Journal of the Korea Academia-Industrial cooperation Society
Vol. 22, No. 1 pp. 104-115, 2021

https://doi.org/10.5762/KAIS.2021.22.1.104
ISSN 1975-4701 / eISSN 2288-4688

Nurse Staffing and Patient Outcomes in Korea: A Systematic Review

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Abstract The purpose of this review was to systematically assess empirical studies on the relationship between nurse staffing and patient outcomes through systematic literature review. Peer-reviewed articles published between January 2009 and December 2018 were identified in CINAHL, Pubmed, EBSCOhost, RISS, and Dbpia databases. A total of 13 articles relating to nurse staffing and patient outcomes in Korea were systematically reviewed and analyzed. The review showed that better nurse staffing aligned with better patient outcomes. However, some studies did not directly correlate patient outcomes with nurse staffing. This is because each study examined varied aspects of nurse staffing and different patient outcomes. These inconsistent study results indicate that continuous study is required . There should be continued efforts to establish guidelines and strategies for deploying nurse staff by maintaining optimal patient-to-nurse ratio.

요 약 본 연구의 목적은 체계적 문헌고찰을 통해 국내 급성기 병원 간호인력 배치 수준과 환자 건강 결과 간의 관계에 대한 연구를 체계적으로 평가하기 위함이다. 2009년 1월부터 2018년 12월까지 CINAHL, Pubmed, EBSCOhost, RISS, Dbpia 데이터베이스에 출판된 급성기 병원 간호인력 배치 수준과 환자 건강 결과 간의 관계에 대한 연구를 검색하였다. 국내 급성기 병원 간호 인력 배치 수준과 환자 건강 결과에 대한 관계를 파악한 연구 13편을 체계적으로 고찰하였다. 대부분의 연구에서 국내 급성기 병원의 간호 인력 배치 수준이 높을수록 환자 건강 결과가 제고됨을 확인하였다. 하지만, 몇몇 연구에서는 간호 인력과 환자 건강 결과 간의 유의한 관계가 없는 것으로 확인되었다. 이처럼 일관되지 않은 연구 결과는 연구들마다 서로 다른 측면의 간호 인력과 환자 건강 결과를 측정했기 때문인 것으로 사료된다. 이는 이와 관련한 지속적인 연구가 필요함을 시사한다. 환자 건강결과 향상을 위해 적정 수준의 환자 대 간호사 비율을 산정하고 이를 바탕으로 간호사들을 배치하는 전략 및 가이드라인을 세우기 위한 지속적인 노력이 필요하다.

Keywords : Nurse staffing, Nursing staff, Patient, Outcome, Systematic review

1. Introduction

Nurse provides holistic care to patients throughout the day and night [1]. Nurses are in a good position to monitor and prevent adverse events. Also, more complicated healthcare procedures are required in hospitals [2]. Thus, appropriate nurse staffing in hospitals are

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (2020R1I1A1A01066972)
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Received September 2, 2020 Revised October 27, 2020
Accepted January 8, 2021 Published January 31, 2021

associated patient outcomes [3]. Increasing the number of the nurses has been recommended as a means to improve the quality of patient care [4].

In South Korea, a medical law was enacted in 1962 to employ one nurse for every 2.5 patients in hospitals [5]. However, hospital do not comply with this recommendation. In 2016, nearly 60 years later, only 17.4% of medical institutions follow government recommended staffing levels [6]. Also, a financial-incentive policy on nurse staffing, the nursing fee differentiation policy (NFDP) was implemented in 1999 [2]. The NFDP sets up a system in which hospitalization fees are paid differently for medical care, depending on the level of nursing-staff acquisition and consists of seven grades. The system was introduced to prevent the deterioration of nursing quality by delegating nursing services to certified nurse assistants (CNAs) and other caregivers for patients. Grades are determined by the ratio of beds to nurses in the general ward [2]. However, the rating calculation criterion has changed to the ratio of beds to patients in 2018. These nurse-staffing policies aim to improve quality of care to ensure appropriate nurse staffing level. Despite these policies, South Korea's quality of care and number of nurses have been rated lower than the average in Organisation for Economic Co-operation and Development member countries [7].

