BMJ Open

Measuring perceived adequacy of staffing to incorporate nurses' judgement into hospital capacity management: a scoping review

Carmen J E M van der Mark ,[1,2] Hester Vermeulen,[2,3] Paul H J Hendriks,[4] Catharina J van Oostveen[5,6]

To cite: van der Mark CJEM, Vermeulen H, Hendriks PHJ, *et al*. Measuring perceived adequacy of staffing to incorporate nurses' judgement into hospital capacity management: a scoping review. *BMJ Open* 2021;**11**:e045245. doi:10.1136/bmjopen-2020-045245

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2020-045245).

Received 27 September 2020
Revised 05 March 2021
Accepted 08 March 2021

For numbered affiliations see end of article.

Correspondence to
Ms Carmen J E M van der Mark; cvandermark@rijnstate.nl

ABSTRACT

Background Matching demand and supply in nursing work continues to generate debate. Current approaches focus on objective measures, such as nurses per occupied bed or patient classification. However, staff numbers do not tell the whole staffing story. The subjective measure of nurses' perceived adequacy of staffing (PAS) has the potential to enhance nurse staffing methods in a way that goes beyond traditional workload measurement or workforce planning methods.

Objectives To detect outcomes associated with nurses' PAS and the factors that influence PAS and to review the psychometric properties of instruments used to measure PAS in a hospital setting.

Design and methods A scoping review was performed to identify outcomes associated with PAS, factors influencing PAS and instruments measuring PAS. A search of PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Business Source Complete and Embase databases identified 2609 potentially relevant articles. Data were independently extracted, analysed and synthesised. The quality of studies describing influencing factors or outcomes of PAS and psychometric properties of instruments measuring PAS were assessed following the National Institute for Health and Care Excellence quality appraisal checklist and the COnsensus-based Standards for the selection of health Measurement INstruments guidelines.

Results Sixty-three studies were included, describing 60 outcomes of PAS, 79 factors influencing PAS and 21 instruments measuring PAS. In general, positive PAS was related to positive outcomes for the patient, nurse and organisation, supporting the relevance of PAS as a staffing measure. We identified a variety of factors that influence PAS, including demand for care, nurse supply and organisation of care delivery. Associations between these factors and PAS were inconsistent. The quality of studies investigating the development and evaluation of instruments measuring PAS was moderate.

Conclusions Measuring the PAS may enhance nurse staffing methods in a hospital setting. Further work is needed to refine and psychometrically evaluate instruments for measuring PAS.

Strengths and limitations of this study

- This scoping review is the first to assess (1) the relationship between nurses' expert opinion of staffing adequacy and outcomes, (2) factors influencing nurses' perceived adequacy of staffing, and (3) the reliability and validity of instruments measuring perceived adequacy of staffing.
- The literature search was extensive, and designed and conducted with the help of a clinical librarian.
- Study selection, data extraction and quality appraisal of included studies and instruments were performed by two researchers.
- Limitations of this review include the potential that we have missed original literature on influencing factors or outcomes, because we excluded grey literature and qualitative studies.

INTRODUCTION

Since the early 1970s, both researchers and practitioners have been searching for the best way to match demand for nursing work with nursing supply. Societal developments have made adequate staffing more relevant today than ever. Driven by an ageing population and technological progress, demand for care is rising. At the same time, the WHO expects a worldwide shortage of over 7 million nurses and midwives by 2030,[1] putting continued pressure on staff. Previous research has indicated an association between nurse staffing levels and nurse-sensitive outcomes such as mortality, adverse events, fall rates, failure-to-rescue and missed care.[2–4] Inadequate staffing is also related to burn-out and job dissatisfaction among nurses.[5] Not only quantity but also quality in terms of skill mix matters; a higher proportion of registered nurses (RNs) is associated with better outcomes.[6 7] Inadequate staffing ultimately threatens safety, quality, affordability and accessibility of

care. Therefore, a thorough understanding of staffing adequacy is needed.

The concept of adequacy of staffing can be divided into 'staffing' and 'adequacy'. 'Staffing' has been defined in multiple studies. Jelinek and Kavois[8] defined nurse staffing as the process of determining the appropriate number and mix of nursing resources necessary to meet workload demand for nursing care at the unit or departmental level. Burke *et al*[9] described hospital staffing as determining the number of personnel with the required skills to meet predicted requirements. Both of these definitions include balancing demand for nursing work with the adequate number and skill mix of nurses. Adding the word 'adequacy' to the concept of staffing, the meaning shifts from the process of staffing to a condition in which staffing is adequate. The American Nurse Association defined staffing adequacy as a match between RN expertise and recipient needs within the practice setting,[10] but details on what this match entails were omitted. Kramer and Schmalenberg[11] asked nurses if their staffing was adequate and received ambiguous answers: 'That depends – adequate for what? Safe care to all patients? (…) Quality care? (…) Or comprehensive care?' (p.194).

In the absence of an explicit clarification of what adequate staffing means,[12] nurses and managers continue to search for staffing measures that can objectify staffing requirements.[13] These measures need to facilitate different inter-related staffing decisions, for example, how many nurses to employ, staff-shift schedule, nurse roster and nurse-ward allocation.[14] Many workload and resource planning tools are available related to demand for nursing work, resource planning and workload evaluation.

Demand for nursing work

Demand for nursing work has been estimated by a volume-based approach, that is, patient counts multiplied by an administrative measure of work. This has been expressed as the nursing hours per patient day (HPPD),[15] nurse-to-patient ratios[2] and full-time equivalent numbers.[4] These have been criticised as measures for staffing decisions because different patient needs are ignored.[16] The workload-based approach takes different patient care requirements into account and is categorised into activity-based and dependency-based methods.[17] The activity-based method is based on how long nursing tasks take and the dependency-based method relies on patient classification of patients' needs based on indicators, based on which the amount of nursing time can be derived. Disadvantages of the workload-based approach include lack of reliability, validity and flexibility, and the need for time-consuming manual registration.[17–19]

Resource planning tools

Other resource planning tools indirectly measure adequacy of staffing by quantifying demand and supply. One example is the RAFAELA patient classification system.[20] It estimates optimum levels of nursing intensity by balancing demand for care with nursing resources available. The tool is used on a large scale in Finland, but preimplementation in the Netherlands encountered issues of validity and acceptability.[21]

Workload evaluation tools

Other workload tools evaluate nurses' workload. Tools to evaluate workload can be objective indirect measures of mental workload, such as brain activity and cardiac responses, or subjective tools such as the NASA Task Load Index and the Subjective Workload Assessment Technique.[22] These subjective instruments involve short questionnaires with items that reflect experiences (eg, mental demand, physical demand, temporal demand). Those type of measures are commonly used to evaluate workload or validate measures of staffing requirements,[13] reflecting on a broader definition than adequacy of staffing.

In 2010, Fasoli and Haddock[18] reported reliability and validity issues with the available workload measurement systems. Nine years later, another review[13] concluded that available systems were still highly uninformative. Scientists dispute whether nursing work can be accurately quantified. Hughes[23] states that 'it appears that nursing is more concerned with knowledge processing and nurses' intentions than just with the activities of caring' (p.317). Griffiths *et al*[13] describe that 'there is a limit to what can be achieved through measurement, both because of the fallible nature of the measures, but also because of the complex judgements that are required' (p.9). In the absence of applicable tools, professional judgement was identified as the nearest to a gold standard workload measurement.[13]

Professional judgement

The match between nurse demand and supply can be measured using the nurses' perceived adequacy of staffing (PAS). This measure relies on nurses' expert opinion in which nurses take the unquantifiable fluctuating patient needs and context and situation into account in assessing adequacy of staffing.[24] This direct approach to measuring adequacy of staffing contrasts traditional tools that measure staffing adequacy according to demand and supply. Nurses' perceptions have been accepted as a significant indicator of quality of care,[2] while nurse-perceived quality of care was highly associated with objectively measured nurse-sensitive outcomes, showing the validity of the measure.[25] Regarding nurse staffing tools, relying on nurses' perceptions is less common as most approaches attempt to objectify staffing needs.[13] However, a reliable and valid measure of PAS may be the optimal approach to helping head nurses and managers make nurse staffing decisions. A positive association of PAS with outcomes for patient, staff and organisation enables evidence-based staffing decision making. Staffing adequacy can potentially be predicted by associating structure and process factors of PAS. Data science techniques may minimise nurse effort by analysing these

factors in hospital information systems. However, these techniques have not been explored in nurse staffing literature.[26 27]

The concept of PAS potentially enhances nurse staffing methods, going beyond traditional workload measurement or workforce planning tools.

To explore this alternative to objective workload measurement tools, we conducted a scoping review to study the potential relevance of nurses' PAS in the setting of hospital wards. We asked the following research questions:

1. How is PAS associated with outcomes for the patient, nurse and organisation?
2. Which factors influence PAS?

If these findings show PAS to be a potentially relevant measure for a new staffing method, we will go on to answer the following research questions:

3. Which PAS measurement instruments are available in the literature?
4. What is the reliability and validity of those instruments?

METHODS

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses—Extension for Scoping Reviews checklist and guidelines to ensure our review was robust and replicable.[28] We did not publish a protocol for this review.

Search strategy

PubMed, CINAHL, Business Source Complete (through EBSCOhost) and Embase were searched from inception to November 2019. The following free-text and database subject headings were combined to search for peer-reviewed articles: *nursing staff, nurses, nurse, staffing adequacy, inadequate staffing, staffing inadequacy, adequate staffing, requirements for nursing resources, attitude of health personnel, perception* and *perceive*, and truncation symbols, for example, nurs*, were used if suitable. Additionally, we screened reference lists of included studies and reviews on nurse staffing for other relevant studies. No limits regarding publication status, date or language were imposed. The complete search strategy for each database is presented in online supplemental appendix 1. The search was designed and conducted with the help of a clinical librarian.

Study selection

References from the databases were combined and downloaded into a reference manager, and duplicates were removed. Articles were screened in two phases. First, two reviewers (CM and CO) independently screened all titles and abstracts and selected articles that met the inclusion criteria (table 1). For the measurement instruments that were applied, the primary development and evaluation study was included. The screening resulted in a Cohen's κ of 0.80. Disagreements about inclusion of studies between the two reviewers (CM and CO) were resolved by discussion. Next, full-text versions were independently screened by the two reviewers and excluded if articles did not meet the inclusion criteria (table 1). Authors were contacted for irretrievable articles.

Data extraction

Data were independently extracted by two reviewers (CM and CO) using a predefined, structured data abstraction form. The form included the author, year of publication, country, journal, aim, research design, population, test setting, sample size, staffing measures, instruments (including subscales), measurement type, validity, reliability, associations between PAS and outcomes, and associations between influencing factors and PAS. Full details of associations were documented and expressed as correlation coefficients (r), β-coefficients (β) derived from linear regression analysis or ORs derived from logistic regression analysis, including their p values and 95% CIs. We also documented whether the associations were corrected for other factors by multivariate analysis.

Quality assessment

Quality of the study outcomes associated with PAS and the factors influencing PAS were evaluated according to the National Institute for Health and Care Excellence quality appraisal checklist for quantitative studies reporting correlations and associations,[29] adapted from Griffiths *et al*.[3] The checklist assesses bias across four categories—population, confounding factors, measures and analyses—using five response options (++, +, -, not reported, not applicable). The resulting score indicates whether the external validity (ie, the generalisability) and the internal validity (ie, the validity of the associations) are strong, moderate or weak.

The methodological quality of the included PAS instruments was appraised using the COnsensus-based

Table 1 Inclusion and exclusion criteria for primary screening

Inclusion	Exclusion
Studies including front-line nurses in hospitals	Systematic reviews, qualitative studies, columns, newspaper or opinion articles, conference abstracts
Studies using PAS to evaluate nurse staffing	
Studies developing or evaluating an instrument for measuring PAS	

PAS, perceived adequacy of staffing.

Standards for the selection of health Measurement INstruments (COSMIN) Risk of Bias checklist.[30 31] This checklist, which has been developed to assess the methodological quality of patient-reported outcome measure studies, is suitable for assessing the risk of bias of PAS instruments. Instrument development, structural validity, internal consistency and other measurement properties in the included studies were assessed. Quality was judged as very good, adequate, doubtful or inadequate, and the overall quality was the lowest item rating in the COSMIN boxes.[31] Measurement properties were rated sufficient (+), insufficient (-) or indeterminate (?) following the criteria for good measurement properties.[31]

Quality was appraised by one reviewer (CM) and cross-checked by a second reviewer (CO). Disagreements between reviewers were solved by consensus.

Data analysis

Outcomes for each research question were summarised. With regard to the influencing factors and outcome studies, variables analysed by t-tests, (multivariate) analysis of variance ((M)ANOVA), χ^2, correlation or regression were judged significant if the value of p was <0.05 or their CI did not enclose the value of 0 or 1. We judged the structural validity and internal consistency of measurement instruments based on the original development study.

Data synthesis

Data for outcomes/influencing factors and measurement instruments were structured separately. The structure-process-outcome model[32] was used to structure the influencing factors and outcomes. Influencing factors are factors related to (1) Structure, that is, the physical and organisational context of care delivery, and (2) Process, that is, the technical and interpersonal process of care delivery. Outcomes reflect the impact of those factors demonstrating the result of structure and process. Following the patient care delivery model,[33] the influencing factors and outcomes of PAS were clustered into patient, staff and organisation categories. Models including PAS as a dependent variable are described separately.

Both single-item and multi-item measurement instruments were included.

Patient and public involvement

No patient was involved.

RESULTS

Study selection and characteristics

The search identified 3120 studies. After removing duplicates and screening titles and abstracts, 135 eligible studies were included for full-text review, including 6 studies that were identified in the reference lists of included studies. Full-text review excluded a further 59 studies. The main reasons for exclusion were no instrument development or associations with influencing factors or outcomes (24/59), no measurement of PAS (10/59) and staffing measures that were not PAS (8/59). For 13 studies, the full text was not available and the authors did not respond to our request for the full text. In total, 63 studies were included in the analysis (figure 1).

The included studies (tables 2 and 3) were published between 1975 and 2019 worldwide. Most studies (28/63) were carried out in North America,[11 24 34–59] 25 studies were conducted in Europe,[60–84] 5 in Asia,[85–89] 4 in Oceania[90–93] and 1 in multiple continents.[94]

Fifty-two studies included outcomes influenced by PAS or factors that influence PAS.[24 35 37 39 40 42–47 49 52–54 56–60 62 63 65–94] Twenty-one studies described the development and evaluation of PAS instruments.[11 34 36 38 41 43 44 46 48 50 51 54–56 58 61 64 82 86 87 91] Forty-nine studies used a cross-sectional research design,[24 35 37 39 40 42–47 52–54 56 57 59 60 62 63 65–76 78–94] two studies used a longitudinal research design[49 77] and one study used a cross-sectional and longitudinal design.[58] Complete extracted outcomes and influencing factors are provided in online supplemental appendix 2.

Quality assessment of studies investigating influencing factors and outcomes

The methodological quality of most studies was moderate to good (table 4). We revealed serious methodological flaws (weak internal and external validity) in six studies. The risk of bias was increased by cross-sectional research designs, omitting confounding factors, and the lack of multilevel studies and objective measures. External validity was weak because the source population was not clearly described and because of the use of single sites. An overview of the compete quality appraisal is presented in online supplemental appendix 3.

Outcomes influenced by PAS

Our first research question was to explore the associations between PAS and outcomes for the patient, nurse and organisation. Sixty outcomes were found to be influenced by PAS—27 of these were patient-related, 26 were nurse-related and 7 were organisation-related (table 2). Job satisfaction was investigated in nine studies,[39 46 47 52 66 72 75 78 86] quality of care in eight studies,[35 47 66 72 75 85 86 94] safety in four studies,[71 73 75 77] and missed care,[40 62 87] emotional exhaustion,[66 68 75] and occupation dissatisfaction[39 52 75] in three studies. Forty-nine outcomes were investigated in two or fewer studies. Most outcomes were positively associated with PAS.

Associations with PAS were found for the patient outcomes pain,[84] pressure ulcers[24] and patient-centred care.[60] Williams and Murphy[44] asked nurses to rate 10 aspects of care, (including basic hygiene, feeding and medication) from poor to good in six units. Scores for each category were generally higher when staffing was adequate, but results were inconsistent within individual units. Patient safety associated positively with PAS in all studies[71 73 77] except for one,[75] which reported mixed

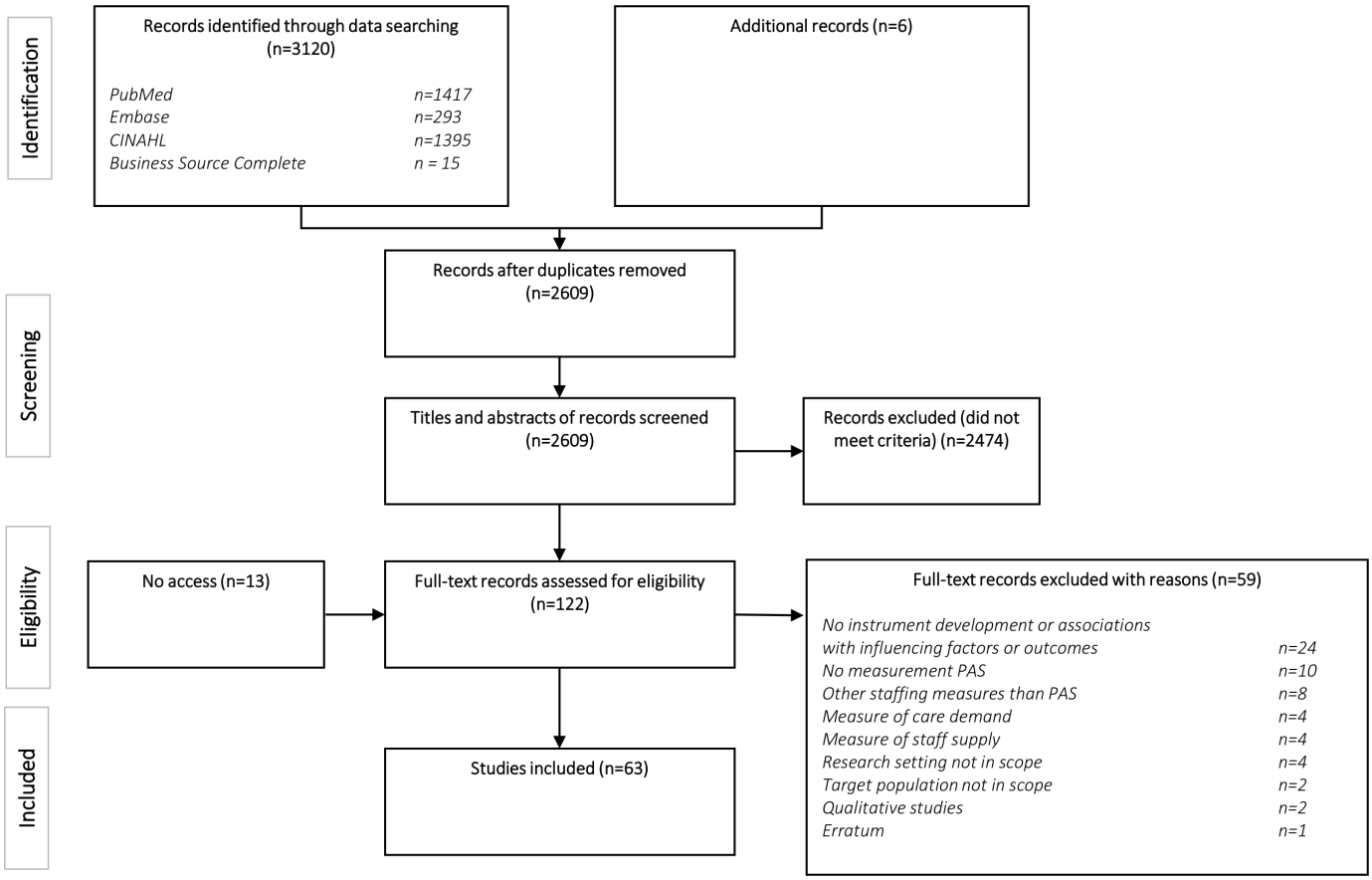


Figure 1 Flow diagram of the search and selection process.

results. Associations with PAS were also mixed for adverse events,[87] infections,[49 74] survival,[73] patients' ability to manage care after discharge,[76] communication with nurses[44 87] and missed care.[40 45 62 70 87] Cho *et al*[87] found that missed communication and basic care mediate the association between patient-perceived staffing and adverse events and communication with nurses.

PAS had a personal effect on nurses. It affected job satisfaction,[39 46 47 52 66 72 75 78 86] burn-out,[78 86] effort-reward imbalance,[67] depersonalisation, personal accomplishment,[68] feelings of being a safe practitioner and workplace cognitive failure,[77] psychosocial attention,[75] and change efficacy.[81] The reported effects of satisfaction with the occupation,[39 52 75] intention to leave the occupation,[76] intention to leave employment,[80 86 89 94] emotional exhaustion,[66 68 75] depressive symptoms,[67] pain,[53] blood pressure and total cholesterol level[82] were inconsistent. Pain in the neck, shoulder, arm, lower extremities and musculoskeletal system[53] as well as low-density lipoprotein cholesterol levels[82] and change commitment[81] were not influenced by PAS.

PAS affected organisational outcomes, including nurses' turnover,[42 47] absenteeism,[45] quality of nursing[73] and quality improved within the last year.[75] Mixed results were reported for quality of care.[35 47 66 72 75 85 86 94] Patients' hospital rating was associated with patient-perceived staffing adequacy but not with nurse-perceived staffing adequacy.[87] Anzai *et al*[85] found no association between PAS and nurses' ability to provide quality nursing care.

Influencing factors of PAS

For the second research question, we identified the structural and process factors that influence PAS.

Structural factors

Fifty-two structural factors that influence PAS were identified. These were categorised into demand for care (11 factors), nurse supply (30 factors) and organisation of care delivery (11 factors). The setting type was investigated in seven studies[44 47 75 83 84 91 92] and patients-per-nurse in three studies.[24 59 87] The remaining 50 factors were investigated in two or fewer studies. Associations were mainly positive, that is, higher scores on structural factors led to more positive PAS.

With regard to demand for care, no consistent results were found for factors associated with PAS. Inconsistent results were found for census,[43 44] number of maximum care patients[43] and patient classification category.[43 58 69] New admissions, transfers, discharges, postoperative patients, specialised nursing procedures[43] and crowding scores in the emergency department[54] were not related to PAS.

