Though an increasing body of knowledge supports the linkage between nurse staffing and acute-care hospital outcomes (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007), other factors also affect the provision of quality nursing care (Needleman, Kurtzman, & Kizer, 2007). Extended work hours for hospital nurses have become the norm, and the physical and psychological job demands have increased (Trinkoff, Geiger-Brown, Brady, Lipscomb, & Muntaner, 2006). Excessive job demands, such as interruptions and increased workload, adversely influence care by reducing a nurse’s ability to address patient needs (Geiger-Brown et al., 2004). Frequent interruptions affect the ability to deliver safe care because they require nurses to remember all disrupted interventions and to find time to complete them (Tucker & Spear, 2006). Interruptions are a major contributor to medication errors (Westbrook, Woods, Rob, Dunsuir, & Day, 2010), and reducing them improves patient care quality.

Job demands can impair performance by contributing to stress, fatigue, or injury (Bongers, Kremer, & ter Laak, 2002; Gurses, Carayon, & Wall, 2009). When psychological demands combine with high levels of physical exertion, the risk of injury increases (Ariens, Bongers, Hoogendoorn, van der Wal, & Mechelen, 2002). Nurses’ work schedule characteristics, such as long work hours, have also been reported to affect patient-care outcomes and errors (Olds & Clarke, 2010; Trinkoff et al., 2011). Fatigued or injured nurses need rest and recovery time. Having other nurses compensate with overtime or floating can adversely affect care (Hinshaw, 2006). Fatigue and injury also may increase the rate of nurse turnover (Owen, 2000).

On the other hand, positive nursing practice environments could moderate the relationship between other factors, such as job demands and patient outcomes. For our study, we defined the nursing practice environment as reflecting nurse input and autonomy, peer and supervisor support, and patient safety of care, as intended by the National Quality Forum (2004). Certain aspects of the nursing practice environment, such as nurse autonomy and input, have been shown to improve patient care (MacDavitt, Chou, & Stone, 2007). However, study findings on the effects of the practice environment on patient outcomes have been conflicting (Mark, 2006; Tourangeau, Cranley, & Jeffs, 2006). In a study of intensive care units, Knaus, Draper, Wagner, & Zimmerman (1986) found that hospitals with the lowest standardized mortality ratios had excellent nurse-physician relationships, but Shortell et al. (1994) found no association between collaboration and mortality. Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti (2005) found that collaborative relationships between nurses and physicians were associated with lower mortality at the facility level. Studies have shown that staff nurses can reduce errors and promote patient safety when they have control over processes of care (Lin & Liang, 2007). Other findings suggest that organizations with environments promoting quality care have care decisions made by those closest to patients and provide the necessary resources and environment for safe practice (Nieva & Sorra, 2003; Singer et al., 2003). These conflicting findings suggest the need for further study.

Concept and Theory
In this study, we used nursing work environment as an umbrella term that includes staffing, job demands, work schedule, and nursing practice environment. Job demands were conceptualized...
as having two dimensions, psychological demands such as interruptions and physical demands such as heavy lifting (Karasek, 1985). The conceptual model, shown in Figure 1, also illustrates the two levels of data collection: nurse and hospital.

Our conceptual framework comes from balance theory, in which excessive demands increase the load on the nurse and adversely affect job performance unless they are balanced by enhancing the positive aspects of the job or reducing the demands (Carayon & Gurses, 2005; Gurses et al., 2009). Balance theory was created to assess organizational-level conditions, using data from individual employees, as was done in this study. Based on this theory, we hypothesized that organizations with better nursing work environments would be associated with better patient outcomes. Specifically, we hypothesized that high job demands and adverse work schedules would be associated with higher mortality and complication rates, even after adjustment for staffing. We also hypothesized that positive nursing practice environments may balance the impact of these demands and schedules and moderate the effects on patient outcomes.

The purpose of the study was to answer two research questions:
1. Do job demands and work schedule adversely affect patient outcomes (mortality and complications) when controlling for staffing?
2. Does a positive nursing practice environment moderate the relationship of job demands and schedules on patient outcomes?

Findings can provide evidence to support changes in nursing work environments that can improve the safety of patient care.

**Methods**

This article presents a secondary analysis of hospital-level patient outcomes and staffing data linked to nurse-level survey data on work environments obtained from nurses working within these hospitals.

**Sample and Data Collection**

This study used patient-outcome and staffing data collected in 2004 from 71 acute-care hospitals in North Carolina (NC) and Illinois (IL). The sample included hospitals that employed at least four nurse respondents; an average of nine nurses per hospital responded \(n = 633\), and 80% of study hospitals had more than four nurse respondents. This sampling technique has been validated in other domains and is often used to survey health-care administrators on the state of care in their facilities (Muntaner et al., 2004; Singer et al., 2003).

Nurse survey data were collected as part of the Nurses Worklife and Health Study (NWHS) after obtaining Institutional Review Board approval (Trinkoff, Le, Geiger-Brown, Lipscomb, & Lang, 2006). The NWHS study was a three-wave, longitudinal, mailed survey that examined how working conditions influenced nurses’ health (Trinkoff, Le, et al., 2006). For our analysis, we used the wave 3 data because it was the only one that included facility names.