Nurse staffing is measured by either skill mix (proportion ot professional staff) or staffing level. Staffing mix means nursing professional skill mix and reflects the quality of the nursing staff. With respect to skill mix, the registered nurse (RN) staffing ratio is often used to represent the proportion of RNs in the total number of nursing staff, including RNs, licensed practical nurses (LPNs), and CNAs [2]. However, because South Korea has no LPNs, it usually means the ratio of RNs to CNAs. Because the policy of nursing staff in other countries is the ratio of patients to nurses, the level of nurse staffing is mainly measured by the nurse-to-patient ratio and reflects the quantity of nursing staff. The standard measure of nurse staffing in South Korea is the number of beds [6]. For this reason, research on nurse staffing in domestic studies is mainly measured by the nurse-to-bed ratio. Many researchers examined the relationship between nurse staffing and patient outcomes [8,9,10]. The lower the nurse-to-patient ratio (better nurse staffing) [8,9], and the lower the nurse-to-bed ratio (better nurse staffing), the higher the percentage of nurses on staff (better RN skill mix) and the better the patient health outcomes [10].

The relationship or nurse staffing to patient outcomes was studied abroad and in South Korea. In the international literature, a systematic review of the relationship between nursing staff and patient outcomes was conducted in 2007 [8]. The researchers found that increased RN staffing aligns with lower hospital-acquired pneumonia, unplanned extubation, respiratory failure, cardiac arrest, and hospital mortality rate. However, no systematic review of the literature has occurred for 12 years, despite changes in nursing-staff calculation standards and patient-outcome variables due to changes in various nurse-staffing policies and changes in the medical environment. This review included recently published studies (2009~2018) investigating associations between nurse-staffing levels and patient outcomes in South Korea. In addition, although fragmentary studies assessed nursing-staff level and patient outcomes in South Korea, no study reported comprehensive results.

Considering that Korea's nursing staffing policy is different from other countries, the impact of the level of nursing staff deployment on patient health outcomes may vary, it is also necessary to conduct a systematic review in Korea. Study results provide evidence for

establishing a nurse-staffing policy to improve patient outcomes.

2. Methods

For this study, I used the guidelines for conducting systematic reviews in health care developed by the Centre for Reviews and Dissemination [11].

2.1 Search Strategy and Data Sources

The search strategy included five electronic databases: CINAHL, Pubmed, EBSCOhost, RISS, and Dbpia. I searched title, abstract, and keyword to identify relevant journals in June of 2019. I used the search terms—nurse staffing, patient outcomes, Korea—in all databases. I also reviewed the reference lists of included studies to search relevant studies. I limited the search to work conducted from January 2009 to December 2018.

2.2 Inclusion Criteria

I selected and reviewed studies published since 2009 if they met all of the following inclusion criteria: (a) researchers examined the associations between nurse staffing and patient outcomes in a hospital setting (acute setting), (b) articles were written in English or Korean with the full text available, (c) the research was peer-reviewed, and (d) the methodology was quantitative

2.3 Screening

I conducted a systematic literature review following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA; Figure 1). The first screening stage included deleting duplicate literature. The second stage entailed review of all titles and abstracts. All papers that passed screening proceeded to full-text screening using the inclusion criteria.

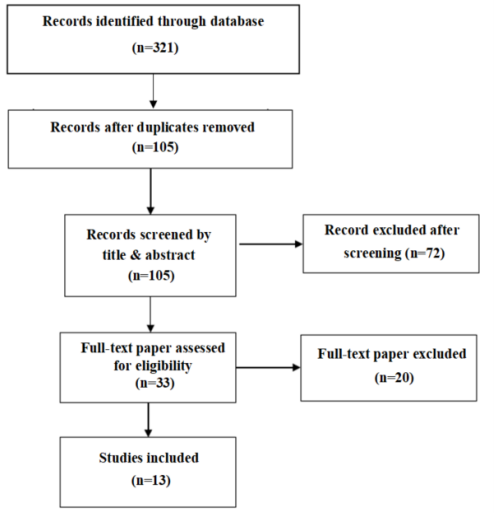

Fig. 1. Selection of studies for review

2.4 Data Extraction

I extracted the following data from the included 13 studies: author, year of publication, study design, sample and setting (population), measure of nurse staffing, outcome measures, analytic techniques, and key findings, covariates.