Nurse supply factors influencing PAS were full-time equivalent RNs per patient day,[58] HPPD,[24] nursing hours,[43]

Table 2 Influencing factors and outcomes of PAS

	Patient	Adverse events	Communication with nurses	Basic feeding and toileting	Basic hygiene	Implementation of new orders without undue delay	Implicit rationing of nursing care	Medications, IVs	Missed care	Missed communication	Mobility	Observation	Occurrence of central line-associated bloodstream infection	Overall survival	Patients' ability to manage care after discharge	Pain	Patient care interventions omitted or delayed	Patient-centred care	Rounds with or assist MD	Safety	Special procedures	Surgical site infection after total hip arthroplasty	#
Anzai, Douglas, and Bonner[55]																							1
Asiret, Kapucu, Kose, Kurt, and Ersoy[53]																							2
Bachnick, Ausserhofer, Baernholdt, and Simon[60]																							1
Bae, Brewer, Kelly, and Spencer[49]																							1
Bragadottir, Kalisch, and Tryggvadottir[62]																							1
Bragadottir, Kalisch, and Tryggvadottir[79]																							
Bruyneel, Van den Heede, Diya, Aiken, and Sermeus[78]																							
Burmeister *et al*[64]																							
Cho *et al*[66]																							
Cho *et al*[57]																							
Choi and Staggs[24]																							
De Groot, Burke, and George[47]																							
Desmedt, De Geest, Schubert, Schwendimann, and Ausserhofer[63]																							
Duchanne, Bernhardt, Padula, and Adams[35]																							
Escobar-Aguilar *et al*[54]																							
Fuentelsaz-Gallego, Moreno-Casbas, Gomez-Garcia, and Gonzalez-Maria[65]																							
Gunnarsdottir, Clarke, Rafferty, and Nutbeam[56]																							
Hegney *et al*[51]																							
Heinen *et al*[76]																							
Jafree, Zakar, Zakar, and Fischer[58]																							
Jolliet *et al*[52]																							
Kalisch and Lee[37]																							
Kalisch, Lee, and Rochman[39]																							
Kalisch, Tschannen, and Lee[52]																							
Kalisch, Tschannen, Lee, and Friese[60]																							
Kalisch, Friese, Choi and Rochman[59]																							
Kim *et al*[53]																							
Leineweber *et al*[68]																							
Lin, Chiang, and Chen[59]																							
Lovch, O'Hara, Gardner and O'Connor[77]																							
Mark, Salyer and Harless[58]																							
Nelson-Brantley, Park, Bergquist-Beringer[42]																							
O'Brien-Pallas *et al*[45]																							
Pineau, Lascinger, Regan, and Wong[46]																							
Rauhala and Fagerström[69]																							
Reeder, Burleson, and Garrison[54]																							
Roche and Duffield[92]																							
Roche, Duffield, and White[93]																							
Rochon, Heale, Hunt, and Parent[87]																							
Sasso *et al*[80]																							
Schubert, Glass Clarke, Schaffert-Witvliet, and De Geest[70]																							
Sharma *et al*[81]																							
Smeds, Tishelman, Runesdotter, and Lindqvist[71]																							
Spence *et al*[50]																							
Spence Laschinger[56]																							
Slalpers, Van Der Linden, Kaljouw, and Schuurmans[72]																							
Trivedi and Hancock[43]																							
Tvedt, Sjetne, Helgeland, and Bukholm[73]																							
Tvedt, Sjetne, Helgeland, Lower, and Bukholm[74]																							
Weigl, Schmuck, Helden, Angerer, and Müller[82]																							
Williams and Murphy[44]																							
Zander, Dobler, and Busse[75]																							
#	1		2	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	4	1	1	

Continued

Table 2 Continued

Outcome	Nurse	Surgical site infection after total hip arthroplasty for non-elective patients	Any musculoskeletal pain	Arm pain	Burn-out	Blood pressure	Change commitment	Change efficacy	Depersonalisation	Depressive symptoms	Effort-reward imbalance	Emotional exhaustion	Intention to leave	Intention to leave and stay in nursing	Intention to leave nursing	Intention to stay in employment	Job satisfaction	#
Surgical site infection after total hip arthroplasty for non-elective patients		1																1
Survival after acute myocardial infarction																		1
Therapeutic interventions omitted or delayed																		1
Unit-acquired pressure ulcers																		1
Ventilator-associated pneumonia																		1
Vital signs																		1
Any musculoskeletal pain	1												3			1		3
Arm pain	1												1					1
Burn-out	2																	1
Blood pressure	1																	1
Change commitment	1																	1
Change efficacy	1																	1
Depersonalisation	1																	1
Depressive symptoms	1																	1
Effort-reward imbalance	1																	1
Emotional exhaustion	3																	3
Intention to leave	3																	3
Intention to leave and stay in nursing	1																	1
Intention to leave nursing	1																	1
Intention to stay in employment	1																	1
Job satisfaction	9																	9

Continued

Table 2 Continued

		Anzai, Douglas, and Bonner[56]	Aslan, Kapucu, Kose, Kurt, and Ersoy[53]	Bachnick, Ausserhofer, Baernholdt, and Simon[60]	Bae, Brewer, Kelly, and Spencer[49]	Bragadóttir, Kalisch, and Tryggvadóttir[62]	Bragadóttir, Kalisch, Tryggvadóttir[79]	Bruyneel, Van den Heede, Diya, Aiken, and Sermeus[78]	Burmeister et al[64]	Cho et al[58]	Cho et al[67]	Choi and Staggs[24]	De Groot, Burke, and George[47]	Desmedt, De Geest, Schubert, Schwendimann, and Ausserhofer[63]	Duchatrme, Bernhardt, Padula, and Adams[35]	Escobar-Aguilar et al[64]	Fuentelsaz-Gallego, Moreno-Casbas, Gomez-Garcia, and Gonzalez-Maria[55]	Gunnarsdóttir, Clarke, Rafferty, and Nutbeam[66]	Hegney et al[61]	Heinen et al[76]	Jarrea, Zakar, Zakar, and Fischer[68]	Jolivet et al[52]	Kalisch and Lee[37]	Kalisch, Lee, and Rochman[39]	Kalisch, Tschannen, and Lee[62]	Kalisch, Tschannen, Lee, and Friese[60]	Kalisch, Friese, Choi and Rochman[59]	Kim et al[53]	Lehnewber et al[68]	Lin, Chiang, and Chen[69]	Louch, O'Hara, Gardner and O'Connor[77]	Mark, Salyer and Harless[58]	Nelson-Brantley, Park, Bergquist-Beringer[42]	O'Brien-Pallas et al[45]	Pineau, Laschinger, Regan, and Wong[46]	Rauhala and Fagerström[69]	Reeder, Burleson, and Garrison[54]	Roche and Duffield[92]	Roche, Duffield, and White[93]	Rochon, Heale, Hunt, and Parent[57]	Sasso et al[80]	Schubert, Glass Clarke, Schaffert-Witvliet, and De Geest[70]	Sharma et al[81]	Smeds, Tishelman, Runesdotter, and Lindqvist[71]	Spence et al[90]	Spence Laschinger[56]	Stalpers, Van Der Linden, Kaljouw, and Schuurmans[72]	Trivedi and Hancock[43]	Tvedt, Sjetne, Helgeland, and Bukholm[73]	Tvedt, Sjetne, Helgeland, Lower, and Bukholm[74]	Weigl, Schmucki, Helden, Angerer, and Müller[82]	Williams and Murphy[44]	Zander, Dobler, and Busse[75]	#
	LDL cholesterol level																																																x	1
	Low back pain																											x*																					1
	Lower extremity pain																											x																					1
	Neck/shoulder pain																											x																					1
	Number of areas in pain																											x*																					1
	Occupation dissatisfaction																									x*	x*																					3
	Personal accomplishment																												x*																				1
	Psychosocial attention																																																1
	Safe practitioner																														x*																		1
	Total cholestrol level																															x*																	1
	Workplace cognitive failure																															x*																	1
Organisation	Ability to provide quality nursing care	x																																															1
	Absenteeism																																x*																	1
	Overall hospital rating																																																1
	Quality of care	x*								x	x*		x*		x				x*																														8
	Quality improved within the last year																																																1
	Quality of nursing																																																1
	Turnover												x*																		x*																	2
Demand for care	Census																																														x*	2
	Crowding (ED)																																																1
	Discharges																																																	1
	New admissions																																																1
	Number of maximum care patients																																																1
	OPCQ																																																1

Continued

Table 2 Continued

		Azzal, Douglas, and Bonner[55]	Aslet, Kapucu, Kose, Kurt, and Ersoy[53]	Bachnick, Ausserhofer, Baernholdt, and Simon[60]	Bae, Brewer, Kelly, and Spencer[49]	Bragadottir, Kalisch, and Tryggvadottir[52]	Bragadottir, Kalisch, Tryggvadottir, and Tryggvadottir[79]	Brunneel, Van den Heede, Diya, Aiken, and Sermeus[78]	Burmeister *et al*[24]	Cho *et al*[66]	Cho *et al*[67]	Choi and Staggs[24]	De Groot, Burke, and George[47]	Desmedt, De Geest, Schubert, Schwendimann, and Ausserhofer[63]	Duchamme, Bernhardt, Padula, and Adams[35]	Escobar-Aguilar *et al*[64]	Fuentelsaz-Gallego, Moreno-Casbas, Gomez-Garcia, and Gonzalez-Maria[65]	Gunnarsdottir, Clarke, Rafferty, and Nutbeam[68]	Hegney *et al*[21]	Helmen *et al*[76]	Jarree, Zakar, Zakar, and Fischer[38]	Jolivet *et al*[57]	Kalisch and Lee[37]	Kalisch, Lee, and Rochman[29]	Kalisch, Tschannen, and Lee[52]	Kalisch, Tschannen, Lee, and Friese[50]	Kalisch, Friese, Choi and Rochman[59]	Kim *et al*[53]	Leineweber *et al*[68]	Lin, Chiang, and Chen[69]	Louch, O'Hara, Gardner and O'Connor[77]	Mark, Salyer and Hartess[58]	O'Brien-Pallas *et al*[45]	Pineau, Lasichinger, Regan, and Wong[48]	Rauhala and Fagerstrȍm[69]	Reeder, Burleson, and Garrison[54]	Roche and Duffield[52]	Roche, Duffield, and White[93]	Rochon, Heale, Hunt, and Parent[57]	Sasso *et al*[80]	Schubert, Glass Clarke, Schaffert-Witvliet, and De Geest[70]	Sharma *et al*[61]	Smeds, Tishelman, Runesdotter, and Lindqvist[71]	Spence *et al*[50]	Spence Laschinger[56]	Stalpers, Van Der Linden, Kaljouw, and Schuurmans[72]	Tirvedi and Hancock[43]	Tvedt, Sjetne, Helgeland, and Bukholm[73]	Tvedt, Sjetne, Helgeland, Lower, and Bukholm[74]	Weigl, Schmuck, Helden, Angerer, and Müller[62]	Williams and Murphy[44]	Zander, Dobler, and Busse[75]	#
Nurse supply	Patient classification																																																		1
	Patient technology																																		x*																	1
	Postoperative patients																																																		1
	Specialised nursing procedures																																																	1
	Transfers																																																		1
	Age	x																																																	2
	Assistive personnel																																																		1
	Educational level		x*																																																1
	Emotional stability																																																		1
	FTE RNs per patient day																																																		1
	Gender		x																																																2
	Hours per patient day																																																		1
	Level of agreeableness																																																		1
	Level of conscientiousness																																																		1
	Life orientation																																																			1
	Mental stress																																																				2
	Non-RN hours per patient day																																																			1
	Nurse hours per patient day																																																			1
Structure	Nursing hours																																																			1
	Nursing role			x																																																2
	Part time																																																				1
	Patients per nurse																																																				3
	Psychological capital																																																				1
	RN temporary nursing care hours per patient day																																																			1
	Skill mix																																																				2

Continued

Table 2 Continued

Process		Azzal, Douglas, and Bonner[85]	Astret, Kapucu, Kose, Kurt, and Ersoy[93]	Bachnick, Ausserhofer, Baernholdt, and Simon[60]	Bae, Brewer, Kelly, and Spencer[49]	Bragadottir, Kalisch, and Tryggvadottir[62]	Bragadottir, Kalisch, and Tryggvadottir[79]	Bruyneel, Van den Heede, Diya, Aiken, and Sermeus[78]	Burmeister et al[94]	Cho et al[88]	Cho et al[87]	Choi and Staggs[24]	De Groot, Burke, and George[47]	Desmedt, De Geest, Schubert, Schwendimann, and Ausserhofer[63]	Duchatrme, Bernhardt, Paduli, and Adams[35]	Escobar-Aguilar et al[64]	Fuentelsaz-Gallego, Moreno-Casbas, Gomez-Garcia, and Gonzalez-Maria[65]	Gunnarsdottir, Clarke, Rafferty, and Nutbeam[66]	Hegney et al[91]	Heinen et al[76]	Jaffree, Zakar, Zakar, and Fischer[86]	Jolliet et al[92]	Kalisch and Lee[37]	Kalisch, Lee, and Rochman[39]	Kalisch, Tschannen, and Lee[52]	Kalisch, Tschannen, Lee, and Friese[60]	Kalisch, Friese, Choi and Rochman[59]	Kim et al[53]	Leineweber et al[68]	Lin, Chiang, and Chen[89]	Louch, O'Hara, Gardner and O'Connor[77]	Mark, Salyer and Harless[58]	Nelson-Brantley, Park, Bergquist-Beringer[42]	O'Brien-Pallas et al[45]	Pineau, Lasichinger, Regan, and Wong[96]	Rauhala and Fagerström[69]	Reeder, Burleson, and Garrison[54]	Roche and Duffield[82]	Roche, Duffield, and White[83]	Rochon, Heale, Hunt, and Parent[57]	Sasso et al[80]	Schubert, Glass Clarke, Schaffert-Witvliet, and De Geest[70]	Sharma et al[81]	Smeds, Tishelman, Runesdotter, and Lindqvist[71]	Spence et al[60]	Spence Laschinger[56]	Staipers, Van Der Linden, Kaljouw, and Schuurmans[72]	Trivedi and Hancock[43]	Tvedt, Sjetne, Helgeland, and Bukholm[73]	Tvedt, Sjetne, Helgeland, Lewer, and Bukholm[74]	Weigl, Schmuck, Heiden, Angerer, and Müller[26]	Williams and Murphy[34]	Zander, Dobler, and Busse[75]	#
Organisation of care delivery	Staff hours																																																		1
	Staff hours per maximum care patient																																																		1
	Staff hours per patient																																																		1
	Students																																																		2
	Total temporary nursing care hours per patient day				x																																													1
	Use of causal staff																																																		1
	Use of relief staff																																																	1
	Work capacity																																																		2
	Work experience																																																		2
	Working duration in unit		x																																																1
	Case mix index																																	x*																	2
	Managerial planning and organisation of the work																																																		1
	Meetings/training during shift																																																		2
	Number of beds on the unit																																																		1
	Number of high technology services																																																		1
	Organisation of manager																																																		1
	Planning of the shift schedule																																																		1
	Planning of the work rota																																																		1
	Setting			x																																															7
	Substitute resources																																																		1
	Unit size																																																		1
Process	Backup																																																	2

Table 2 Continued

	Cooperation/ coordination with other staff	Cooperation in your own group	Cooperation with doctors	Cooperation within the organisation	Cooperation with peer nurses	Error reporting culture	Governance	Nurse co-worker relations	Nurse foundations for quality care	Nurse leaders' perceived influence	Nurse manager ability, leadership and support	Nurse participation in hospital affairs	Nurses' feeling of respect	Organisational commitment	Patient-perceived staffing	Professional commitment	Professional practice climate	Role support	Shared mental models	Structural empowerment	#
Anzai, Douglas, and Bonner[55]																					
Asiret, Kapucu, Kose, Kurt, and Ersoy[53]																					
Bachnick, Ausserhofer, Baernholdt, and Simon[60]																					
Bae, Brewer, Kelly, and Spencer[49]																					
Bragadottir, Kalisch, and Tryggvadottir[62]																					
Bragadottir, Kalisch, and Tryggvadottir[79]																			x*		
Bruyneel, Van den Heede, Diya, Aiken, and Sermeus[78]																					
Burmeister et al[84]																					
Cho et al[86]																					
Cho et al[87]															x*						
Choi and Staggs[24]																					
De Groot, Burke, and George[47]														x*							
Desmedt, De Geest, Schubert, Schwendimann, and Ausserhofer[63]																x*					
Ducharme, Bernhardt, Padula, and Adams[35]										x*							x*				
Escobar-Aguilar et al[64]																					
Fuentelsaz-Gallego, Moreno-Casbas, Gomez-Garcia, and Gonzalez-Maria[65]																					
Gunnarsdottir, Clarke, Rafferty, and Nutbeam[66]																					
Hegney et al[81]																					
Helmen et al[76]																					
Jafree, Zakar, Zakar, and Fischer[88]						x*	x*	x*	x*		x*	x*									
Jolivet et al[67]																					
Kalisch and Lee[37]																			x*		
Kalisch, Lee, and Rochman[39]																					
Kalisch, Tschannen, and Lee[52]																					
Kalisch, Tschannen, Lee, and Friese[70]																					
Kalisch, Friese, Choi and Rochman[59]																					
Kim et al[53]																					
Leineweber et al[68]																					
Lin, Chiang, and Chen[89]																					
Lourch, O'Hara, Gardner and O'Connor[77]																					
Mark, Salyer and Harless[58]																					
Nelson-Brantley, Park, Bergquist-Beringer[42]																					
O'Brien-Pallas et al[45]																					
Pineau, Laschinger, Regan, and Wong[48]																				x*	
Reeder, Burleson, and Garrison[54]																					
Roche and Duffield[82]																					
Roche, Duffield, and White[93]																		x			
Rochon, Heale, Hunt, and Parent[57]																					
Sasso et al[90]																					
Schubert, Glass Clarke, Schaffert-Witvliet, and De Geest[70]																					
Sharma et al[91]																					
Smeds, Tishelman, Runesdotter, and Lindqvist[71]																					
Spence et al[50]			x*		x*																
Spence Laschinger[56]													x*								
Stalpers, Van Der Linden, Kaljouw, and Schuurmans[72]																					
Trivedi and Hancock[43]																					
Tvedt, Sjetne, Helgeland, and Bukholm[73]																					
Tvedt, Sjetne, Helgeland, Lower, and Bukholm[74]																					
Weigl, Schmucki, Helden, Angerer, and Müller[82]																					
Williams and Murphy[44]																					
Zander, Dobler, and Busse[75]																					
#	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	

Continued

Table 2 Continued

	Anzai, Douglas, and Bonner[85]	Asiret, Kapucu, Kose, Kurt, and Ersoy[83]	Bachnick, Ausserhofer, Baernholdt, and Simon[60]	Bae, Brewer, Kelly, and Spencer[49]	Bragadóttir, Kalisch, and Tryggvadóttir[62]	Bragadóttir, Kalisch, and Tryggvadóttir[79]	Bruyneel, Van den Heede, Diya, Aiken, and Sermeus[78]	Burmeister *et al*[94]	Cho *et al*[86]	Cho *et al*[87]	Choi and Staggs[24]	De Groot, Burke, and George[47]	Desmedt, De Geest, Schubert, Schwendimann, and Ausserhofer[63]	Ducharme, Bernhardt, Padula, and Adams[35]	Escobar-Aguilar *et al*[84]	Fuentelsaz-Gallego, Moreno-Casbas, Gomez-Garcia, and Gonzalez-Maria[65]	Gunnarsdóttir, Clarke, Rafferty, and Nutbeam[66]	Hegney *et al*[91]	Heinen *et al*[76]	Jafree, Zakar, Zakar, and Fischer[88]	Jolivet *et al*[67]	Kalisch and Lee[37]	Kalisch, Lee, and Rochman[39]	Kalisch, Tschannen, and Lee[52]	Kalisch, Tschannen, Lee, and Friese[40]	Kalisch, Friese, Choi and Rochman[59]	Kim *et al*[53]	Leineweber *et al*[68]	Lin, Chiang, and Chen[89]	Louch, O'Hara, Gardner and O'Connor[77]	Mark, Salyer and Harless[58]	Nelson-Brantley, Park, Bergquist-Beringer[42]	O'Brien-Pallas *et al*[45]	Pineau, Laschinger, Regan, and Wong[46]	Rauhala and Fagerström[69]	Reeder, Burleson, and Garrison[54]	Roche and Duffield[92]	Roche, Duffield, and White[93]	Rochon, Heale, Hunt, and Parent[57]	Sasso *et al*[80]	Schubert, Glass Clarke, Schaffert-Witvliet, and De Geest[70]	Sharma *et al*[81]	Smeds, Tishelman, Runesdotter, and Lindqvist[71]	Spence *et al*[90]	Spence Laschinger[56]	Stalpers, Van Der Linden, Kaljouw, and Schuurmans[72]	Trivedi and Hancock[43]	Tvedt, Sjetne, Helgeland, and Bukholm[73]	Tvedt, Sjetne, Helgeland, Løwer, and Bukholm[74]	Weigl, Schmuck, Heiden, Angerer, and Müller[82]	Williams and Murphy[44]	Zander, Dobler, and Busse[75]	#
Team leadership scores						x*																x*																															2
Team orientation						x*																	x*																														2
Teamwork						x*																	x*															x															3
Trust						x*																x*																															2
Unexpected rise in patient volume and/or acuity																										x*																											1
Ward morale	x*																																																				1

ED, emergency department; FTE, full-time equivalent; LDL, low-density lipoprotein; OPCQ, Oulu Patient Classification Qualisan; PAS, perceived adequacy of staffing; RN, registered nurse; x, non-significant; x*, significant; x', mixed results; x°, descriptive study.

Table 3 Instruments for measuring perceived adequacy of staffing (PAS), including characteristics and psychometric properties

Title—author	Country	Measurement aim	Items, formats, subscale	Measurement type	Quality of instrument/ subscale development	Sample size	Structural validity		Internal consistency		Other measurement properties			
							Meth. Quality	*Rating*	*Meth. Quality*	*Rating*	*Yes/ no*	*Specification*	*Meth. Quality*	*Rating*
Adequate staff for care—Spence Laschinger[56]	Canada	To measure nurses' perceptions of adequate staffing to provide high quality of nursing care.	Single item, item not reported	Possible score range 1–5	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
American Association of Critical-Care Nurses Healthy Work Environment (AACN-HWE) Assessment Tool[50]	USA	To assess the health of the work environment.	Subscale Appropriate staffing, 3 items: 1. Administrators and nurse managers work with nurses and other staff to make sure there are enough staff to maintain patient safety 2. Administrators and nurse managers make sure there is the right mix of nurses and other staff to ensure optimal outcomes 3. Support services are provided at a level that allows nurses and other staff to spend their time on the priorities and requirements of patient and family care	5-point Likert Scale (strongly disagree–strongly agree)	Inadequate	500	Inadequate	NR	Very good	+ α>0.80	Yes	Hypothesis testing	Inadequate	NR OOM
Assessment of real-time demand for the emergency department (ED)—Reeder, Burleson, and Garrison[54]	USA	To assess the current real-time demands for the ED	Single item; Are the demands on current resources significantly greater than your available resources?	Exceeded/not exceeded	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
Head nurse questionnaire - Trivedi and Hancock[43]	USA	To measure and predict workload on nursing units using perceptions of head nurses	Nursing workload, 6 items: (Q1) If one additional person was available to you on your unit for today's shift: How would you express the need for that person if that person was an (1) RN (2) LPN (3) aide? (Q3) If one person had been withdrawn from your unit for staffing elsewhere: With what degree of difficulty could you have released that person if that person was an (4) RN (5) LPN (6) aide?	5-point Likert Scale (no need–very great need) 5-point Likert Scale (very great difficulty–no difficulty)	Doubtful	For the day shift, the head nurse of five study units completed the questionnaire for a 7-week period	NA	NA	NA	NA	No	NA	NA	NA

Continued

Table 3 Continued

Title—author	Country	Measurement aim	Items, formats, subscale	Measurement type	Quality of instrument/ subscale development	Sample size	Structural validity		Internal consistency		Other measurement properties			
Hospital Survey on Patient Safety Culture (HSOPS) —Sorra & Nieva[55]	USA	To assess the culture of patient safety in healthcare organisations	Subscale Staffing, 4 items; (A2) We have enough staff to handle the workload (A5) Staff in this unit work longer hours than is best for patient care (negatively worded) (A7) We use more agency/ temporary staff than is best for patient care (negatively worded) (A14) We work in 'crisis mode' trying to do too much, too quickly (negatively worded)	5-point Likert Scale (strongly disagree–strongly agree)	Doubtful	1437	Very good	+EFA and CFA loadings NR, CFI≥0.90, RMSEA 0.04	Very good	- α 0.63	Yes	Hypothesis testing Hypothesis testing	Doubtful Doubtful	+OOM ? KG
MISSCARE Survey—Kalisch and Williams[38]	USA	MISSCARE Survey: to measure missed nursing care	Single item, part of unit and staff characteristics; % of the time perceived staffing adequacy in the unit	5-point Likert Scale 100% of the time (1), 75% of the time (2), 50% of the time (3), 25% of the time (4), 0% of the time (5)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
New graduates' perception of adequate staffing—Pineau Stam *et al*[46]	Canada	To measure new graduates' perceptions of adequate staffing for the successful provision of care	Single item; In the last month how often has short staffing affected your ability to meet your patient/clients' needs?	5-point Likert Scale (1=never, 2=monthly, 3=weekly, 4=several times a week, 5=daily)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
Nurse-perceived staffing adequacy—Cho *et al*[87]	South Korea	To measure nurse-perceived staffing adequacy	Single item; Was there a sufficient number of nurses to provide quality nursing care on the unit?	4-point Likert Scale (very insufficient–very sufficient)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
Nursing Teamwork Survey—Kalisch *et al*[48]	USA	To measure levels of nursing teamwork in acute care settings	Single item, part of unit and staff characteristics; % of the time perceived staffing adequacy in the unit	5-point Likert Scale 100% of the time (1), 75% of the time (2), 50% of the time (3), 25% of the time (4), 0% of the time (5)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
Nursing Work Index - Extended Organisation (NWI-EO)—Bonneterre *et al*[61]	France	To assess perceived levels of stress caused by psychosocial and organisational work factors	Subscale Staffing inadequacy to perform duties, 2 items: 1. Enough registered nurses on staff to provide quality patient care 2. Enough staff to get the work done	4-point Likert Scale (strongly agree–strongly disagree)	Doubtful	4085	Adequate	–EFA loadings NR	Very good	+α 0.89	Yes	Reliability Hypothesis testing	Doubtful Doubtful	- Spearman's *r* 0.61 ? KG
Nursing Work Index - Revised (NWI-R)—Aiken and Patrician[34]	USA	To measure characteristics of professional nursing practice environments	No staffing subscale derived in original study[34]	4-point Likert Scale (strongly agree–strongly disagree)	NA	NA	NA	NA	NA	NA	NA			

