



# Nurse staffing and nurse outcomes: A systematic review and meta-analysis

Sujin Shin, PhD, RN<sup>a</sup>, Jin-Hwa Park, PhD, APRN-BC, RN<sup>b</sup>,  
Sung-Heui Bae, PhD, MPH, RN<sup>a,\*</sup>

<sup>a</sup> College of Nursing, Ewha Womans University, Seoul, Republic of Korea

<sup>b</sup> College of Nursing, Daegu Catholic University, Daegu, Republic of Korea

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## ABSTRACT

**Background:** A great number of studies have been conducted to examine the relationship between nurse staffing and patient outcomes. However, none of the reviews have rigorously assessed the evidence about the effect of nurse staffing on nurse outcomes through meta-analysis.

**Purpose:** The purpose of this review was to systematically assess empirical studies on the relationship between nurse staffing and nurse outcomes through meta-analysis.

**Methods:** Published peer-reviewed articles published between January 2000 and November 2016 were identified in CINAHL, PubMed, PsycINFO, Cochrane Library, EBSCO, RISS, and DBpia databases.

**Findings:** This meta-analysis showed that greater nurse-to-patient ratio was consistently associated with higher degree of burnout among nurses (odds ratio: 1.07; 95% confidence interval [CI]: 1.04–1.11), increased job dissatisfaction (odds ratio: 1.08; 95% CI: 1.04–1.11), and higher intent to leave (odds ratio: 1.05; 95% CI: 1.02–1.07). With respect to needlestick injury, the overall effect size was 1.33 without statistical significance.

**Discussion:** The study findings demonstrate that higher nurse-to-patient ratio is related to negative nurse outcomes. Future studies assessing the optimal nurse-to-patient ratio level in relation to nurse outcomes are needed to reduce adverse nurse outcomes and to help retain nursing staff in hospital settings.

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## Introduction

Hospital nursing staff provides holistic care to patients and their families for 24 hours a day. Suboptimal nurse staffing such as lower staffing levels, greater use of nurse overtime, high use of temporary nursing staff, and high

turnover often occur because of nursing shortage (Bae, Kelly, Brewer, & Spencer, 2014). Such suboptimal nurse staffing in hospitals can affect the quality of patient care and nurses' health and well-being (Nantsupawat, Nantsupawat, Kulnaviktikul, & McHugh, 2015).

In recent years, the International Council of Nurses, International Hospital Federation, and other International

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\* Corresponding author: Sung-Heui Bae, College of Nursing, Ewha Womans University, 52, Ewhayeodae-gil, Seodaemun-gu, Seoul, 03760, Republic of Korea.

E-mail address: [sbae@ewha.ac.kr](mailto:sbae@ewha.ac.kr) (S.-H. Bae).

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Health professional associations emphasized a Positive Practice Environments (PPE) campaign to prevent aggravating nursing shortages and to ensure the health, safety, and personal well-being of health professionals including nurses (World Health Organization, 2010). According to the PPE campaign, a safe nurse staffing level, which is one of the elements of PPE in health-care services, leads to a higher retention rate and overall job satisfaction (World Health Organization, 2010). In fact, several countries including South Korea are currently implementing a nurse staffing policy to regulate nurse staffing levels. In the United States, many state legislatures have approved nurse staffing policies that incorporate one or more of the following strategies: (a) mandated nurse-to-patient ratios (California), (b) mandated nurse staffing committees (e.g., Texas), or (c) mandated disclosure of hospital nurse staffing level (e.g., New York) (Jones, Bae, Murry, & Hamilton, 2015). In South Korea, a financial incentive policy on nurse staffing, namely, the nursing fee differentiation policy (NFDLP), has been implemented since 1999 (Kim, 2007). This NFDLP consists of a seven-nurse staffing grade system, and each grade reflects the average number of bed per nurse in general hospitals (Health Insurance Review & Assessment Service, 2017). All of these nurse staffing policies aim to improve the positive practice environment in health-care services to ensure appropriate levels of nurse staffing.

Nurse staffing is often measured by either staffing level or staffing mix, or both. Nurse staffing levels consist of a total number of nurses or nursing care hours per patient volume (e.g., number of beds or patient days). The nurse-to-patient ratio (or the patient-to-nurse ratio) and the total nursing hours per patient days (NHPPD) are often used to measure nurse staffing level. With respect to staffing mix, registered nurse (RN) staffing ratio is often used to represent the proportion of RNs in the total number of nursing staff, which include RNs, licensed practice nurse (LPN), and nurse aids. It often shows the nursing professional skill mix. Another nurse staffing measure is subjective nurse staffing adequacy using nurses' perception regarding nurse staffing (Aiken, Clarke, & Sloane, 2002). The nurse staffing policy in several countries is implemented based on the nurse-to-patient ratio (e.g., California).

A great number of studies have been conducted to examine the relationship between nurse staffing and patient outcomes. It has been shown that lower nurse-to-patient ratio (better nurse staffing) and RN skill mix are related to better quality of patient care (Aiken et al., 2011; Kalisch, Tschannen, & Lee, 2012; Staggs, Knight, & Dunton, 2012). Through meta-analysis, Kane and colleagues (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007) have found that increased RN staffing is associated with lower hospital mortality rate, hospital acquired pneumonia, unplanned extubation, respiratory failure, and cardiac arrest in intensive care units. Therefore, relatively conclusive relationships between nurse staffing and patient outcomes have been identified.