2.5 Quality Review

To assess the quality of the 13 quantitative articles, I used the Quality Assessment and Validity Tool for Correlation Studies [12,13]. Items on the quality-assessment tool included design, sample, measurement, and statistical analytic tecniques. I modified items using the independent variables (nurse staffing) and dependent variables (patient outcomes). I evaluated 13 items with the tool yielding a total of 13 possible points. Based on the assigned points, we categorized studies as having low (0-4), moderate (5-9), or high (10-13) quality. A total of 13 quantitative articles had moderate methodological quality (Table 1).

Table 1. Summary of Quality Assessment.

	Number of Articles	
	No	Yes
Design		
Was the study a prospective study?	13	0
Was probability sampling used?	0	13
Sample		
Was the sample size justified?	13	0
Was the sample drawn from more than one site?	1	12
Was anonymity protected?	0	13
Was the response rate more than 60%?	0	13
Measurement		
Were nurse staffing variables measured reliably?	0	13
Was nurse staffing variables measured using a valid instrument?	0	13
Were outcome variables measured using a valid instument?	0	13
Was a theoretical model/framework used for guidance?	12	1
Statistical analysis		
In multiple effects studies, were correlations analyzed?	0	13
Were covariates controlled?	2	11
Were outliers managed?	13	0

2.6 Analysis

I synthesized the extracted data through descriptive synthesis. The meta-analysis was not performed due to the variety of variables that measure nurse staffing and patient outcome. For the descriptive synthesis, I examined study characteristics to identify common threads, based on common characteristics: authors, study design, sample and setting (population), measure of nurse staffing, measure of patient outcome, analytic techniques, and key findings.

3. Results

All the final 13 studies used a cross-sectional design with observation [A1-A13]. These observational studies used either in-hospital databases [A13] or a large database as a secondary analysis [A1-A12]. Large databases accrued from inpatient databases from the National Health Insurance System. I extracted the hospital facility, nurse staffing, and patient outcomes from the Health Insurance Review Agency (HIRA). South Korea has a national health insurance system and almost every Korean citizen is enrolled in it, with information recorded about the use of medical institutions. The sample size varied by study, ranging from 1 to 1,182 hospitals. The number of studies using primary data collection by hospital database was small, whereas the sample size of those studies using secondary data from HIRA was larger.

Following are the characteristics of hospital patients: haemorrhagic and ischemic stroke in the intensive-care unit ICU [A1], cardiovascular disease patients with a primary diagnostic code who used the ICU [A8], surgical patients (general, orthopaedic, and vascular) [A3], surgical patients (neurologic, vascular, gastrointestinal, liver and gallbladder) [A9], all surgical patients [A2], stroke patients in hospitals [A6], patients in five surgical units (thoracic and cardiovascular surgery, surgical digestive tract, pulmonology, obstetrics/gynaecology, and paediatrics) [A11], psychiatric inpatients [A7], and all patients regardless of specific disease or specific unit [A4,A5,A10], Characteristics of these 13 studies included in this systematic review appear in Table 2.

Table 2. Characteristics of Included Studies.