Continued

Table 3 Continued

Title—author	Country	Measurement aim	Items, formats, subscale	Measurement type	Quality of instrument/ subscale development	Sample size	Structural validity		Internal consistency		Other measurement properties			
PAS Scale (part of essentials of magnetism II)—Kramer and Schmalenberg[11]	USA	To measure perceived adequacy of staffing as a process variable	Subscale Perceived adequacy of staffing, 6 items; 1. Adequate to give quality patient care 2. Adequacy varies with/ is affected by type of delivery system 3. Inadequate even if all budgeted positions are filled 4. Adequate for safe patient care 5. Cohesiveness and teamwork help 6. Positively affects job satisfaction	4-point Likert Scale	Adequate	729	Adequate	–EFA loadings 0.549–0.711	Very good	+α 0.873	Yes	Hypothesis testing	Adequate	+KG
Perceived Nursing Work Environment (PNWE)—Choi *et al*[61]	USA	To measure the perceived work environment for critical care practice	Subscale Staffing and resources adequacy, 5 items; 1. Enough staff to get the work done 2. Enough RNs to provide quality patient care 3. Adequate support services allow me to spend time with my patients 4. Enough time and opportunity to discuss patient care problems with nurse 5. A satisfactory salary	4-point Likert Scale (strongly agree–strongly disagree)	Doubtful	2324	Adequate	–EFA loadings 0.47–0.80	Very good	+α 0.83	Yes	Hypothesis testing Hypothesis testing	Doubtful Adequate	+OOM –KG
Perception of staffing adequacy—Cho *et al*[86]	Korea	To measure perceptions of staffing adequacy	Single item; Enough nurses to provide high-quality nursing care	4-point Likert Scale (strongly agree–strongly disagree)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
Perception of work conditions—Gerolamo[36]	USA	To measure nurses' perceptions of the working conditions on their unit	Single item of perceived adequacy of staffing; We had enough staff this shift to handle the workload	5-point Likert Scale (strongly agree–strongly disagree)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
Perceptions of adequacy of staffing—Mark, Salyer, and Harless[58]	USA	To measure perceptions of staffing adequacy	Single item; Evaluate the adequacy of staffing on your unit	5-point Likert Scale (very much above average–very much below average)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
Perceptions of understaffing— Weigl, Schmuck, Heiden, Angerer, and Müller[82]	Germany	To measure perceived staffing level on the ward or hospital unit	Single item; Staffing level is sufficient in this unit/ward	5-point Likert Scale (no, not at all, yes, to a very great extent)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA

Continued

Table 3 Continued

Title—author	Country	Measurement aim	Items, formats, subscale	Measurement type	Quality of instrument/ subscale development	Sample size	Structural validity		Internal consistency		Other measurement properties			
Practice Environment Scale of the Nursing Work Index (PES-NWI)—Lake[41]	USA	To measure the hospital nursing practice environment	Subscale Staffing and resource adequacy, 4 items: 1. Enough staff to get the work done 2. Enough RNs to provide quality patient care 3. Adequate support services allow me to spend time with my patients 4. Enough time and opportunity to discuss patient care problems with other nurses	4-point Likert Scale	Adequate	2299	Adequate	? EFA loading 0.47–0.73	Very good	+α 0.80	Yes	Reliability Hypothesis testing	Adequate Very good	+ICC 0.96 +KG
Professional Assessment of Optimal Nursing Care Intensity Level (PAONCIL)—Fagerström and Rainio[64]	Finland	To assess the nursing care intensity of a ward, that is, the degree to which personnel resources are in balance with the patients' care needs	Professional estimate of the nursing care intensity, single item; Assess the nursing intensity of the patients you nursed during your shift	7-point scale from –3 (very low) to +3 (very high) The estimate can be made with an accuracy of 0.25 points	Inadequate	169	NA	NA	NA	NA	Yes	Hypothesis testing	Adequate	+OOM
Unit staffing/care evaluation form — Williams and Murphy[44]	USA	To obtain charge nurses' evaluations of staffing adequacy and levels of direct care provided	Single item; In general, did you feel that staffing for this shift was:	4-point Likert Scale (more than adequate–inadequate)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA
Workload Perceptions Survey—Hegney *et al*[61]	Australia	To measure adequacy of staffing to meet patient needs	Relevant questions; (Q20) Were sufficient staff employed in your work unit to meet patient/client/resident needs? (Q21) Was the skill mix of nursing/midwifery staff employed in your work unit adequate to meet the daily needs of patients/clients/ relatives?	5-point Likert Scale (never or very seldom–always or nearly always)	Inadequate	NR	NA	NA	NA	NA	No	NA	NA	NA

.CFA, confirmative factor analysis; CFI, Comparative Fit Index; EFA, exploratory factor analysis; ICC, intraclass correlation coefficient; KG, known groups; LPN, licensed practical nurse; NA, not applicable; NR, not reported; OOM, other outcome measurement; RMSEA, root mean square error of approximation; RN, registered nurse.

Table 4 NICE quality appraisal checklist[29] adapted from Griffiths *et al*[3]

Criteria	Weak		Moderate		Strong	
Section 1: Population						
1.1 Is the source population or source area well described?	15%	(8)	42%	(22)	42%	(22)
1.2 Is the eligible population or area representative of the source population or area?	19%	(10)	44%	(23)	37%	(19)
1.3 Do the selected participants or areas represent the eligible population or area?	8%	(4)	50%	(26)	42%	(22)
Section 2: Confounding factors						
2.1 How well were likely confounding factors identified and controlled?	38%	(20)	19%	(10)	42%	(22)
Section 3: Measures						
3.1 Were the main measures and procedures reliable?	2%	(1)	85%	(44)	13%	(7)
3.2 Were the outcome measurements complete?	0%	(0)	50%	(26)	50%	(26)
Section 4: Analyses						
4.0 Study design and analyses	92%	(48)	8%	(4)	0%	(0)
4.1 Was the study sufficiently powered to detect an effect (if one exists)?	8%	(4)	23%	(12)	69%	(36)
4.2 Were the analytical methods appropriate?	37%	(19)	46%	(24)	17%	(9)
4.3 Was the precision of association given or calculable? Is association meaningful?	8%	(4)	19%	(10)	73%	(38)
Section 5: Summary						
5.1 Are the study results internally valid (ie, unbiased)?	27%	(14)	40%	(21)	33%	(17)
5.2 Are the findings generalisable to the source population (ie, externally valid)?	15%	(8)	37%	(19)	48%	(25)

NICE, National Institute for Health and Care Excellence.

patients-per-nurse,[24 59 86] (RN) skill mix,[24 58] educational level,[83] assistive personnel,[59] causal/relief staff,[90] mental stress,[69 90] nurses' psychological capital[46] and life orientation.[47] Mixed results were reported for staff hours available,[44] presence of students,[69 90] nursing role,[67 85] gender,[75 85] work experience[75 83 90] and nurses' work capacity.[69 90] Nursing HPPD, non-RN HPPD,[24 59] temporary nursing-care HPPD,[49] age[75 83] and part-time nurses[75] were not related to PAS. Louch *et al*[77] found that levels of agreeableness and conscientiousness moderated the association between PAS and whether nurses feel they can act as a safe practitioner, and that emotional stability moderated the association between PAS and patient safety.

Organisation of care delivery factors unit size, number of beds and number of high-technology hospital services[58] affect PAS. Spence *et al*[90] reported that organisation of the clinical manager's work and the shift schedules was the most important of nine factors that increase workload. In contrast, Rauhala and Fagerström[69] found no relationship between managerial planning, work organisation, work rota planning and Professional Assessment of Optimal Nursing Care Intensity Level (PAONCIL) Scores. Mixed results were found for the setting,[44 47 75 83 84 91 92] case mix index,[58 59] and meetings and training during shifts.[69 90] Substitute resources did not correlate with PAONCIL Scores.[69]

Process factors

Twenty-seven process factors were investigated in relation to PAS. Most process factors were positively associated with PAS, that is, higher process factor values were related to more positive PAS.

Teamwork was investigated in three studies, and other factors were examined in two or fewer studies. Ward morale,[85] error reporting culture, governance, nurse participation in hospital affairs, nurse manager ability, leadership and support, foundations for quality nursing care,[88] trust, shared mental models, team leadership, backup,[37 79] structural empowerment,[46] nurses' feeling of respect,[56] organisational and professional commitment, professional practice climate,[47] and unexpected rise in patient volume or acuity,[59] all influenced PAS. An increase in positive patient perceptions of staffing was related to an increase in positive perceptions of nurse staffing.[87] Intraprofessional and interprofessional cooperation[69 88 90] and teamwork[37 57 79] showed inconsistent associations with PAS. The perceived influence of nurse leaders was associated with PAS in four out of six leadership domains.[35] PAS was not associated with role support.[93]

Models

Three studies explained PAS using regression models. Kalisch *et al*[59] reported four different models with variables HPPD, case mix index, nursing education, unexpected rise in patient volume and acuity, and inadequate number of assistive personnel. The model including all variables explained most variance in PAS (33.8%). Mark *et al*[58] studied three models explaining between 33% and 51% of the variance in PAS. Patient technology, number of beds, growing admissions, and case mix index were relevant in all three models. Rauhala and Fagerström[69]

built models for 22 wards including patient classification and non-patient questions as independent variables. The median variance explained by patient factors alone was 45%. Adding non-patient factors increased the median variance to 55%, indicating that patient factors contributed to PAS more strongly than non-patient factors did.

Measurement instruments of PAS

The third research question investigated instruments used to measure the PAS. We found 21 studies that described PAS measurement instruments (table 3),[11 34 36 38 41 43 44 46 48 50 51 54–56 58 61 64 82 86 87 91 91] 20 of which were found in the development studies. Most instruments were developed in the last two decades, except for two that were developed in the 1970s.[43 44] Most instruments (12/19) were developed in the USA.[11 34 36 38 41 43 44 48 51 54 55 58]

The measurement aim, items and response options of the different instruments varied considerably. Instruments with a direct practical purpose of balancing nurse demand and supply were the head nurse questionnaire,[43] PAONCIL,[64] assessment of real-time demand for the emergency department[54] and the unit staffing/care evaluation form.[44] These instruments are used on a daily basis.

PAS is measured in the different questionnaires by single items,[36 38 44 46 48 54 56 58 64 82 86 87] multiple items[43 91] and multi-item subscales to evaluate safety culture[55] and nursing work environment.[11 34 41 50 51 61] Some items assess the adequacy of staffing numbers (eg, 'Enough staff to get the work done'),[36 41 43 46 51 55 61 82 86 87 91] and some assess the skill mix (eg, 'Enough registered nurses on staff to provide quality patient care').[41 43 50 51 61 91] Some instruments attempt to specify the purpose of adequate staffing (eg, adequate 'for quality care',[11 41 51 56 61 86 87] 'to handle the workload',[36 55] 'to meet your patient/clients' needs',[46 91] 'to get the work done'[41 51 61] and 'to maintain patient safety'[50]) while other instruments just measure adequacy of staffing without specifying what this entails.[38 44 48 58 82]

The target respondents of all instruments are nurses in general, head nurses,[43] critical care nurses,[50 51] charge nurses[44] or new graduates.[46] One study asked both nurses and patients to assess PAS.[87] Most instruments used a 4-point or 5-point Likert Scale.[11 34 36 38 41 43 44 46 48 50 51 55 56 58 61 82 86 87 91] Real-time demand for the emergency department[54] was assessed using a dichotomous scale: exceed or not exceed. The PAONCIL includes a 7-point scale, and estimates can be made with an accuracy of 0.25 points.[64]

Reliability and validity

The fourth research question assessed the reliability and validity of PAS measurement instruments. We found methodological flaws in most studies. With regard to the single-item instruments, construct validity of PAONCIL was tested by hypothesising a correlation between PAONCIL scores and patient classification scores.[64] No other studies of single-item or multi-item measures reported reliability or validity testing. The Nursing Work Index - Revised development study did not use a staffing subscale,[34] so we could not assess psychometric properties. For the remaining six subscales,[11 41 50 51 55 61] the methodological quality of structural validity and internal consistency were adequate, except for structural validity of the American Association of Critical-Care Nurses Healthy Work Environment. However, while internal consistency was sufficient in most studies, structural validity was sufficient in only one study.

DISCUSSION

Our scoping review found that mostly positive perceptions of staffing adequacy (measured using the PAS) are related to positive outcomes for patient, nurse and organisation, confirming the importance of the measure. We identified many factors that influence PAS, but the associations were inconsistent. Twenty-one instruments were identified that measure PAS, and these different instruments had different measurement aims.

Most studies reported that positive perceptions of staffing adequacy are related to positive outcomes for the patient, nurse and organisation. Effects on patient outcomes were inconsistent, mainly because of severe methodological flaws in one study.[44] The positive relationship between staffing and outcomes was confirmed by different staffing measures, such as nurse-to-patient ratios.[13 95] However, studies explained more of the variation in patient outcomes of PAS than staffing measures such as nurse-to-patient ratios and HPPD,[24 60] indicating the informative value. Kalisch *et al*[59] found moderate correlations between nurse-reported staffing adequacy, nurse-to-patient ratios and nursing HPPD, clarifying that these measures 'may capture different elements of the unit context to explain nurse staffing' (p.775). It seems that adequate staffing depends on more than just staff numbers and skill mix elements, and that nurses take these additional factors into account when assessing PAS.[24 96] In agreement with this, we identified many factors that influence PAS in the present study, including demand for care, nurse staffing, and organisation and process factors. Whether outcomes are improved by objective measurement of workload on a daily basis is unclear.[12] The RAFAELA system has provided some evidence that patient safety and mortality are associated with workload level.[97] Our finding that measuring the PAS is associated with positive outcomes indicates that measuring the PAS will strengthen nurse staffing tools, which will in turn improve staffing decisions. Measuring the PAS was also found to be relevant in research areas other than nurse staffing. For example, PAS was one of the eight essential factors of magnetism. Magnetism refers to elements that are essential for a work environment that can attract and retain nurses while providing a high level of job satisfaction and quality of care.[98]

We identified a variety of factors that influence PAS, but were unable to define a valid set of factors that were relevant to nurse staffing. Most factors were investigated in

one study and results were inconsistent between studies. There appear to be many factors affecting PAS, including patient-related and nurse-related factors and how care delivery is organised. Factors related to the work environment were also important, such as cooperation, leadership and teamwork. This is in agreement with other studies of factors that influence demand for care.[99–102] Hence, patient, nurse and organisation factors were recommended to consider in a staffing model.[101] Nurses have disputed traditional instruments for measuring workload because they involve time-consuming manual registration and cannot forecast staffing adequacy.[17–19 96 100 103] Including influencing factors in a staffing model can solve these issues, enabling decision makers to align nursing resources in a timely fashion. The study by Trivedi and Warner[104] was one of the first attempts to predict staffing adequacy using data. They designed a multivariate regression model that predicted head nurse perceptions of staffing adequacy and used this model to allocate float nurses at the beginning of the shift. Nowadays, more advanced techniques are available. Machine learning and artificial intelligence can be used to analyse hospital data and potentially explain and forecast PAS, supporting staffing decisions. These methods are a prerequisite for reliable and valid measurement of PAS.

Most of the PAS measurement instruments we found were single items, and they did not include psychometric testing. However, multiple psychometric tests can be performed on single items, including tests for content validity, inter-rater variability and responsiveness.[105] Although a single item is suitable in some situations,[106] multiple items are more reliable. Multiple items should be used for complex constructs as they define the meaning of the construct for the rater.[105] Kramer and Schmalenberg found that multiple items are needed to measure PAS.[107] However, the downside of administrative burdens have been shown to inhibit successful implementation.[21] Most relevant shortcomings of multiple-item instruments of PAS are a lack of information on subscale development, omitting to fully determine structural validity by confirmative factor analysis and confirm other psychometric properties such as reliability, criterion validity, hypothesis testing, measurement error and responsiveness.

Overall, development and evaluation of PAS instruments has been moderate; this reflects the varying use of the measure. There is no established definition of staffing adequacy. Most instruments reflect the adequacy of staff numbers, and some include skill mix (which is becoming increasingly relevant).[3 108] In addition, the measurement aims differ between instruments. For some measurements such as safety[55] and work environment,[34 41] it is sufficient to grade adequacy of staffing, while for nurse staffing decision making understaffing or overstaffing need to be graded. Moreover, instruments measure PAS by referring to the adequacy of full-time equivalent numbers[11] or team composition.[41] This tactical/strategic decision level of staffing differs from instruments on operational decision levels of capacity management, where decisions involve the staff schedule of a specific shift. Just as for workload measurement tools,[12] the decisions supported by the PAS instrument are mostly unspecified. As a result, there are a variety of available instruments, so practical use of PAS in the nurse staffing process is still limited. Decision makers continue to search for objective staffing measures and rely only moderately on nurses' opinions, so there is still a significant gap between managers and nurses in daily operations.

Strengths and limitations

The strengths of our review includes that our review was set up systematically and assessed the quality of included studies, something which is not mandatory for a scoping review.[109] But, there are some limitations to our study. First, we were unable to assess the full text of some studies (0.5%) because of no access and failing requests to researchers. However, because of the small amount of inaccessible studies we consider these studies of minimum impact on our results and conclusions. Second, we searched for studies that developed and validated PAS instruments, which could have affected our results as other publications discussing psychometric properties of included instruments were not included. Finally, we excluded qualitative studies and grey literature, which may have included potential influencing factors or outcomes. Because these studies are often followed up by quantitative studies to determine influencing factors,[102] it is likely that these factors and outcomes already are included in the quantitative studies included in this review. Nevertheless, in future research qualitative data should be explored as an extension of the results reported in this review.

Practical implications

Adequate staffing is essential for the patient, nurse and organisation.[110] In an ideal situation, PAS would be evaluated daily on the hospital ward to identify inadequate staffing either at the beginning of a shift or in upcoming shifts. Using existing patient and nurse data avoids additional administrative work and incorporating nurses' judgement potentially generates valid and reliable information acceptable to nursing staff. Measuring PAS in this way is in accordance with existing design principles.[101] The information is input for a mutual dialogue and decision making on a team, ward or cross-departmental level. Nursing managers should recognise that staff numbers do not tell the whole staffing story and avoid investing in traditional patient classification systems. Machine learning and artificial intelligence will provide new opportunities for measuring adequacy of staffing in the near future. For adequate and practical measurement of PAS, a balance should be found between using multiple items for reliability and limiting the effort needed to use them. For this to work, practitioners need to be involved in developing adequate PAS measures.

CONCLUSIONS

This scoping review found that PAS is positively associated with outcomes for patient, nurse and organisation, supporting the relevance of PAS as a measure for

nurse staffing decisions. Many factors were identified that influence PAS, but associations were inconsistent. Instruments used to measure PAS were found to have moderate reliability and validity. Measuring PAS could enhance nurse staffing methods by predicting staffing adequacy based on existing patient and nurse data using machine learning and artificial intelligence techniques. This approach goes beyond traditional workload measurement or workforce planning methods. Further work is needed to refine and psychometrically evaluate instruments measuring PAS.

Author affiliations
[1]Department of Capacity Management, Rijnstate Hospital, Arnhem, The Netherlands
[2]Radboud Institute for Health Sciences, Scientific Center for Quality of Healthcare (IQ healthcare), Radboudumc, Nijmegen, The Netherlands
[3]Faculty of Health and Social Studies, HAN University of Applied Sciences, Nijmegen, The Netherlands
[4]Institute for Management Research, Radboud University, Nijmegen, The Netherlands
[5]Erasmus School of Health Policy & Management, Erasmus University Rotterdam, Rotterdam, The Netherlands
[6]Spaarne Gasthuis Academy, Spaarne Gasthuis Hospital, Hoofddorp and Haarlem, The Netherlands

Acknowledgements The authors thank On Ying Chan, information specialist, Radboud University Medical Center, the Netherlands, for her help with developing and refining the search strategy.

Contributors All authors (CM, HV, PH and CO) were involved in planning the scoping review. CM and CO were involved in the search strategy, extraction, quality appraisal and synthesis of data, and wrote the first draft of the manuscript. All authors revised the manuscript drafts and approved the final manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository.

ORCID iD
Carmen J E M van der Mark http://orcid.org/0000-0002-7384-5413

REFERENCES

1 World Health Organization. Health workforce requirements for universal health coverage and the Sustainable Development Goals. (Human Resources for Health Observer, 17) 2016.
2 Aiken LH, Sermeus W, Van den Heede K, *et al*. Patient safety, satisfaction, and quality of hospital care: cross sectional surveys of nurses and patients in 12 countries in Europe and the United States. *BMJ* 2012;344:e1717.
3 Griffiths P, Recio-Saucedo A, Dall'Ora C, *et al*. The association between nurse staffing and omissions in nursing care: a systematic review. *Journal of Advanced Nursing* 2018;74:1474–87.
4 Kane RL, Shamliyan TA, Mueller C, *et al*. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Medical Care* 2007;45:1195–204.
5 Aiken LH, Clarke SP, Sloane DM, *et al*. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *JAMA* 2002;288:1987–93.
6 Griffiths P, Ball J, Drennan J, *et al*. Nurse staffing and patient outcomes: strengths and limitations of the evidence to inform policy and practice. A review and discussion paper based on evidence reviewed for the National Institute for health and care excellence safe staffing Guideline development. *International Journal of Nursing Studies* 2016;63:213–25.
7 McGillis Hall L, Doran D, Baker GR, *et al*. Nurse staffing models as predictors of patient outcomes. *Medical Care* 2003;41:1096–109.
8 Jelinek RC, Kavois JA. Nurse staffing and scheduling: past solutions and future directions. *J Soc Health Syst* 1992;3:75–82.
9 Burke EK, De Causmaecker P, van der Berghe G, *et al*. The state of the art of nurse Rostering. *Journal of Scheduling* 2004;7:441–99.
10 American Nurses Association. ANA's principles for nurse staffing 2012.
11 Kramer M, Schmalenberg C. Revising the essentials of magnetism tool. *JONA: The Journal of Nursing Administration* 2005;35:188–98.
12 Saville CE, Griffiths P, Ball JE, *et al*. How many nurses do we need? A review and discussion of operational research techniques applied to nurse staffing. *International Journal of Nursing Studies* 2019;97:7–13.
13 Griffiths P, Saville C, Ball J, *et al*. Nursing workload, Nurse Staffing Methodologies & Tools: a systematic scoping review & discussion. *International Journal of Nursing Studies* 2020;103.
14 Kortbeek N, Braaksma A, Burger CAJ, *et al*. Flexible nurse staffing based on hourly bed census predictions. *International Journal of Production Economics* 2015;161:167–80.
15 Twigg D, Duffield C. A review of workload measures: a context for a new staffing methodology in Western Australia. *International Journal of Nursing Studies* 2009;46:132–40.
16 Upenieks VV, Kotlerman J, Akhavan J, *et al*. Assessing nursing staffing ratios: variability in workload intensity. *Policy, Politics, & Nursing Practice* 2007;8:7–19.
17 Alghamdi M. Nursing workload: a concept analysis. *Journal of Nursing Management* 2016;24:449–57.
18 Fasoli DR, Haddock KS. Results of an integrative review of patient classification systems. *Annual Review of Nursing Research* 2010;28:295–316.
19 McGillis Hall L, Pink L, Lalonde M, *et al*. Decision making for nurse staffing: Canadian perspectives. *Policy, Politics, & Nursing Practice* 2006;7:261–9.
20 Fagerström L, Rainio A-K, Rauhala A, *et al*. Validation of a new method for patient classification, the Oulu patient classification. *Journal of Advanced Nursing* 2000;31:481–90.
21 van Oostveen CJ, Ubbink DT, Mens MA, *et al*. Pre-implementation studies of a workforce planning tool for nurse staffing and human resource management in university hospitals. *Journal of Nursing Management* 2016;24:184–91.
22 Rubio S, Díaz E, Martín J, *et al*. Evaluation of subjective mental workload: a comparison of SWAT, NASA-TLX, and workload profile methods. *Applied Psychology* 2004;53:61–86.
23 Hughes M. Nursing workload: an unquantifiable entity. *Journal of Nursing Management* 1999;7:317–22.
24 Choi J, Staggs VS. Comparability of nurse staffing measures in examining the relationship between Rn staffing and unit-acquired pressure ulcers: a unit-level descriptive, correlational study. *International Journal of Nursing Studies* 2014;51:1344–52.
25 McHugh MD, Stimpfel AW. Nurse reported quality of care: a measure of hospital quality. *Research in Nursing & Health* 2012;35:566–75.
26 Leary A, Punshon G. Determining acute nurse staffing: a hermeneutic review of an evolving science. *BMJ Open* 2019;9:e025654.
27 Hyun S, Bakken S, Douglas K, *et al*. Evidence-Based staffing: potential roles for informatics. *Nurse Econ* 2008;26:151–73.
28 Tricco AC, Lillie E, Zarin W, *et al*. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of Internal Medicine* 2018;169:467.
29 National Institute for Clinical Excellence. *Methods for the development of NICE public health guidance*. 3. Londen: NICE, 2012.

