The association between nurse staffing and quality of care in emergency departments: A systematic review

Jonathan Drennan [a,*], Ashling Murphy [b], Vera J.C. McCarthy [b], Jane Ball [c], Christine Duffield [d,e], Robert Crouch [c], Gearoid Kelly [b], Croia Loughnane [b], Aileen Murphy [f], Josephine Hegarty [b], Noeleen Brady [b], Anne Scott [g], Peter Griffiths [c]

[a] School of Nursing, Midwifery and Health Systems, University College Dublin, Dublin, Ireland
[b] School of Nursing and Midwifery, University College Cork, Cork, Ireland
[c] School of Health Sciences, University of Southampton, Southampton, United Kingdom
[d] School of Nursing and Midwifery, Edith Cowan University, Joondalup, Western Australia, Australia
[e] University of Technology Sydney, Sydney, New South Wales, Australia
[f] Department of Economics, Cork University Business School, University College Cork, Cork, Ireland
[g] University of Galway, Galway, Ireland

ARTICLE INFO

ABSTRACT

Background: The relationship between nurse staffing, skill-mix and quality of care has been well-established in medical and surgical settings, however, there is relatively limited evidence of this relationship in emergency departments. Those that have been published identified that lower nurse staffing levels in emergency departments are generally associated with worse outcomes with the conclusion that the evidence in emergency settings was, at best, weak.

Methods: We searched thirteen electronic databases for potentially eligible papers published in English up to December 2023. Studies were included if they reported on patient outcomes associated with nurse staffing within emergency departments. Observational, cross-sectional, prospective, retrospective, interrupted time-series designs, difference-in-difference, randomised control trials or quasi-experimental studies and controlled before and after studies study designs were considered for inclusion. Team members independently screened titles and abstracts. Data was synthesised using a narrative approach.

Results: We identified 16 papers for inclusion; the majority of the studies (n = 10/16) were observational. The evidence reviewed identified that poorer staffing levels within emergency departments are associated with increased patient wait times, a higher proportion of patients who leave without being seen and an increased length of stay. Lower levels of nurse staffing are also associated with an increase in time to medications and therapeutic interventions, and increased risk of cardiac arrest within the emergency department.

Conclusion: Overall, there remains limited high-quality empirical evidence addressing the association between emergency department nurse staffing and patient outcomes. However, it is evident that lower levels of nurse staffing are associated with adverse events that can result in delays to the provision of care and serious outcomes for patients. There is a need for longitudinal studies coupled with research that considers the relationship with skill-mix, other staffing grades and patient outcomes as well as a wider range of geographical settings.

Tweetable abstract: Lower levels of nurse staffing in emergency departments are associated with delays in patients receiving treatments and poor quality care including an increase in leaving without being seen, delay in accessing treatments and medications and cardiac arrest.

What is already known

- Whilst a substantial amount of literature is available pertaining to nurse staffing and patient outcomes, this tends to focus on medical and surgical settings with a lower level of evidence available that examines nurse staffing levels and skill mix and outcomes within emergency departments.

* Corresponding author at: School of Nursing, Midwifery and Health Systems, University College Dublin, Belfield, Dublin 4, Ireland.
E-mail address: Jonathan.Drennan@ucd.ie (J. Drennan).
Social media: @jdadrennan.

- A previous review found limited evidence that lower levels of nurse staffing in emergency departments have a negative impact on patient care, including longer waits, increased emergency department care time, lower patient satisfaction and an increase in the number of patients leaving the department without being seen.

What this paper adds

- This paper confirms that lower levels of nurse staffing are associated with an increase in patients leaving without being seen, time patients spend in the department and patient satisfaction.
- Outcomes not reported in a previous review are identified, including that lower levels of nurse staffing are associated with an increase in time to therapeutic interventions and unexpected cardiac arrest and mortality within the ED.
- Although strengths in the design of studies were identified, there remain a number of limitations, including variability in measuring staffing, majority are single site studies and lack of information on the structure of the workforce in measuring the association between nurse staffing, processes of care and patient outcomes in emergency settings.

1. Introduction

1.1. Nurse staffing in emergency departments

Internationally, emergency departments are facing increasing pressures due to crowding, and complex patient presentations (Pearce et al., 2023); these pressures are resulting in challenges in the recruitment and retention of nursing staff (Wretborn et al., 2020; Amritzer et al., 2021). Issues with recruitment and retention of nursing staff in these settings have further been exacerbated by the impact on the wellbeing of healthcare workers as a consequence of the Covid-19 pandemic (Maben and Bridges, 2020) with a reported increase in the number of nurses stating they will leave emergency nursing in the future due to factors relating to the working environment and the pandemic (Cornish et al., 2021; Poon et al., 2022).

Due to these issues, the delivery of healthcare and treatment of patients within emergency departments are becoming more complex and effective staff allocation and utilisation of resources are increasingly challenging. Crowding of emergency departments, shortage of specialised emergency staff, uncertainty of presentations and receiving timely care from staff have increasingly become issues internationally in EDs resulting in increased delays in patients receiving safe and effective care (Di Somma et al., 2015; Care Quality Commission, 2020; Health Information and Quality Authority, 2022; Muir et al., 2023). Impacts on patient care previously associated with lower levels of nurse staffing, such as an increase in the number of patients leaving without being seen, delays in accessing care and treatments and long waiting times to be seen can result in adverse patient experiences (Recio-Saucedo et al., 2015). It has also been identified that the increased crowding of emergency departments is resulting in delays in the provision of care and long waiting times for patients to be admitted; this requires emergency departments to provide levels of care normally associated with in-patients and the need to determine staffing levels based on patient need whilst in an emergency department (Wolf et al., 2017). In addition, it has been identified that crowding in emergency departments is not only related to patient demand and hospital bed capacity, but also a shortage of nursing staff (Di Somma et al., 2015) which can result in reduced patient flow through an emergency department. However, despite a number of recommendations in this area, approaches to identify safe staffing levels in emergency departments are inconsistent and can rely on untested approaches such as nurse to patient ratios and benchmarking, legacy issues or professional judgement rather than evidence-based systematic approaches (Wise et al., 2015; Wolf et al., 2017; Youd, 2015).

1.2. Rationale for the systematic review

A previous systematic review of the literature on safe nurse staffing published in 2015 concluded that levels of nurse staffing in the emergency department are associated with patients leaving without being seen, patient care time in the department, and levels of patient satisfaction (Recio-Saucedo et al., 2015). Although the review concluded that lower nurse staffing levels in emergency departments are generally associated with worse outcomes, it was identified that, overall, the evidence on the association between nurse staffing and patient outcomes (the focus of this review) in these settings was, at best, weak.

Since the publication of the 2015 review, several countries are completing or have undertaken an examination of nurse staffing in emergency departments with the view to identify a systematic approach to determine the numbers and skill-mix required (Department of Health 2018, 2022; NHS Improvement, 2018). In implementing these systematic approaches, there is an acknowledgement that there is a need for an evidence base on which to measure changes to nurse staffing in emergency settings and associated patient outcomes (Wise et al., 2015).

Although the relationship between nurse staffing and patient outcomes has been well explored through studies and systematic reviews in medical and surgical settings (Aiken et al., 2014; Assaye et al., 2020; Griffiths et al., 2018; Kane et al., 2007), it is argued that emergency departments are a distinct service within a hospital setting, and outcomes measured in other settings (in particular, acute in-patient wards) such as mortality rates would not apply to this very different context. Measuring the association between nurse staffing and patient processes and outcomes in emergency departments is different due to the unpredictability of patient presentation, the acuity of patients presenting, overcrowding, and length of stay, which are all very different to the acute in-patient setting (Pearce et al., 2023). Relevant care processes and outcomes may overlap to some extent between clinical settings, for example, observation and prevention of deterioration, but others, such as leaving without being seen, time to be seen, and time to immediate treatments are different within the emergency department context (Recio-Saucedo et al., 2015). In addition, it has been reported that there is great variation in the number of patients per registered nurses as well as skill-mix in emergency departments (Amritzer et al., 2021); however, the extent to which this variation in nurse staffing impacts on patient care processes and outcomes requires exploration. No recent review of the literature on the association between nurse staffing and patient outcomes in emergency departments has been published so we aim to provide a review that addresses this limitation. Therefore, in this paper we aim to provide an up-to-date review of the association between variation in nurse staffing levels and skill-mix and patient outcomes in emergency departments. Furthermore, we aim to identify those patient outcomes that have been reported in the literature as being associated with nurse staffing levels.

