, technology	Each additional patient per nurse increased the odds of intent to leave. Staffing and the quality of the work environment were significantly associated with nurse outcomes.
McHugh and Ma (2014) USA	Intent to leave their job within the next year	(1) Wage (2) Work environment	Nurse: gender, education level, unit type, years of experience Hospital: market competition with the Herfindahl–Hirschman index, teaching status, number of beds, technology level, ownership, state, urban–rural location	Staffing was significantly associated with intent to leave. Magnet recognition was associated with lower odds of intent to leave.
Van den Heede et al. (2013) Belgium	Intent to leave their job within the next year	(1) Work environment (2) Nurse education	Nurse: age, gender, years worked as a nurse Hospital: bed size, teaching status, technology level Region (Wallonia, Brussels-Capital, Flanders)	Higher P/N ratio was associated with higher rates of intention to leave the hospital.
Aiken et al. (2010) USA	—	Work environment	Nurse: age, sex, race, degree, experience, type of unit assigned to Hospital: location (state), teaching status, technology status, bed size	Poorer staffed hospitals have significantly higher odds on reporting that their workloads cause them to look for a new position (factor 1,6). Outcomes are better for nurses in hospitals that meet a benchmark based on California staffing mandates.
Aiken et al. (2008) USA	Intent to leave their job within the next year	Work environment	Nurse: sex, experience, education, nursing specialty Hospital: size, teaching status, technology	Nurse staffing had no significant effect on intention to leave. Only the care environment had a significant effect on intentions to leave.
Kutney-Lee et al. (2013) USA	Intent to leave their job within the next year	Work environment	Nurse: age, sex, education, full-time status, unit type Hospital: teaching status, size, technology status Baseline staffing and work environment values (in 1999)	Improvements in nurse staffing were not found to be significantly associated with changes in intentions to leave, in contrast to work environments (where an association with lower rates of intention to leave were found).

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TABLE 4 (Continued)

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
Tervo-Heikkinen et al. (2009) Finland	RN-WCBI—intent to leave (7 items)	Work environment (control of own practice, adequacy of material resources, attitudes towards technical equipment)	Can't tell	P/N ratio did not correlate statistically significantly with intent to leave.
Heinen et al. (2013) Europe (10)	Intent to leave their job within the next year & differentiate between leaving the hospital and leaving the profession	(1) Work environment (2) Burnout (3) Perceived quality & safety of care (4) Nurse characteristics	Country and hospital-unit (limited info)	P/N ratio did not correlate with intention to leave the profession at the ten country level, nor in any of the individual countries. Elements of work environment are associated with intention to leave the nursing profession.
Lindqvist et al. (2014) Finland, Norway, Sweden	Intent to leave their job within the next year (as a result of dissatisfaction)	Involvement in direct patient care	Nurse: age, sex, experience, reported number of nursing staff Hospital	Significant associations between direct patient care and intention to leave (only in Swedish sample) This relationship is u-shaped: higher odds ratios among nurses that provided most or least direct patient care
<b>Needlestick injuries</b>				
Clarke et al. (2002) USA	Have you ever been stuck with a needle or sharp object contaminated with blood (& how many times: previous year & previous month)? Further details about the most recent injury & near-miss incidents in the past month	(1) Organisational climate (2) Safety equipment	Nurse characteristics, nature of work, perceived risk factors, specific types of protective equipment	Risk of sharps injuries in nurses is importantly related to nurse staffing levels and working climate. Nurses in the hospitals where administrative support was lowest and workload was heaviest were 50% more likely to report an injury.
Clarke et al. (2002) USA	Have you ever been stuck with a needle or sharp object contaminated with blood (& how many times: previous year & previous month)? & prospective data (exposures to sharps and near-miss injuries)	Organisational climate	Nursing organisation: resource adequacy, nurse manager leadership, emotional exhaustion	Nurses working on units with lower staffing levels were substantially more likely to report the presence of risk factors associated with needle stick injuries.
<b>Nurses' perceptions on quality of care</b>				
Aiken et al. (2008) USA	Report quality of nursing care on their unit as poor or fair; not confident that management will resolve patient care problems; not confident that patients can manage their care when discharged; would not recommend hospital to family member	Work environment	Nurse: sex, experience, education, nursing speciality Hospital: size, teaching status, technology	Each additional patient per nurse increased the odds of negative nurses' perceptions on quality of care.