30 Mokkink LB, de Vet HCW, Prinsen CAC, *et al*. COSMIN risk of bias checklist for systematic reviews of patient-reported outcome measures. *Quality of Life Research : An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation - Official Journal of the International Society of Quality of Life Research* 2018;27:1171–9.
31 Prinsen CAC, Mokkink LB, Bouter LM, *et al*. COSMIN guideline for systematic reviews of patient-reported outcome measures. *Quality of Life Research : An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation - Official Journal of the International Society of Quality of Life Research* 2018;27:1147–57.
32 Donabedian A. Evaluating the quality of medical care. *Milbank Quarterly* 2005;83:691–729.
33 O'Brien-Pallas L, Meyer RM, Hayes LJ, *et al*. The Patient Care Delivery Model - an open system framework: conceptualisation, literature review and analytical strategy. *Journal of Clinical Nursing* 2011;20:1640–50.
34 Aiken LH, Patrician PA. Measuring organizational traits of hospitals: the revised nursing work index. *Nursing Research* 2000;49:146–53.
35 Ducharme MP, Bernhardt JM, Padula CA, *et al*. The professional practice environment, and nurse engagement in essential nursing practice. *Journal of Nursing Administration* 2017;47:367–75.
36 Gerolamo AM. An exploratory analysis of the relationship between psychiatric nurses' perceptions of workload and unit activity. *Archives of Psychiatric Nursing* 2009;23:243–50.
37 Kalisch BJ. Lee KHDU school or nursing, Durham, North Carolina, 27710. variations of nursing teamwork by Hospital, patient unit, and staff characteristics. *Applied Nursing Research* 2013;26:2–9.
38 Kalisch BJ, Williams RA. Development and psychometric testing of a tool to measure missed nursing care. *JONA: The Journal of Nursing Administration* 2009;39:211–9.
39 Kalisch BJ, Lee H, Rochman M. Nursing staff teamwork and job satisfaction. *J Nurs Manage* 2010;18:938–47.
40 Kalisch BJ, Tschannen D, Lee H, *et al*. Hospital variation in missed nursing care. *Am J Med Qual* 2011;26:291–9.
41 Lake ET. Development of the practice environment scale of the nursing work index ‡. *Research in Nursing & Health* 2002;25:176–88.
42 Nelson-Brantley HV, Park SH, Bergquist-Beringer S. Characteristics of the nursing practice environment associated with lower Unit-Level Rn turnover. *Journal of Nursing Administration* 2018;48:31–7.
43 Trivedi V, Hancock W. Measurement of Nursing Work Load Using Head Nurses' Perceptions. *Nursing Research* 1975;24:371–6.
44 Williams MA, Murphy LN. Subjective and objective measures of staffing adequacy. *JONA: The Journal of Nursing Administration* 1979;9:21–9.
45 O'Brien–Pallas L, XM L, Wang S, *et al*. Evaluation of a patient care delivery model: system outcomes in acute cardiac care. *CJNR* 2010;42:98–120.
46 Pineau Stam LM, Spence Laschinger HK, Regan S, *et al*. The influence of personal and workplace resources on new graduate nurses' job satisfaction. *Journal of Nursing Management* 2015;23:190–9.
47 De Groot HA, Burke LJ, George VM. Implementing the differentiated pay structure model: process and outcomes. *The Journal of Nursing Administration* 1998;28:28–38.
48 Kalisch BJ, Lee H, Salas E. The development and testing of the nursing teamwork survey. *Nursing Research* 2010;59:42.
49 Bae S-H, Brewer CS, Kelly M, *et al*. Use of temporary nursing staff and nosocomial infections in intensive care units. *Journal of Clinical Nursing* 2015;24:980–90.
50 AACN healthy work environment assessment tool, 2015. Available: https://www.aacn.org/nursing-excellence/healthy-work-environments/aacn-healthy-work-environment-assessment-tool [Accessed December 11, 2019].
51 Choi J, Bakken S, Larson E, *et al*. Perceived nursing work environment of critical care nurses. *Nursing Research* 2004;53:370–8.
52 Kalisch B, Tschannen D, Lee H. Does missed nursing care predict job satisfaction? *Journal of Healthcare Management / American College of Healthcare Executives* 2011;56:117–31.
53 Kim S-S, Okechukwu CA, Dennerlein JT, *et al*. Association between perceived inadequate staffing and musculoskeletal pain among hospital patient care workers. *International Archives of Occupational and Environmental Health* 2014;87:323–30.
54 Reeder TJ, Burleson DL, Garrison HG. The overcrowded emergency department: a comparison of staff perceptions. *Academic Emergency Medicine* 2003;10:1059–64.
55 Sorra J, Nieva V. Hospital survey on patient safety culture 2004.
56 Spence Laschinger H. Hospital nurses' perceptions of respect and organizational justice. *JONA: The Journal of Nursing Administration* 2004;34:354–64.
57 Rochon A, Heale R, Hunt E, *et al*. Teamwork and patient care teams in an acute care hospital. *Nurs Leadersh* 2015;28:28–39.
58 Mark B, Salyer J, Harless D. What explains nurses' perceptions of staffing adequacy? *JONA: The Journal of Nursing Administration* 2002;32:234–42.
59 Kalisch BJ, Friese CR, Choi SH, *et al*. Hospital nurse staffing: choice of measure matters. *Medical Care* 2011;49:775–9.
60 Bachnick S, Ausserhofer D, Baernholdt M, *et al*. Patient-Centered care, nurse work environment and implicit rationing of nursing care in Swiss acute care hospitals: a cross-sectional multi-center study. *International Journal of Nursing Studies* 2018;81:98–106.
61 Bonneterre V, Ehlinger V, Balducci F, *et al*. Validation of an instrument for measuring psychosocial and organisational work constraints detrimental to health among hospital workers: the NWI-EO questionnaire. *International Journal of Nursing Studies* 2011;48:557–67.
62 Bragadóttir H, Kalisch BJ, Tryggvadóttir GB. Correlates and predictors of missed nursing care in hospitals. *Journal of Clinical Nursing* 2017;26:1524–34.
63 Desmedt M, De Geest S, Schubert M, *et al*. Ausserhofer D. a multi-method study on the quality of the nurse work environment in acute-care hospitals: positioning Switzerland in the magnet Hospital research. *Swiss Medical Weekly* 2012;142:w13733.
64 Fagerström L, Rainio A-K. Professional assessment of optimal nursing care intensity level: a new method of assessing personnel resources for nursing care. *Journal of Clinical Nursing* 1999;8:369–79.
65 Fuentelsaz-Gallego C, Moreno-Casbas T, Gomez-Garcia T, *et al*. Work setting, satisfaction and burnout of the nurses in critical care units and hospitalization units. *RN4CAST-Spain project. Enferm Intensiva* 2013;24:104–12.
66 Gunnarsdóttir S, Clarke SP, Rafferty AM, *et al*. Staffing and nurse-doctor relationships as predictors of nurse and patient outcomes. A survey of Icelandic Hospital nurses. *International Journal of Nursing Studies* 2009;46:920–7.
67 Jolivet A, Caroly S, Ehlinger V, *et al*. Linking hospital workers' organisational work environment to depressive symptoms: A mediating effect of effort-reward imbalance? The ORSOSA study. *Social Science & Medicine* 2010;71:534–40.
68 Leineweber C, Westerlund H, Chungkham HS, *et al*. Nurses' practice environment and work-family conflict in relation to burn out: A multilevel modelling approach. *PLoS ONE* 2014;9:e96991.
69 Rauhala A, Fagerström L. Are nurses' assessments of their workload affected by non-patient factors? An analysis of the RAFAELA system. *Journal of Nursing Management* 2007;15:490–9.
70 Schubert M, Glass TR, Clarke SP, *et al*. Validation of the Basel extent of rationing of nursing care instrument. *Nursing Research* 2007;56:416–24.
71 Smeds Alenius L, Tishelman C, Runesdotter S, *et al*. Staffing and resource adequacy strongly related to RNs' assessment of patient safety: a national study of RNs working in acute-care hospitals in Sweden. *BMJ Quality & Safety* 2014;23:242–9.
72 Stalpers D, Van Der Linden D, Kaljouw MJ, *et al*. Nurse-perceived quality of care in intensive care units and associations with work environment characteristics: a multicentre survey study. *J Adv Nurs* 2017;73:1482–90.
73 Tvedt C, Sjetne IS, Helgeland J, *et al*. An observational study: associations between nurse-reported Hospital characteristics and estimated 30-day survival probabilities. *BMJ Qual Saf* 2014;23:757–64.
74 Tvedt C, Sjetne IS, Helgeland J, *et al*. Nurses' reports of staffing adequacy and surgical site infections: A cross-sectional multi-centre study. *Int J Nurs Stud* 2017;75:58–64.
75 Zander B, Dobler L, Busse R. The introduction of DRG funding and hospital nurses' changing perceptions of their practice environment, quality of care and satisfaction: Comparison of cross-sectional surveys over a 10-year period. *International Journal of Nursing Studies* 2013;50:219–29.
76 Heinen MM, van Achterberg T, Schwendimann R, *et al*. Nurses' intention to leave their profession: A cross sectional observational study in 10 European countries. *International Journal of Nursing Studies* 2013;50:174–84.
77 Louch G, O'Hara J, Gardner P, *et al*. The daily relationships between staffing, safety perceptions and personality in hospital nursing: a longitudinal on-line diary study. *International Journal of Nursing Studies* 2016;59:27–37.

78 Bruyneel L, Heede KV, Diya L, *et al*. Predictive validity of the International Hospital outcomes study questionnaire: an RN4CAST pilot study. *Journal of Nursing Scholarship* 2009;41:202–10.
79 Bragadóttir H, Kalisch BJ, Bergthóra Tryggvadóttir G. The extent to which adequacy of staffing predicts nursing teamwork in hospitals. *Journal of Clinical Nursing* 2019;28:4298–309.
80 Sasso L, Bagnasco A, Catania G, *et al*. Push and pull factors of nurses' intention to leave. *Journal of Nursing Management* 2019;27:946–54.
81 Sharma N, Herrnschmidt J, Claes V, *et al*. Organizational readiness for implementing change in acute care hospitals: an analysis of a cross-sectional, multicentre study. *Journal of Advanced Nursing* 2018;74:2798–808.
82 Weigl M, Schmuck F, Heiden B, *et al*. Associations of understaffing and cardiovascular health of hospital care providers: a multi-source study. *International Journal of Nursing Studies* 2019;99.
83 Asiret GD. Attitudes and satisfaction of nurses with the work environment in turkey. *International Journal of Caring Sciences* 2017;10:771–80.
84 Escobar-Aguilar G, Gómez-García T, Ignacio-García E, *et al*. Work environment and patient safety: data comparison between Seneca and RN4CAST projects. *Enfermeria Clinica* 2013;23:103–13.
85 Anzai E, Douglas C, Bonner A. Nursing practice environment, quality of care, and morale of hospital nurses in Japan. *Nurs Health Sci* 2014;16:171–8.
86 Cho S, June KJ, Kim YM, *et al*. Nurse staffing, quality of nursing care and nurse job outcomes in intensive care units. *Journal of Clinical Nursing* 2009;18:1729–37.
87 Cho S, Mark BA, Knafl G, *et al*. Relationships Between Nurse Staffing and Patients' Experiences, and the Mediating Effects of Missed Nursing Care. *Journal of Nursing Scholarship* 2017;49:347–55.
88 Jafree SR, Zakar R. Nurse perceptions of organizational culture and its association with the culture of error reporting: a case of public sector hospitals in Pakistan. *BMC Health Services Research* 2016;16:1–13.
89 Lin S-Y, Chiang H-Y, Chen I-L. Comparing nurses' intent to leave or stay: Differences of practice environment perceptions. *Nursing & Health Sciences* 2011;13:463–7.
90 Spence K, Tarnow-Mordi W, Duncan G, *et al*. Measuring nursing workload in neonatal intensive care. *Journal of Nursing Management* 2006;14:227–34.
91 Hegney DG, Rees CS, Osseiran-Moisson R, *et al*. Perceptions of nursing workloads and contributing factors, and their impact on implicit care rationing: a Queensland, Australia study. *Journal of Nursing Management* 2019;27:371–80.
92 Roche M, Duffield C. A comparison of the nursing practice environment in mental health and medical-surgical settings. *Journal of Nursing Scholarship* 2010;42:195–206.
93 Roche M, Duffield C, White E. Factors in the practice environment of nurses working in inpatient mental health: a partial least squares path modeling approach. *International Journal of Nursing Studies* 2011;48:1475–86.
94 Burmeister EA, Kalisch BJ, Xie B, *et al*. Determinants of nurse absenteeism and intent to leave: an international study. *Journal of Nursing Management* 2019;27:143–53.
95 Shin S, Park JH, Bae SH. Nurse staffing and nurse outcomes: a systematic review and meta-analysis. *Nursing Outlook* 2018;66:273–82.
96 van Oostveen CJ, Mathijssen E, Vermeulen H. Nurse staffing issues are just the tip of the iceberg: A qualitative study about nurses' perceptions of nurse staffing. *International Journal of Nursing Studies* 2015;52:1300–9.
97 Fagerström L, Kinnunen M, Saarela J. Nursing workload, patient safety incidents and mortality: an observational study from Finland. *BMJ Open* 2018;8:e016367.
98 Kramer M, Schmalenberg C. Development and evaluation of essentials of magnetism tool. *The Journal of Nursing Administration* 2004;34:365–78.
99 van den Oetelaar W, van Stel H, van Rhenen W, *et al*. Balancing nurses' workload in hospital wards: study protocol of developing a method to manage workload. *BMJ Open* 2016;6:1–11.
100 van Oostveen CJ, Vermeulen H, Gouma DJ, *et al*. Explaining the amount of care needed by hospitalised surgical patients: a prospective time and motion study. *BMC Health Services Research* 2013;13.
101 Fasoli DR, Fincke BG, Haddock KS. Going beyond patient classification systems to create an evidence-based staffing methodology. *The Journal of Nursing Administration* 2011;41:434–9.
102 Myny D, Van Goubergen D, Gobert M, *et al*. Non-direct patient care factors influencing nursing workload: a review of the literature. *J Adv Nurs* 2011;67:2109–29.
103 Goossen WTF, Epping P, Van den Heuvel WJA*et al*. Development of the nursing minimum data set for the Netherlands (NMDSN): identification of categories and items. *J Adv Nurs* 2000;31:536–47.
104 Trivedi VM, Warner DM. A branch and bound algorithm for optimum allocation of float nurses. *Manage Sci* 1976;22:972–81.
105 de Vet HCW, Terwee CB, Mokkink LB, *et al*. *Measurement in medicine : a practical guide*. Cambridge: Cambridge University Press, 2011.
106 Sloan J, Aaronson N, Cappelleri J, *et al*. Assessing the clinical significance of single items relative to summated scores. *Clin Ther* 2002;24:6–7.
107 Schmalenberg C, Kramer M. Perception of adequacy of staffing. *Crit Care Nurse* 2009;29:65–71.
108 Aiken LH, Sloane DM, Bruyneel L, *et al*. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. *Lancet* 2014;383:1824–30.
109 Munn Z, Peters MDJ, Stern C, *et al*. Systematic review or scoping review? guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol* 2018;18.
110 Unruh L. Nurse staffing and patient, nurse, and financial outcomes. *Am J Nurs* 2008;108:62–71.

Database	*Key*	*Range of years*
PubMed	("Personnel Staffing and Scheduling"[Mesh:noexp] OR staffing adequacy OR inadequate staffing OR staffing inadequacy OR adequate staffing OR requirements for nursing resources[tiab]) AND ("Attitude of Health Personnel"[Mesh:NoExp] OR perception*[tiab] OR perceive*[tiab]) AND ("Nursing Staff"[Mesh] OR "Nurses"[Mesh] OR nurs*[tiab])	1966 - 2019
Embase	(health care personnel management/ or hospital personnel management/ or nurse patient ratio/ OR ((Staffing ADJ5 (inadequate OR adequate OR inadequacy OR adequacy)) OR requirements for nursing resources).ti,ab,kw.) AND (nurse attitude/ OR (perception* OR perceive*).ti,ab,kw.) AND (exp nurse/ or nursing staff/ OR nurs*.ti,ab,kw)	1978 - 2019
CINAHL	((MH "Personnel Staffing and Scheduling+") OR TI (staffing adequacy OR inadequate staffing OR staffing inadequacy OR adequate staffing OR requirements for nursing resources) OR AB (staffing adequacy OR inadequate staffing OR staffing inadequacy OR adequate staffing OR requirements for nursing resources)) AND ((MH "Nurse Attitudes") OR TI (perception* OR perceive*) OR AB (perception* OR perceive*)) AND ((MH "Nurses+") OR (MH "Nursing Home Personnel") OR TI nurs* OR AB nurs*)	1984 - 2019
Business Source Complete	(DE "WORKFORCE planning" OR TI (staffing adequacy OR inadequate staffing OR staffing inadequacy OR adequate staffing OR requirements for nursing resources) OR AB (staffing adequacy OR inadequate staffing OR staffing inadequacy OR adequate staffing OR requirements for nursing resources)) AND ((DE "EMPLOYEE attitudes" OR DE "JOB involvement" OR DE "JOB satisfaction") OR TI (perception* OR perceive*) OR AB (perception* OR perceive*)) AND (DE "NURSES" OR DE "FLOAT nurses" OR DE "HOSPITAL nursing staff" OR DE "NURSE liaisons" OR DE "VISITING nurses" OR TI nurs* OR AB nurs*)	1976 - 2018

Author (year)	Country	Aim	Study design	Population	Setting	Sample size	Instrument	Influencing factors	(statistical) analysis	Corrected	Results	Outcomes	(statistical) analysis	Corrected	Results
Anzai, Douglas, and Bonner [85]	Japan	To describe Japanese hospital nurses' perceptions of the nursing practice environment and examine its association with nurse-reported ability to provide quality nursing care, quality of patient care, and ward morale.	Cross-sectional	Nurses working in acute inpatient wards	12 acute-care (i.e., medical, surgical, and mixed) inpatient wards in a large teaching hospital in the middle of Japan	n=223	Staffing and resource adequacy subscale of the PES-NWI (Japanese version)	Occupation (ward nurse manager or staff nurse)	t-test		NS	Ability to provide quality nursing care	Pearson's correlation		NS
								Ward morale	Pearson's correlation		r=0.33, p<0.01	Quality of patient care	""		r=0.29, p<0.01
								Ward morale	Hierarchical regression	Demographics (gender, years working as a nurse, education), work characteristics (position, shift type, number of total shifts, percentage of day shifts, hours of overtime work, number of patients in day shifts), and PES-NWI subscales (nurse participation in hospital affairs, nursing foundations for quality of care, nurse manager ability, leadership, and support of nurses, collegial nurse-physician relations)	β=0.17, p=0.03	Ability to provide quality nursing care	Hierarchical regression	Demographics (gender, years working as a nurse, education), work characteristics (position, shift type, number of total shifts, percentage of day shifts, hours of overtime work, number of patients in day shifts), and PES-NWI subscales (nurse participation in hospital affairs, nursing foundations for quality of care, nurse manager ability, leadership, and support of nurses, collegial nurse-physician relations)	NS
												Quality of patient care	""	""	β=0.18, p=0.02
Asiret, Kapucu, Kose, Kurt, and Ersoy [83]	Turkey	To determine the effect of the factors affecting nurses' work environment and the work environment itself on the satisfaction of nurses	Cross-sectional	Nurses	A university hospital in Ankara	n=327	Staffing and resource adequacy subscale of the PES-NWI	Educational level	t-test		t=2.392, p=0.017				
								Professional experience	""		t=3.049, p=0.002				
								Age	""		NS				
								Gender	""		NS				
								Working duration in unit	""		NS				
								Work unit	ANOVA		NS				
Bachnick, Ausserhofer, Baernholdt, and Simon [60]	Switzerland	To describe patient-centered care in Swiss acute care hospitals and to explore the associations with nurse work environment factors and implicit rationing of nursing care.	Cross-sectional	Registered nurses	Medical, surgical and mixed units of Swiss acute care hospitals	n=2073 patient n=1810 nurses	Staffing and resource adequacy subscale of the PES-NWI					Patient-centered care (PCC): Easy to understand	Generalized linear mixed model	Patient characteristics (age, gender, language, levels of education)	β=0.486, CI 0.06 - 0.91, p<0.05
												Sufficient information	""	""	β=0.638, CI 0.30 - 0.98, p<0.001,
												Involved in decision	""	""	β=0.351, CI 0.03 - 0.67, p<0.05
												Treatment & care adapted	""	""	β=0.456, CI 0.04 - 0.87, p<0.05
Bae, Brewer, Kelly, and Spencer [49]	U.S.	To examine the nature and prevalence of the use of temporary nursing staff in intensive care units and relationships between the use of temporary nursing staff and the occurrence of nosocomial infections (central lineassociated blood stream infections and ventilator-associated pneumonia).	Retrospective, longitudinal, secondary analysis	Staff nurses	12 intensive care units at six hospitals	n=144 ICU-month data points n=84 for staffing and resource adequacy	Staffing and resource adequacy subscale of the PES-NWI	Total temporary nursing care hours per patient day	ANOVA		NS	Occurrence of central line-associated blood stream infection (CLABSI) model 1	Logistic regression	Total temporary nursing staff, Nursing unit covariates (RN care hours, UAP care hours, nursing professional skill mix, unit size and work environment characteristics)	OR=0.050, p<0.01
								RN temporary nursing care hours per patient day	""		NS				
												CLABSI model 2	""	RN temporary nursing staff, Nursing unit covariates	OR=0.069, p<0.01
												Ventilator-associated pneumonia (VAP) model 1	""	Total temporary nursing staff, Nursing unit covariates	OR=0.215, p<0.01
												VAP model 2		RN temporary nursing staff, Nursing unit covariates	OR=0.166, p<0.01
Bragadóttir, Kalisch, and Tryggvadóttir [62]	Iceland	To identify the contribution of hospital, unit, staff characteristics, staffing adequacy and teamwork to missed nursing care in Iceland hospitals.	Cross-sectional	Registered nurses and practical nurses	27 medical, surgical and intensive care inpatient units in eight hospitals in Iceland	n=527	MISSCARE Survey					Missed nursing care	ANOVA		F(3,514) = 6.099, p<0.001
												Missed nursing care	Hierarchical regression	Unit type, role, age	PAS 75%; **NS** PAS 50%; NS PAS 0-25%; NS
												Missed nursing care	""	Unit type, role, age, teamwork	PAS 75%; NS PAS 50%; NS PAS 0-25%; NS
Bragadóttir, Kalisch, and Tryggvadóttir [79]	Iceland	To examine the extent to which staffing adequacy predicts nursing teamwork, controlling for demographic and background variables.	Cross-sectional	Registered nurses, practical nurses, nurse unit managers and unit secretaries	All inpatient medical, surgical and intensive care units in Iceland	n=567	Nursing Teamwork Survey	Overall teamwork	t-test		p<0.001				
								Trust	""		p<0.001				
								Team orientation	""		p<0.05				
								Backup	""		p<0.001				
								Shared mental models	""		p<0.001				
								Team leadership	""		p<0.001				
								Overall teamwork	Linear regression	Unit type, role, experience on unit, intent to leave	B=0.17, SE=0.04, β=0.16. p<0.001				

Bruyneel, Van den Heede, Diya, Aiken, and Sermeus [78]	Belgium	To study the predictive validity of the instrument used in the International Hospital Outcomes Study (IHOS) for an upcoming EU-funded project (RN4CAST), which will indicate the effect of the nursing work environment and nursing staff deployment on nurse recruitment, retention, and productivity; and on patient outcomes in 11 European countries.	Cross-sectional	Nurses working in direct patient care in general acute hospitals	Four Belgian general acute-care hospitals	n=179	Staffing and resource adequacy subscale of the NWI-R (translated in Dutch)					High job satisfaction	Univariate logsitic regression		OR 2.87, CI 1.48-5.58, p<0.01
												""	Multivariate regression modelling	Highest degree obtained (undergraduate, bachelor's in nursing/registered nurse, master's in nursing), employment (part-time, full-time), years worked in direct patient care	OR 2.81, CI 1.38-5.72, p<0.01
												Excellent nurse perceived quality of care			NS
												""	Univariate logsitic regression Multivariate regression modelling	Highest degree obtained (undergraduate, bachelor's in nursing/registered nurse, master's in nursing), employment (part-time, full-time), years worked in direct patient care	NS
												Intention to leave within a year			NS
												""	Univariate logsitic regression Multivariate regression modelling	Highest degree obtained (undergraduate, bachelor's in nursing/registered nurse, master's in nursing), employment (part-time, full-time), years worked in direct patient care	NS
												Burnout			OR 0.23, CI 0.12-0.46, p<0.001
												""	Univariate logsitic regression	Highest degree obtained (undergraduate, bachelor's in nursing/registered nurse, master's in nursing), employment (part-time,	OR 0.23, CI 0.12-0.47, p<0.001
Burmeister et al. [94]	Australia, Iceland, Italy, South Korea, Lebanon, Turkey and the United States	To determine factors associated with nurses' intent to leave their positions and absenteeism	Cross-sectional	Registered nurses	Medical-surgical, rehabilitative, intermediate, and intensive care patient units in acute care hospitals	n=6212	MISSCARE Survey					Intention to leave	Logistic regression		100% of time: OR 1.00 75% of time: OR 1.22, CI 0.97-1.53 50% of time: OR 2.15, CI 1.68-2.74 25% of time: OR 3.85, CI 2.96-5.01 0% of time: OR 2.94, CI 2.08-4.14
												""	""	Country, hospital, age, education, unit experience, full or part-time, satisfaction with job, satisfaction with nursing, satisfaction with team, sex, patient turnover	100% of time: AOR 1.00 75% of time: AOR 0.78, CI 0.57-1.07 50% of time: AOR 1.01, CI 0.71-1.43 25% of time: AOR 1.72, CI 1.17-2.54 0% of time: AOR
												Absenteeism	""		100% of time: OR 1.00 75% of time: OR 1.53, CI 1.32-1.77 50% of time: OR 1.76, CI 1.49-2.09 25% of time: OR 1.72, CI 1.40-2.10 0% of time: OR 1.83, CI 1.39-2.43
												""	""	Country, hospital, age, satisfaction with job, satisfaction with role, education, full or part-time, staffing perception, patient turnover	100% of time: AOR 1.00 75% of time: AOR 1.23, CI 1.00-1.52 50% of time: AOR 1.40, CI 1.10-1.79, 25% of time: AOR 1.46, CI 1.09-1.97 0% of time: AOR
Cho et al. [86]	Korea	To examine the relationship between nurse staffing and nurse-rated quality of nursing care, job dissatisfaction, burnout and plan to leave among ICU nurses in Korea.	Cross-sectional	Nurse managers, charge and staff nurses	ICUs of 22 general hospitals providing secondary or tertiary care located in Seoul or Kyeonggi Province	n=1365	Perception of staffing adequacy	Patients per nurse	t-test		p=0.004	Nurse rated quality of care	Multilevel logistic regression	Hospital, ICU and nurse characteristics	OR=2.97, CI 2.22 - 3.97
												Job dissatisfaction	""	""	OR=0.30, CI 0.23 - 0.40
												Burn out	""	""	OR=0.50, CI 0.34 - 0.70
												Planning to leave	""	""	OR=0.40, CI 0.28 -