2. Method

2.1. Eligibility criteria

The studies in this review were selected if they included reference to, and variation in, nurse staffing and associated processes of care, outcomes or measures of patient experience or quality of care. Processes of care were identified as those steps or procedures undertaken by nurses in the emergency department in administering treatments or managing a patient's condition. Outcomes of care were identified as those that impacted on the patient's health status or experience of care. We only focused on patient measures associated with nurse staffing and excluded those studies that measured organisational, environmental, or staffing outcomes. We also excluded studies that reported on computer simulations of staffing. Eligible studies were those published in English and research designs included observational, cross-sectional, prospective, retrospective, interrupted time-series designs,

randomised control trials or quasi-experimental studies (including natural experiments), and controlled before and after studies; however, we anticipated that the majority of the research would be observational. We excluded conference abstracts, commissioned reports and dissertations. We only included hospital based emergency departments that provided 24-hour care and excluded minor injury units, paediatric or specialist emergency departments (for example, eye clinics, rapid, medical or surgical assessment units, and clinical decision units) due to the different characteristics of these types of settings (Anderson et al., 2016). We also excluded studies that measured service reconfiguration or re-design or if they primarily examined other specialist nursing roles in emergency departments such as mental health nurses, emergency nurse practitioners or advanced nurse practitioners.

2.2. Databases accessed and search strategy

We searched the following databases: CINAHL, Econlit and Medline, Cochrane Database of Systematic Reviews (CDSR), Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Methodology Register (CMR), Database of Abstracts of Reviews of Effects (DARE), Health Technology Assessment Database (HTA), NHS Economic Evaluation Database (EED), JSTOR, Emerald Insight, EMBASE and Scopus (see Supplementary file I). A combination of key search terms was searched using Boolean terms (Table 1).

As in a previous review (Recio-Saucedo et al., 2015), the search included studies published since 1994 with this review exploring evidence generated to date (December 2023). This search resulted in the inclusion of six studies identified in the Recio-Saucedo et al. (2015) review and ten new studies published since that review.

2.3. Study selection

Search results were imported into the EndNote (Clarivate, 2021) reference management software where the results from the multiple databases were merged into one file and any duplicates removed. Using Covidence (2023), an initial screening of titles and abstracts was performed independently by two members of the research team. The full text of papers of potential interest were then retrieved and reviewed in detail by two reviewers to assess their eligibility for inclusion against the pre-specified criteria. Disagreements were resolved by consensus within the research team. Reasons for exclusion were recorded and are displayed in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram (Moher et al., 2009; Page et al., 2021, Fig. 1).

2.4. Analysis method/evidence synthesis

The papers that met the inclusion criteria were heterogeneous in terms of study designs, interventions tested, and processes and outcomes measured; therefore a meta-analysis was not feasible. As a consequence, we summarise the findings narratively with studies reported by care process or patient outcome. Studies that reported on more than one care process or outcome are discussed at each individual level rather than at the study level.

2.5. Quality appraisal

Risk of bias assessment was undertaken using the National Institute for Health and Care Excellence (NICE) public health guidance framework (NICE, 2012) (Table 2). The framework includes a checklist (see Supplementary file II) which consists of five sections and is designed for reviewers to assess the internal and external validity of the studies for risk of bias. Internal validity included an assessment of the study design, the reliability of the outcome measures used and the identification and control of confounding factors. External validity considered the extent to which results were generalisable to the population of emergency department admissions. Each study was measured on five checklist responses: 1) the study is designed to minimise the risk of bias (++); 2) the research may not have addressed all possible sources of bias for that particular study design (+); 3) significant sources of bias identified (−); 4) not reported (NR); and 5) not applicable. This process then facilitates an overall quality grading of the study in terms of internal validity and an overall grade for external validity. This tool has previously been used in similar reviews of nurse staffing in emergency

Table 1
PICO search terms, inclusion and exclusion criteria for review.

Search terms	Inclusion	Exclusion
Population intervention/area of interest:	Examined the impact of targeted/purposeful investigation of:	Studies were excluded if they focused on the impact of:
Title/abstract search using terms: (nurs* OR "advance* pract*" OR "advanced practice") AND (staffing OR "skill mix" OR "skill-mix" OR rota OR schedul* OR manpower OR turnover OR workforce OR workflow or workload OR (Work N3 hour) OR (work adj3 hour) OR (visit N3 hour) OR (visit adj3 hour) OR "whole time equivalent*" OR overtime OR bank OR agency OR casemix OR "case mix" OR roster* OR ratio OR shift) AND ("emergency department" OR "emergency room*" OR "emergency unit*" OR "emergency ward*" OR "emergency service*" OR "accident and emergency" OR "assessment unit" OR "clinical decision unit" OR "medical short-stay" OR "medical short stay" OR "injury unit" OR "acute floor").	• Variation in nurse staffing and outcomes • Nurse staffing interventions • New nursing roles e.g. ANP, ED flow managers and outcomes	• Information systems • Changes in clinical work practices • Workflow processes where ED nurse staffing was not the primary focus • Nursing roles relating to coordination of care outside the ED context. • Nurse staffing in extraordinary situations e.g. disasters, disaster preparedness, mobile emergency services, during large events, conflicts.
Comparison	None required as an initial screening criterion	
Outcomes	Any measure of patient care processes and/or patient outcomes as reported in the studies.	The results pertaining to the impact of emergency department nurse staffing were not discernible from staffing/interventions more broadly. Described staffing levels within units rather than data on impact of staffing levels
Study designs	Observational, cross-sectional, prospective, retrospective, interrupted time-series designs, difference-in-difference, randomised control trials or quasi-experimental studies and controlled before and after studies.	Case studies, conference presentations, discussion, narrative reviews of literature, opinion papers, qualitative studies.
Context	Emergency departments/units in countries of medium to very high development index.	Nurse staffing in other contexts e.g. local injury units, stepdown units, clinical decision units.
Timeframe	January 1994–December 2023	
Language	English	

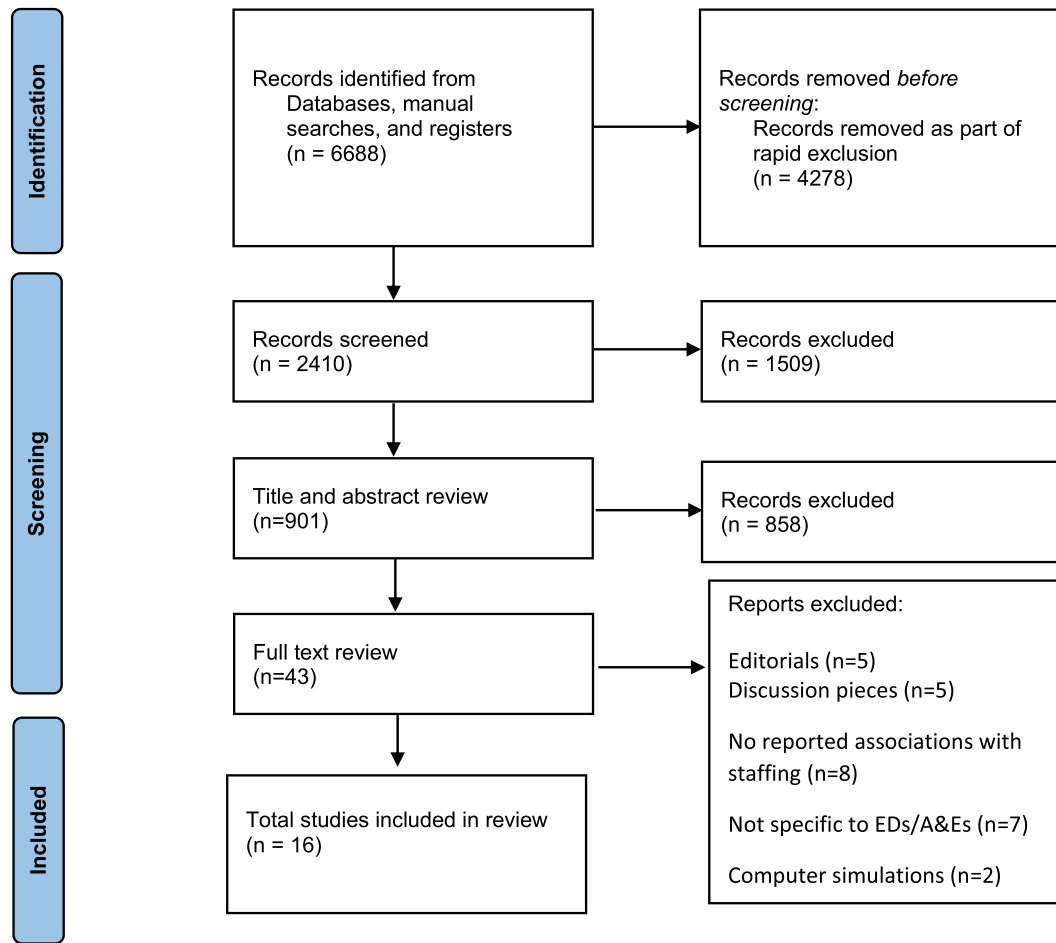Identification of studies via databases, manual searches, and registers.