With respect to nurse outcomes, researchers have found that lower nurse staffing is associated with higher nurse burnout and job dissatisfaction (Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Kim, 2007; Nantsupawat et al., 2015; Sheward, Hunt, Hagen, Macleod, & Ball, 2005), and intent to leave (Aiken et al., 2012; Cho et al., 2009). Low nurse staffing is also related to needlestick injury (Clarke, Sloane, & Aiken, 2002; Nantsupawat et al., 2015). However, a study of nurses in Finland showed that nurse staffing is not related to job satisfaction and job stress (Terivo-Heikkinen, Kiviniemi, Partanen, & Vehviläinen-Julkunen, 2009). However, to the best of our knowledge, none of the reviews have rigorously or systematically assessed the evidence about the effect of nurse staffing or specific nurse staffing levels on nurse outcomes through meta-analysis. Because of variations in nurse staffing measures among studies, study findings from these studies should be systematically evaluated to draw a conclusion on the relationship between nurse staffing and nurse outcomes.

Therefore, the current review conducted a systematic assessment of empirical studies to examine the relationship between nurse staffing and nurse outcomes. Based on systematic reviews, we found that the majority of studies used the nurse-to-patient ratios to measure nurse staffing. Nurse outcomes included in this study were rather adverse nurse outcomes, including nurse burnout, job dissatisfaction, intent to leave, and needlestick injuries. Thus, we conducted a meta-analysis to determine the association between the nurse-to-patient ratios and the nurse outcomes, mainly nurse injuries and well-being. The results of this study can provide evidence for developing guidelines on the nurse-to-patient ratio in hospitals to prevent adverse nurse outcomes and to promote nurses' health and well-being.

## Methods

### Design

This study reviewed published studies that examined the relationship between nurse staffing and nurse outcomes in hospitals. However, these studies varied in terms of their study design, outcome variables, and analytical approaches. Therefore, only a subset of reviewed articles was included in the meta-analysis. To ensure methodological rigor, a systematic five-step approach was used, and it consisted of problem formulation, literature search, data evaluation, data analysis, and presentation as outlined by Cooper (1989). As such, the search strategy, search outcome, quality appraisal, data abstraction, and synthesis of study results regarding the relationship between nurse staffing and nurse outcomes are presented. Problem formulation included identifying the variables of interest—population (nursing staff in hospitals) and outcomes (nurse outcomes)—to

examine the relationship between nurse staffing and nurse outcomes in hospitals.

### Search Strategy

To understand the impact of nurse staffing on nurse outcomes, journal articles were identified in the following electronic bibliographic databases: CINAHL, PubMed, PsycINFO, Cochrane Library, EBSCO, RISS, and DBpia. Title, keyword (or subject heading when applicable), and abstract searches were performed to identify the relevant articles. Search terms were combinations of nurse staffing and hospital(s). A search was conducted between November and December 2016. Studies published since January 2000 were selected and reviewed if they met the following inclusion criteria: (a) studies examined the associations between nurse staffing and nurse outcomes in a hospital setting; (b) studies reported a primary research; (c) studies were published either in English or in Korean, and (d) studies were published in peer-reviewed journals. We found that the majority of studies used the nurse-to-patient ratios to measure nurse staffing based on systematic reviews. Thus, the selection criteria included in the meta-analysis were (a) studies reported nurse staffing as the nurse-to-patient ratio and (b) studies used logistic regression to examine the relationship between the nurse-to-patient ratio and the nurse outcomes and reported odds ratio.

### Search Outcome

A systematic literature review was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Figure 1) (Moher, Liberati, Tetzlaff, & Altman, 2009). After deleting duplicates, the initial search yielded 402 articles. Screening of titles resulted in exclusion of 303 articles. Of the remaining 99 articles, 83 articles did not study nurse outcomes (they studied patient outcomes or organizational outcomes instead), two articles did not measure nurse staffing with use of staffing levels (they measured subjective staffing adequacy instead), and one article was not peer-reviewed. Therefore, the remaining 13 articles that examined the relationship between nurse staffing and nurse outcomes were systematically reviewed and synthesized.

### Quality Appraisal

For quality appraisal of the 13 quantitative articles, Quality Assessment and Validity Tool for Correlation Studies was used (Cummings et al., 2008, 2010; Estabrooks et al., 2001; Estabrooks, Floyd, Scott-Findlay, O'Leary, & Gushta, 2003). The original items of quality assessment included design, sample, measurement, and statistical analyses. We modified several items using the independent variables (nurse staffing) and dependent