No	Source	Nurse Staffing	Patient Outcomes	Study design	Sample, setting	Analysis	Key findings	covariate
1	Cho et al., 2009	Nurse-to-bed ratio	In-hospital mortality 30-day mortality after discharge	Retrospective Cross-sectional	Hemorrhagic and ischemic stroke who were admitted to ICUs of 185 hospitals (40 teritary and 145 secondary), 6957 patients	Logistic regression	Better nurse staffing is associated with lower in-hospital and 30-day mortality	Age, gender, type of medical security, primary diagnosis, and secondary diagnosis
2	Cho et al., 2011	Nurse staffing grade based on the Nurse-to-bed ratio	Length of stay In-hospital mortality Mortality within 30 days of admission	Retrospective Cross-sectional	Inpatient database from the National Health Insurance (subject to surgical hospitalization claims only with medical year 2008) 1,182 hospitas	Multilevel analysis	In teritary hospital, no significant findings related to length of stay and in-hopital morality within nurse staffing grade in teritary hospital. The better nurse staffing grade, the lower the mortality within 30 days In hospital, the better nurse staffing grade, the lower length of stay, in-hospital mortality, mortality within 30 days of admission	Severity, Percentage of inpatients over the age of 65, location, number of beds,
3	Cho et al., 2015	Nurse-to-Patient ratio	Mortality within 30 days of admission	Retrospective Cross-sectional	Hospital facility data with staff nurse survey data (N=1,024) and surgical patient (general, orthopedic, or vascular surgery) discharge data (N=76,036) from 14 high-technology teaching hospitals with 700 or more beds, collected between January 1, 2008 and December 31, 2008	Logistic regression	Additional patient per nurse is associated with an 5% increase in the odds of patient death within 30 days of admission	Location, number of beds, teaching status, echnology, age, gender, type of admission, type of surgery, chronic onditions, Clinical Modification (ICD-10-CM) codes
4	Cho et al., 2018	Nurse-to-Patient ratio	Length of stay	Retrospective Cross-sectional	The survey data (N = 1,665) were linked with patient discharge data (N = 113,438) and hospital facility data from 58 hospitals with 100 or more beds, 2008~2009	Multilevel analysis	Nurse staffing was significantly associated with the length of stay of surgical patients in acute care hospitals.	Location, age, gender, type of admission, transfer status, major diagnostic category, Elixhauser comorbidities
5	Chung, 2013	Nurse-to-Patient ratio CNA-to-Patient ratio CNA-to-Nurse ratio	Length of stay	Retrospective Cross-sectional	National Health Insurance Service-Senior (NHIS-Senior) claim database from 2010 1,254 hospitals, 484,014 patients	Logistic regression	In teritary hospital, higher Nurse-to-Patient ratio (better nurse staffing) related to lower length of stay No significant findings relatedto length of stay and CNA-to-Patient ratio, CNA-to-Nurse ratio In hospital, higher Nurse-to-Patient ratio, CNA-to-Patient ratio, CNA-to-Nurse ratio (better nurse staffing) related to lower length of stay	Age, geder, Insurance type, type of admission, location
6	Chung & Shon, 2018	Nurses per 100beds	In-hospital mortality	Retrospective Cross-sectional	2009 NHI claims data and included the details of stroke patients admitted to variously sized hospitals 615 hospitals, 11 819 patients	Logistic regression	More nurses per beds is associated with lower in-hospital mortality	Comorbidities, physician-to-bed ratio, and medical costs.
7	Han et al., 2015	Number of nurses	Readmissions within 30 days of discharge	Retrospective Cross-sectional	National Health Insurance claim data 2010-2013 81 hospitals, 21,315 patients	Multilevel analysis	Readmission rates for psychiatric disorders within 30days of discharge were lower in-hospitals with a higher number of nurses	N/A