Fig. 1. PRISMA flow chart (Page et al., 2021).

departments (Recio-Saucedo et al., 2015) and nurse staffing and omissions of care (Griffiths et al., 2018).

3. Results

3.1. Study selection

The initial search identified 6688 papers, and following rapid exclusion and removal of duplicates, 901 papers were identified; following title and abstract review 43 papers remained. These papers were reviewed in full text with 27 papers being excluded as they did not meet the eligibility criteria (Fig. 1). The remaining 16 papers were included in the review. Studies excluded were identified as editorials, discussion papers, reported on service reconfiguration, reported no associations with nurse staffing, included computer simulations of staffing or were not specific to emergency departments providing 24-hour care.

3.2. Study characteristics

3.2.1. Study location, design and data sources

Of the 16 studies reviewed, the vast majority were undertaken in the US (n = 13) with one study each in Canada (Daniel, 2013), South Korea (Lee et al., 2021), and Taiwan (Tsai et al., 2021).

The majority of the studies used cross-sectional, retrospective designs (Anderson et al., 2016; Brown et al., 2012; Daniel, 2013; Johansen et al., 2015; Hoxhaj et al., 2004; Lee et al., 2021; Nelson et al., 2018; Ramsey et al., 2018; Rathlev et al., 2020; Shindul-Rothschild et al., 2017)

with two prospective observational (Chan et al., 2009, 2010), one before-and-after study design (Weichenthal and Hendey, 2011), two used a retrospective cohort design (de Cordova et al., 2017; Tsai et al., 2021), and one a time series analysis (Rathlev et al., 2012); no randomised control trails were identified. The majority of the sources of data were secondary, including a retrospective review of emergency department patient records at hospital, regional or national levels with one study analysing the association between nurse staffing and cross-sectional patient experience survey data (Daniel, 2013).

3.2.2. Emergency department sites and participants

The majority of the studies were undertaken in single site emergency departments; of those that used multiple departments, the maximum was 407 departments (Anderson et al., 2016). All departments included in the studies reviewed were part of a larger hospital system.

Patient records reviewed ranged from a minimum of 508 (Tsai et al., 2021) to a maximum of 182,022 (Daniel, 2013). It is also of note that a number of studies analysed data from subsets of patients rather than overall attendances; these included 1343 patients with acute coronary syndrome suggestive of an acute myocardial infarction (de Cordova et al., 2017; Johansen et al., 2015), 1418 patients admitted to ED with abdominal pain (Lee et al., 2021) and 508 patients who were identified as having an unexpected cardiac arrest whilst in an emergency department (Tsai et al., 2021).

3.2.3. Nurse staffing measures

There was variability in the studies reviewed regarding how levels of nurse staffing were measured. These included nurse-to-patient ratios

Table 2
Studies included in the review.

Author(s) (country)	Design	No of EDs	Comparisons	Outcomes	Patients seen (census)	Key results	Internal validity[a]	External validity[a]
Anderson et al. (2016) (USA)	Retrospective observational	407	Physician and RN staffing ratios on leaving before treatment completion	Leaving before treatment completion (LBTC). Door to first provider (DTFP).	ED volumes ranged from 1575 to 153,600 patients per year, with a median volume of 38,700 patients.	Length of stay (LOS) and the time from door to first provider (DTFP) were both strongly associated with LBTC rate (p < 0.001). Patient volume was not significantly associated with LBTC rate (p = 0.16). Cluster analysis demonstrated that better physician and RN staffing ratios correlate with shorter DTFP and lower LBTC.	+	++
Brown et al. (2012) (USA)	Retrospective observational	1	Day-to-day RN shortages (total number of RNs on duty was less than 90 % of scheduled hours)	Leaving without being seen (LWBS)	50,000	When RN staffing was below 90 % requirements, patients who LWBS were 2.4 times higher (OR 2.4, 95 % CI 1.3–4.5, p = 0.006).	−	−
Chan et al. (2009) (USA)	Prospective observational	2	Mandated state nurse-to-patient ratios compared to out-of-ratio care	Time to antibiotic	61,000	No association between nurse to patient ratios and time to antibiotic for patients in ED overall (16 % [CI −66.2 % to 34.2 %], p = 0.531) and those with a diagnosis of pneumonia (8.2 % [CI −4.9 % to 21.3 %]).	+	−
Chan et al. (2010) (USA)	Prospective observational	2	Mandated nurse-to-patient ratios in place compared to out-of-ratio care	Wait time (WT) ED care time (EDCT)	59,733	Patient WT shorter when nurse staffing in ratio (42 min) compared to ED WT when out of ratio (63 min) (WT 16 % longer [95 % CI = 10 % to 22 %, p < 0.001]) EDCT shorter when nurse staffing in ratio (149 min) compared to EDCT when out of ratio (225 min) (EDCT 37 % longer [95 % CI = 34 % to 41 %, p < 0.001])	+	−
Daniel (2013) (Canada)	Retrospective observational	107	Nurse to patient ratios	Patient satisfaction	182,022	A higher proportion of RNs in an ED were found to have a weak statistical association with patient satisfaction with nursing care. For each one per cent increment in RN staff skill mix, there was an associated increase in overall patient satisfaction with care received in the ED of 0.05 on a scale of 0 to 100.	+	+
de Cordova et al. (2017) (USA)	Retrospective cohort study	73	Staffing ratios on weekdays and weekends	Mortality in ED following an acute myocardial infarction on a weekend/holiday and a weekday	1343	Patients who presented to ED on a weekend with an acute myocardial infarction had higher levels of mortality than those who presented on weekdays. Covariates included patient age (b = 0.03, 95 % CI [0.02, 0.04]), hospital technology status (b = 0.75, 95 % CI [0.20, 1.30]) and nurse staffing (b = 0.75, 95 % CI [0.20, 1.30]).	+	+
Hoxhaj et al. (2004) (USA)	Retrospective observational	1	Number of nursing vacancies	Leaving without being treated (LWBT)	92,000	Higher levels of nursing vacancies correlated with a higher number of patients who leave without being treated (r = 0.89, p = 0.007). Total monthly nursing hours to monthly ED census ratio correlated with percentage of patients who left without being treated (r = −0.94, p = 0.002).	−	−
Johansen et al. (2015) (USA)	Retrospective observational	73	Comparison of RN ratios and skill-mix to patient ratio.	Time to aspirin and access to percutaneous coronary intervention (PCI) within 90 min of hospital arrival	1,343 patients with symptoms of acute coronary syndrome suggestive of AMI.	Each additional patient added to a nurse's workload was associated with: a 3.9 % decrease in the likelihood of aspirin and a 1.4 % decrease in PCI within 90 min of hospital arrival. Each 10 % increase in the proportion of registered nurses was significantly associated with a 7.1 % increase in aspirin on arrival and a 6.3 % increase in PCI within 90 min of hospital arrival.	+	+

Table 2 (continued)