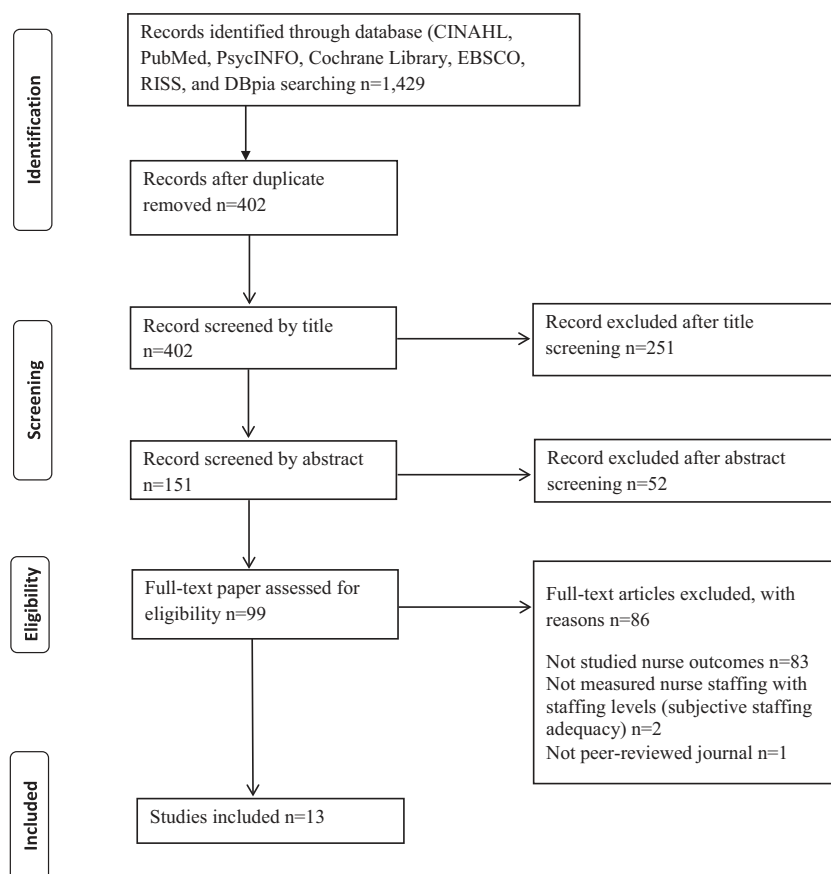


Figure 1 – Flowchart of systematic review.

**Table 1 – Summary of Quality Assessment of the Studies Included**

	Number of Articles	
	No	Yes
<b>Design</b>		
Was the study a prospective study (other than cross-sectional)?	13	0
Was probability sampling used?	7	6
<b>Sample</b>		
Was the sample size justified?	8	5
Was the sample drawn from more than one site?	0	13
Was anonymity protected?	0	13
Was the response rate more than 60%?	4	9
<b>Measurement</b>		
Were nurse staffing variables measured reliably?	0	13
Were nurse staffing variables measured using a valid instrument?	0	13
Were outcome variables measured using a valid instrument?	0	13
Was a theoretical model/framework used for guidance?	11	2
<b>Statistical analysis</b>		
In multiple effects studies, were correlations analyzed?	10	3
Were covariates controlled?	1	12
Were outliers managed?	13	0

variables (nurse outcomes), which were found in the current review. A total of 13 items were used to evaluate the study design, sample, measurement, and statistical analysis in quantitative observational studies with a total of 13 points possible. Total points were then divided by 13. It was considered that the greater the score, the better the quality of the study. Based on the adapted version of quality assessment and validity tool criteria proposed by Cummings et al. (2010), studies that scored less than 0.50 were rated as weak, studies with scores from 0.50 to 0.75 were rated as moderate, and studies with scores greater than 0.75 were rated as strong. A total of 12 quantitative articles had moderate methodological quality, whereas one article had weak methodological quality (Table 1).

#### Data Extraction/Synthesis and Meta-Analysis

The following data were extracted from the 13 articles: author, year, country, sample, setting, design, nurse staffing, nurse outcomes, analysis, and significance of the associations with nurse staffing (Table 2). For the meta-analysis, the available outcome data were presented in the form of pooled odds ratio in all of the published studies; we applied a random effects meta-regression model to make an inference on the heterogeneity parameter and the regression coefficients vector. For applying the meta-regression model, the pooled odds ratio and its standard errors in each

study were log-transformed to obtain the regression coefficient and its standard errors, using which the overall effect was estimated (Borenstein, Hedges, Higgins, & Rothstein, 2009). To implement the random effects meta-regression model and to create a forest plot, “Metagen” and “Meta” package of R (Möbius, 2014) was used. Pooled odds ratio and 95% confidence intervals (CI) were calculated with use of random effects models. Fixed effects models assume that the primary studies have a common effect size. In contrast, random effects models attempt to estimate the distribution of the mean effect size, assuming that each primary study includes a different population. A test for heterogeneity of the effects was performed using the  $I^2$  and  $Tau^2$  statistic. The  $I^2$  statistic describes the percentage of variation across studies that are caused by heterogeneity rather than chance.  $I^2$  is an intuitive and simple expression of the inconsistency of studies’ results.