(Continues)

TABLE 4 (Continued)

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
<i>Nurses' perceptions on quality of care</i>				
Aiken et al. (2012) USA, Europe (12)	Report quality of nursing care on their unit as poor or fair; not confident that management will resolve patient care problems; not confident that patients can manage their care when discharged; would not recommend hospital to family member	Work environment	Nurse: age, sex, full-time employment status, specialty Hospital: size, teaching status, technology	Each additional patient per nurse increased the odds of nurses reporting poor or fair quality care, not confident that patients can manage own care after discharge, not confident that hospital management would resolve patients' problems. Staffing and the quality of the work environment were significantly associated with nurse outcomes.
Sochalski (2004) USA	How would you describe the quality of nursing care delivered to patients on your unit on your last shift?	—	—	The addition of each patient to the nurse's workload is (significant) associated with a 0.07 point decline in quality scores. Mean quality scores declined from 3.6 (excellent/good) to 2.7 (good/fair) as the number of patients cared for rose from 1 to 10 and plateaued after that point.
Cho et al. (2016) South Korea	Nurses' reports on the quality of nursing care on their unit ("poor or fair" or, in contrast, "excellent or good")	Overtime	Nurse: age, gender, education, years worked as a nurse, job status, job security, working unit, last shift worked Hospital: location, bed size, teaching hospital status, high technology status	Higher P/N ratio was significantly associated with higher odds of reporting poor/fair quality of care. An increase of one patient per nurse was associated with a 2 per cent increase in the predicted odds of rating the quality of care as fair or poor.
Aiken et al. (2010) USA	Report quality of nursing care on their unit as poor or fair; not confident that patients can manage their care when discharged; workload causes me to miss changes in patient condition	Work environment	Nurse: age, sex, race, degree, experience, type of unit assigned to Hospital: location (state), teaching status, technology status, bed size	Poorer staffed hospitals have significantly higher odds on reporting that quality of care is poor or fair; they are not confident patients can manage care after discharge, workload causes them to miss changes in patient condition. Outcomes are better for nurses in hospitals that meet a benchmark based on California staffing mandates.
Rafferty et al. (2007) England	Nurses rated the quality of care on their units & assessed whether the quality in their hospitals had improved, deteriorated or remained unchanged over the last year	—	Nurse: age, sex, enrolled (vs. registered) nurse, degree, dependents, clinical specialty Hospital: hospital size, teaching status, technology status	The nurses in the hospitals with the heaviest workloads were 92% more likely to rate the quality of care on their wards as low and 75% more likely to rate the quality of care in their hospitals as deteriorating.

(Continues)

TABLE 4 (Continued)

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
Aiken et al. (2002) USA, Canada, England, Scotland	Assess the quality of care on their unit using a four-point scale; are you confident that patients can manage their care when discharged; do you feel that the quality of patient care has improved, deteriorated or remained the same over the past year?	Organisational support (staffing adequacy and managerial support for nurses' decisions)	Controlled for country/site (limited info)	Staffing had a significant impact on quality of care. Better staffing is positively associated with higher quality of care, though its effect is not as pronounced as the effect of organisation
Tervo-Heikkinen et al. (2009) Finland	RN-WCBI - quality of work (5 items)	Work environment (control of own practice, adequacy of material resources, attitudes towards technical equipment)	Can't tell	P/N ratio did not correlate statistically significantly with RN-assessed quality of care
<i>Nurses' perception on patient safety</i>				
Aiken et al. (2012) USA, Europe (12)	Nurses gave their ward an overall grade on patient safety (item AHRQ HSOPC; Sorra and Nieva, 2004)	Work environment	Nurse: age, sex, full-time employment status, specialty Hospital: size, teaching status, technology	Each additional patient per nurse increased the odds of nurses reporting poor or failing safety grades. Staffing and the quality of the work environment were significantly associated with nurse outcomes.
Louch et al. (2016) UK	Nurses gave their ward an overall grade on patient safety (item AHRQ HSOPC; Sorra and Nieva, 2004) & one-item measure to capture how well nurses felt they were able to act as a safe practitioner	Personality factors	Gender, age, length of time qualified	Significant associations between P/N ratio and the safety perception outcomes. On days when lower P/N ratios were indicated, nurses reported being more able to act as a safe practitioner and more favourable perceptions of patient safety.
Cho et al. (2016) South Korea	Nurses gave their ward an overall grade on patient safety (item AHRQ HSOPC; Sorra and Nieva, 2004)	Overtime	Nurse: age, gender, education, years worked as a nurse, job status, job security, working unit, last shift worked Hospital: location, bed size, teaching hospital status, high technology status	Higher P/N ratio was significantly associated with higher odds of reporting poor/failing patient safety. An increase of one patient per nurse was associated with a 2 per cent increase in the predicted odds of rating their unit's patient safety as failing or poor.