Author(s) (country)	Design	No of EDs	Comparisons	Outcomes	Patients seen (census)	Key results	Internal validity[a]	External validity[a]
Lee et al. (2021) (South Korea)	Retrospective observational	1	Comparison of nurse to patient ratios.	Time to analgesia and pain re-assessment	1428 patients with abdominal pain	For every increase of one patient per nurse, time-to-analgesia increased by 9.6 % (% difference 9.6, 95 % CI 3.62–15.90, p < 0.001). No significant relationship identified between nurse to patient ratios and patient reassessment for pain.	−	−
Nelson et al. (2018) (USA)	Cross-sectional	1	RN hours per patients arriving and RN hours per patient census	Patient experience	3120	Patients on shifts with an additional RN hour per patient were 2.4 percentage points more likely to rate their experience as good/very good (p < 0.05). No statistical association between RN hours per patient census and satisfaction was found.	−	−
Ramsey et al. (2018) (USA)	Retrospective observational	1	Comparison of lowest with highest quartile of nursing hours per day.	Door-to-discharge length of stay (LoS). Door-to-admit LoS. Patients who left without being seen (LWBS).	99,825	Days in the lowest quartile of nursing hours experienced a 28.2-minute increase per patient in door-to-discharge LOS compared to days in the highest quartile of nursing hours (95 % CI [256.4–273.6]). Door-to-admit LOS showed no significant change across quartiles. There was an increase of nine patients per day who left without being seen in the lowest quartile of nursing hours compared to the highest quartile.	−	−
Rathlev et al. (2012) (USA)	Time series analysis	1	Number of ED nurses	Length of stay	91,643	The number of nurses was not associated with patient length of stay.	+	−
Rathlev et al. (2020) (USA)	Cross-sectional	1	Ratio of number of patients per RN	Left without being seen (LWBS)	29,382	Univariate analysis demonstrated association between nurse to patient ratios and patients leaving without being seen; however, this was not statistically significant in multivariate analysis.	−	−
Shindul-Rothschild et al. (2017) (USA)	Retrospective observational	67	Average number of patients cared for per RN in 24 h	Time to a diagnostic evaluation	Not stated	Median time to diagnostic evaluation increased by 3.29 min for each additional patient cared for by an emergency nurse.	+	++
Tsai et al. (2021) (Taiwan)	Retrospective cohort study	1	Nurse-to-patient ratios (NPRs)	Emergency department cardiac arrest (EDCA)	508 adult non-trauma patients with primary emergency department cardiac arrest	Higher incidences of EDCA were noted for NPRs of 8.5–9.5 (RR: 1.33, 95 % CI: 1.054, 1.672) as well as those >9.5 (RR: 1.54, 95 % CI: 1.187, 1.994).	−	−
Weichenthal and Hendey (2011) (USA)	Before-and-after study	1	One year before and one year following the introduction of state mandated nurse-to-patient ratios (NPRs)	Waiting to be seen (WTBS) Leaving without being seen (LWBS) Time to aspirin administration Time to antibiotic administration Medication errors	59,163 (before), 55,976 patients (after)	WTBS increased from 79 min to 123 min (p = 0.001) following the introduction of state mandated NPRs. Patients who LWBS decreased from 11.9 % to 11.2 % (p = 0.00010). No change in the rate of aspirin administration (decrease from 97.7 % to 80.4 % (p = 0.15)). Time to antibiotics decreased from 103 min to 62 min (p = 0.002). No statistical difference in medication errors (0.18/1000 visits to 1.17/1000 visits (p = 0.15)).	−	−

[a] Key: ++ all or majority of criteria fulfilled, conclusions are very unlikely to alter; + some of the criteria fulfilled, the conclusions are unlikely to alter; − few criteria have been fulfilled, conclusions are likely or very likely to alter.

Table 3
Summary impact of higher levels of nurse staffing on process of care and patient outcomes.

Study	Leaving without being seen/before treatment is complete	Time to be seen/wait time	Length of stay/ED care time	Patient experience	Time to medications	Time to treatments/ diagnostic evaluation	Time to re-assessment	ED cardiac arrest/mortality	Medication errors
Anderson et al. (2016)	0 (+)[a]								
Brown et al. (2012)	+								
Chan et al. (2009)					0				
Chan et al. (2010)		+	+						
Daniel (2013)				+					
de Cordova et al. (2017)								+	
Hoxhaj et al. (2004)	+								
Johansen et al. (2015)					+	+			
Lee et al. (2021)					+		0		
Nelson et al. (2018)				+ (0)[b]					
Ramsey et al. (2018)	+		+ (0)[c]						
Rathlev et al. (2012)			0						
Rathlev et al. (2020)	+ (0)[d]								
Shindul-Rothschild et al. (2017)						+ (0)[e]			
Tsai et al. (2021)								+	
Weichenthal and Hendey (2011)	+	−			+ (0)[f]				0

+ Improves, − worse, 0 no effect.

[a] No significant relationship between nurse staffing and LBTC overall; however, hospitals within clusters with higher RN staffing had significantly lower rates of patients LBTC when compared to those within the same cluster with lower RN staffing.

[b] Significant for additional RN hour per patient/not significant for RN hours per patient census.

[c] Significant for length of stay of patients who are discharged from ED; not significant for patients admitted.

[d] Significant in univariate analysis but not in multivariate analysis.

[e] Statistically significant in ED trauma departments, not-significant in non-trauma departments.

[f] Significant for time to antibiotic; not-significant for time to aspirin.

(the most frequently used measure) (Chan et al., 2009, 2010; Daniel, 2013; Johansen et al., 2015; Lee et al., 2021; Rathlev et al., 2012, 2020; Tsai et al., 2021; Weichenthal and Hendey, 2011), nursing hours available (Nelson et al., 2018; Ramsey et al., 2018), number of patients per staffed hours per day (Anderson et al., 2016), average number of patients cared for per RN in the ED over a 12 hour (de Cordova et al., 2017) or 24 hour period (Shindul-Rothschild et al., 2017), proportion of shifts understaffed (Brown et al., 2012) and the number of nursing vacancies (Hoxhaj et al., 2004). All studies measured levels of registered nurse staffing within emergency departments. In addition, three studies were identified (Daniel, 2013; de Cordova et al., 2017; Johansen et al., 2015) that considered skill-mix in measuring the association between staffing and patient outcomes and consisted of the proportion of care provided by RNs in comparison with other grades (licenced/registered practical nurses and nurse aides). There was variability in the period of time that staffing was measured; the majority of studies measured the association between staffing and care processes and patient outcomes over a one year period (Brown et al., 2012; Chan et al., 2009, 2010; Lee et al., 2021; Ramsey et al., 2018; Rathlev et al., 2020; Shindul-Rothschild et al., 2017), with other studies ranging from nine months (Nelson et al., 2018), through to the analysis of data retrospectively over a five year period (Daniel, 2013). One study undertook analysis of data one year before and one year following the introduction of mandated nurse to patient ratios in an emergency department (Weichenthal and Hendey, 2011), with one study comparing nurse staffing levels during the week and at weekends (de Cordova et al., 2017). The retrospective data sets reviewed included measuring nurse to patient ratios every 10 min (Chan et al., 2009, 2010), the daily number of RN hours worked (Brown et al., 2012), RN proportion and worked hours per patient length of stay, RN hours worked per shift (Nelson et al., 2018; Ramsey et al., 2018), 8-hour shift periods (Rathlev et al., 2012; Tsai et al., 2021), and the average number of patients cared for by an RN in a 12-hour (de Cordova et al., 2017) or 24-hour period (Shindul-Rothschild et al., 2017).

3.2.4. Quality of care measures

There was variability in the types of patient care processes and outcomes measured, with a number of studies reporting on multiple measures. These included patient process care measures such as: time to diagnostic evaluation (Shindul-Rothschild et al., 2017), time to medication/treatment (Chan et al., 2009; Johansen et al., 2015; Lee et al., 2021; Weichenthal and Hendey, 2011), and pain re-assessment (Lee et al., 2021). Patient outcome measures included: mortality in patients with acute myocardial infarction (de Cordova et al., 2017), cardiac arrest (Tsai et al., 2021), patient length of stay/wait time (Chan et al., 2010; Ramsey et al., 2018; Rathlev et al., 2012; Weichenthal and Hendey, 2011), patients leaving without being seen/leaving before treatment is complete (Anderson et al., 2016; Brown et al., 2012; Hoxhaj et al., 2004; Ramsey et al., 2018; Rathlev et al., 2020; Weichenthal and Hendey, 2011), and patient experience (Daniel, 2013; Nelson et al., 2018).