## Findings

### Study Characteristics

A total of 52 potentially relevant articles were identified using the search strategy described above, of which 13 cross-sectional studies met the inclusion criteria (Figure 1). Six (46.2%) of these 13 studies used probability sampling. Samples in all studies were drawn from more than one site. Nurse staffing variables were often measured by the nurse-to-patient ratio, which was established by the number of patients the nurses cared for in their last work shift using the nurse survey or by the registered nurse positions to patient census using administrative data. The nurse-to-patient ratio has lower reliability, compared to NHPPD showing high inter-rater reliability (Min & Scott, 2016). In addition, the nurse outcome variables, including nurse burnout, job dissatisfaction, intent to leave, and needlestick injuries, were measured using valid instrument (Maslach & Jackson, 1986; Poghosyan, Aiken, & Sloane, 2009). Characteristics of these 13 studies included in this systematic review are listed in Table 2. Twelve studies (92.3%) reported nurse staffing as the nurse-to-patient ratio, and one study reported the bed-to-nurse ratio and nurse staffing grade. With respect to measuring nurse outcomes, three studies (23.1%) measured needlestick injury, nine studies (69.2%) measured burnout, ten studies (76.9%) measured job dissatisfaction, and four studies (30.8%) measured intent to leave. Eleven studies (84.6%) used logistic regression analysis. With respect to the results of the association between nurse staffing and nurse outcomes, three studies (23.1%) reported that nurse staffing was not related to nurse outcomes, but 10 studies (76.9%) reported that nurse staffing was significantly associated with nurse outcomes.

Among 13 studies included in the systematic review, three studies that analyzed the nurse-to-patient ratio

**Table 2 – Characteristics of the Studies Included**

Author, Year, Country	Sample, Setting	Design	Quality Score	Score Intervals	Nurse Staffing	Measures of Nurse Outcomes	Analysis	Significance of the Associations With Nurse staffing (p ≤ .05)
Clarke et al. (2002), United States	40 inpatient units in 20 general hospitals, 732 nurses	Cross-sectional	0.53	Moderate	Nurse-to-patient ratio	Needlestick injuries in the past one month	Logistic regression modeling employing generalized estimating equations	Nurses in units with lower staffing experience three times more needlestick injuries
McHugh and Ma (2014), United States	26,005 RN in 534 hospitals	Cross-sectional	0.69	Moderate	Hospital's average patient-to-nurse ratio	Burnout, job dissatisfaction, intent to leave	Logistic regression	Higher patient-to-nurse ratio is positively related to job dissatisfaction and burnout
Nantsupawat et al. (2015), Thailand	92 community hospitals, 1,412 nurses	Cross-sectional	0.69	Moderate	Average number of patients per nurse in each hospital	Job dissatisfaction, emotional exhaustion (burnout), needle or sharp injury	Logistic regression	Each additional patient per nurse is related to an increase in nurse dissatisfaction, increase in high emotional exhaustion, and increase in needlestick injury
Nantsupawat et al. (2011), Thailand	39 public hospitals, 5,247 nurses	Cross-sectional	0.69	Moderate	Average number of patients per nurse in each hospital	Job dissatisfaction, burnout	Logistic regression	Addition of each patient to a nurse is related to high burnout
Sheward et al. (2005), United Kingdom	59 acute hospitals, 8,779 nurses	Cross-sectional	0.54	Moderate	Number of patients cared for by the responding nurse in the last shift, number of patients in the last shift divided by the number of nurses	Emotional exhaustion, job dissatisfaction	Logistic regression	Fewer number of patients per nurse is related to a decrease in emotional exhaustion and a decrease in job dissatisfaction
Tervo-Heikkinen et al. (2009), Finland	46 inpatient units in 5 university hospitals, 854 nurses	Cross-sectional	0.61	Moderate	Mean number of patients assigned to the RN	Job dissatisfaction, stress	Bayesian network and causal data analysis	Patient-to-nurse ratio is related to better values of control, and it is not related to job satisfaction, stress

(continued on next page)



**Table 2 – (Continued)**

Author, Year, Country	Sample, Setting	Design	Quality Score	Score Intervals	Nurse Staffing	Measures of Nurse Outcomes	Analysis	Significance of the Associations With Nurse staffing ( $p \leq .05$ )
Aiken et al. (2002), United States, Canada, England, and Scotland	303 hospitals, 10,319 nurses	Cross-sectional	0.61	Moderate	Nurse-to-patient ratio	Job dissatisfaction, burnout	Logistic regression	Worst staffing is not related to job satisfaction and burnout
Cho et al. (2009), South Korea	65 ICUs in 22 hospitals, 1,365 nurses	Cross-sectional	0.61	Moderate	Nurse-to-patient ratio	Job dissatisfaction, burnout, intent to leave	Logistic regression	Fewer patients per nurse is not related to job dissatisfaction burnout, intent to leave
Clarke, Rockett, Sloane, and Aiken (2002), United States	22 hospitals, 2,287 nurses	Cross-sectional	0.46	Weak	Nurse-to-patient ratio	Needlestick injury	Logistic regression	Increase in patient loads is related to needlestick injury
Aiken et al. (2012), 12 Europe, United States	1,105 hospitals, 61,168 nurses	Cross-sectional	0.69	Moderate	Nurse-to-patient ratio	Burnout, job dissatisfaction, intent to leave	Logistic regression	Additional patients per nurse is related to higher burnout, dissatisfaction, and intention to leave
Rafferty et al. (2007), United Kingdom	30 hospitals, 3,984 nurses	Cross-sectional	0.53	Moderate	Patients per nurse	Emotional exhaustion, job dissatisfaction	Logistic regression	Heaviest patient workload is related to greater emotional exhaustion, job dissatisfaction
Kim (2007), South Korea	8 hospitals, 298 nurses	Cross-sectional	0.46	Weak	Nurse staffing grade	Job satisfaction	Analysis of covariance	Better nurse staffing is related to better job satisfaction
Aiken et al. (2008), United States	168 hospitals, 10,184 nurses	Cross-sectional	0.69	Moderate	Mean number of patients assigned to staff nurses	Job dissatisfaction, emotional exhaustion, intent to leave	Logistic regression	Better nurse staffing is not related to emotional exhaustion, job dissatisfaction, intent to leave