Cho et al. [87]	South Korea	To examine the relationship of nurse staffing, as measured by nurse-perceived and patient-perceived staffing adequacy as well as by the patient-to-nurse-ratio, with patient experiences, and to determine the mediating effects of patient-reported missed care on the relationship between nurse staffing and patients' experiences	Cross-sectional	Nurse managers, registered nurses, and patients	Medical and surgical inpatient unit of six hospitals	n=23 nurse managers n=362 registered nurses n=208 patients	Nurse-perceived staffing adequacy	PAS patient: Nurse-perceived staffing adequacy	Descriptive			PAS patient:			
												Missed communication	Descriptive		
												Missed basic care	""		
												Adverse events	""		
												Communication with nurses	""		
												Overall hospital rating	""		
												PAS nurse:			
												Missed communication	Lineair mixed model		RC = –0.58, CI -1.06, - -0.06, p = 0.029
												Missed basic care	""		NS
												Adverse events	Generalized lineair mixed model		NS
												Communication with nurses	""		NS
												Overall hospital rating	""		NS
												Patient, PAS very sufficient:			
												Missed communication	Lineair mixed model		RC -0.69, CI -1.02- -0.35, p<0.001
												Missed basic care	""		RC -0.82, CI -1.32 - -0.31, p<0.01
												Adverse events	Generalized lineair mixed model		OR 0.27, CI 0.09 - 0.86, p<0.05
												Communication with nurses	""		OR 5.81, CI 2.04 - 13.2, p<0.001
												Overall hospital rating	""		
												(patient) Adverse events, adding			
												- missed communication	""		NS
												- missed basic care	""		NS
												Communication with nurses, adding			
												- missed communication	""		OR 2.75, p<0.05
												- missed basic care	""		OR 3.70, p<0.01
												Overall hospital rating, adding			
												- missed communication	""		
												- missed basic care	""		OR 4.87, p<0.01
Choi and Staggs [24]	U.S.	To examine correlations among six nurse staffing measures and to compare their explanatory power in relation to unit-acquired pressure ulcers (UAPUs)	Descriptive, correlational	Registered nurses	US acute care hospitals, including unit types critical care, step-down, medical, surgical, and combined medical–surgical	n=2397 nursing units	Staffing and resource adequacy subscale of the PES-NWI	RN HPPD	Pearson correlation		r=0.228, p<0.001	Unit-acquired pressure ulcers	Logistic regression	Hospital characteristics (size, teaching status, and Magnet status) and unit type	OR=0.782, CI 0.647-0.944, p<0.05
								Total nursing HPPD			r=0.234, p<0.001				
								RN skill mix			r=0.158, p<0.001				
								RN-reported number of assigned patients			r=-0.300, p<0.001	Unit-acquired pressure ulcers	""	Hospital characteristics (size, teaching status, and Magnet status) and unit type, total nursing HPPD, RN skill mix	OR=0.787, CI 0.650 - 0.953, p<0.05 OR=0.783, CI 0.647 - 0.948, p<0.05
								Non-RN HPPD			NS				
												Unit-acquired pressure ulcers	""	Hospital characteristics (size, teaching status, and Magnet status) and unit type, RN HPPD, RN HPPD	
De Groot, Burke, and George [47]	U.S.	To create a budget-neutral compensation distinction for different competencies and educational levels, evaluate the effect of the new salaried model on unit costs and pay, determine the effect of the DPS model on job satisfaction, organizational commitment, and anticipated turnover, and assess the impact of professional commitment, professional practice climate, perception of staffing adequacy, and dispositional optimism on job satisfaction, organizational commitment, and anticipated turnover.	quasi-experimental, non-equivalent control group design	Registered nurses	St. Luke's Medical Center, a not-for-profit, community hospital that provides tertiary care to cardiac and oncology patients	n=232 nurses	Revised version of the Head nurse questionnaire	Life orientation	Correlation		r=0.35, p<0.001	Job satisfaction index:	Correlation		
								Professional commitment			r=0.24, p<0.001	Work			r=0.23, p<0.001
								Professional practice climate			r=0,23, p<0.001	Supervision			r=0.20, p<0.05
								Organizational commitment			r=0,17, p<0.05	Pay			r=0.20, p<0.01
												Promotion			r=0.16, p<0.05
												Coworker			r=0.22, p<0.001
												Perceptions of care quality			r=0.93, p<0.001
												Anticipated turnover			r=0.17, p<0.05
Desmedt, De Geest, Schubert, Schwendimann, and Ausserhofer [63]	Switzerland	To describe the quality of the nurse work environment in 35 Swiss acute care hospitals and to benchmark findings based on international Magnet hospital research.	Multi method design	Registered nurses	35 Swiss acute-care hospitals	Swiss hospitals n=1633 Magnet studies n=755-1610 Nonmagnet studies n=46-72.889	Staffing and resource adequacy subscale of the PES-NWI	Setting (hospital)	ANOVA		F(34,1593) = 11.94, p<0.001				
								Setting (magnet or nonmagnet)	Descriptive		Mean (standard deviation) magnet 2.81 (0.06), nonmagnet 2.40 (0.19)				
Ducharme, Bernhardt, Padula, and Adams [35]	U.S.	To examine relationships between leaders' perceived influence over professional practice environments (PPEs) and clinical nurses' reported engagement in essential professional nursing practice.	nonexperimental method of prediction	Clinical nurses	a 247-bed acute care Magnet hospital	n=30 nurse leaders n=166 clinical nurses	PAS scale	Nurse leaders perceived themselves to be more influential, domain:				Perception quality nursing care	Logistic regression		p<0.0001
								Collegial administrative approach	General linear model		Slope 3.758, CI 0.849-6.666, p=0.014				
								Authority	""		Slope 5.478, CI 2.571-8.384 . p=0.001				
								Access to resources	""		Slope 4.491, CI 1.601-7.381, p=0 .004				
								Leadership expectations of staff	""		Slope 3.790, CI 0.211-7.368, p=0.014				
								Internal strategy and resolve			p=0.308				
								Status	""		p=0.127				

Escobar-Aguilar et al. [84]	Spain	To analyze the relationship between the work environment and burnout of nurses and the quality of care for patient safety at the Spanish National Health System Hospitals included in SENECA and RN4CAST studies.	Secondary analysis	Staff nurses	24 hospitals of more than 150 beds	n= 984 patient records n= 1469 patient surveys n= 1886 professional surveys from SENECA project, n=2139 nurse' surveys from	Staffing and resource adequacy subscale of the PES-NWI					Pain	Pearson's correlation		r = −0.435, p = 0.03
Fuentelsaz-Gallego, Moreno-Casbas, Gomez-Garcia, and Gonzalez-Maria [65]	Spain	To know if there are differences between the critical care units and the medical-surgical care units regarding the perception of the nurses working in National Health System hospitals about their work environment, burnout level and job satisfaction	Cross-sectional	Nurses	Medical-surgical, and critical care units from 59 Spanish hospitals with more than 150 beds	n=7539	Staffing and resource adequacy subscale of the PES-NWI (Spanish version)	Setting (medical-surgical or critical care)	t-test		p<0.001				
Gunnarsdóttir, Clarke, Rafferty, and Nutbeam [66]	Iceland	To investigate aspects of nurses' work environments linked with job outcomes and assessments of quality of care in an Icelandic hospital.	Cross-sectional	Nurses	a 900-bed university hospital, the largest tertiary health centre in Iceland	n=695	Staffing and resource adequacy subscale of the NWI-R (Q1-Q4) (Icelandic version)					Satisfaction with current job	Logistic regression	Nurse characteristics and specialities	OR 2.23, CI 1.63-3.05, p<0.001
												Satisfaction with current job	""	Nurse characteristics and specialities, nurse-physician relations, unit-level support, philosophy of practice, hospital-level support	OR 1.47, CI 1.02-2.10, p<0.05
												Emotional exhaustion	Generalized lineair modelling	Nurse characteristics and specialities	β -3.95, p<0.001
												Emotional exhaustion	""	Nurse characteristics and specialities, nurse-physician relations, unit-level support, philosophy of practice, hospital-level support	β -3.45, p<0.001
												Nurse-rated quality of patient care	Logistic regression	Nurse characteristics and specialities	OR 2.16, CI 1.53-3.04, p<0.001
												Nurse-rated quality of patient care	""	Nurse characteristics and specialities, nurse-physician relations, unit-level support,	NS
Hegney et al. [91]	Australia	To explore nurses' perceptions of factors affecting workloads and their impact on patient care	Exploratory, descriptive, cross-sectional	Membership of the Queensland Nurses and Midwives Union employed as a regulated or un-regulated nurse and/or midwife	Public (acute hospital, community, and other public health), private (acute hospital, domiciliary, community, and other private) and aged care (public and private) sectors	n=2397	Workload perceptions survey	Sector	Chi-square and Fisher exact test		Number: $\chi2$ = 93.60, df = 12, p < 0.001 Skill mix: $\chi2$ = 78,01, df = 12, p < 0.001				
Heinen et al. [76]	Belgium, Finland, Germany, Ireland, the Netherlands, Norway, Poland, Spain, Switzerland and the United	To determine factors associated with nurses' intention to leave the profession across European countries.	Cross-sectional	Nurses	2025 surgical and medical units from 385 hospitals in ten European countries	n=23159	Staffing and resource adequacy subscale of the PES-NWI					Intention to leave nursing (Germany)	Multilevel anaysis	Five subscales of the PES-NWI, Patient to nurse staffing ratio on unit level, burnout, quality of care, safety of care, hospital size, age, gender, working full-time or part-time, educational level, country and hospital-unit	OR=0.66, CI 0.47-0.92, p<0.05
												Intention to leave nursing (other countries)	""		NS
Jafree, Zakar, Zakar, and Fischer [88]	Pakistan	To investigate the association between organizational culture and the culture of error reporting, as perceived by nurses.	Cross-sectional data, mixed methodology	Registered female nurses, including nurse supervisors, nurse ward heads, nurse instructors, staff nurses and nurse students	Two tertiary care public sector hospitals from Lahore	n=309	Staffing and resource adequacy subscale of the PES-NWI	Error reporting culture	Pearson's correlation		r=0.630, p<0.01				
								Governance	""		r=0.591, p<0.01				
								Nurse participation in hospital affairs	""		r=0.715, p<0.01				
								Nurse manager ability, leadership and support	""		r=0.676, p<0.01				
								Nurse foundations for quality care							
								Nurse coworker relations	""		r=0.614, p<0.01				
								Higher error reporting culture	""		r=0.710, p<0.01				
								Higher error reporting culture	Logistic regression		OR 7.83, CI 4.64-13.22, p<0.001				
									Mulitvariable regression	Nurse age, nurse literacy, nurse monthly income	AOR 7.86, CI 4.18-14.78, p<0.001				
Jolivet et al. [67]	France	To test the hypothesis that some organisational constraints at the work-unit level may be related to depressive symptoms in hospital workers, either directly or through individual perceptions of effortereward imbalance (ERI).	Cross-sectional results of a longitudinal survey	Female registered nurses and nursing aids	Medicine (including geriatric, psychiatric and paediatric units), surgery, and emergency or intensive care units of teaching hospitals	n=3316	Staffing inadequacy to perform duties subscale of the Nursing Work Index - Extended Organisation	Occupation (nursing aid or RN)	t-test		p<0.001	Depressive symptoms	Multilevel anaysis		**RN OR=0.20, 0.05<p<0.01 NA OR=0.22, 0.05<p<0.01**
												Depressive symptoms	""	NWI-EO, age, profession, speciality of the work unit, work schedule	NS
												Depressive symptoms	""	"", ERI model	OR -0.16, 0.05<p<0.01
												Effort-reward imbalance	""	NWI-EO	OR=0.98, p<0.001
												Effort-reward imbalance	""	NWI-EO, age, profession, speciality of the work unit, work week, work schedule	OR=1.38, p<0.001

Kalisch and Lee [37]	U.S.	To examine the relationship among hospital, patient units, and staff characteristics and nursing teamwork	Cross-sectional	Registered nurses, licensed practical nurse, nursing assistants, nursing leaders, and unit secretaries	95 patient care units in six hospitals in Michigan and California	n= 3769	Nursing Teamwork Survey	Teamwork	Linear regression	Hospital effects, nursing role, Full-time equivalency, shift worked, years of experience in the unit, absenteeism, unit type	β=0.13, t=10.02, p=0.00				
								Trust	""	""	β=0.17, p<0.01				
								Team orientation	""	""	β=0.13, p<0.01				
								Backup	""	""	β=0.21, p<0.01				
								Shared mental models (SMMs)	""	""	β=0.15, p<0.01				
								Team leadership scores	""	""	β=0.19, p<0.01				
Kalisch, Lee, and Rochman [39]	U.S.	To explore the influence of unit characteristics, staff characteristics and teamwork on job satisfaction with current position and occupation	Cross-sectional	Registered nurses, licensed practical nurses, assistive personnel and unit secretaries	Four Midwestern hospitals, one Southern hospital and 80 different patient care units	n=3675	Nursing Teamwork Survey					Satisfaction with the current position	Linear regression		p<0.001
												Satisfaction with the occupation	""		p<0.001
												Satisfaction with the current position	Hierarchical regression	Hospital effects, type of unit, age, job title, years of experience in the current working unit, number of patients cared for, hospital	β=0.36, p<0.001
												Satisfaction with the current position	""	Hospital effects, type of unit, age, job title, years of experience in the current working unit, number of patients cared for, hospital, teamwork	β =0.30, p<0.001
												Satisfaction with the occupation	Logistic regression	Hospital effects, teamwork, gender, age, education, job title, years of experience on the current working unit, number of patients	OR=1.553, p=0.000
Kalisch, Tschanen, and Lee [52]	U.S.	To explore the impact of missed nursing care (required patient care that is omitted) on job satisfaction of nursing personnel.	Cross-sectional	Registered nurses and nursing assistants	Ten midwestern hospitals	n=4074	MISSCARE Survey					Job satisfaction	Linear regression	Hospital effects, missed care, age, type of unit, hospital	β=0.326, p<0.001
												Occupation dissatisfaction	Logistic regression	Hospital effects, gender, job title, education, hospital	OR = 1.49, CI 1.35-1.64
Kalisch, Tschannen, Lee, and Friese [40]	U.S.	To investigate the extent and type of nursing care missed and the reasons for missed care.	Cross-sectional	Registered nurses and nursing assistants	Acute care hospitals	n = 4086	MISSCARE Survey					Missed nursing care	Multiple regression	Hospital effects, constant, seks, age, job title, shift worked, years of experience in the role, absenteeism, number of patients cared for	β=-0.104, p=0.000
Kalisch, Friese, Choi & Rochman [59]	U.S.	To examine empirically the correlations among 3 measures of nurse staffing (nurse-reported patient workload on the last shift, nurse-perceived staffing adequacy, and hours of care per patient day) and to identify characteristics associated with these measures	Cross-sectional, correlational	Registered nurses	Medical-surgical, rehabilitation, and intermediate in 11 acute care hospitals	n=92 patient care units	MISSCARE Survey	Nurse-reported patient load, last shift	Pearson's correlation		r^2=-0.384, p<0.01				
								Unexpected rise in patient volume and/or acuity	""		r^2=-0.288, p<0.01				
								Inadequate number of assistive personnel	""		r^2=-0.426, p<0.01				
								HPPD	""		NS				
								Case mix index	""		NS				
								HPPD	Multivariable lineair regression	Hospital effects	r^2=0.105, p=0.044				
								HPPD, CMI	""	""	r^2=0.041, p=0.242				
								HPPD, CMI, Nursing education≥BSN	""	""	r^2=0.036, p=0.275				
								HPPD, CMI, Nursing education≥BSN,	""	""	r^2=0.338, p=0.000				
Kim et al. [53]	U.S.	To examine association between perceived inadequate staffing and musculoskeletal pain and to evaluate the role of work-related psychosocial and physical work factors in the association among hospital patient care workers	Cross-sectional	Registered nurses, licensed practical nurses, and patient care/nursing assistants with direct patient care responsibilities	Two large academic hospitals in the metropolitan Boston area	n=1339	Staffing and resource adequacy subscale of the NWI-R (Q1-Q4) Response set is frequency on a 5 point scale (always - never)					Neck/Shoulder pain	Multilevel logistic regression		NS
												Arm pain	""		NS
												Low back pain	""		OR 1.49, CI 1.04 - 2.13, p<0.05
												Lower extremiity	""		NS
												Any musculoskeletal pain	""		NS
												Number of area in pain	""		OR 1.42, CI 1.02 - 1.99, p<0.05
												Neck/Shoulder pain	""	Work characteristics (age, race, gender, job title, having a second job or not, day shift or not, worked hours per week, and BMI)	NS
												Arm pain	""	"	NS
												Low back pain	""	"	OR 1.50, CI 1.06 - 2.14, p<0.05
												Lower extremiity	""	""	NS
												Any musculoskeletal pain	""	""	NS
												Number of area in pain	""	""	OR 1.42, CI 1.01 - 2.00, p<0.05
												Neck/Shoulder pain	""	Work characteristics, physical work factors including use of a lifting device, and the amount of time on the job for each of five physical activities on the job (i.e. sitting, standing, walking, lifting and carrying, pushing and pulling	NS
												Arm pain	""	""	NS
												Low back pain	""	""	OR: 1.50, CI: 1.03 - 2.19, p<0.05
												Lower extremenity	""	NS	NS
												Any musculoskeletal pain	""	NS	NS
												Number of area in pain	""	NS	NS
												Neck/Shoulder pain	""	Work characteristics, work-related psychosocial factors (i.e. job demands, job control, supervisor support, co-worker support)	NS
												Arm pain	""	""	NS
												Low back pain	""	""	NS
												Lower extremenity	""	""	NS
												Any musculoskeletal pain	""	""	NS

Leineweber et al. [68]	Sweden	To investigate associations between nurse work practice environment measured at department level and individual level work-family conflict on burnout, measured as emotional exhaustion, depersonalization and personal accomplishment among Swedish RNs.	Cross-sectional	Registered nurses	369 departments in 53 hospitals	n=8620	Staffing and resource adequacy subscale of the PES-NWI				Risk for emotional exhaustion	Multilevel logistic regression	Department level variables (NWI-PES variables)	OR=0.724 CI 0.684-0.766, p<0.001
											""	""	Department level variables and individual variables (age, sex, baccalaureate degree in nursing, years of experience as RN, work-family conflict)	OR=0.733 CI 0.693-0.775, p<0.001 OR=0.856 CI 0.782-0.937, p<0.05
											Depersonalization	""	Department level variables	OR=0.864 CI 0.788-0.948, p<0.05
											""	""	Department level variables and individual variables	OR=0.883 CI 0.882-0.950, p<0.001 OR=0.888 CI 0.824-0.957, p<0.05
											Personal accomplishment	""	Department level variables	
											""	""	Department level variables and individual variables	
Lin, Chiang, and Chen [89]	Taiwan	To compare the differences between nurses with intent to leave and those with intent to stay in employment and nursing regarding their perceptions of the practice environment in Taiwan.	Cross-sectional	Nurses	Four hospitals in southern Taiwan: one medical center, one regional hospital, and two local hospitals	n=524	Staffing and resource adequacy subscale of the PES-NWI (Chinese version)				Intention to stay in employment Intent to leave and stay in nursing	t-test ""		t=4.4, p<0.001 t=5.9, p<0.001
Louch, O'Hara, Gardner and O'Connor [77]	U.K.	To examine nurses' daily perceptions of staffing and patient safety and to explore the potential role of personality factors as moderators of daily level associations	Longitudinal	Staff nurses	Acute NHS Trusts	n= 324 diary days (for 83 participants)	Hospital Survey on Patient Safety Culture				Perceptions of patient safety	Hierarchical linear model		p<0.001
											Safe practitioner	""		p<0.001
											Workplace cognitive failure	""		p<0.001
											Safe practitioner (at high level of agreeableness)	""		β=0.139, p<0.001
											Safe practitioner (at low level of agreeableness)	""		β=0.245, p<0.001
											Perceptions of patient safety (at high level of emotional stability)	""		β=0.666, p<0.001
											Perceptions of patient safety (at low level of emotional stability)	""		β=0.409, p<0.001
											Safe practitioner (at high level of conscientiousness	""		β=0.151, p<.001
											Safe practitioner (at low level of	""		β=0.226, p<0.001
Mark, Salyer and Harless [58]	U.S.	To examine the impact of hospital characteristics, nursing unit characteristics, nurse characteristics, and patient characteristics on nurses' perceptions of staffing adequacy.	Secondary analysis, cross-sectional and longitudinal	Registered nurses	60 hospitals in the Southeastern United States	Nurses n=1583 (time 1) n=1023 (time 2) Patient n=1231 (time 1) n=1235 (time 2)	Perceptions of adequacy of staffing	Time 1: Number of high technology services Case mix index Skill mix Workload Unit size Time 2: Number of high technology services Number of beds on the unit	Correlation	r=0.216, p=0.018 r=0.206, p=0.024 r=0.204, p=0.025 r=-0.221, p=0.015 r=-0.231, p=0.011 r=0.278,p=0.002 r=-0.309, p=0.001				
								Model 1: cross-sectional Hospital (case mix index, case mix index squared), hospital size ("high tech" services, teaching status, life cycle - grower, life cycle - decliner, life cycle - unstable), unit (total staff, skill mix, workload, number of beds, support services, patient technology, education, life cycle - grower, life cycle - decliner, life cycle - unstable), nurse, (experience, age), patient (age)	Regression model	r^2=**0,348**, p<.000			
								Model 2: delayed effects Hospital (case mix index, case mix index squared), hospital size ("high tech" services, teaching status, life cycle - grower, life cycle - decliner, life cycle - unstable), unit (total staff, skill mix, workload, number of beds, support services, patient technology, education, life cycle - grower, life cycle - decliner, life cycle - unstable), nurse, (experience,	""	r^2=0,325, p<.000			
								Model 3: dynamic model Hospital (case mix index, case mix index squared), hospital size ("high tech" services, teaching status, life cycle - grower, life cycle - decliner, life cycle - unstable), unit (total staff, skill mix, workload, number of beds, support services, patient technology, education, life cycle - grower, life cycle - decliner, life cycle - unstable, lagged perceptions), nurse, (experience, age), patient (age)	""	r^2=0.512, p<0.000			
Nelson-Brantley, Park, Bergquist-Beringer [42]	U.S.	To examine characteristics of the nursing practice environment associated with lower RN turnover	Secondary analysis	Staff nurses	162 acute care hospitals in the United States	n=1002 nursing units	Staffing and resource adequacy subscale of the PES-NWI				RN-turnover	Lineair regression	Practice environment characteristics, magnet status, hospital size, teaching status, hospital ownership,CMI, unit type, RN age, RN tenure, and RN education levels	RC=-0.16, CI -0.23 - -0.09, p<0.01