3.3. Quality assessment and risk of bias

The external validity of two studies was assessed as strong (Anderson et al., 2016; Shindul-Rothschild et al., 2017) with three studies assessed as moderate (Daniel, 2013; de Cordova et al., 2017; Johansen et al., 2015). These studies were generally representative of acute general hospital emergency departments at national and/or regional levels. The remaining studies were evaluated as weak for external validity as they were generally single hospital sites or were not representative of general emergency department admissions. Five studies were evaluated as having a moderate risk of bias (internal validity) (Anderson et al., 2016; Chan et al., 2009, 2010; Daniel, 2013; Johansen et al., 2015; Shindul-Rothschild et al., 2017) with the remaining assessed as being weak in terms of internal validity (see Table 2).

3.4. Results of individual studies

3.4.1. Process care measures

3.4.1.1. Association between nurse staffing and time to diagnostic evaluation, medications and re-assessment. A number of studies reported on the association between nurse staffing and the time that patients wait prior to accessing medications and treatments as part of their care in the emergency department; these included time to diagnostic evaluation

(Shindul-Rothschild et al., 2017), time to aspirin and percutaneous coronary intervention (Johansen et al., 2015), time to analgesia and reassessment of pain levels (Lee et al., 2021), time to antibiotic administration (Chan et al., 2009) and time to antibiotic and aspirin administration (Weichenthal and Hendey, 2011). Four of the studies considered RN staffing only (Chan et al., 2009; Lee et al., 2021; Shindul-Rothschild et al., 2017), with one study taking the skill-mix of the staff in the emergency department into consideration (Johansen et al., 2015). Each of the studies, apart from one (Chan et al., 2009), reported that lower levels of nurse staffing were associated with increases in the time taken for patients to access medications and therapeutic interventions.

Shindul-Rothschild et al. (2017), in a study assessed as at moderate risk of bias with high external validity, investigated hospital characteristics associated with time to diagnostic evaluation by a qualified healthcare professional (doctor, nurse, nurse practitioner, physician's assistant). Two predictors explained 38 % of the variance in time to diagnostic evaluation: nurse staffing (β 0.559, 95 % CI [1.61–4.97], p < 0.001), and trauma centres (β 0.576, 95 % CI [10.86–32.19], p < 0.001). In trauma centres, the time to a diagnostic evaluation significantly increased (p = 0.042) from 30.2 min when a nurse cared for fewer than 11.32 patients to 61.4 min when a nurse cared for 14.85 or more patients. The median time to diagnostic evaluation increased by 3.29 min for each additional patient cared for by a nurse in the emergency department. This result was not statistically significant in non-trauma departments (F = 1.079, p = 0.349).

One study, assessed as being at moderate risk of bias with good external validity, identified that for each additional patient added to a nurse's workload there was a 3.9 % decrease in the likelihood of aspirin being administered on arrival and a 1.4 % decrease in percutaneous coronary intervention (PCI) within 90 min of hospital arrival (p < 0.0001) (Johansen et al., 2015: 211). Unlike the majority of studies in this review, this study also considered skill-mix in measuring the association with the process of care where it was identified that each 10 % increase in the proportion of RNs in an emergency department resulted in a 7.1 % increase in aspirin administration on arrival (p < 0.0001).

One study also explored the relationship between nurse staffing (nurse to patient ratios) and time-to-analgesia and reassessment of pain levels for patients and who attended an emergency department with abdominal pain (Lee et al., 2021). For every increase of one patient per nurse, time-to-analgesia increased by 9.6 % (% difference 9.6, 95 % CI [3.62–15.90], p < 0.001). There was no association identified between nurse to patient ratios and time to pain reassessment (p = 0.07).

One study identified a decrease in time to administration of antibiotics for patients with pneumonia following the introduction of state mandated ratios but no change in time to aspirin for patients admitted following chest pain or a myocardial infarction (Weichenthal and Hendey, 2011). In contrast, Chan et al. (2009), in a study assessed as being at moderate risk of bias, compared time to antibiotics when nurse to patient ratios were within mandated state ratios and out of mandated ratios. In this case, no significant association was identified.

3.4.2. Patient outcomes

This section outlines the association between nurse staffing and patient outcomes including patients leaving without being seen, patient length of stay, mortality, and patient experience.

3.4.2.1. Patients leaving without being seen/before treatment is complete. The most frequent outcome noted in the literature reviewed was the association with emergency department nurse staffing and patients leaving without being seen, generally classified as a patient who has registered in the department but left before receiving a consultation with a healthcare professional or leaving before treatment had been completed.

Three studies, all assessed as being at a high risk of bias, reported that lower RN staffing was associated with a higher proportion of patients leaving without being seen/before treatment is complete, with two studies, also assessed as being at high risk of bias, reporting mixed outcomes.

In the three studies that identified an association, there was variability in the measurements of staffing and how leaving without being seen was defined. Brown et al. (2012) reported that short-staffed shifts (less than 90 % of scheduled hours) were associated with an increase in patients who leave without being seen (OR 2.4, 95 % CI 1.3–4.5, p < 0.006) whilst Hoxhaj et al. (2004) identified that a higher number of nursing vacancies in an emergency department were strongly correlated with the proportion of patients who left without treatment (r = 0.89, p = 0.007) as well as a relationship between the ratio of monthly nursing hours to the monthly emergency department census also had a strong correlation with the number of patients who leave without being treated (r = −0.94, p = 0.002). Ramsey et al. (2018), also reported lower nursing hours available contributed to a significant increase in the number of patients who leave without being seen, independent of daily emergency department volume, hospital occupancy and admission rate. There was an increase of nine patients per day who left without being seen by a healthcare provider in the lowest quartile of nursing hours per day (336 to 442 h) (Mean LWBS = 22, 95 % CI [20–24]) compared to the highest quartile of nursing hours (505 to 580 h) (Mean LWBS = 13, 95 % CI [12–15]). Weichenthal and Hendey (2011) also reported that the percentage of patients who leave without being seen decreased from 11.9 % to 11.2 % (p < 0.0001) following the introduction of state mandated nurse to patient ratios.

Two studies reported mixed results. Anderson and colleagues, in a study assessed as being at high risk of bias, explored the relationship between a number of factors, including physician and nurse staffing and patients leaving before treatment is complete in 407 emergency departments. Although, initial analysis did not report a correlation between nurse staffing and leaving before treatment is complete overall, when hospitals within clusters that were highly similar in terms of patient volume, patient acuity and proportion of patients admitted were compared, those hospitals with higher physician and RN staffing had significantly lower rates of patients leaving (2.39 % vs 4.37 %, p = 0.03). Rathlev et al. (2020), in a study evaluated as being at high risk of bias, reported that there was a statistically significant relationship between patient to RN ratios and leaving without being seen in univariate analysis (1 RN to 4.2 patients − lower proportion of patients leave without being seen; 1 RN:4.7 patients − higher proportion of patients leave without being seen (p < 0.001)), this association was not statistically significant in multivariate analysis.

3.4.2.2. Association between nurse staffing and time to be seen and patient length of stay in an emergency department. Four studies, two assessed as being at high risk of bias (Ramsey et al., 2018; Weichenthal and Hendey, 2011) and two assessed as being at moderate risk of bias (Chan et al., 2010; Rathlev et al., 2012), measured the association between nurse staffing and patients' length of stay. Definitions of length of stay differed in the studies reviewed; generally it was defined as time from registration to time to discharge or decision to admit (Ramsey et al., 2018) with one study defining it as the time from placement on an emergency department trolley to either discharge or admission (Chan et al., 2010). In addition to emergency department care time, Chan and colleagues also measured the association between nurse staffing and time to be seen by a healthcare decision-maker (doctor or nurse practitioner).

Two studies reported that lower nurse staffing was associated with an increased length of stay for patients in the emergency department (Chan et al., 2010; Ramsey et al., 2018) whereas one study reported that patient length of stay increased following the introduction of state mandated nurse to patient ratios (Weichenthal and Hendey, 2011) with one study reporting no association between nurse staffing levels and patients' length of stay in the emergency department (Rathlev et al., 2012).