Quality score intervals: < 0.50 = weak, 0.5 to 0.74 = moderate, >0.75 = strong.

by using categorical variables, not a continuous variable, were not included in the meta-analysis. Two studies that used analysis of covariance or Bayesian network analysis, and not logistic regression to analyze the relationship between the nurse-to-patient ratio and the nurse outcomes, were not included in the meta-analysis performed in this study. Thus, a total of eight studies were used in this meta-analysis. The total number of studies used in each meta-analysis varied according to each nurse outcome.

### Nurse Burnout

Seven studies were included to analyze nurse burnout according to the nurse-to-patient ratio. Higher nurse-to-patient ratio was consistently associated with high degree of burnout among nurses. An increase of one patient per RN ratio was associated with a 7% increase in the odds of burnout (odds ratio: 1.07; 95% CI: 1.04–1.11). When studies were combined in the meta-analysis, high heterogeneity was observed ( $\tau^2 = 0.0013$ ,  $p < .001$ ) (Figure 2).

### Job Dissatisfaction

In the result of meta-analysis of seven studies that analyzed job dissatisfaction among nurses, higher nurse-to-patient ratio was associated with an increase in the odds of nurse job dissatisfaction. An increase of one patient per RN ratio was associated with an 8% increase in the odds of job dissatisfaction (odds

ratio: 1.08; 95% CI: 1.04–1.11). When all studies were combined in the meta-analysis, high heterogeneity was observed ( $\tau^2 = 0.0015$ ,  $p < .001$ ) (Figure 3).

### Intent to Leave

Results of the meta-analysis that included four studies for assessing the degree of nurses' intent to leave according to the nurse-to-patient ratio are shown in Figure 4. The overall effect size was 1.05 (95% CI: 1.02–1.07). These studies were homogeneous ( $\tau^2 = 0.00$ ,  $p = .77$ ). Nurses' intention to leave was increased 1.05 times when the nurse-to-patient ratio was increased by 1.

### Needlestick Injury

Results of the meta-analysis for needlestick injury according to the nurse-to-patient ratio are shown in Figure 5. Three studies were included in this analysis (Figure 5). The overall effect size was 1.33 (95% CI: 0.91–1.95) without statistical significance.

### Discussion

This review focused on synthesizing studies that examined the relationship between nurse staffing and nurse outcomes. Nurse staffing was measured by the nurse-to-patient ratio and nurse staffing grade. Based on our findings in the meta-analysis, an increase in

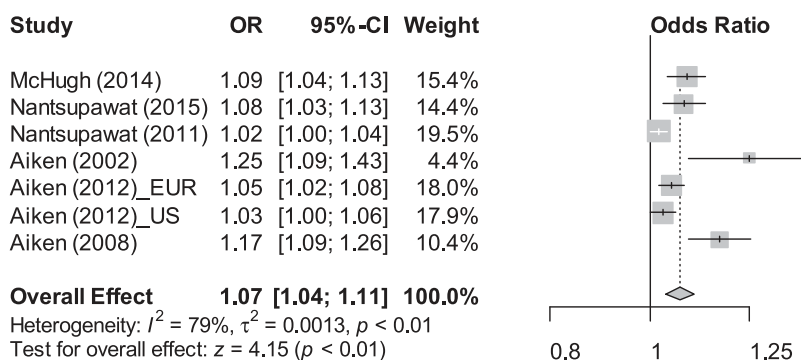


Figure 2 – Forest plot of nurse's burnout.

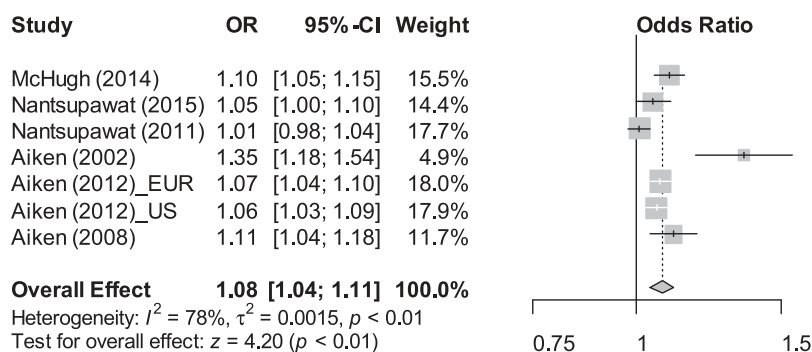


Figure 3 – Forest plot of nurse's job dissatisfaction.