O'Brien-Pallas et al. [45]	Canada	To determine the work environment and nurse staffing variables at the nursing-unit level that influence system outcomes, and identify optimal staffing levels for achieving positive system outcomes.	Prospective, correlational	Staff nurses	Cardiac and cardiovascular units of six participating hospitals in the Canadian provinces of Ontario and New Brunswick	n=1198 patients and 555 nurses	Staffing and resource adequacy subscale of the NWI-R (Q1-Q4)				Absenteeism	Hierarchical linear regression	Nurse level (years of work experience in nursing, education, full-time employment, clinical expertise, overtime hours, unit instability, shift change, effort-reward imbalance, emotional exhaustion, physical health, mental health, nurse-patient ratio), patient level (resource intensity weight, number of nursing diagnoses, pre-operative clinics, medical consequences, physical health at admission, mental health at admission), unit level (step-down unit, skill mix, average number of patient care interventions omitted or delayed, average autonomy score, staffing utilization)	β=-0.26, OR=0.77, p≤0.05
											Patient care interventions omitted or delayed	""	""	β=-0.48, OR=0.6, p≤0.05
											Therapeutic interventions omitted	""	""	β=-0.44, OR=0.6,
Pineau Stam, Laschinger, Regan, and Wong [46]	Canada	To examine the influence of new graduate nurses' personal resources (psychological capital) and access to structural resources (empowerment and staffing) on their job satisfaction.	Secondary analysis of data from a longitudinal study	New graduate nurses (NGNs) who had been working <3 years in the profession	Specialty unit medical-surgical, critical care, mental health, maternal child, community/public health and long	n=205	New graduates' perception of adequate staffing	Psychological capital Structural empowerment	Correlation Correlation	r=0.12, p<0.05 r=0.16, p<0.01	Job satisfaction Job satisfaction	Correlation Hierarchical multiple regression	Psychological capital, structural empowerment	r=0.29, p<0.01 β=0.19, p<0.001
Rauhala and Fagerström [69]	Finland	To identify the contribution of the information about non-patient factors to the RAFAELA PCS in routine use and to identify how strong an association there is between NCI and PAONCIL in routine use, compared with the association between non-patient factors and PAONCIL	non-experimental, retrospective	Nurses	Somatic wards of a secondary healthcare hospital on the west coast of Finland	n=4870	PAONCIL	Managerial planning and organization of the work Planning of the work rota Substitute situation Meetings, training Students Co-operation with doctors Co-operation/coordination with other staff Co-operation within the organization Co-operation in your own group Own work ability Mental stress Other factors OPCQ (22 wards) OPCQ and 6 non-patient factors	Pearson's correlation Linear regression ""	p=0.392 p=0.064 p=0.054 r=0.160, p<0.001 p=0.294 r=0.109, p=0.011 r=0.097, p=0.024 r=0.165, p<0.001 p=0.308 p=0.09 r=0.19, p<0.001 r=0.348, p<0.001 r^2 0.000 - 0.648, 12/22 wards p<0.001, 18/22 wards p<0.05, median r^2=0.450 r^2 0.249 - 0.817, 13/20 wards p<0.001, 20/20 wards p<0.05.			
Reeder, Burleson, and Garrison [54]	U.S.	To measure physician and nursing staff subjective assessments of ED overcrowding, to compare the agreement of this assessment between physician and nursing staff, to use data to calculate proposed READI scores to assess ED demand, and to compare the READI scores with staff perceptions to evaluate the agreement of these scores and the ability to predict resource demands that exceed available	Prospective	Physicians and charge nurses of the ED	Emergency department of the Pitt County Memorial Hospital, a tertiary referral academic medical center in rural eastern North Carolina	n=221	Assessment of real time demand for the ED	Crowding scores (READI)	Kappa	NS				
Roche and Duffield [92]	Australia	To examine the differences between characteristics of the work environment of nurses working in mental health and general acute inpatient nursing settings.	Secondary analysis	RNs, enrolled nurses (similar to Licensed Vocational Nurse or Licensed Practical Nurse in the United States), and assistants in nursing (similar to patient care assistants)	24 public acute general hospitals across two Australian states	n=2556	Staffing and resource adequacy subscale of the PES-NWI	Setting (mental health, medical or surgical)	t-test	t=4.063, p≤0.01				
Roche, Duffield, and White [93]	Australia	To test a model of hypothesized relationships between aspects of the practice environment and the therapeutic commitment of nurses working in mental health, and to identify those characteristics of the practice environment that impact most significantly on therapeutic	Model testing, cross-sectional	Registered nurses enrolled nurses	Six mental health wards attached to five public general acute hospitals in metropolitan areas of New South Wales Australia	n=149	Staffing and resource adequacy subscale of the PES-NWI	Role support	Partial least squares path modeling	NS				
Rochon, Heale, Hunt, and Parent [57]	Canada	To determine the perceived level of nursing teamwork by registered nurses, registered practical nurses, personal support workers and unit clerks working on patient care teams in one acute care hospital in northern Ontario, Canada, and to determine if a relationship exists between the staff scores on the Nursing Teamwork Survey and participant perception of	Descriptive, cross-sectional	Registered nurses, registered practical nurses, personal support workers, unit clerks, nurse clinicians and managers	One acute care hospital in northern Ontario	n=200	Nursing Teamwork Survey	Nursing teamwork	Not reported	p=0.258				

Sasso et al. [80]	Italy	To investigate the push and pull factors of nurses' intention to leave the profession in Italy.	Cross-sectional	Staff nurses	292 units of general and surgery in 40 acute hospitals	n=3667	Staffing and resource adequacy subscale of the PES-NWI					Intention to leave	Logistic regression		OR=0.347, CI 0.309-0.39
												Intention to leave	""	Gender, setting, nurse-physician relationship, leadership, quality of care, participation in hospital affairs, emotional exhaustion, depersonalisation, personal accomplishment, satisfcation with current job	NS
Schubert, Glass Clarke, Schaffert-Witvliet, and De Geest [70]	Switzerland	To examine the validity and reliability of the newly developed BERNCA instrument.	Psychometric analysis	Nurses	Five Swiss acute care hospitals	n=957	Nursing resources and autonomy subscale of the NWI-R, items not reported					Implicit rationing of nursing care	Spearman correlation		r=-0.46, p=0.01
Sharma et al. [81]	Switzerland	To assess nurse-reported organizational readiness for implementing change in acute care hospitals.	Secondary analysis	Registered Nurses	124 medical, surgical and medical–surgical (mixed) units in 23 acute care hospitals across Switzerland's	n=1833	Staffing and resource adequacy subscale of the PES-NWI	Change commitment	Linear regression	Individual factors (education level, nursing work experience), work environment (nursing foundation for quality of care, supportive leadership, standardized staffing), organizational characteristics (unit type)	**NS**				
								Change efficacy	""	""	**β=0.125, CI 0.0008-0.243, SE=0,06, p=0.037**			
Smeds Alenius, Tishelman, Runesdotter, and Lindqvist [71]	Sweden	To investigate how RNs' assessments of the safety of patient care at their workplace, the nursing work environment, the patient safety culture, as well as their level of involvement in direct patient care, and length of work experience as an RN relate to, and interact with, RNs' global assessment of patient safety in acute-care hospitals in Sweden	Secondary analysis, cross-sectional	Registered nurses	Acute care hospitals	n=9236	Staffing and resource adequacy subscale of the PES-NWI					RN-reported patient safety	Spearman's correlation		r=0.27-0.43 for staffing items, p<0.0001
												RN-reported patient safety	Regression		OR=5.44 CI 5.06-5.85
												RN-reported patient safety	Regression	Gender, education, work environment, RNs' level of involvement in direct patient care, patient safety culture, work experience	OR=2.74 CI 2.52-2.97
Spence et al. [90]	Australia	To determine if a suitable method of measuring nursing workload could be developed in neonatal intensive care units (NICUs).	Descriptive, cross-sectional	Front-line clinical nurses	Two NICUs, one in a perinatal centre (perinatal) and one in a predominately neonatal surgical unit in a children's hospital (children's).	n=12649 acuity tools n=6727 PAONCIL	PAONCIL	<5 year work experience	Regression		1<OR>10				
								Use of causal staff	""		""				
								Mental stress	""		""				
								Own work capacity	""		""				
								Presence of students (Perinatal)	""		""				
								Meetings during shift (Children's)	""		""				
								Use of relief staff	""		""				
								Planning of shift schedule	""		""				
								Organisation of manager	""		""				
								Cooperation with peer nurses	""		""				
								Cooperation with docters	""		""				
								Presence of students (Children's)	""		NS				
								Meetings during shift (Perinatal)	""		NS				
Spence Laschinger [56]	Canada	To test an exploratory model of the antecedents and consequences of nurses' perceptions of respect in hospitals.	Cross-sectional	Staff nurses	Ontario urban teaching hospitals	n=285	Adequate staff for care	Nurses' feelings of respect	Pearson's correlation		r=0.30				
Stalpers, Van Der Linden, Kaljouw, and Schuurmans [72]	The Netherlands	To assess job satisfaction and nurse-perceived quality of care in a sample of Dutch ICUs and to determine work environment characteristics that, according to ICU nurses are associated with overall job satisfaction and with perceived quality of care, after controlling for the effects of overall job satisfaction	Cross-sectional	Nurses working in the ICUs	Three Dutch intensive care units based in teaching hospitals (level III)	n=123	PAS scale (Dutch version)					Overall job satisfaction	Hierarchical regression		β=0.42, p<0.001
												Nurse perceived quality of care	""	Overall job satisfaction	β=0.34, p<0.001
												Nurse perceived quality of care	""	"", nurse characteristics	β=0.35, p<0.001
Trivedi and Hancock [43]	U.S.	To measure levels of need for nursing care based on the perceptions of head nurses.	Cross-sectional	Head nurses	Five units of a 300-bed community general short-term hospital in the Midwest: medical-surgical (60 beds), pediatric (28 beds), surgical (68 beds), ICU/CCU (16 beds), and medical (86	The head nurse of each of the five study units completed the questionnaire for the seven-week period	Head nurse questionnaire	Nursing hours	Stepwise regression		p=0.05				
								Census	""		p=0.05				
								Patient classification	""		NS				
								New admissions	""		NS				
								Transfers	""		NS				
								Discharges	""		NS				
								Postoperative patients	""		NS				
								Specialized nursing procedures	""						
								Patient classification (pediatric and	""		p=0.05				
Tvedt, Sjetne, Helgeland, and Bukholm [73]	Norway	To determine the correlations between hospital-aggregated, nurse-assessed quality and safety, and estimated probabilities for 30-day survival in and out of hospital.	Observational, ecological	Nurses	30 Norwegian hospitals with more than 85 beds	n=3556	Staffing and resource adequacy subscale of the NWI-R (Q1, Q2, Q4)					Overall survival	Stepwise regression	Patient safety management	RC=0.09, p=0.002
												Quality of nursing	""		0.44, p<0.001
												Patient safety	""	Patient safety management	0.24, p=0.005
												Survival after acute myocardial infarction	""	Local university hospital, regional university hospital	NS

Tvedt, Sjetne, Helgeland, Løwer, and Bukholm [74]	Norway	To examine the associations between nurse-reported characteristics of the work environment and incidence of surgical site infections after total hip arthroplasty.	Cross-sectional	Nurses	16 Norwegian hospitals with 20 wards specialized in orthopaedic care	n=320 nurses n=2885 patients	Staffing and resource adequacy subscale of the PES-NWI (Q1, Q2, Q4)						Surgical site infection after total hip arthroplasty	Univariate mixed-effects logistic regression		OR=0.97, CI 0.95, 0.99, p=0.009
													""	Mixed-effects logistic regression model		OR=1.00, CI 0.96, 1.02, NS
													""	Mixed-effects logistic regression model	Interaction: elective procedure × staffing adequacy	OR=0.94, CI 0.91, 0.97, p=0.001
													"" for non-elective procedures	""		NS
Weigl, Schmuck, Heiden, Angerer, and Müller [82]	Germany	To determine individual and shared associations between understaffing and psychosocial work characteristics and cardiovascular health outcomes in hospital nurses.	Cross-sectional	Nursing professionals	Intensive care units, operating rooms, anesthesia units, three inpatient wards, and the intra-hospital patient transportation services of an academic hospital	n=273	Perceptions of understaffing						Blood pressure	Regression		NS
													Total cholestrol level	""		NS
													LDL cholestrol level	""		NS
													Blood pressure	""		OR=1.60, CI 1.05-2.43
													Total cholestrol level	""		OR=1.42, CI 1.04-1.95
													LDL cholestrol level	""		NS
Williams and Murphy [44]	U.S.	To determine to what extent associations existed between objective measures of staffing adequacy, the patient care services provided under various staffing conditions, and charge nurses' subjective judgements of both these elements	Multi method design	Charge nurses	Four nursing units in a 316 bed private hospital and two nursing units in a 260 bed county hospital located in inland northern California.	n=204 shifts n=155 patients (waiting time and drug administration)	Unit staffing/care evaluation form	Setting (County medical, county surgical, private medical, private surgical, private coronary care, private post-coronary care)	Descriptive		County medical 19/30 adequate, county surgical 20/30 adequate, private medical 13/30 adequate, private surgical 17/30 adequate, private coronary care 30/42 adequate, private post-coronary care 33/42 adequate	Six units combined: Patient service (10 categories)	Corralation		p<0.0005 (for all categories)
													Six units:	""		
													Basis hygiene	""		5/6 units p<0.05, 1/6 units NS
													Basic feeding and toileting	""		4/6 units p<0.05, 2/6 units NS
													Mobility	""		5/6 units p<0.05, 1/6 units NS
													Medications, IV's	""		2/6 units p<0.05, 4/6 units
													Communication with patient/family	""		6/6 units p<0.05
													Special procedures	""		4/6 units p<0.05, 2/6 units NS
							Census	Correlation		2/6 units p<0.05, 4/6 units NS	Observation of patient	""		6/6 units p<0.05
							Number of maximum care patients	""		1/6 units p<0.05, 5/6 units NS	Vital signs	""		3/6 units p<0.05, 3/6 units NS
							Staff hours available	""		3/16 shifts p<0.05, 13/16 shifts NS	Rounds with or assist MD	""		5/6 units p<0.05, 1/6 units
							Staff hours available per patient	""		5/16 shifts p<0.05. 11/16 shifts NS	Implementation of new orders without undue delay	""		4/6 units p<0.05, 2/6 units NS
							Staff hours available per maximum care patient	""		5/16 shifts p<0.05, 11/16 shifts NS				
											CCU/PCCU			
											Signal response: minutes	""		1/2 units p<0.05, 1/2 units NS
											Filling of request: minutes	""		1/2 units p<0.05, 1/2 units NS
											Number of analgestics	""		1/2 units p<0.05, 1/2 units
											Number of tranquilizers	""		NS
Zander, Dobler, and Busse [75]	Germany	To analyze whether the DRG implementation in German acute hospitals (as well as other changes over the 10-year period) had measurable effects on (1) the nurse work environment (including e.g. an adequate number of nursing staff to provide quality patient care), (2) quality of patient care and safety (incl. confidence into patients' ability to manage care when discharged), and (3) whether the effects from (1) and (2) – if any – impacted on the nurses themselves (satisfaction with their current job and their choice of profession as well as emotional exhaustion).	pre-post comparison with two cross-sectional sets	Nurses	1998/1999 29 acute care hospitals, 2009/2010 49 acute care hospitals	1998/1999 n=2681, 2009/2010 n=1511	Staffing items of the PES-NWI (items not reported)	Wave	Logistic regression	Female, professional experience>10years, part time, general medical ward, mixed ward, age	OR=0.405, 95%CI 0.339-0.484, p<0.001	1998/1999: Quality of care on wards	Logistic regression		OR=4.118, CI 2.822-6.009, p<0.001
																OR=2.081, CI 1.624-2.666, p<0.001
							1998/1999:				Quality improved within the last year					OR=4.726, CI 3.390-6.590, p<0.001
							Female			OR=-.709. CI -.521-0.966, p=0.029						OR=0.255, CI 0.199-0.328, p<0.001
											Patient safety on ward					NS
							General medical ward			OR=1.837. CI1.464-2.306, p<0.001						
											Lack of psychosocial attention					
							Mixed ward			OR=1.640. CI 1.164-2.311, p=0.005						
										NS						
										NS	Patients' ability to manage care after discharge					
							Professional experience>10years			NS						
							Part time			NS						
							Age			NS						
							2009/2010			NS						
							Female			NS						
							Professional experience>10years			NS						
							Part time			NS						
							General medical ward									
							Mixed ward									

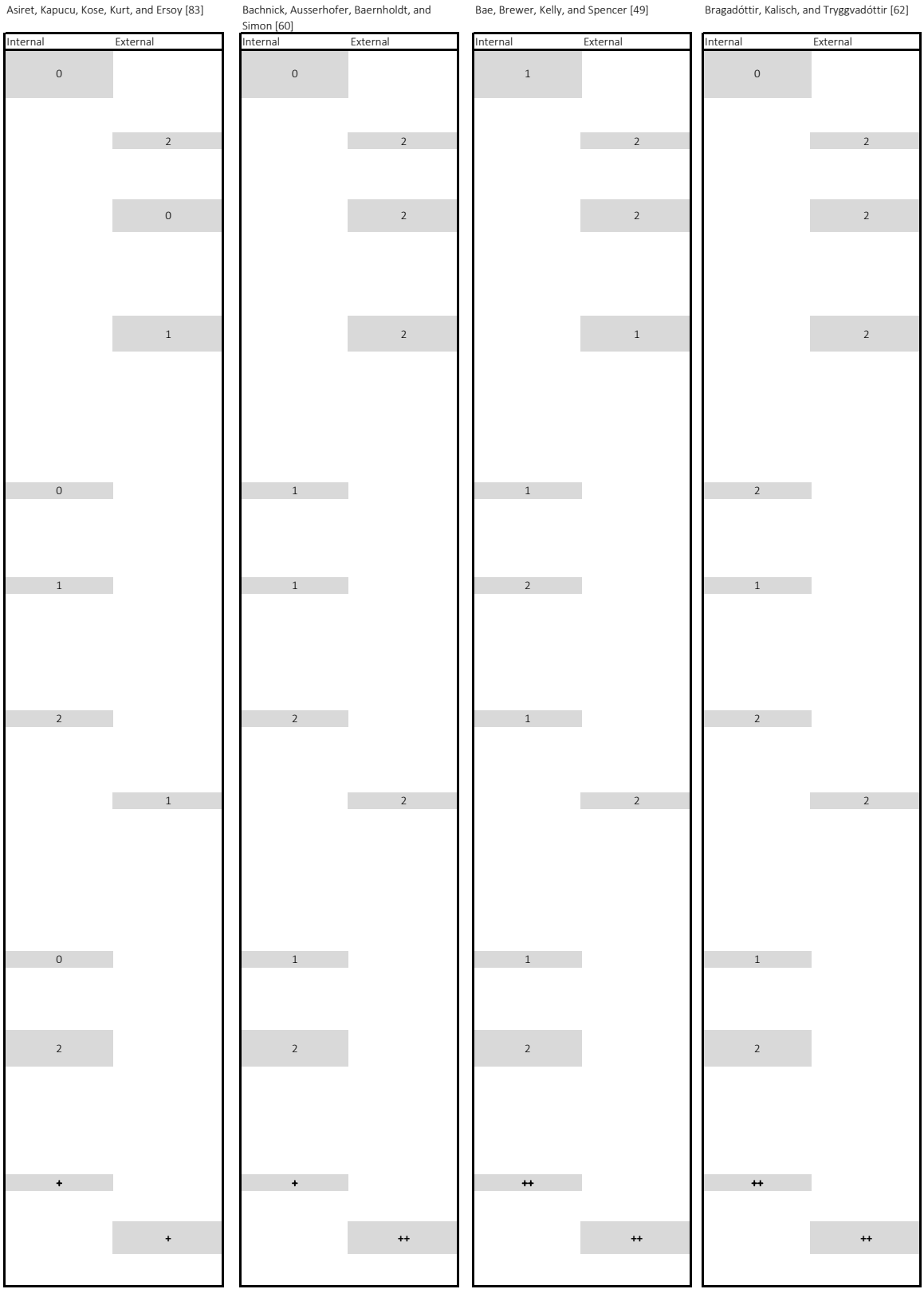
	2009/2010:	
	Quality of care on wards	OR=3.504, 95%CI 2.360-5.202, p<0.001
	Quality improved within the last year	OR=2.470, 95%CI 1.811-3.368, p<0.001
	Lack of psychosocial attention	OR=0.336, 95%CI 0.245-0.459, p<0.001
	Patients' ability to manage care after discharge	OR=2.058, 95%CI 1.443-2.935, p<0.001
	Patient safety on wards	NS
	1998/1999:	
	Satisfaction with current job	OR=1.920, CI 1.262-2.921, p<0.002
	Dissatisfaction with choice of profession	NS
	Emotional exhaustion	NS
	2009/2010:	
	Satisfaction with current job	OR=2.914, CI 1.870-4.541, p<0.001
	Emotional exhaustion	OR=0.440, 95%CI 0.284-0.683, p<0.001
	Dissatisfaction with choice of	NS

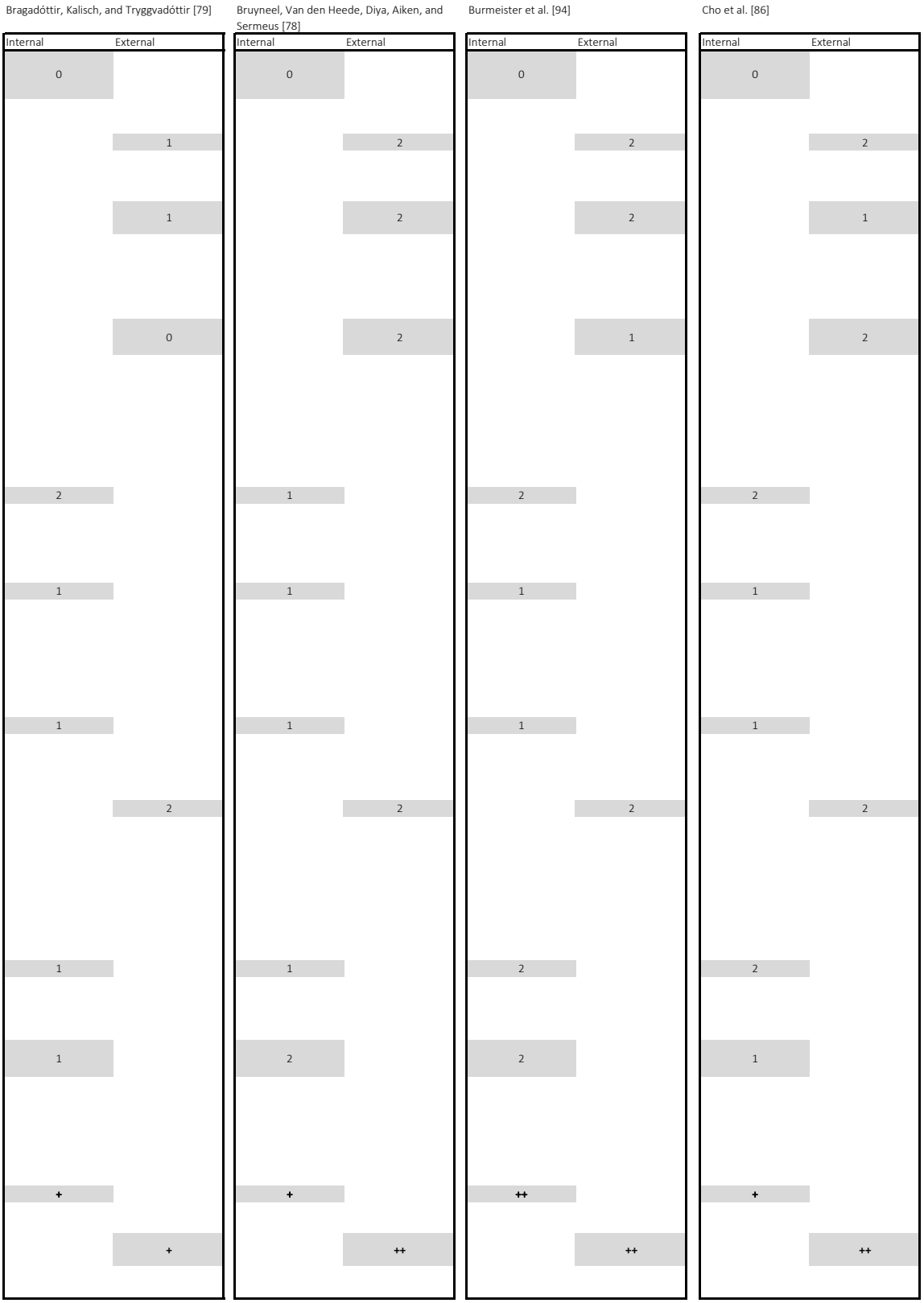
Abbriviations
- ANOVA: analysis of variance
- AOR: adjusted odds ratio
- CI: confidence interval
- ED: emergency department
- ERI: effort-reward imbalance
- HPPD: hours per patient day
- ICU: intensive care unit
- MANOVA: multivariate analysis of variance
- NA: nursing assistent
- NCI: nursing care intensity
- NS: non-significant
- OR: odds ratio
- PCS: patient classification system
- Q: question
- RC: regression coefficient
- READI: Real-time Emergency Analysis of Demand Indicators
- RN: registered nuse