Chan et al. (2010) reported that patients whose nurse was deemed out-of-ratio (one nurse caring for more patients than state-mandated ratios for more than 20 min) spent 37 % (95 % CI [34 % to 41 %], p < 0.001) longer in the emergency department than those patients whose nurse patient ratio was in-ratio; this was also the same for wait times (37 % longer waits time [95 % CI [34 to 41 %], p < 0.001]). Similarly, independent of daily emergency department volume, hospital occupancy and emergency department admission rate, Ramsey et al. (2018) identified that days in the lowest quartile of nursing hours (336 to 422 nursing hours) (95 % CI [256.4–273.6]) experienced a 28.2-minute increase in length of stay per patient (time from registration to discharge) compared to days in the highest quartile of nursing hours (505 to 580 nursing hours) (95 % CI [229.0–244.4]). However, door-to-admit length of stay showed no significant association with nurse staffing between the lowest nursing hour quartile (95 % CI [436.6–427.7]) and the highest nursing hour quartile (95 % CI [420.0–452.4]) (Ramsey et al., 2018).

In contrast, Rathlev et al. (2012) reported no association between nurse staffing levels and patients' length of stay in the emergency department, identifying that predictors of increased length of stay included increases in hospital occupancy and the number of admissions from the department both to the hospital and intensive care unit. In addition, Weichenthal and Hendey (2011) reported that, following the introduction of mandated nursing ratios in an emergency department in California, the time patients spent in the department increased (room time, increased from 79 to 123 min (p < 0.0001); throughput time, increased from 365 to 397 min (p < 0.001), and admission time, increased from 447 to 552 min (p < 0.0001)). It is of note that the full-time equivalent of nursing staff remained unchanged pre and post the introduction of mandated ratios but the number of patients allocated to nursing staff reduced.

3.4.2.3. Association between nurse staffing and cardiac arrest and mortality in ED. Two studies, one assessed as being at moderate risk (de Cordova et al., 2017) and one assessed as being at high risk of bias (Tsai et al., 2021) explored the relationship between nurse staffing and the incidence of cardiac arrest and mortality whilst a patient was waiting in an emergency department. Tsai et al. (2021) reported a higher incidence of cardiac arrest in a department was associated with nurse to patient ratios of between 8.5 to 9.5 patients (reference nurse to patient ratio < 8.5) (RR: 1.33, 95 % CI [1.054, 1.672]) and for greater than 9.5 patients (RR: 1.54, 95 % CI [1.187, 1.994]) with the rate of emergency department cardiac arrest increasing significantly when the ratios were greater than 1 nurse to 9 patients. de Cordova et al. (2017) also identified an association between nurse staffing and the probability of death for patients admitted to an emergency department during the weekend with an acute myocardial infarction (b = −0.08, 95 % CI [−0.13, −0.04]).

3.4.2.4. Association between nurse staffing and patient experience. Two studies were identified that measured the association between nurse staffing and patient self-reports of their experience in an emergency department with both reporting an association between higher staffing levels and better patient experiences. One study (high risk of bias) identified that patients who were cared for in a department with one additional RN hour per patient arriving to the department were 2.4 percentage points more likely to rate their experience as "Good" or "Very Good" (p < 0.05); however, there was no association between RN hours per patient present in the emergency department and patient experience (Nelson et al., 2018). Daniel (2013) (high risk of bias) reported that a higher proportion of RNs in an emergency department were found to have a weak association with patient satisfaction with nursing care, patient satisfaction with overall care in the ED, and the likelihood to recommend the ED to friends and family; for each one per cent increment in RN staff skill mix, there was an associated increase in overall patient satisfaction with care received in the emergency department of 0.05 on a scale of 0 to 100.

4. Discussion

4.1. Summary of evidence

As with a previous systematic review (Recio-Saucedo et al., 2015), the outcomes identified as being associated with variability in nurse staffing in this updated review were patients leaving without being seen, time to medication administration, patient experience and waiting times. It was also identified in this review that studies measured care processes and outcomes not previously identified in the Recio-Saucedo et al. review including, time to therapeutic treatments and diagnostic evaluation and unexpected cardiac arrest whilst in an emergency department. Overall, the findings in emergency settings were generally consistent with those identified in studies in other medical and surgical settings (Griffiths et al., 2018; Kane et al., 2007), that higher nurse staffing is associated with improved quality and a reduction in adverse patient outcomes; however, the level of evidence assessed in emergency departments was weaker than that identified in the studies published in other acute settings (see Table 3).

Patients leaving without being seen was the most frequently measured patient outcome that was identified as being associated with nurse staffing. This was highlighted as being a risk to patients as the majority of patients who leave an emergency department without being seen will, at some stage, need to re-present for care within 24 h (Kennedy et al., 2008) and is a key indicator of the quality of the patient experience (Anderson et al., 2016). The complexity of factors associated with patients leaving without being seen was highlighted in two studies (Rathlev et al., 2020; Anderson et al., 2016); the results from these studies indicated that the point in the emergency department process where patients interact with nursing staff, in particular timely triage assessment and the care delivered by advanced nurse practitioners, have a role in reducing the proportion of patients who leave without being seen.

Nurse staffing was also reported as being related to patient length of stay in the emergency department, with higher levels of staffing associated with reduced lengths of stay. As the number of patients increased in an emergency setting, this resulted in elevated workloads for nursing staff who were therefore delayed in processing the next steps in a patient's care pathway resulting in increased lengths of stay (Shindul-Rothschild et al., 2017). As Tsai et al. (2021) highlight, delays in processing the next step in the patient pathway may result in the inability of staff to complete vital sign observations and undertake surveillance of patients, particularly in crowded emergency departments.

Apart from two studies (de Cordova et al., 2017; Johansen et al., 2015), the association between skill-mix (the proportion of care provided by RNs compared to nursing assistants) and patient outcomes in emergency departments is unclear, although Johansen et al. (2015) did indicate that a higher proportion of RNs were associated with better patient outcomes, a result similar to that identified in studies undertaken in medical and surgical settings (Griffiths et al., 2016; Griffiths et al., 2018). This is due to the fact that emergency departments tend to be staffed by a higher proportion of RNs than that seen in general settings (Amritzer et al., 2021).

We assessed the majority of the studies as being of high risk of bias and with relatively poor external validity with the vast number of studies using cross-sectional designs that were undertaken at single hospital sites. However, there were exceptions, with three studies in particular taking a more rigorous approach to measuring the association between nurse staffing and patient outcomes in an emergency department (Johansen et al., 2015; Rathlev et al., 2020; Shindul-Rothschild et al., 2017).

Although there is evidence of advances in research examining staffing in emergency settings over the last decade, there remain a number of gaps in the literature exploring the association between nurse staffing and patient care processes and outcomes. These include a lack of longitudinal studies, which are stronger in measuring the causal

relationship between nurse staffing and patient outcomes, and those which take into consideration the role of other staff groups, including physicians, advanced practitioners and the use of temporary staff in emergency settings. In addition, there is a need to extend the number of emergency departments from which data is collected to enhance the generalisability of the findings; it is of note that very few of studies in this review were undertaken outside of the US.

There was also a number of differences in defining the patient outcomes measured in the studies reviewed; for example, patients leaving a department without being seen were defined in a number of ways, including leaving before treatment has commenced or leaving before being discharged by a physician, the latter including those patients who leave following screening or leave against advice (Anderson et al., 2016). The complexity of measuring the association between nurse staffing and patient outcomes in emergency departments was particularly highlighted in the studies by Anderson et al. (2016) and Rathlev et al. (2020). Although Anderson and colleagues identified that the strongest predictor of leaving before treatment is completed is the time patients spend from registration to be seen by a physician or advanced practitioner, both medical and RN staffing and the organisation of the ED, not patient volume, were central factors determining when patients are seen by a key decision-maker.

There was also inconsistency in the measurements of nurse staffing in emergency departments in the included studies, an issue highlighted in reviews of staffing in medical and surgical settings (Dall'Ora et al., 2022); this makes it difficult to compare studies. In addition, although the evidence reviewed suggests that higher levels of nurse staffing are associated with better patient outcomes, there remains an issue on the actual number of nurses and the skill-mix required to safely staff emergency departments, an issue identified in other clinical settings (Griffiths et al., 2020). This was highlighted in the studies that measured the impact of state mandated nurse to patient ratios where the evidence was mixed (Chan et al., 2009, 2010; Weichenthal and Hendey, 2011). Using the mandated nurse to patient ratio in emergency departments is a particular challenge due to the fluctuation in levels of patient attendance and patient acuity levels (Department of Health, 2022).