No	Source	Nurse Staffing	Patient Outcomes	Study design	Sample, setting	Analysis	Key findings	covariate
8	Kim, 2018	Nurse staffing grade based on the Nurse-to-bed ratio -Level of nurse staffing was categorized into 4 groups in each year: grade 1 to 2, grade 3 to 4, grade 5 to 6, and grade 7 to 9	30-day mortality after discharge In-hospital mortality	Retrospective Cross-sectional	National Health Insurance Service-Senior (NHIS-Senior) claim database from 2002 to 2013 We included CV disease inpatients as a primary diagnostic who had their ICU utilization (17,081 patients)	Cox proportional hazards model	In general hospital, hazard ratio for 30-day mortality after discharge and in-hospital 30-day mortality were higher in grade 7 to 9 than grade 1 to 2, but not in teritary hospital	Age, sex, income, type of insurance, region, primary diagnosis, route of admission, Charlson Comorbidity Index (CCI), organization type, number of doctors, hospital technology
9	Kim et al., 2012	Nurse staffing grade based on the Nurse-to-bed ratio	Mortality Pneumonia Sepsis UTI	Retrospective Cross-sectional	National Health Insurance Service-Senior (NHIS-Senior) claim database from 2009 111,491 surgical patients	Logistic regression	Higher nurse staffing grade (better nurse staffing) is associated with lower mortality, pneumonia, sepsis No significants findings related to nurse staffing grade amd UTI	Type of hospital, location, doctor staffing, Insurance type,income,history, type of operation, route of admission,severity of disease
10	Kim et al., 2018	Nurse-to-bed ratio	Urinary tract infection Upper gastrointestinal tract bleeding Deep vein thrombosis Hospital acquired Pneumonia Pressure ulcer Sepsis Shock/cardiac arrest CNS complication In-hospital mortality Wound infection Physoilogic/metabolic Derangement Pulmonary failure	Retrospective Cross-sectional	46 hospitals 3,665,307 patients 19 years or older and admitted at tertiary hospitals for two years (2013-2014) using electronic reimbursement claims data.	Logistic regression	Six nursing-sensitive outcomes rates (urinary tract infection, upper gastrointestinal tract bleeding, hospital-acquired pneumonia, shock/cardiac arrest, in-hospital death, and wound infection) showed an increasing trend as nurse staffing level degraded	Age, sex, socioeconomic status, route of admission, surgical operation, use of ICU, Charlson's comorbidity score, number of beds, location
11	Kim & Kim, 2018	Nurse staffing grade based on the Nurse-to-bed ratio	Repiratory tract infection Gastrointestinal infection Pneumonia Sepsis Arrest/shock/respiratory failure Wound infection Postoperative cardiopulmonary complication Pressure ulcer	Retrospective Cross-sectional	Health insurance review and assessment data for all children under 18 years old admitted at 46 tertiary hospitals in Korea between 2013 and 2014.	Logistic regression	Nurse staffing levels had a clear relationship with the occurrence of lower respiratory tract infection and gastrointestinal infection. Five paediatric nursing-sensitive outcomes (pneumonia, sepsis, arrest / shock / respiratory failure, wound infection and postoperative cardiopulmonary complication) showed weak relationships with nurse staffing levels. Pressure ulcers and failure to rescue had thelowest incidences in hospitals with the lowest nurse staffing levels.	N/A

No	Source	Nurse Staffing	Patient Outcomes	Study design	Sample, setting	Analysis	Key findings	covariate
12	Lee et al., 2011	Nurse-to-bed ratio CNA-to-bed ratio	Length of stay	Retrospective Cross-sectional	Among the hospitals where the medical year and month of care responded to the survey from January to March 2008, 259 hospitals with the number of doctors and nursing assistants registered in the health insurance review and evaluation institute's nursing institution status DB system	Logistic regression	The higher the number of operatinghospital beds per RN ande higher the number of operating hospital beds per CNA are related to longer the length of stay.	Type of hospital, number of beds, type of medical security
13	Yu & Kim, 2015	number of nurses	Length of stay Mortality	Retrospective Cross-sectional	1 hospital, For unit-level evaluations, 5 surgical units (thoracic and cardiovascular surgery, surgical digestive tract, pulmonology, obstetrics/gynaecology and paediatrics) that had the same composition of 42 beds 210beds), 16 nurses	Logistic regression	The length of stay was significantly shorter after the additional RN was assigned to the unit No significant findings related to mortality and number of nurses	N/A

3.1 Nurse Staffing

From many of the studies, it appears that the relationship between nurse staffing and patient outcomes aligns more with RN staffing levels and the proportion of RNs in the total staff mix [14]. Three studies reported nurse staffing as the nurse-to-patient ratio [A3,A4,A5], four studies reported the nurse-to-bed ratio [A1,A6,A10,A12], and four studies reported the nurse staffing grade (NFDP), calculated on the basis of the nurse-to-bed ratio [A2,A8,A9,A11]. Only one study reported nurse staffing as the CNA-to-RN ratio [A5], and two studies reported the CNA-to-bed ratio [A5,A12]. Two studies reported the total number of nurses [A7,A13].

3.2 Patient Outcomes

Mortality rate is the most powerful assessment of the quality of care a patient receives during hospitalization. Mortality is widely used to assess the quality of health care [15]. Researchers used various approaches to measure mortality in the analysed studies. Four studies used in-hospital mortality [A1,A2,A6,A8,A9,A13], two studies used mortality within 30 days of admission [A2,A3], and two studies used 30-day mortality after discharge [A1,A8] to measure patient outcomes.

Also, researchers often used length of stay to assess the quality of care with length of stay reduced by preventing adverse effects on patients when sufficient numbers of nurses are working [16]. In five of the 13 studies, length of stay was used as an indicator of patient outcomes [A2,A4,A5,A12,A13]. Only one study used readmissions within 30 days of discharge as an indicator of patient outcomes [A7].