(Continues)



TABLE 4 (Continued)

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
<i>Nurses' perception of care left undone</i>				
Ball et al. (2014) England	On your most recent shift, which of the following activities were necessary but left undone because you lacked the time to complete them?	(1) Nurse ratings of the quality of care (2) Nurse ratings of the patient safety environment	Can't tell	As the P/N ratio decreases, so does the amount and occurrence of missed care. RN staffing level was significantly associated with missed care for 8 of the 13 care activities.
Himno, Partanen, Vehviläinen-Julkunen (2011) Finland, The Netherlands	RNs' evaluations of whether they had enough time to perform the listed nursing tasks and the tasks RNs performed daily	—	Can't tell	The P/N ratio was significantly related to nurses' concerns about the time available to perform nursing tasks. When the P/N ratio rose the perceived time to perform nursing tasks significantly declined (Finnish data).
Schubert et al. (2013) Switzerland	Number of necessary nursing tasks for patients withheld/not performed in the last seven working days, due to inadequate time, staffing levels and/or skill mixes (revised version of BERNCA-R instrument)	(1) Number of patients needed support with all ADLs (2) Number of patients needed hourly monitoring	Nurse: gender, age, employment Hospital typology	P/N ratio was significantly associated with rationing.
Kalisch et al. (2011) USA	MISSCARE survey (part A)	—	Hospital: nine dummy variables (limited info)	HPPD was significantly associated with missed nursing care: the higher the HPPD the lower the levels of missed care.
Cho et al. (2016) South Korea	Number of necessary nursing tasks for patients withheld/ not performed in their last shift, due to inadequate time, staffing levels and/or skill mixes (BERNCA instrument)	Overtime	Nurse: age, gender, education, years worked as a nurse, job status, job security, working unit, last shift worked Hospital: location, bed size, teaching hospital status, high technology status	Higher P/N ratio was significantly associated with higher odds of reporting having care left undone due to lack of time. An increase of one patient per nurse was associated with a 3 per cent increase in the predicted odds of care left undone due to lack of time.
Ball et al. (2016) Sweden	Number of necessary nursing tasks for patients withheld/not performed in their last shift, due to inadequate time, staffing levels and/or skill mixes (BERNCA instrument)	(1) Work environment (2) Time of shift (3) Patient mix (4) Nurses' role	Roles taken by nurses Patient dependency Level of staffing by support workers	P/N ratio <10:1 is associated with reduced odds of care being left undone P/N ratio <6:1 the odds of care being left undone are more than halved P/N ratio <4:1 reduced the odds of care being left undone by 85%.

(Continues)

TABLE 4 (Continued)

Reference	Measurement outcome	Other explanatory variables taken into account (alongside staffing)	Confounder	Conclusion
Cho, Kim, Yeon, You, and Lee (2015) South Korea	MISSCARE survey (part A & B)	–	Nurse: educational level and work experience	Working in the high staffing units (vs. low-staffing units) was associated with a 0.136-point decrease in missed nursing care.
Aiken et al. (2018) England	On your most recent shift, which of the following activities were necessary but left undone because you lacked the time to complete them?	Work environment	Nurse: role, full-time status, years of experience, unit type Hospital: size, technology, location	Higher P/N ratios are significantly related to higher numbers of types of missed care, while better work environments are significantly related to fewer types of missed care.

### 3.3.8 | Nurses' perception of care left undone

Care left undone was addressed by eight studies. Nurses were asked to specify which activities were necessary but left undone due to time pressure. The listed activities differed from study to study. All studies reported a significant relationship between staffing and nurses' concerns about the time available to perform nursing tasks. As the P/N ratio decreases, so does the occurrence and amount of missed care (Ball et al., 2014). Furthermore, an increase in one patient per nurse was associated with a three per cent increase in the predicted odds of care left undone due to lack of time (Cho et al., 2016). According to Ball et al., there was more care left undone on day and afternoon shifts than on night shifts (Ball et al., 2014).