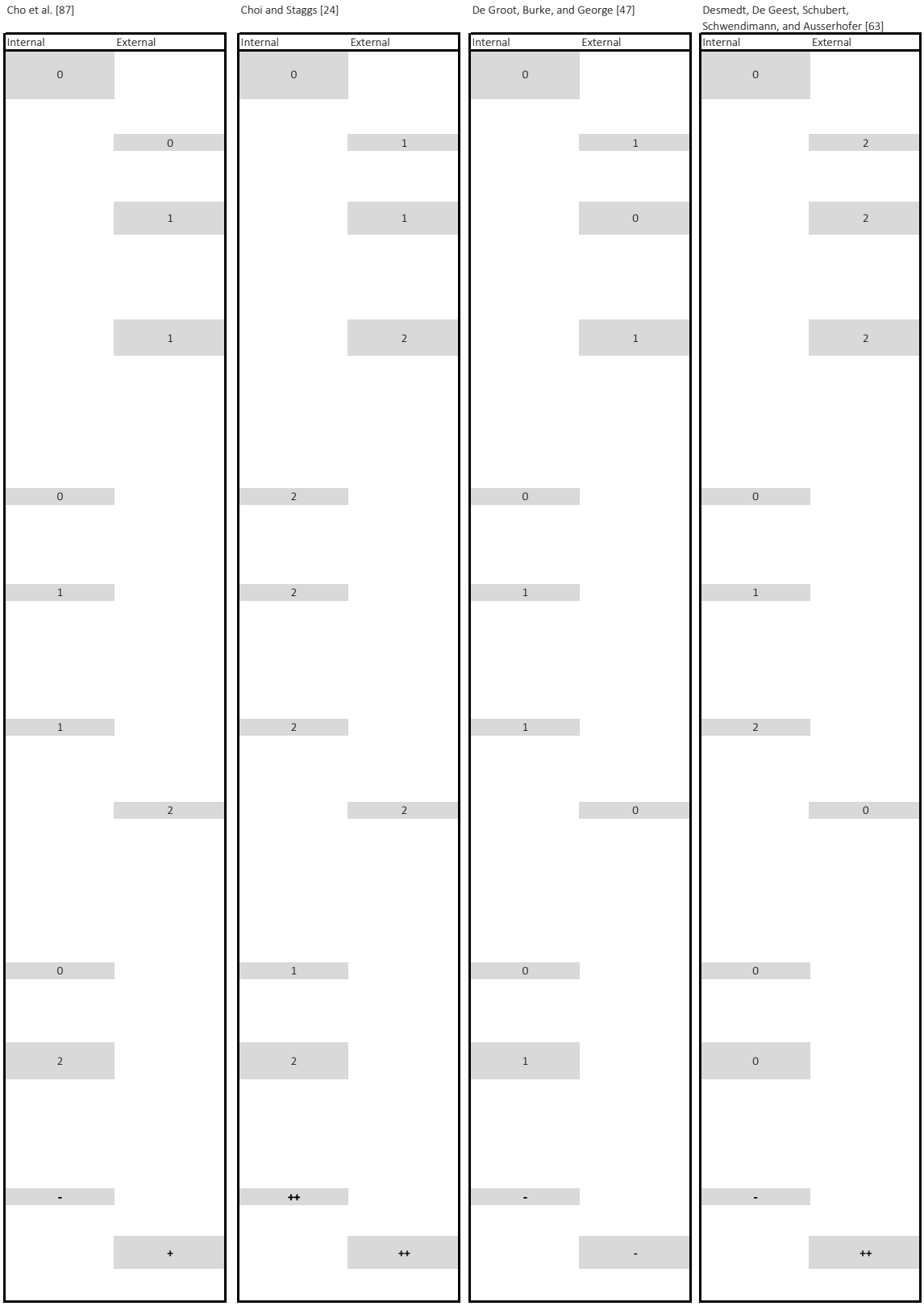
	Anzai, Douglas, and Bonner [85]	
	Internal	External
Study design & analysis cross sectional (-) or allows for cause / effect (exposure precedes outcome time series) (+) / RCT	0	
Section 1: Population		
1.1 Is the source population or source area well described? To whom or what aims the study to represent? Was the country (e.g. developed or non-developed, type of health care system), setting (primary schools, community centres etc), location (urban, rural), population demographics etc adequately described?		2
1.2 Is the eligible population or area representative of the source population or area? Was the recruitment of individuals, clusters or areas well defined (e.g. advertisement, birth register)? Was the eligible population representative of the source? Were important groups underrepresented? *Single hospital (0), multiple hospitals, limited representative for source population (1), included patients/nurses representative for source population (2).*		0
1.3 Do the selected participants or areas represent the eligible population or area? Was the method of selection of participants from the eligible population well described? What % of selected individuals or clusters agreed to participate? Were there any sources of bias? Were the inclusion or exclusion criteria explicit and appropriate? *Was the selection process of participants clearly described? (+1), What % of eligible individuals (staff / patients) participated (60% + is acceptable)?(+1), Were the inclusion or exclusion criteria explicit and appropriate? (+1)*		2
Section 2: Method of selection of exposure (or comparison) group		
2.1 How well were likely confounding factors identified and controlled? Were there likely to be other confounding factors not considered or appropriately adjusted for? Was this sufficient to cause important bias? Where relevant confouding factors uncluded for patient, nurse, and organization?	2	
Section 3: Measures		
3.1 Were the main measures and procedures reliable?	0	
· Were main measures subjective (-1) or objective (give ++ for completely objective measures)		
· How reliable were measures (e.g. inter- or intra-rater reliability scores)? +1 for evidence of reliability		
Where relevant, was there any indication that measures had been validated (e.g. validated against a gold standard measure or assessed for content)		
3.2 Were the outcome measurements complete? Were all or most of the study participants who met the defined study outcome definitions likely to have been identified? Where measurement levels optimal?	2	
Section 4: Analyses		
4.1 Was the study sufficiently powered to detect an effect (if one exists)?		1
· Were there sufficient units / hospitals / wards / patients to give variation and enough patients to detect effects		
· Large multi-hospital (20+) studies (state / national / international) with administrative data ++		
· Smaller studies / single hospital with large numbers of patients (000,000) +		
· Other - look at confidence intervals / sample size give (-) if unclear that results are sufficiently precise		
· 10 cases per factor in regresioon analysis +		
4.2 Were the analytical methods appropriate?	1	
· Was there adjustment for clustering of data within hospitals? (+ 1), Where relevant was there control for ward / hospital characteristics (+1)		
· Multilevel (2), confounding factors (1), no adjustment (0)		
4.3 Was the precision of association given or calculable? Is association meaningful? Were confidence intervals or p values for effect estimates given or possible to calculate? Were CIs wide or were they sufficiently precise to aid decision-making? If precision is lacking, is this because the study is under-powered? *Descriptive design (0), comparison groups or correlation (1)*	1	
Section 5: Summary		
5.1 Are the study results internally valid (i.e. unbiased)? How well did the study minimise sources of bias (i.e. adjusting for potential confounders)? Were there significant flaws in the study design?	-	+
5.2 Are the findings generalisable to the source population (i.e. externally valid)? Are there sufficient details given about the study to determine if the findings are generalisable to the source population?	-	+

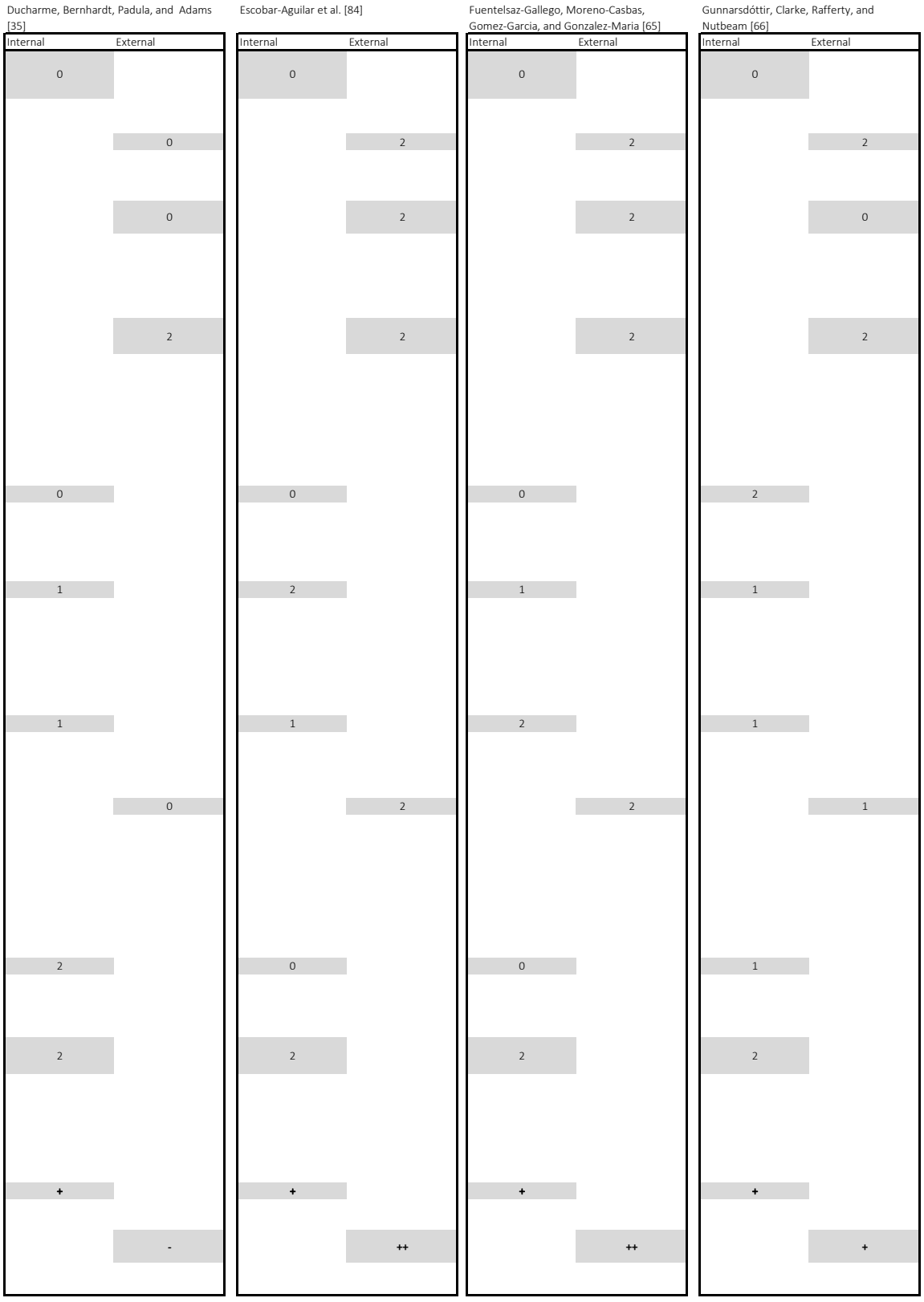
strong (++) All / most checklist items fulfilled, limitations very unlikely to alter conclusions
moderate (+) Some checklist criteria fulfilled, limitations unlikely to alter conclusions
weak (-) Few criteria fulfilled, conclusions likely to alter

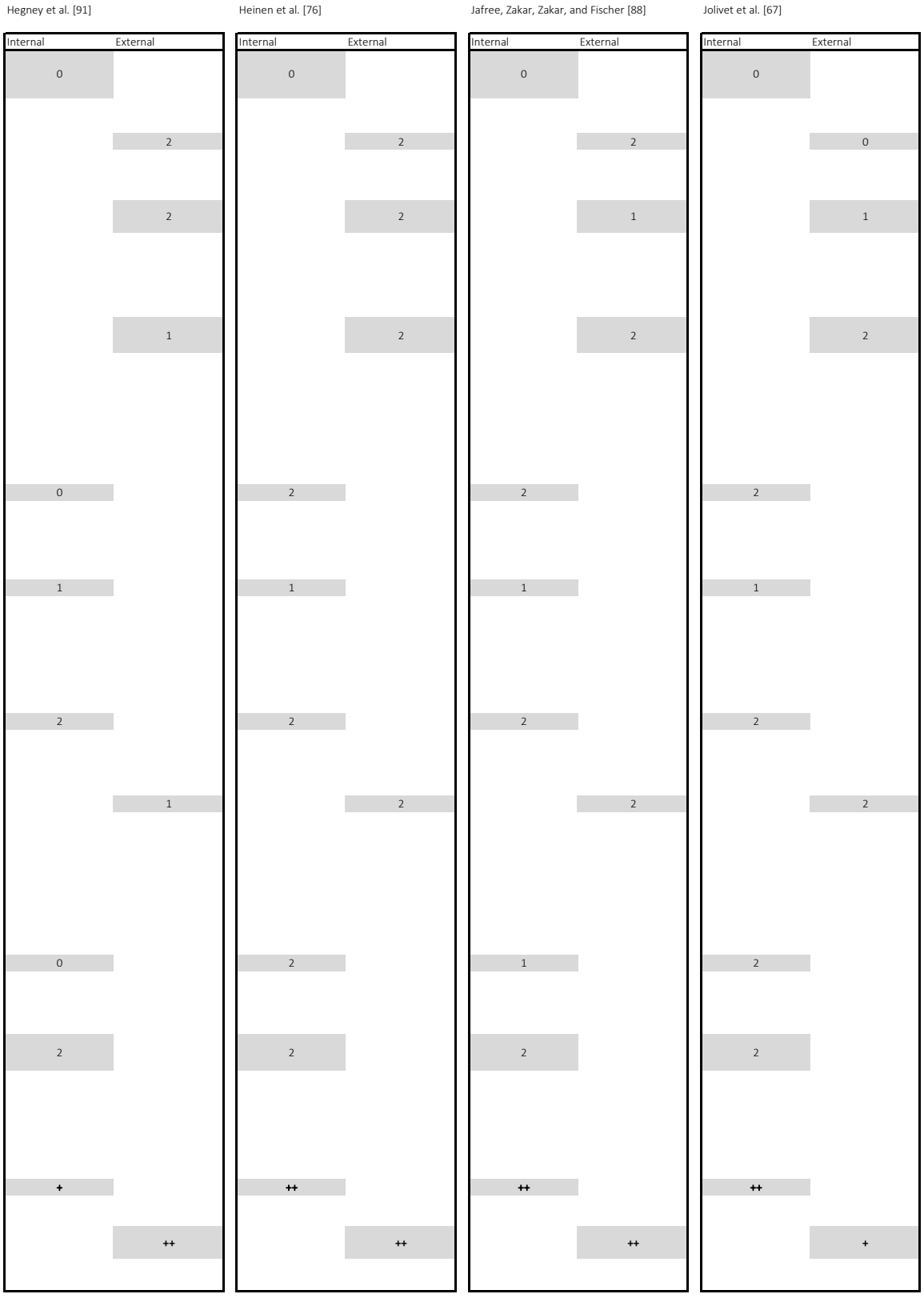
2 strong (++)
1 moderate (+)
0 weak (-)
NA not applicable (rare)
NR not recorded

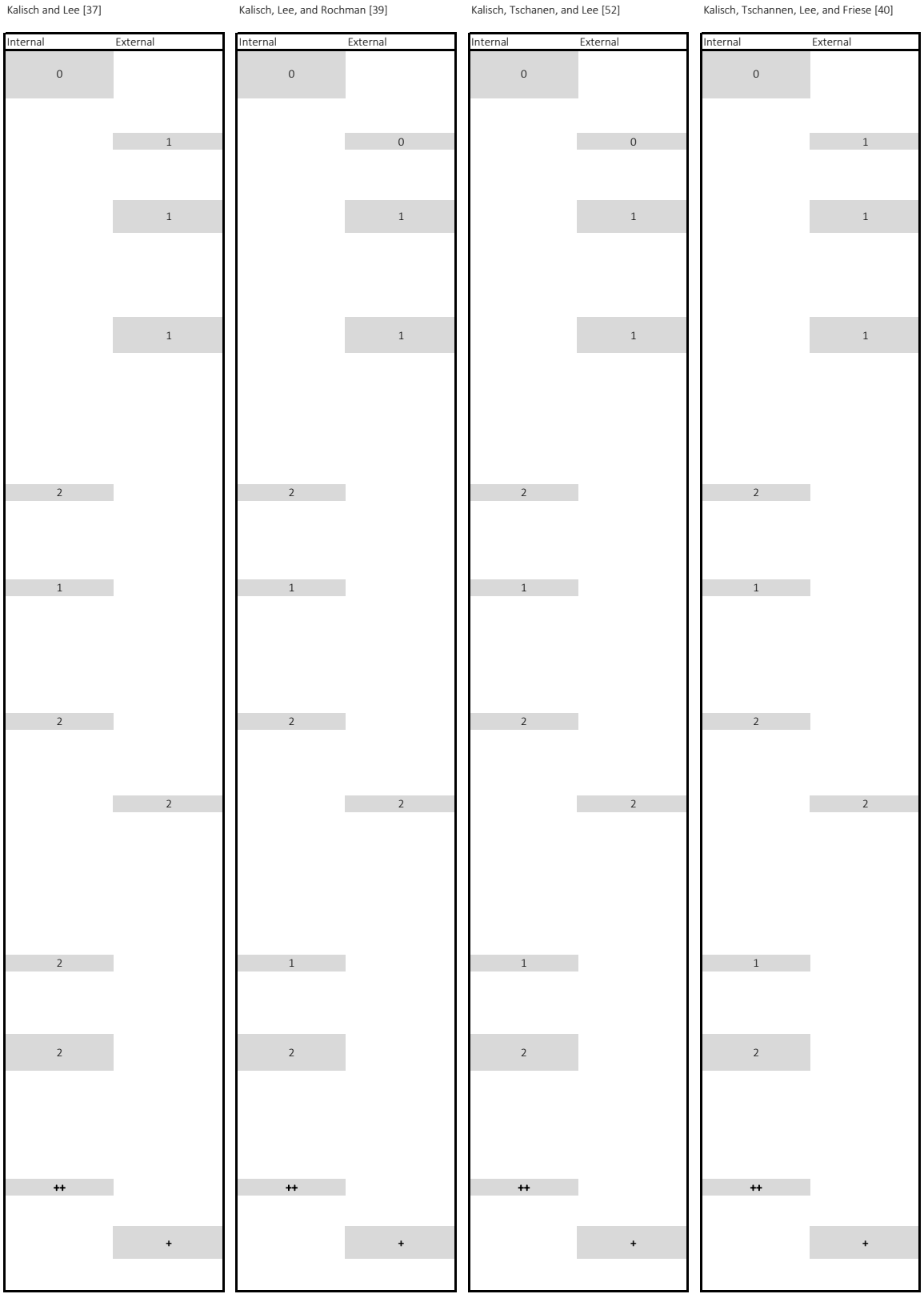

Asiret, Kapucu, Kose, Kurt, and Ersoy [83]
Internal
External
0
2
0
1
0
1
2
1
0
2
+
+
Bachnick, Ausserhofer, Baernholdt, and Simon [60]
Internal
External
0
2
2
1
2
2
1
2
1
2
+
++
Bae, Brewer, Kelly, and Spencer [49]
Internal
External
1
2
2
1
1
2
1
2
1
2
++
++
Bragadóttir, Kalisch, and Tryggvadóttir [62]
Internal
External
0
2
2
2
2
1
2
2
1
2
++
++

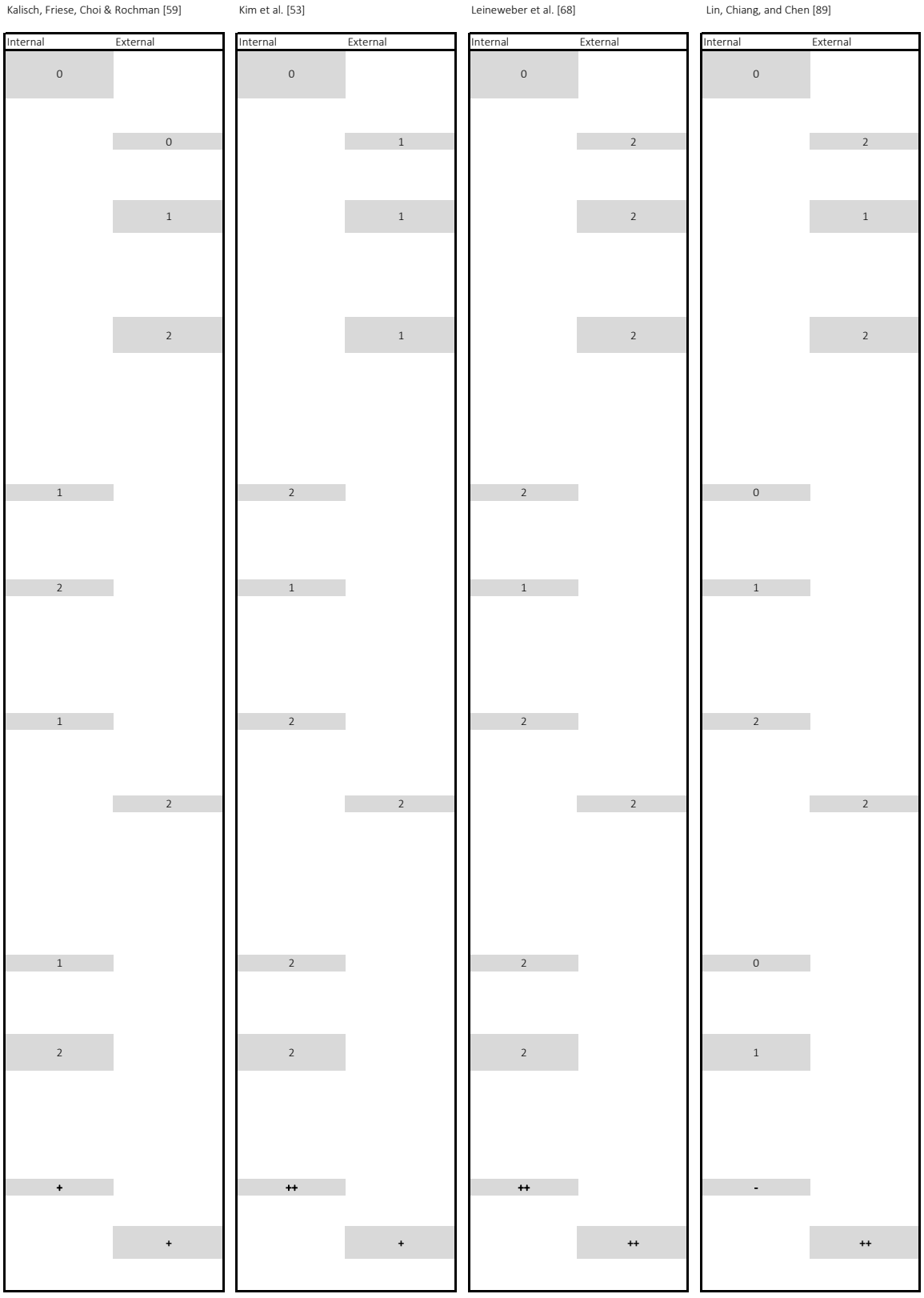

Bragadóttir, Kalisch, and Tryggvadóttir [79]
Internal
External
0
1
1
0
2
1
1
2
1
1
2
1
1
2
+
+
Bruyneel, Van den Heede, Diya, Aiken, and Sermeus [78]
Internal
External
0
2
2
2
1
1
1
2
2
1
2
2
+
++
Burmeister et al. [94]
Internal
External
0
2
2
1
2
1
1
1
2
2
2
2
++
++
Cho et al. [86]
Internal
External
0
2
1
2
2
1
1
1
2
2
1
2
+
++

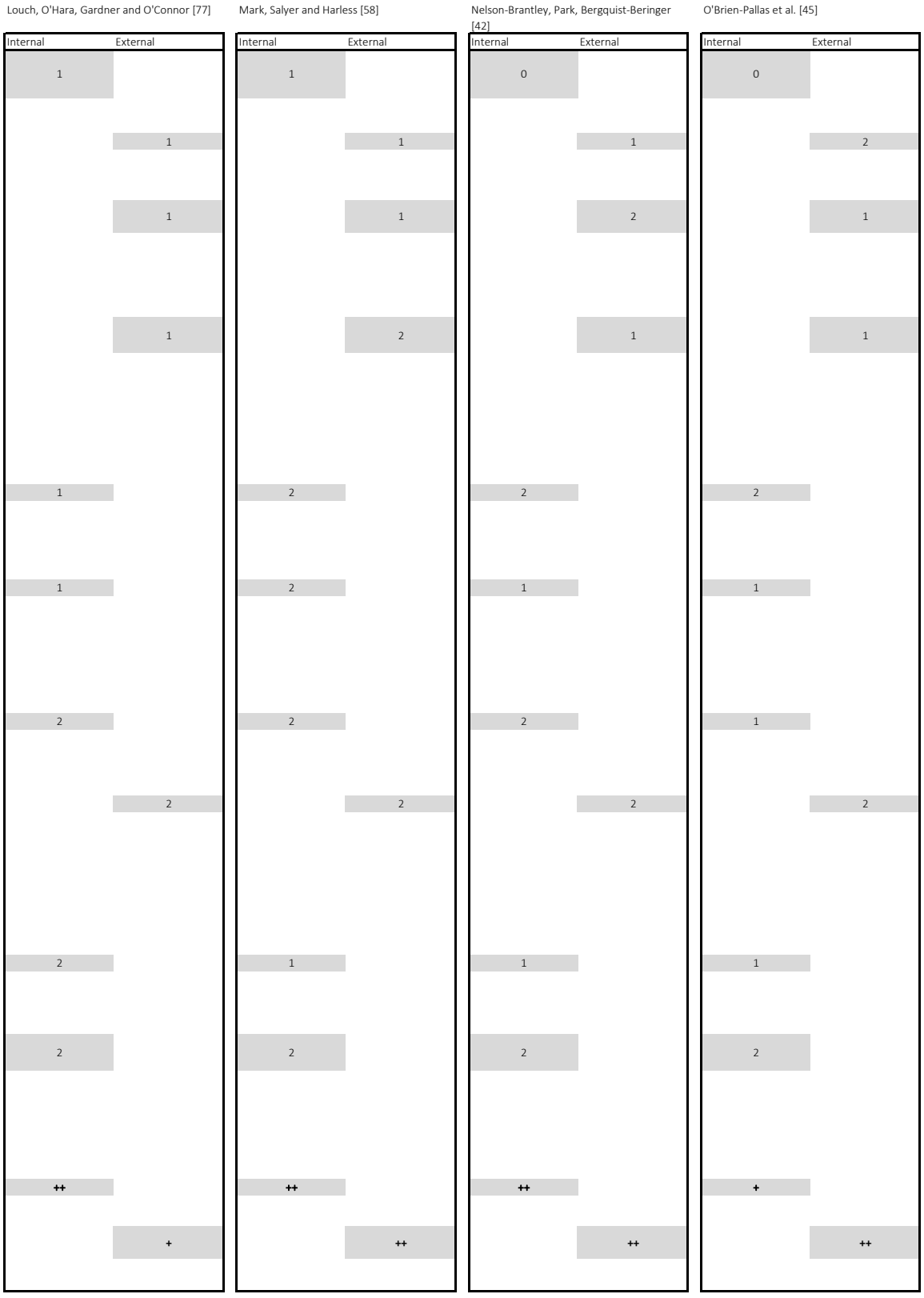

Cho et al. [87]
Internal
External
0
0
1
1
0
1
1
2
-
+
Choi and Staggs [24]
Internal
External
0
1
1
2
2
2
2
2
1
2
++
++
De Groot, Burke, and George [47]
Internal
External
0
1
0
1
1
0
1
0
0
1
-
-
Desmedt, De Geest, Schubert, Schwendimann, and Ausserhofer [63]
Internal
External
0
2
2
2
0
0
1
2
0
0
0
0
-
-
++
++