Three studies examined the effect of nurse staffing on nursing-sensitive outcomes (NSOs). In the study of surgical patients [A9], pneumonia, sepsis, and urinary-tract infection, which can occur especially frequently in postoperative patients, were used as patient outcomes. Kim and Bae (2018) used NSOs as an indicator of patient outcome [A10]. They defined the denominator,

numerator, and exclusion criteria using the ICD-10 codes to calculate incidences of 13 NSOs for each indicator. The indicators are urinary-tract infection, upper-gastrointestinal-tract bleeding, deep-vein thrombosis, hospital-acquired pneumonia, pressure ulcer, sepsis, shock/cardiac arrest, central-nervous-system complications, in-hospital death, incidences of wound infection, physiologic/metabolic, derangement, and pulmonary failure. Kim and Kim (2018) also defined numerator, denominator, and exclusion criteria using the ICD-10 codes to calculate incidences of 11 paediatric NSOs for each indicator [A11]. Central-venous-line infection and infectious disease of 13 paediatric NSOs were excluded because the child's weight is not included in the HIRA database, and the incubation period cannot be calculated using HIRA data. Accordingly, the final indicators that Kim and Kim (2018) selected to meausre patitne outcomes were as follows: respiratory-tract infection, gastrointestinal infection, pneumonia, sepsis, arrest/shock/respiratory failure, wound infection, postoperative cardiopulmonary complication, and pressure ulcer.

3.3 Relationships Between Nurse Staffing and Patient Outcomes

Increased nurse staffing included more RN in the staffing skill mix, bed-to-nurse ratio, patient-to-nurse ratio, bed-to-CNA ratio, higher nursing grade, and more RNs in settings. In most studies, patient outcomes positively relating to nurse staffing were mortality, length of stay, and NSOs. The greater amount of time nurses can engage in surveillance of patients, including detection of patient conditions and needs, as well as nursing care to reduce the occurrence of adverse events, the better the reduction in length of stay, mortality, and NSOs [17].

However, in a study conducted separately comparing the superior general hospital and general hospital, no difference emerged in mortality between nursing grades in the superior general hospital [A2]. Also, a significant difference in mortality emerged between nursing grades in general hospitals. Thus, effective patient-health outcomes may vary by type of medical institution. Also, a study that examined the relationship between nurse staffing and urinary-tract-infection rate in postoperative patients showed that nurse staffing did not align with the urinary-tract-infection rate [A9]. These inconsistent study results indicate that continuous study is required.

3.4 Risk Adjustment/Control Measures Used in Studies

To control for alternative explanations of patient outcomes, several studies used variables as covariates in examining the relationship between nurse staffing and patient outcomes. These covariates included patient characteristics and hospital characteristics. The purpose of including these covariates was to reduce errors and find unbiased relationships between nurse staffing and patient outcomes. Researchers controlled for the following patient characteristics: age, sex, primary diagnosis, secondary diagnosis, disease severity, type of status, transfer status, chronic conditions, comorbidities, type of insurance, and income. Researchers controlled for the following hospital characteristics: location, number of beds, teaching status, organization type, and number of doctors.

4. Discussion

This review showed that a higher level of nurse staffing aligned with a decrease in the risk of mortality, readmission, length of stay, and better NSOs. Unfortunately, all of the reviewed studies used cross-sectional design so no causal

relationship can be determined. Future studies need to be conducted with longitudinal designs.

In a study on the relationship between nursing staff and patient outcomes conducted in South Korea, researchers mainly measured nurse-staffing level with bed-to-nurse ratios. Due to guidelines from a financial-incentive policy on nurse staffing (NFDP), the standard of calculation for this system is the number of beds, implemented since 1999 in South Korea [2]. Nursing grades were set according to the bed-to-patient ratio and incentives are paid differently according to nursing grade. The seven grades are determined by the ratio of beds to RNs in general wards. Grade 1 should have a ratio lower than 2.5:1, Grade 2 a ratio ranging from 2.5:1 to less than 3:1, Grade 3 a ratio ranging from 3 to less than 3.5:1, Grade 4 a ratio ranging from 3.5 to less than 4:1, Grade 5 a ratio ranging from 4 to less than 4.5:1, Grade 6 a ratio ranging from 4.5 to less than 6:1, and Grade 7 a ratio ranging from more than 6:1.