### 3.3.9 | Additional explanatory variable: work environment

Additional features are often taken into account together with staffing when nurse outcomes are analysed. We will only discuss the work environment here as it stands out because of its extensive use as a predictor and considering concerns are often expressed about the related quality of care of these environments (Aiken et al., 2012, 2014, 2013). This measurement consists of five subscales of which the resource adequacy and staffing subscales are often dropped because of the high correlation with the P/N ratio (Aiken et al., 2018).

Several included studies described the relationship between positive environments, staffing and improved outcomes for nurses (Aiken et al., ; Ball et al., 2016; Heinen et al., 2013; Kutney-Lee et al., 2013; McHugh & Ma, 2014). Even when there was no association found between staffing and a specific nurse outcome, a significant association could sometimes be found for the work environment and that specific outcome (Kutney-Lee et al., 2013). Consequently, nurse perceived presence of characteristics of a positive work environment corresponded to better nurse outcomes (Aiken et al., 2012; Casalicchio et al., 2017; Kutney-Lee et al., 2013). Furthermore, Magnet-credentialed hospitals (indicating the presence of a positive work environment for nurses) were associated with lower odds of dissatisfaction, burnout and intent to leave (McHugh & Ma, 2014).

## 4 | DISCUSSION

This paper provides an overview of the literature that examined the relationship between the P/N ratio and nurse outcomes. The results of this review, structured according to the eight selected nurse outcomes, show some important findings.

First of all, a large majority of the studies showed a significant association between higher P/N ratios and adverse nurse outcomes. There were no studies describing any opposite direction of this relationship and only a few studies found no statistically significant relationship for one or more of the specified outcomes (Aiken et al., 2008; Fujimura, Tanii, & Saijoh, 2011; Heinen et al., 2013; Kutney-Lee et al., 2013; Tervo-Heikkinen et al., 2009). In case of the latter,

the studies examining “job stress” and “intent to leave” give no conclusive evidence.

Second, the use of the P/N ratio as a method to compare nurse staffing has its limitations. It does not take into account the difference in patient acuity or the presence of supportive services, both important factors in determining the workload (Hughes, Bobay, Jolly, & Suby, 2015). In addition, the idea of creating a comparable method has led to narrowing down to conventional medical-surgical units and day shifts (Aiken, Clarke, & Sloane, 2002) with the result of losing the variation in workload between shifts. This latter can vary greatly, even within shifts. Because of these reasons, various invisible and complex aspects of nurses’ workload are not included in the P/N ratio and a more refined measurement that relies on “weighted patients” according to their “care load” should be considered.

Third, the California’s mandated unit-based minimum ratios in acute hospitals have been studied extensively. The enactment of this law has proven to be effective in increasing retention (Aiken et al., 2010) and maintaining job satisfaction for nurses (Tellez & Seago, 2013). However, not everyone is equally enthusiastic about the available empirical evidence and concerns about the extra costs on the already overburdened health care system are often expressed (Olley, Edwards, Avery, & Cooper, 2018). Despite the latter, fourteen states in the United States have introduced some form of legislation mandating nurse staff ratios. Furthermore, in Queensland (Australia), the Queensland legislation came into force in 2016 in prescribed medical, surgical and mental health units (Queensland Health, 2019). Future research will tell what the impact of these ratios is on nursing, patient and organisational outcomes. It is clear that the issue of staffing ratios still is hot-button and future research should be able to depend on reliable and robust data, which to this day is still insufficient.

Fourth, almost all the studies used self-reported nurse surveys which may be prone to response and recall bias. Furthermore, the outcomes based on nurses’ perception are open to the subjective experiences of the nurses. Despite these disadvantages, self-reports have considerable predictive validity and can focus explicitly on staffing at the patient bedside (Aiken, Clarke, & Sloane, 2002; Aiken et al., 2008, 2010).

Fifth, the vast majority of the reviewed articles are based on group-level associations. Nearly half of the studies were analysed at the hospital level, leaving a minority that was analysed at the unit level. Access to this unit-level staffing data is necessary to advance nurse staffing research and to ensure the use of this research by nursing management at the unit level.