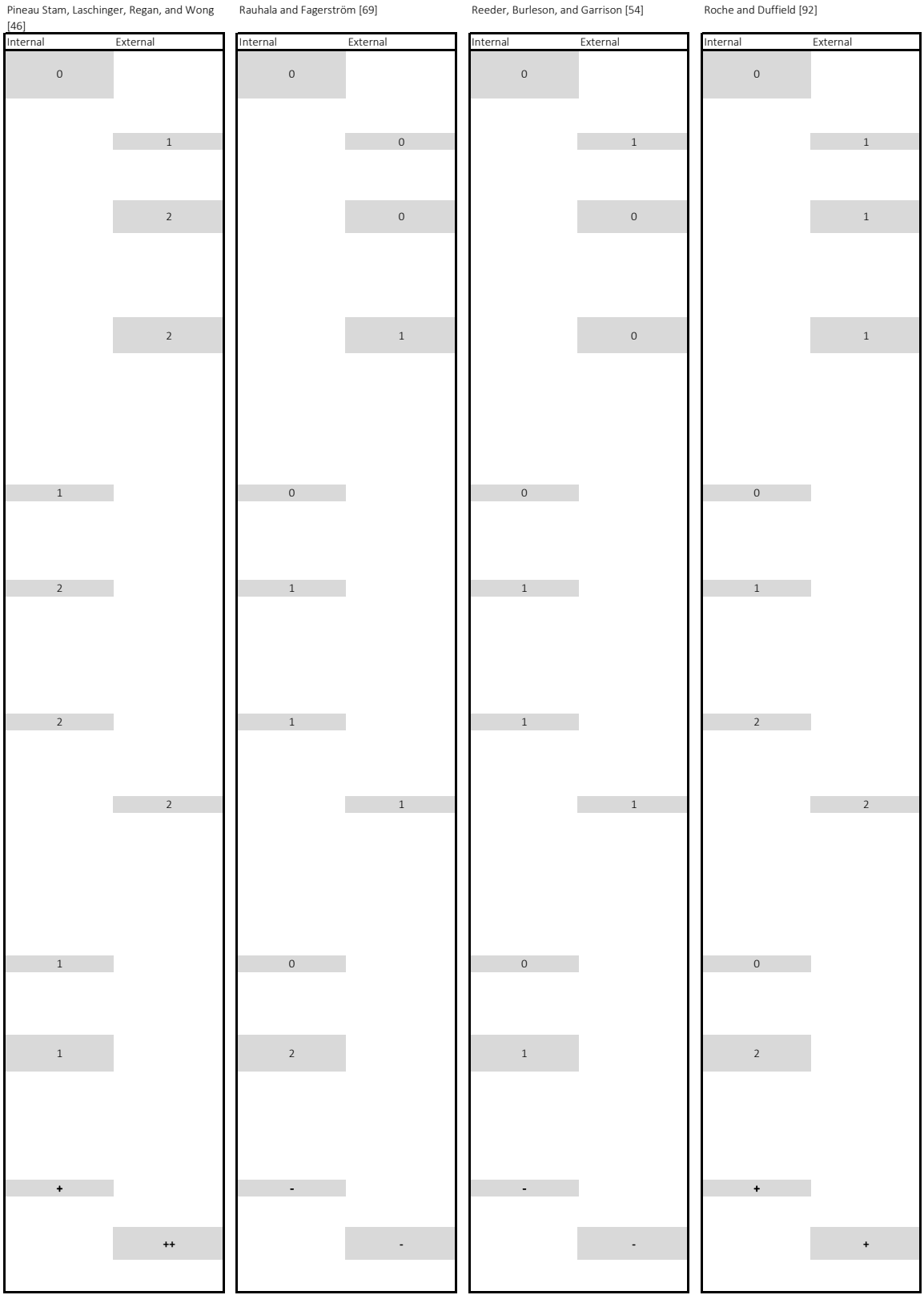

Ducharme, Bernhardt, Padula, and Adams [35]
Internal
External
0
0
0
2
0
1
1
0
2
2
+
-
Escobar-Aguilar et al. [84]
Internal
External
0
2
2
0
2
1
2
2
0
2
2
+
++
Fuentelsaz-Gallego, Moreno-Casbas, Gomez-Garcia, and Gonzalez-Maria [65]
Internal
External
0
2
2
0
1
2
0
2
2
+
++
Gunnarsdóttir, Clarke, Rafferty, and Nutbeam [66]
Internal
External
0
2
0
2
1
1
1
2
1
1
+
+

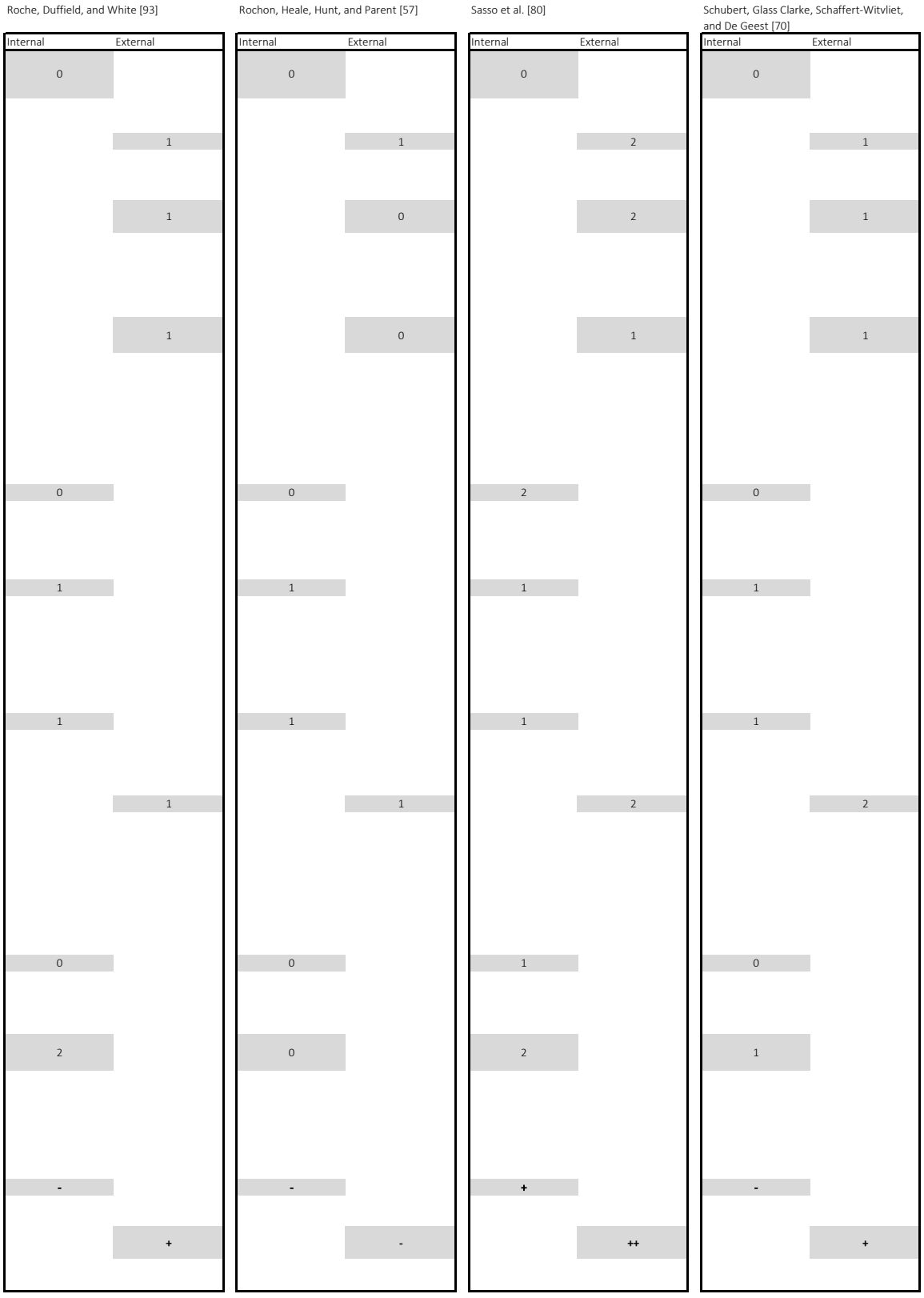

Hegney et al. [91]
Internal
External
0
2
2
1
0
1
2
1
0
2
+
++
Heinen et al. [76]
Internal
External
0
2
2
2
1
2
2
2
2
2
++
++
Jafree, Zakar, Zakar, and Fischer [88]
Internal
External
0
2
2
1
2
1
2
2
1
2
++
++
Jolivet et al. [67]
Internal
External
0
0
1
2
2
1
2
2
2
2
++
+

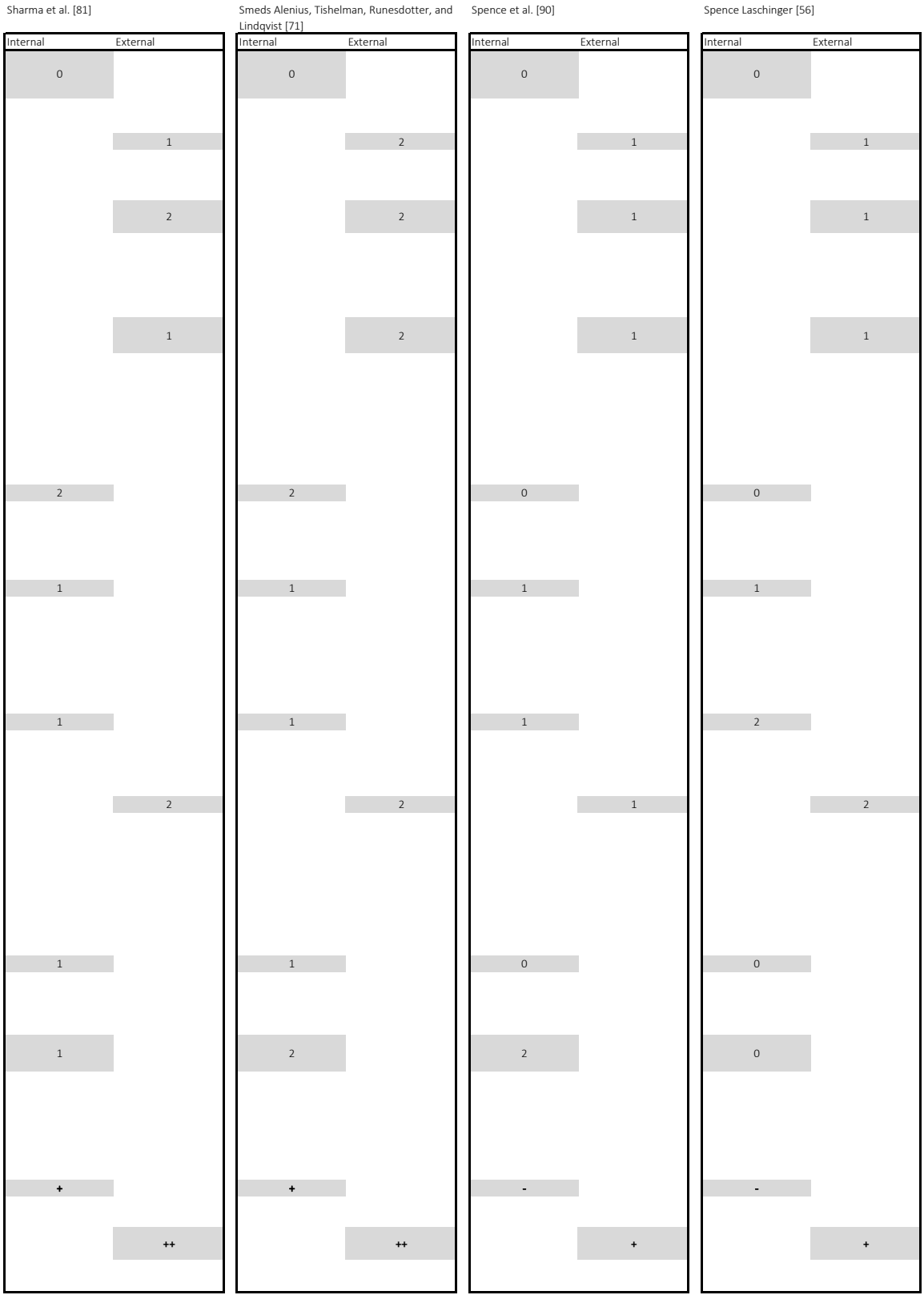

Kalisch and Lee [37]
Internal
External
0
1
1
1
2
1
2
2
2
++
+
Kalisch, Lee, and Rochman [39]
Internal
External
0
0
1
1
2
1
2
2
2
++
+
Kalisch, Tschanen, and Lee [52]
Internal
External
0
0
1
1
2
1
2
2
2
++
+
Kalisch, Tschannen, Lee, and Friese [40]
Internal
External
0
1
1
1
2
1
2
2
2
++
+

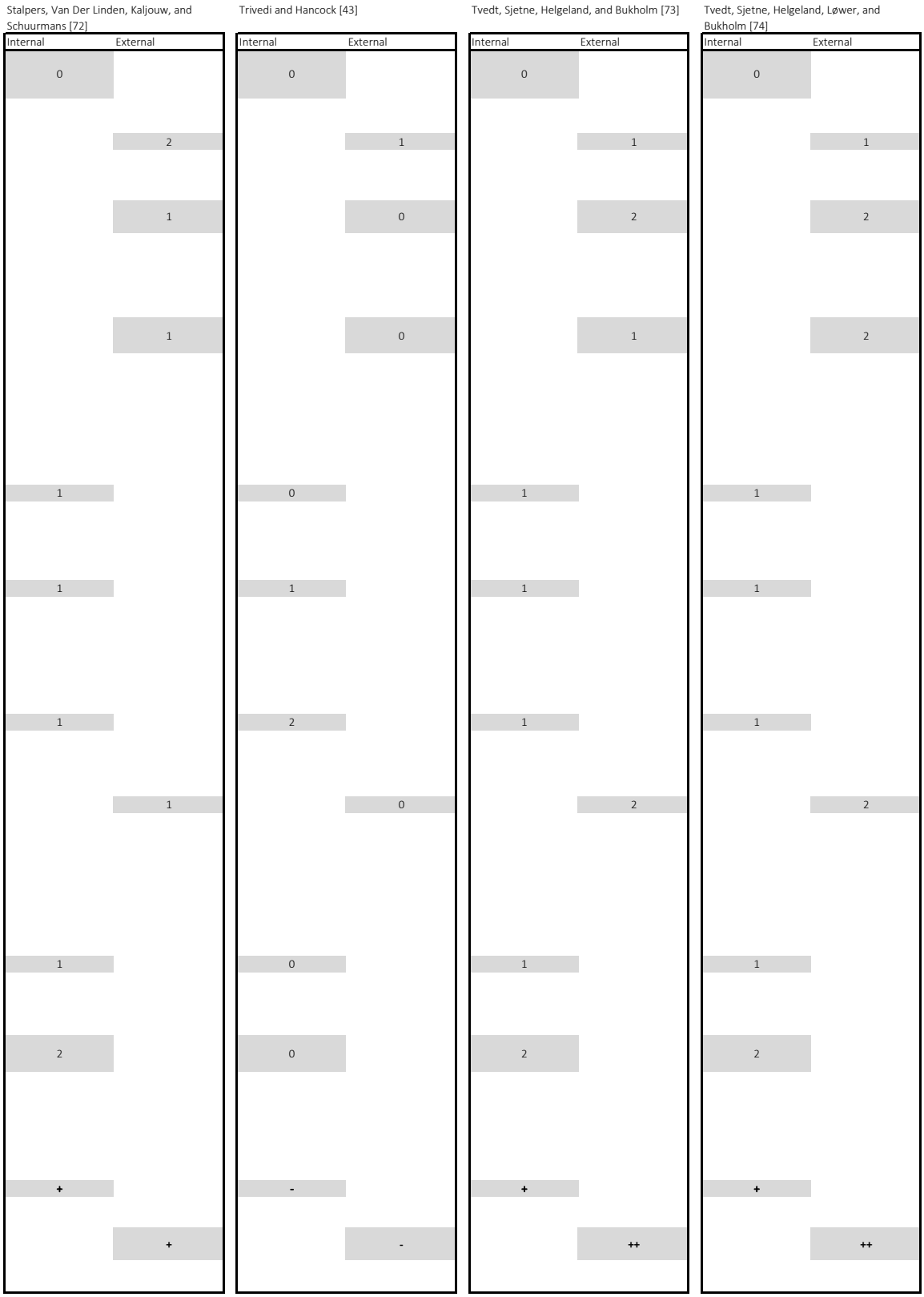

Kalisch, Friese, Choi & Rochman [59]
Internal
External
0
0
1
2
1
1
2
2
1
2
2
1
2
2
1
2
2
1
2
2
+
+
Kim et al. [53]
Internal
External
0
1
1
1
2
2
2
1
2
2
2
2
2
2
2
2
++
+
Leineweber et al. [68]
Internal
External
0
2
2
2
2
1
2
2
2
2
2
2
2
2
2
2
++
++
Lin, Chiang, and Chen [89]
Internal
External
0
2
1
2
0
1
2
2
0
1
-
++

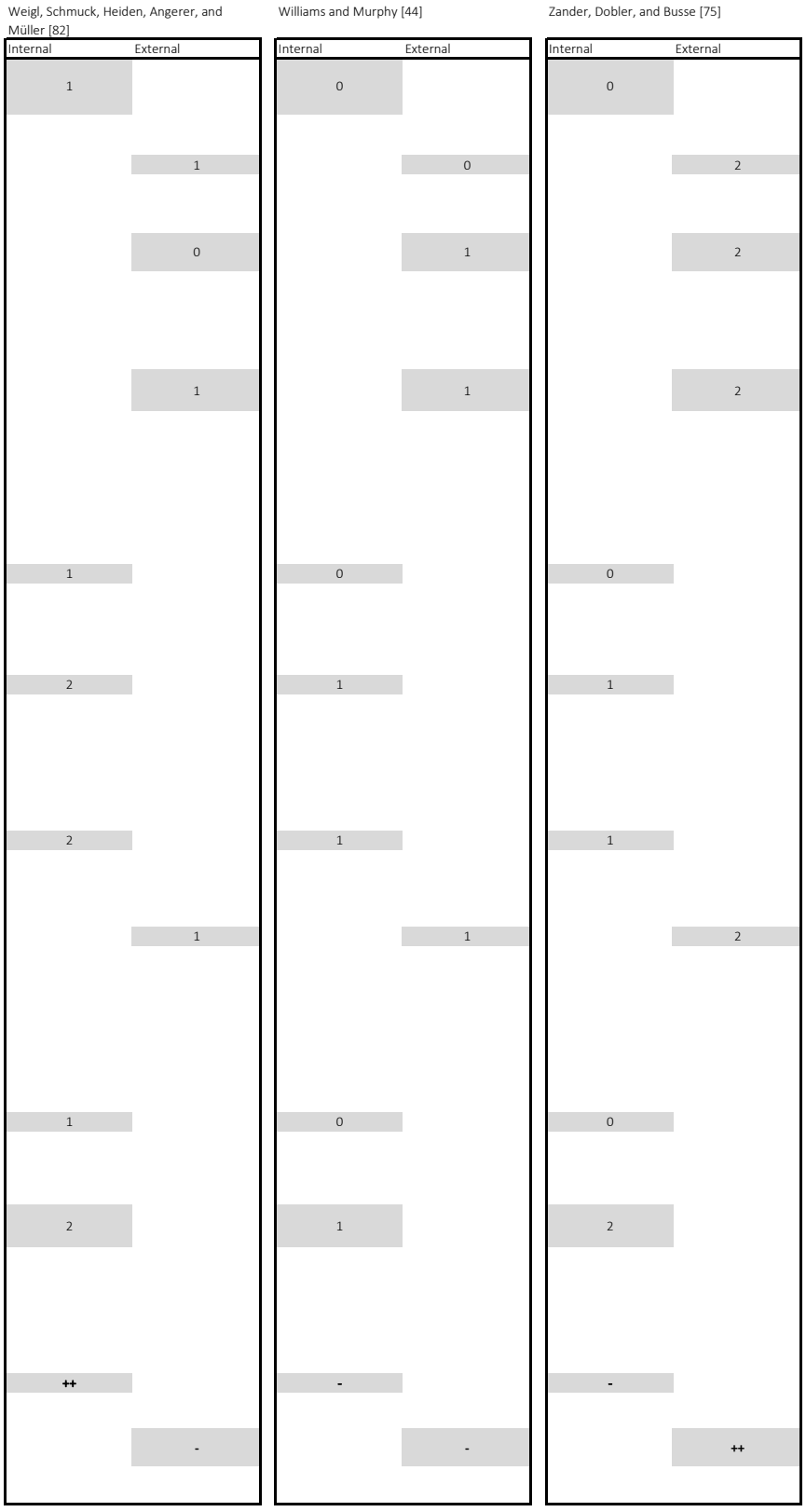

Louch, O'Hara, Gardner and O'Connor [77]
Internal
External
1
1
1
1
1
2
1
2
2
2
2
2
++
+
Mark, Salyer and Harless [58]
Internal
External
1
1
1
2
2
2
1
2
2
2
2
2
++
++
Nelson-Brantley, Park, Bergquist-Beringer [42]
Internal
External
0
1
2
1
2
1
2
2
1
2
2
2
++
++
O'Brien-Pallas et al. [45]
Internal
External
0
2
1
2
1
1
1
2
1
2
2
2
+
++


Pineau Stam, Laschinger, Regan, and Wong [46]
Internal
External
0
1
2
2
1
2
2
1
1
2
+
++
Rauhala and Fagerström [69]
Internal
External
0
0
0
1
2
1
0
1
1
2
-
-
Reeder, Burleson, and Garrison [54]
Internal
External
0
1
0
1
0
1
0
1
1
1
-
-
Roche and Duffield [92]
Internal
External
0
1
1
1
0
1
0
2
2
2
+
+


Roche, Duffield, and White [93]
Internal
External
0
1
1
1
0
1
1
1
0
2
-
+
Rochon, Heale, Hunt, and Parent [57]
Internal
External
0
1
0
1
0
1
1
1
0
0
-
-
Sasso et al. [80]
Internal
External
0
2
2
1
2
1
1
1
1
2
1
2
+
++
Schubert, Glass Clarke, Schaffert-Witvliet, and De Geest [70]
Internal
External
0
1
1
1
0
1
1
1
0
1
-
+


Sharma et al. [81]
Internal
External
0
1
2
1
2
1
1
2
1
2
1
1
2
1
1
2
+
++
Smeds Alenius, Tishelman, Runesdotter, and Lindqvist [71]
Internal
External
0
2
2
2
2
1
1
2
1
2
1
1
2
1
2
+
++
Spence et al. [90]
Internal
External
0
1
1
1
0
1
1
1
0
1
1
0
2
-
+
Spence Laschinger [56]
Internal
External
0
1
1
1
0
1
1
2
0
2
0
-
+


Stalpers, Van Der Linden, Kaljouw, and Schuurmans [72]
Internal
External
0
2
1
1
1
1
1
1
+
+
Trivedi and Hancock [43]
Internal
External
0
1
0
1
0
0
2
1
0
0
-
-
Tvedt, Sjetne, Helgeland, and Bukholm [73]
Internal
External
0
1
2
1
1
1
1
2
1
2
+
++
Tvedt, Sjetne, Helgeland, Løwer, and Bukholm [74]
Internal
External
0
1
2
1
1
1
1
2
1
2
+
++


Weigl, Schmuck, Heiden, Angerer, and Müller [82]
Internal
External
1
1
0
1
1
2
2
2
1
1
2
++
-
Williams and Murphy [44]
Internal
External
0
0
1
1
0
1
1
1
0
1
-
-
Zander, Dobler, and Busse [75]
Internal
External
0
2
2
2
0
1
1
1
0
2
-
++