The majority of the studies reviewed did not comment on or measure the structure of the team in terms of experience, specialist qualifications in emergency nursing or length of service and patient outcomes, with the exception of Lee et al. (2021) who found no association between years of staffing experience in ED and time to analgesia. Other studies that have explored the structure of the team have reported variability in the association between years of RN experience and mortality, failure to rescue, and adverse patient events in acute care hospitals with the majority of studies reporting no association (Audet et al., 2018). One study has reported an association between nurse experience and triage decisions with more experienced nurses correctly classifying low-urgency patients but under triaging high urgency patients whereas the opposite was identified in less-experienced nurses (Levis-Elmelech et al., 2022).

Relatively few studies identified in the review considered other staffing grades such as physicians or health and social care professionals and the association with patient outcomes. Those that did (Anderson et al., 2016; Rathlev et al., 2020), reported that higher physician and RN staffing levels were associated with better patient outcomes. No studies were identified that, apart from nurses and physicians, included other staffing groups within the ED; the paucity of studies that measure the association between the multidisciplinary team staffing levels and patient outcomes has been identified in other healthcare settings (Dall'Ora et al., 2022). This lack of consideration of other healthcare professions in the studies reviewed is acknowledged as a potential for bias when reporting observed outcomes (Dall'Ora et al., 2022) and the associations between nursing levels and patient outcomes could be due to the effect of other cohorts of healthcare professionals as well as nurse staffing (Griffiths et al., 2016).

4.2. Limitations

There are a number of limitations in the review. The heterogeneity of the study designs, measures of nurse staffing, processes of care and outcomes may limit the ability to draw definitive conclusions or identify consistent patterns across the included studies. The focus on care processes and patient outcomes may not have captured the full spectrum of other outcomes associated with nurse staffing including organisational, environmental or staffing outcomes. Computer simulation studies were also excluded and with the growth in machine learning techniques and artificial intelligence, the inclusion of these study designs may add valuable contributions to the field. The review's search strategy and inclusion criteria might risk publication bias. By focusing on English-language studies and excluding conference abstracts, commissioned reports, and dissertations, there was a risk of missing relevant data or studies with conflicting results that could impact the overall findings; however, this literature would have had to be extensive to alter the overall conclusions. Although there was a level of subjectivity in the use of the NICE framework which could introduce biases in the evaluation process, there was very little variation in the assessors' assessment of the quality of the study designs reviewed. Excluding studies focusing on other specialist nursing roles in emergency departments, such as mental health nurses or advanced nurse practitioners, might overlook valuable insights into how different staffing compositions affect patient outcomes. However, these studies are very limited and we believe they would not have changed our overall conclusions.

5. Conclusion, and recommendations

Measuring the association between emergency department nurse staffing and patient outcomes is complex and is dependent on many interrelated factors including the number of registered nurses working in the emergency department, skill mix, presence or absence of various nursing staff categories, actual RN care time in the emergency setting, patient related variables, other healthcare professionals and patient flow. Given that an association between nurse staffing levels and patient outcomes, particularly mortality, in in-patient ward contexts has been demonstrated, the question about the impact of nurse staffing levels in emergency departments still needs to be addressed more comprehensively.

The heterogeneity and low overall quality of the studies within this review make it difficult to draw definitive conclusions. The heterogeneity stems from a number of compounding variables which include the variability in health systems in which the research is conducted, the differences in hospital size and infrastructure, presence/absence of support staff, variability in nursing roles and associated scope of practice. It was identified, however, that there is evidence of adverse effects on patient care from low staffing including unexpected cardiac arrest, delayed time to treatments and, in particular, leaving without being seen. There is also a need for longitudinal studies coupled with economic evaluations which take account of patient dependency, acuity, and staffing levels where interventions are clearly defined and build upon the existing body of knowledge outlined in this review. In addition, further studies are required that, as well as examining the relationship between the size of the workforce and patient outcomes in emergency departments, should also consider the association with structure and experience of the workforce. It is also noted that, whilst there are some similarities with other settings, emergency departments have a set of unique outcomes when measuring their association with nurse staffing. We would further argue that due to the uniqueness of emergency departments and the difference in patient outcomes when compared to acute in-patient settings, there is a need to contribute the results from these settings to the extant literature.

Increasingly, as well as nurses and physicians, other healthcare professions, such as physiotherapists and occupational therapists, are providing care in emergency departments and future studies are required to take their roles into consideration when measuring patient outcomes

in emergency settings. There is also a need to identify what constitutes a safe nurse staffing level in an emergency department; this will require a systematic approach that calculates the staffing complement based on patient need and presentation.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnurstu.2024.104706.

CRediT authorship contribution statement

Jonathan Drennan: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition. **Ashling Murphy:** Investigation, Methodology, Writing – original draft, Writing – review & editing. **Vera J.C. McCarthy:** Investigation, Writing – original draft, Writing – review & editing, Supervision. **Jane Ball:** Conceptualization, Writing – original draft, Writing – review & editing. **Christine Duffield:** Writing – original draft, Writing – review & editing. **Robert Crouch:** Conceptualization, Writing – original draft, Writing – review & editing. **Gearoid Kelly:** Investigation, Methodology, Writing – original draft, Writing – review & editing. **Croia Loughnane:** Investigation, Methodology, Writing – original draft, Writing – review & editing. **Aileen Murphy:** Investigation, Methodology, Writing – original draft, Writing – review & editing. **Josephine Hegarty:** Investigation, Methodology, Writing – original draft, Writing – review & editing. **Noeleen Brady:** Conceptualization, Writing – original draft, Writing – review & editing. **Anne Scott:** Writing – review & editing. **Peter Griffiths:** Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Professor Peter Griffiths is Executive Editor of the International Journal of Nursing Studies

Professor Jonathan Drennan is an Associate Editor on the International Journal of Nursing Studies.

References

Aiken, L.H., Sloane, D.M., Bruyneel, L., VandenHeede, K., Griffiths, P., Busse, R., Diomidous, M., Kinnunen, J., Kózka, M., Lesaffre, E., McHugh, M.D., Moreno-CasbasMT, Rafferty A. M., Schwendimann, R., Scott, P.A., Tishelman, C., vanAchterberg, T., Sermeus, W., 2014. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. Lancet 383, 1824–1830. https://doi.org/10.1016/S0140-6736(13) 62631-8.

Amritzer, M.A., Muntlin, Å., Berg, L.M., Göransson, K.E., 2021. Nursing staff ratio and skill mix in Swedish emergency departments: a national cross-sectional benchmark study. J. Nurs. Manag. 29 (8), 2594–2602. https://doi.org/10.1111/jonm.13424.

Anderson, D., Pimentel, L., Golden, B., Wasil, E., Hirshon, J.M., 2016. Drivers of ED efficiency: a statistical and cluster analysis of volume, staffing, and operations. Am. J. Emerg. Med. 34 (2), 155–161. https://doi.org/10.1016/j.ajem.2015.09.034.

Assaye, A.M., Wiechula, R., Schultz, T.J., Feo, R., 2020 Feb. Nurse staffing models in medical–surgical units of acute care settings: a cross-sectional study. Int. J. Nurs. Pract. 26 (1), e12812. https://doi.org/10.1111/ijn.12812 Epub 2019 Dec 16 31840875.

Audet, L.A., Bourgault, P., Rochefort, C.M., 2018. Associations between nurse education and experience and the risk of mortality and adverse events in acute care hospitals: a systematic review of observational studies. Int. J. Nurs. Stud. 80, 128–146.

Brown, L., Arthur, A.O., Lynch, B., Gray, W., Zumwalt, N., Goodloe, J.M., ... Thomas, S.H., 2012. 271 impact of nursing short-staffing and emergency department left without being seen. Ann. Emerg. Med. 60 (4), S97.

Care Quality Commission, 2020. Project Reset in Emergency Medicine—Patient FIRST. CQC.

Chan, T.C., Vilke, G.M., Killeen, J.P., Guss, D.A., Marshall, J., Edward, C.M., 2009. 310: impact of mandated nurse-patient ratios on time to antibiotic administration in the emergency department. Ann. Emerg. Med. Conf. 54 (3), S97.

Chan, T.C., Killeen, J.P., Vilke, G.M., Marshall, J.B., Castillo, E.M., 2010. Effect of mandated nurse–patient ratios on patient wait time and care time in the emergency department. Acad. Emerg. Med. 17 (5), 545–552.