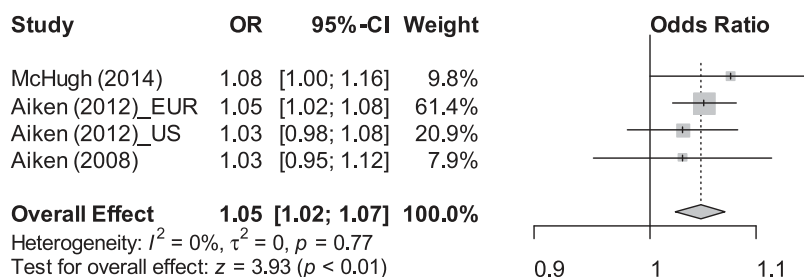


Figure 4 – Forest plot of nurse's intent to leave.

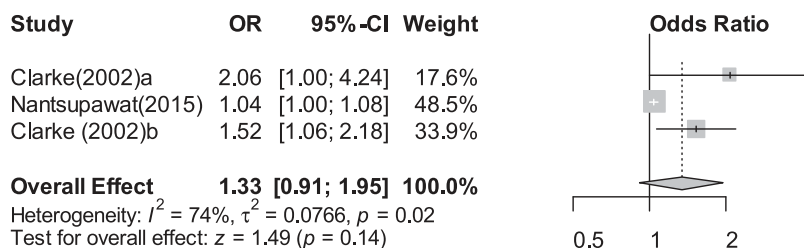


Figure 5 – Forest plot of needlestick injury.

patient per RN ratio was associated with an increase in the likelihood of three adverse nurse outcomes out of four outcomes. Even if there is an inconsistency regarding the research methods among studies, we found a consistent relationship between the nurse-to-patient ratio and these adverse nurse outcomes. We did not find any opposite direction of this relationship. Thus, greater nurse-to-patient ratio is related to increase in adverse nurse outcomes.

We also assessed the heterogeneity among studies to determine generalizability of the findings and we found high heterogeneity showing more than 75% of  $I^2$  values in studies of burnout, job satisfaction, and needlestick injury (Higgins et al., 2003). We decided to use random effect model to compute the effect size, because we assumed that variation of studies comes from differences in clinical study setting and participants. Overall, pooled effect size indicated that the higher the nurse-to-patient ratio, the higher the adverse nurse outcome. This result supports the findings of a previous study that staffing adequacy as a subgroup of nursing work environments is a predictor of emotional exhaustion in nurses (Laschinger & Leiter, 2006).

The results of this meta-analysis showed that the effect size for nurses' job dissatisfaction was higher (odds ratio: 1.08; 95% CI: 1.04–1.11) than that for nurse burnout (odds ratio: 1.07; 95% CI: 1.04–1.11) or intent to leave (odds ratio: 1.05; 95% CI: 1.02–1.07). This finding implies that the nurse-to-patient ratio is a critical factor related to nurses' job dissatisfaction, which might affect nurses' retention and turnover. Thus, with other strategies to prevent nurse turnover, maintaining the appropriate nurse staffing level is an important managerial strategy to improve nurse retention.

However, when we examined the pooled effect size of needlestick injury, the largest overall effect size was found without statistical significance (odds ratio: 1.33; 95% CI: 0.91–1.95). One can think that this occupational injury might not be affected by the nurse-to-patient ratio. However, this result might have been because of the study by Nantsupawat et al. (2015), which had the highest weight (48.5%) among the total three studies. This means that the study of Nantsupawat et al. (2015) could influence the most on overall results of meta-analysis of included needlestick injury studies. Compared with other studies, the study of Nantsupawat et al. (2015) had a small variance of the mean, showing the narrowest CI (Geoff, 2012).

With respect to the study design, all 13 studies (100%) used a cross-sectional study design. Therefore, we were unable to establish causality in the association between the nurse-to-patient ratio and the nurse outcomes. Six studies (46.2%) used probability sampling such as two-stage sampling, stratified random sampling, and multistage sampling. With these types of sampling methodology, studies could create highly representative subjects in the population, decrease the sampling bias, and be able to make inferences about the population. However, other studies (53.8%) from different countries and regions may show a change in the effect of the nurse-to-patient ratio on nurse outcomes. Therefore, without rigorous sampling consideration, comparisons of nurse outcomes related to the nurse-to-patient ratio are tenuous. With respect to case mix adjustment, in this meta-analysis, we did not control the design effect of various studies to help account for variations among the included studies, such as severity of patient illness, because most of the studies modeled the data with various clinical inpatient units



and hospital levels without considering the severity of patient illness. Thus, this review may confound the interpretation of association between the nurse-to-patient ratio and the nurse outcomes.

Some limitations of this study must be recognized. First, several studies might have used similar datasets. For example, data from studies by Aiken et al. (2002), Aiken et al. (2008), Rafferty et al. (2007), and Sheward et al. (2005) were derived from 1999 surveys in nations that participated in the International Hospital Outcomes Study (IHOS). Although each study used a subset of the IHOS data, it is possible that these studies may have been related to each other or overlapping each other. If this is the case, the results of this meta-analysis might have overestimated the relationship between the nurse-to-patient ratio and the nurse outcomes. Another limitation of this study is that most (69.2%) of the studies were conducted in the United States or Europe. As a result, generalizability of the study findings all over the globe may be limited. Direct comparison of the effect size in the relationship between the nurse-to-patient ratio and the nurse outcomes with that in previous studies might not be possible because only a few systematic studies were conducted to assess the relationship between nurse staffing and nurse outcomes (Lang, Hodge, Olson, Romano, & Kravitz, 2004), and the previous systematic literature review did not estimate the effect size.