Despite the differential incentive payments, many lower rated medical institutions are thought to require greater sanctions. The rating-calculation criteria have changed to the ratio of beds to patients, in 2018 [2], calculated based on the number of patients in other countries such as the United States, Australia, and Japan [18]. In addition, Japan changed the ratio of nurses-to-patients to shift-work hours rather than assessing on a daily basis, in 2006. The United States and Australia also calculate the patient-to-nurse ratio by shift. In South Korea, the number of patients in each nurse's charge is still simply stated, not by shift. Therefore, the inpatient database from the National Health Insurance System are not been reflected in this way. A further limitation is that studies in South Korea mainly used the inpatient database from the National Health Insurance to assess the relationship between nursing staff and patient outcomes. Therefore, future studies need to be conducted on the relationship between nurse staffing by shift and patient outcomes.

Needleman et al [19] investigated the relationship with the length of stay, readmission, and mortality of patients to analyse the economic effects of skill mix. As a result, the researchers suggested that the number of nurses be increased and the number of CNAs reduced to bring about improvements in patient outcomes without increasing hospital staffing costs. The same result came from a UK prospective study using direct observation of nursing activity; the researchers found that the quality of nursing care improved as the ratio of qualified and further trained staff-to-patients increased, and by increasing grade mix [20]. Only one study used skill mix. In South Korea, the smaller the hospital, the larger the number of CNAs. Therefore, domestic research is needed to understand the relationship between skill mix and patient outcomes.

Only one [A1] of the 13 studies used a conceptual framework. The conceptual framework was based on Donabedian's structure-process-outcome model [21]. The conceptual framework presents the direction of how to explore the research question and purpose of the researcher and what to explore. It is quite important because it lays the foundation for research progress, and even if it addresses the same research topic, it can yield completely different results, depending on the theoretical framework used. Therefore, it is important to select and apply the appropriate theoretical framework when conducting these studies in the future.

Nurse staffing has usually been considered a structural variable in the relationship between nurse staffing and patient outcomes [22]. However, nurse staffing can be used a process variable. Process variables may include how nursing staff interact with other staff and with patients. Future studies need to examine if

staffing is a process variable.

Some studies analysed results using logistic regression. In developing statistical modelling, researchers have recommended that data on patients who are clustered in organizations be treated by advanced analytic methods (e.g., multilevel analysis). Only three [A2,A4,A7] of the 13 studies used a multilevel analysis. Future studies need to use a multilevel analysis method.

5. Conclusion

This study systematically reports the main content of studies after searching and evaluating nurse staffing and patient outcomes. I used 13 quantitative studies in the analysis. Some limitations of this study follow. First, several studies might have used similar datasets. For example, data from studies by Cho et al. (2011) [A2], Cho et al. (2015) [A3], and Lee et al. (2011) [A12] derived from surveys in a 2008 inpatient database from the National Health Insurance. Data in studies by Kim et al. (2018) [A8] and Kim and Kim. (2018) [A9] derived from surveys in a 2013~2014 inpatient database from the National Health Insurance. Another limitation of this study is that only studies up to 2018 were used in the analysis, so criteria to calculate nursing grades did not reflect changes in the number of beds to patients in 2018.

Despite the above limitations, this study provides empirical evidence that nurse staffing is an important factor to improving patient outcomes. Accumulating evidence shows a relationship between nurse staffing, especially a higher patient-to-nurse ratio, and patient outcomes. However, this review has shown that each study examined different aspects of nurse staffing and different patient outcomes. Also, some indicators, such as the relationship of skill mix and length of stay and patient-to-CNA ratio and length of stay showed inconsistent results. It is hard to determine the appropriate staffing level to improve patient outcomes in South Korea. Therefore, inconsistent findings suggest that more studies are needed in this area. The results of this study contribute to the calculation of appropriate levels of nurse staffing to improve patient outcomes in the future.

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Appendix 1. The List of Systematic Review Articles

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〈Research Interests〉
Nursing staff, Long-term care, Education