Clarivate, 2021. The Endnote Team. Clarivate, Philadelphia, PA Avaliable at Endnote.com.

de Cordova, P.B., Johansen, M.L., Martinez, M.E., Cimiotti, J.P., 2017. Emergency department weekend presentation and mortality in patients with acute myocardial infarction. Nurs. Res. 66 (1), 20–27.

Cornish, S., Klim, S., Kelly, A.M., 2021. Is COVID-19 the straw that broke the back of the emergency nursing workforce? Emerg. Med. Australas. 33 (6), 1095–1099.

Covidence systematic review software, 2023. Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org.

Dall'Ora, C., Saville, C., Rubbo, B., Turner, L., Jones, J., Griffiths, P., 2022. Nurse staffing levels and patient outcomes: a systematic review of longitudinal studies. Int. J. Nurs. Stud. 134, 104311.

Daniel, I., 2013. The relationship between nurse staffing and patient satisfaction in emergency departments. Value Health 16 (3), A206.

Department of Health, 2022. Framework for Safe Nurse Staffing and Skill Mix in Adult Emergency Care Settings in Ireland. Final Report and Recommendations by the Taskforce on Staffing and Skill Mix for Nursing (available at file:///C:/Users/armurphy/Downloads/226687_1a13b01a-83a3-4c06-875f-010189be1e22%20(1).pdf).

Di Somma, S., Paladino, L., Vaughan, L., Lalle, I., Magrini, L., Magnanti, M., 2015. Overcrowding in emergency department: an international issue. Intern. Emerg. Med. 10, 171–175.

Griffiths, P., Ball, J., Drennan, J., Dall'Ora, C., Jones, J., Maruotti, A., Pope, C., Recio Saucedo, A., Simon, M., 2016. 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. Int. J. Nurs. Stud. 63, 213–225 (Nov).

Griffiths, P., Recio-Saucedo, A., Dall'Ora, C., Briggs, J., Maruotti, A., Meredith, P., Smith, G.B., Ball, J., Missed Care Study Group, 2018. The association between nurse staffing and omissions in nursing care: a systematic review. J. Adv. Nurs. 74 (7), 1474–1487 (Jul).

Griffiths, P., Saville, C., Ball, J., Jones, J., Pattison, N., Monks, T., Safer Nursing Care Study Group, 2020. Nursing workload, nurse staffing methodologies and tools: a systematic scoping review and discussion. Int. J. Nurs. Stud. 103, 103487 (Mar).

Health Information Quality Authority, 2022. Healthcare overview report: monitoring programme against the national standards in emergency departments. December 2022. Available at https://hiqa.ie/reports-and-publications/key-reports-investigations/healthcare-overview-reort-2022.

Hoxhaj, S., Moseley, M.G., Reese, C.L., 2004. Nurse staffing levels affect the number of emergency department patients who leave without treatment. Acad. Emerg. Med. 11, 459.

Johansen, M.L., de Cordova, P.B., Wei, D., Martinez, M.E., Cimiotti, J.P., 2015. The implications of nurse resources on cardiac care in the emergency department. Appl. Nurs. Res. 28 (2), 210–212. https://doi.org/10.1016/j.apnr.2014.06.002.

Kane, R., Shamliyan, T., Mueller, C., Duval, S., Wilt, T., 2007. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. Med. Care 45 (12), 1195–1204.

Kennedy, M., MacBean, C.E., Brand, C., Sundararajan, V., McD Taylor, D., 2008. Leaving the emergency department without being seen. Emerg. Med. Australas. 20 (4), 306–313.

Lee, S.R., Hong, H., Choi, M., Yoon, J.Y., 2021. Nursing staff factors influencing pain management in the emergency department: both quantity and quality matter. Int. Emerg. Nurs. 58, 101034.

Levis-Elmelech, T., Schwartz, D., Bitan, Y., 2022. The effect of emergency department nurse experience on triage decision making. Human Factors Healthc. 2, 100015.

Maben, J., Bridges, J., 2020. Covid-19: supporting nurses' psychological and mental health. J. Clin. Nurs. 29 (15-16), 2742.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., PRISMA Group*, 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann. Intern. Med. 151 (4), 264–269.

Muir, K.J., Sloane, D.M., Aiken, L.H., Hovsepian, V., McHugh, M.D., 2023. The association of the emergency department work environment on patient care and nurse job outcomes. J. Am. Coll. Emerg. Physicians Open 4 (5), e13040. https://doi.org/10.1002/emp2.13040 (2023 Sep 28, PMID: 37781503; PMCID: PMC10537505).

Nelson, D., Hearld, L.R., Wein, D., 2018. The impact of emergency department RN staffing on ED patient experience. J. Emerg. Nurs. 44 (4), 394–401.

NHS Improvement, 2018. Safe, Sustainable and Productive Staffing in Urgent and Emergency Care. NHS Improvement, London.

NICE, 2012. Methods for the development of NICE public health guidance—third edition. available atNational Institute for Health and Clinical Excellence https://www.nice.org.uk/process/pmg4/chapter/introduction.

Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., ... Moher, D., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst. Rev. 10, 1–11.

Pearce, S., Marchand, T., Shannon, T., Ganshorn, H., Lang, E., 2023. Emergency department crowding: an overview of reviews describing measures causes, and harms. Intern. Emerg. Med. 1–22.

Poon, Y.S.R., Lin, Y.P., Griffiths, P., Yong, K.K., Seah, B., Liaw, S.Y., 2022. A global overview of healthcare workers' turnover intention amid COVID-19 pandemic: a systematic review with future directions. Hum. Resour. Health 20 (1), 1–18.

Ramsey, Z., Palter, J.S., Hardwick, J., Moskoff, J., Christian, E.L., Bailitz, J., 2018. Decreased nursing staffing adversely affects emergency department throughput metrics. West. J. Emerg. Med. 19 (3), 496.

Rathlev, N.K., Obendorfer, D., White, L.F., Rebholz, C., Magauran, B., Baker, W., ... Olshaker, J., 2012. Time series analysis of emergency department length of stay per 8-hour shift. West. J. Emerg. Med. 13 (2), 163.

Rathlev, N.K., Visintainer, P., Schmidt, J., Hettler, J., Albert, V., Li, H., 2020. Patient characteristics and clinical process predictors of patients leaving without being seen from the emergency department. West. J. Emerg. Med. 21 (5), 1218.

Recio-Saucedo, A., Pope, C., Dall'Ora, C., Griffiths, P., Jones, J., Crouch, R., Drennan, J., 2015. Safe staffing for nursing in emergency departments: evidence review. Emerg. Med. J. 32 (11), 888–894.

Shindul-Rothschild, J., Read, C.Y., Stamp, K.D., Flanagan, J., 2017. Nurse staffing and hospital characteristics predictive of time to diagnostic evaluation for patients in the emergency department. J. Emerg. Nurs. 43 (2), 138–144.

Tsai, L.H., Chien, W.C., Chen, C.B., Tsai, S.L., Chaou, C.H., Weng, Y.M., ... Chien, C.Y., 2021. Association of patient-to-emergency department staff ratio with the incidence of cardiac arrest: a retrospective cohort study. Signa Vitae 17 (4), 118–124.

Weichenthal, L., Hendey, G.W., 2011. The effect of mandatory nurse ratios on patient care in an emergency department. J. Emerg. Med. 40 (1), 76–81. https://doi.org/10.1016/j.jemermed.2009.02.037 (Epub 2009 Apr 3. PMID: 19345043).

Wise, S., Fry, M., Duffield, C., Roche, M., Buchanan, J., 2015. Ratios and nurse staffing: the vexed case of emergency departments. Aust. Emerg. Nurs. J. 18 (1), 49–55.

Wolf, L.A., Perhats, C., Delao, A.M., Clark, P.R., Moon, M.D., 2017. On the threshold of safety: a qualitative exploration of nurses' perceptions of factors involved in safe staffing levels in emergency departments. J. Emerg. Nurs. 43 (2), 150–157.

Wretborn, J., Henricson, J., Ekelund, U., Wilhelms, D.B., 2020. Prevalence of crowding, boarding and staffing levels in Swedish emergency departments-a National Cross Sectional Study. BMC Emerg. Med. 20, 1–8.

Youd, J., 2015. Workforce planning for urgent care services. Emerg. Nurse 23 (4), 14–19. https://doi.org/10.7748/en.23.4.14.