Despite the above limitations, this study provides substantial evidence that the nurse-to-patient ratio is an important contributing factor to negative nursing outcomes such as needlestick injury, burnout, job dissatisfaction, and intent to leave. Through a comprehensive systematic review and a meta-analysis of studies related to the nurse-to-patient ratio and nurse outcomes, the results of this study can help us establish strategies to prevent adverse nurse outcomes. These results can also lead to a more effective use of health-care human resources and help for setting a nurse staffing policy.

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## REFERENCES

- Aiken, L. H., Cimiotti, J. P., Sloane, D. M., Smith, H. L., Flynn, L., & Neff, D. F. (2011). Effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments. *Med Care*, 49(12), 1047-1053. <http://dx.doi.org/10.1097/MLR.0b013e3182330b6e>.
- Aiken, L. H., Clarke, S. P., & Sloane, D. M. (2002). Hospital staffing, organization, and quality of care: Cross-national findings. *Nurs Outlook*, 50(5), 187-194. <http://dx.doi.org/10.1067/mno.2002.126696>.
- Aiken, L. H., Clarke, S. P., Sloane, D. M., Lake, E. T., & Cheney, T. (2008). Effects of hospital care environment on patient mortality and nurse outcomes. *J Nurs Adm*, 38(5), 223-229. <http://dx.doi.org/10.1097/01.NNA.0000312773.42352.d7>.
- Aiken, L. H., Sermeus, W., Van den Heede, K., Sloane, D. M., Busse, R., McKee, M., ... Kutney-Lee, A. (2012). Patient safety, satisfaction, and quality of hospital care: cross sectional surveys of nurses and patients in 12 countries in Europe and the United States. *Br Med J*, 344, e1717. <http://dx.doi.org/10.1136/bmj.e1717>.
- Bae, S.-H., Kelly, M., Brewer, C. S., & Spencer, A. (2014). Analysis of nurse staffing and patient outcomes using comprehensive nurse staffing characteristics in acute care nursing units. *J Nurs Care Qual*, 29(4), 318-326. <http://dx.doi.org/10.1097/ncq.000000000000057>.
- Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. West Sussex, UK: Wiley.
- Cho, S.-H., June, K. J., Kim, Y. M., Cho, Y. A., Yoo, C. S., Yun, S.-C., & Sung, Y. H. (2009). Nurse staffing, quality of nursing care and nurse job outcomes in intensive care units. *J Clin Nurs*, 18(12), 1729-1737. <http://dx.doi.org/10.1111/j.1365-2702.2008.02721.x>.
- Clarke, S. P., Rockett, J. L., Sloane, D. M., & Aiken, L. H. (2002). Organizational climate, staffing, and safety equipment as predictors of needlestick injuries and near-misses in hospital nurses. *Am J Infect Control*, 30(4), 207-216. <http://dx.doi.org/10.1067/mic.2002.123392>.
- Clarke, S. P., Sloane, D. M., & Aiken, L. H. (2002). Effects of hospital staffing and organizational climate on needlestick injuries to nurses. *Am J Public Health*, 92(7), 1115-1119.
- Cooper, H. (1989). *Integrating Research: A Guide for Literature Reviews*. NJ: Sage.
- Cummings, G., Lee, H., MacGregor, T., Davey, M., Wong, C., Paul, L., & Stafford, E. (2008). Factors contributing to nursing leadership: A systematic review. *J Health Serv Res Policy*, 13(4), 240-248. <http://dx.doi.org/10.1258/jhsrp.2008.007154>.
- Cummings, G. G., MacGregor, T., Davey, M., Lee, H., Wong, C. A., Lo, E., ... Stafford, E. (2010). Leadership styles and outcome patterns for the nursing workforce and work environment: A systematic review. *Int J Nurs Stud*, 47(3), 363-385. <http://dx.doi.org/10.1016/j.ijnurstu.2009.08.006>.
- Estabrooks, C., Goel, V., Thiel, E., Pinfold, P., Sawka, C., & Williams, I. (2001). Decision aids: are they worth it? A systematic review. *J Health Serv Res Policy*, 6(3), 170-182. <http://dx.doi.org/10.1258/1355819011927431>.
- Estabrooks, C. A., Floyd, J. A., Scott-Findlay, S., O'Leary, K. A., & Gushta, M. (2003). Individual determinants of research utilization: A systematic review. *J Adv Nurs*, 43(5), 506-520. <http://dx.doi.org/10.1046/j.1365-2648.2003.02748.x>.
- Geoff, C. (2012). *Understanding the new statistics: effect sizes, confidence intervals, and meta-analysis*. New York, NY: Routledge.
- Health Insurance Review & Assessment Service. (2017). *Inpatient Fee in South Korea*. Retrieved from <http://www.hira.or.kr/dummy.do?pgmid=HIRAA020033000000#none>.
- Higgins, J. P. T., Thompson, S. G., Deeks, J. J., & Altman, S. G. (2003). Measuring inconsistency in meta-analyses. *BMJ*, 327(7414), 557-569. <http://dx.doi.org/10.1136/bmj.327.7414.557>.
- Jones, T., Bae, S. H., Murry, N., & Hamilton, P. (2015). Texas nurse staffing trends before and after mandated nurse staffing committees. *Policy Polit Nurs Pract*, 16(3-4), 79-96. <http://dx.doi.org/10.1177/1527154415616254>.
- Kalisch, B. J., Tschannen, D., & Lee, K. H. (2012). Missed nursing care, staffing, and patient falls. *J Nurs Care Qual*, 27(1), 6-12. <http://dx.doi.org/10.1097/NCQ.0b013e318225aa23>.
- Kane, R. L., Shamliyan, T. A., Mueller, C., Duval, S., & Wilt, T. J. (2007). The association of registered nurse staffing levels and