Sixth, the work environment was the most commonly used additional explanatory variable. Unfortunately, administrative databases do not capture them (Djukic, Kovner, Brewer, Fatehi, & Cline, 2013) and that is why hospital management should systematically start tracking these data and convert these into useful policy guidelines. In addition, programmes that are recognized for their positive hospital work environments, for example the Magnet recognition programme, could be implemented to improve the quality of this environment (Van den Heede et al., 2013). Furthermore, research also

suggests that creating better work environments is reasonably low cost interventions and also creates added value in terms of better patient outcomes (Aiken et al., 2018). Alternative methods to enhance the work environment should be explored. Self-scheduling and the use of self-managing teams could be one approach to boost nursing outcomes. This staffing method has already been introduced in the past and, although the lack of thorough research makes the evidence inconclusive, the potential benefits are worth giving this method a second glance (Bailyn, Collins, & Song, 2007).

Seventh, the role of the nurse is seldom mentioned. A study of Lindqvist et al. (2014) reported that nurses are more satisfied in roles with more direct patient care, implying that it may be feasible to let nurses work in greater proximity to patients.

Finally, most studies used a cross-sectional design which often lacked evidence for causality. The five studies that included longitudinal designs reported inconclusive results. The use of the latter should be encouraged so that findings using cross-sectional designs can be confirmed, taking current research a step closer to provide evidence that the relationship is indeed causal.

#### 4.1 | Limitations

Our systematic reviews focused exclusively on the nurse, and by doing so disregarding the nursing assistant and support services. Also, more than half of the studies analysed the data at hospital level and therefore also included data from specialty-specific units (e.g., intensive care units). The latter is an exclusion criterion for this review because they have different patient characteristics and different staffing levels. Furthermore, a significant number of studies were performed by the same research group, while often using similar datasets. It is possible that connections between these studies are present or that datasets overlap with each other. Finally, although some of the included studies are relatively dated we still believe the insights are valuable given that a few studies were performed not long after the introduction of the legislation mandating unit-based minimum ratios in 1999, California.

#### 4.2 | Implications for future research and policy

Notwithstanding these limitations, the findings in this review have several implications. First, it can be assumed that each additional patient per nurse increased the odds of adverse nurse outcomes (with the exception of “job stress” and “intent to leave”). Hospital management should keep this in mind to prevent the departure of dissatisfied nurses. Additionally, a positive work environment should be pursued, especially since interventions to achieve this can be relatively low in cost and yet have a high added value. Furthermore, current review publications lack the link between the P/N ratio and different health care systems, as well as the link between the P/N ratio and different clinical units (e.g., geriatrics, orthopaedics). Efforts should be made to secure the comparability between studies, since the practice of nursing would benefit a great deal from this knowledge. In addition, future research should focus especially

on the unit-level analysis so it is possible to understand, compare and eventually even predict the ideal amount of nurses at different moments of the day (e.g., morning vs. evening) and for each type of unit (e.g., geriatrics) individually. Finally, our systematic review reconfirmed that the often used cross-sectional designs are limited and the use of other methodologies should be encouraged. Also, the growing information systems and administrative databases deliver data that structures patients and nurses into units, clinical specialties, hospitals and regions. The possibilities of this multilevel material are infinite. Access and use of reliable data should be pursued so that the validity and generalizability of the findings of previous studies can be assessed.

## 5 | CONCLUSION

In this study, we reviewed the available evidence on the relationship between the P/N ratio staffing and different nurse outcomes. Our analysis showed that the P/N ratio is an important contributing factor to the following nurse outcomes: job (dis)satisfaction, emotional exhaustion or burnout, needle stick injuries, nurses' perception of quality of care, safety of patients and care left undone. Many studies confirmed that a higher P/N ratio can be associated with higher nurse outcomes, and this regardless of the variety in methodology.

In addition to that, staffing alone is not enough to ensure quality of care. It should be clear that apart from the P/N ratio, other variables have to be taken into consideration such as the skill mix, patient acuity, nurses' education, the role of the nurse and the work environment. The latter could be a strong and complementary predictor. Apart from that, different research designs and the lack of uniformity make it impossible to systematically compare the different studies with each other. Furthermore, longitudinal data are lacking, making it difficult to demonstrate causality. Now that more and more detailed data are available, it is possible to concentrate on the unit level and to look in more detail how the workload differs per organisational structure on a single unit. It is there that decisions about the allocation of resources ultimately achieve results.

## ETHICAL APPROVAL

Ethical approval was not required for this paper.

## AUTHOR CONTRIBUTIONS

All authors have contributed to the conception, design and writing of this review. They have given their approval of the version to be published.

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#### SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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