- patient outcomes: Systematic review and meta-analysis. *Medical Care*, 45(12), 1195-1204. <http://dx.doi.org/10.1097/MLR.0b013e3181468ca3>.
- Kim, J. K. (2007). Job satisfaction and patient satisfaction related to nurse staffing. *J Korean Nurs Adm Acad Soc*, 13(1), 98-108.
- Lang, T. A., Hodge, M., Olson, V., Romano, P. S., & Kravitz, R. L. (2004). Nurse-patient ratios: A systematic review on the effects of nurse staffing on patient, nurse employee, and hospital outcomes. *J Nurs Adm*, 34(7/8), 326-337.
- Laschinger, H. K. S., & Leiter, M. P. (2006). The impact of nursing work environments on patient safety outcomes: The mediating role of burnout/engagement. *J Nurs Adm*, 36(5), 259-267.
- Maslach, C., & Jackson, S. E. (1986). *Maslach burnout inventory: manual* (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.
- McHugh, M. D., & Ma, C. (2014). Wage, work environment, and staffing: Effects on nurse outcomes. *Policy Polit Nurs Pract*, 15(3-4), 72-80. <http://dx.doi.org/10.1177/1527154414546868>.
- Min, A., & Scott, L. D. (2016). Evaluating nursing hours per patient day as a nurse staffing measure. *J Nurs Manage*, 24(4), 439-448.
- Möbius, T. W. D. (2014). Metagen. Retrieved from <http://00tau.github.io/metagen/>.
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Br Med J*, 339, b2535. <http://dx.doi.org/10.1136/bmj.b2535>.
- Nantsupawat, A., Nantsupawat, R., Kulnaviktikul, W., & McHugh, M. D. (2015). Relationship between nurse staffing levels and nurse outcomes in community hospitals, Thailand. *Nurs Health Sci*, 17(1), 112-118. <http://dx.doi.org/10.1111/nhs.12140>.
- Nantsupawat, A., Srisuphan, W., Kunaviktikul, W., Wichaikhum, O. A., Aunguroch, Y., & Aiken, L. H. (2011). Impact of nurse work environment and staffing on hospital nurse and quality of care in Thailand. *J Nurs Scholarsh*, 43(4), 426-432. <http://dx.doi.org/10.1111/j.1547-5069.2011.01419.x>.
- Poghosyan, L., Aiken, L. H., & Sloane, D. M. (2009). Factor structure of the Maslach burnout inventory: An analysis of data from large scale cross-sectional surveys of nurses from eight countries. *Int J Nurs Stud*, 46(7), 894-902.
- Rafferty, A. M., Clarke, S. P., Coles, J., Ball, J., James, P., McKee, M., & Aiken, L. H. (2007). Outcomes of variation in hospital nurse staffing in English hospitals: Cross-sectional analysis of survey data and discharge records. *Int J Nurs Stud*, 44(2), 175-182. <http://dx.doi.org/10.1016/j.ijnurstu.2006.08.003>.
- Sheward, L., Hunt, J., Hagen, S., Macleod, M., & Ball, J. (2005). The relationship between UK hospital nurse staffing and emotional exhaustion and job dissatisfaction. *J Nurs Manage*, 13(1), 51-60. <http://dx.doi.org/10.1111/j.1365-2834.2004.00460.x>.
- Staggs, V. S., Knight, J. E., & Dunton, N. (2012). Understanding unassisted falls: Effects of nurse staffing level and nursing staff characteristics. *J Nurs Care Qual*, 27(3), 194-199. <http://dx.doi.org/10.1097/NCQ.0b013e318241da2d>.
- Tervo-Heikkinen, T., Kiviniemi, V., Partanen, P., & Vehviläinen-Julkunen, K. (2009). Nurse staffing levels and nursing outcomes: A Bayesian analysis of Finnish-registered nurse survey data. *J Nurs Manage*, 17(8), 986-993. <http://dx.doi.org/10.1111/j.1365-2834.2009.01020.x>.
- World Health Organization (2010). Positive Practice Environments Campaign. (2017, August 14). Retrieved from <http://www.who.int/workforcealliance/about/initiatives/ppe/en/>.