**Variables**

For NC, we obtained patient-outcome data from the Healthcare Cost and Utilization Project’s State Inpatient Database. For IL, we obtained patient-outcome data from the Illinois Department of Health. For hospital-level outcomes, we used the Agency for Healthcare Research and Quality (AHRQ) inpatient quality indicators (IQIs) and patient safety indicators (PSIs). We selected outcomes that have been reported as nursing-sensitive and that have sufficient rates of occurrence to generate reporting data for over 90% of the hospitals. The IQIs were in-hospital mortality for pneumonia, acute myocardial infarction (AMI), congestive heart failure (CHF), stroke, and craniotomy. The PSIs were postoperative pulmonary embolism/deep vein thrombosis (PE/DVT) and hemorrhage; selected infections from medical care; respiratory failure; and sepsis. We defined hospitals with adverse outcomes as those with indicator rates above the 75th percentile for consistency with other studies (Needleman, Buerhaus, Stewart, Zelevinsky, & Mattke, 2006).

Two types of job demands were measured: psychological and physical. We assessed psychological demands using seven items adapted from Karasek’s Job Content Questionnaire (JCQ) (Karasek, 1985) with four Likert-type response categories ranging from strongly agree to strongly disagree (alpha for our nurse survey = 0.81) (Trinkoff, Lipscomb, Geiger-Brown, Storr, & Brady, 2003). We measured physical demands using 12 items that assessed duration, level, and frequency of exposure (Bernard, 1997) with four response categories (alpha for our nurse survey = 0.89) (Trinkoff et al., 2003). We measured work schedules using 12 items covering hours per day and per week, weekends per month, breaks, time off, overtime, and on-call (Trinkoff, Le, et al., 2006; Trinkoff et al., 2011). To minimize unusual or atypical...
For the nursing practice environment, we incorporated 17 Likert-type items with four response categories (alpha for our nurse survey = 0.88). We obtained items from the Nursing Work Index-Revised (NWI-R) (Lake, 2002), the JCQ supervision and peer-support domain (Karasek, 1985), the Patient Safety Center of Inquiry (PSCI) Culture Survey (Singer et al., 2003), and the Hospital Survey on Patient Safety Culture (HSP) (Sorra & Nieva, 2004). The JCQ reflects the organizational-level psychosocial work environment, and the PSCI and HSP were designed to assess the hospital patient-safety culture. To avoid multicollinearity, we omitted the items from the NWI-R (Lake, 2002) that measured staffing and work schedules, though these items were collected in our survey.

Staffing was measured using the 2004 American Hospital Association (AHA) Annual Survey of Hospitals, representing full- and part-time staff registered nurses (RNs) and licensed practical nurses. Nursing hours per patient day were calculated
from full-time equivalent measures, using equations provided by Kane et al. (2007). The equations are based on the assumption that nurses worked 37.5 hours per week and 48 weeks per year. Hospital variables commonly used to reflect contextual characteristics—state (IL vs. NC) and teaching status (hospitals with resident physicians vs. those without) were included in the analysis as hospital-level covariates (Jones, 2005).

### Analysis

To address concerns about multicollinearity of items used to measure psychological demands, physical demands, work schedule, and nursing practice environment and to create independent components, we conducted principal components analyses. Components accounting for 80% or more of the variance for the underlying dimension were retained in the analysis. Using the component scores, we calculated the composite scores representing the dimensions of psychological demands, physical demands, work schedule, and nursing practice environment. For the demands and schedule, higher scores reflect more adverse nursing work environments, but for nursing practice environment, higher scores represent better nursing work environments. (See Table 1.)

We also examined the correlation of job demands, work schedule, and nursing practice environment with each other to assess their relative independence in relation to outcomes. Nursing practice environment and work schedule were not correlated with job demands; physical and psychological demands were moderately correlated ($r = 0.57$). We therefore generated three models: one for physical demands, one for psychological demands, and one for both physical and psychological demands. Because the findings were similar across all models, the combined model is presented in the results.

To answer the research questions, we used generalized linear models with generalized estimating equations (GEE). To meet the assumptions of GEE, we tested job demands, work schedule, and nursing practice environment for missing completely at random. As this assumption was met using Little’s test, we implemented GEE with pairwise deletion (Roth, 1994).

For research question 1, we used binomial logistic models for GEE. GEE allowed us to account for within-hospital correlation that comes from having nested data. For research question 2, we created and tested interaction terms for nursing practice environment and job demands and for nursing practice environment and work schedule on outcomes in GEE. Finally, we explored the components extracted from the principal components analysis for job demands, work schedule, and nursing practice environment in relation to the outcomes, using GEE.

### Results

Staffing (licensed hours per patient day) and skill mix (RN proportion) were higher in study hospitals than in all acute general hospitals in the two states overall, though the differences were not significant (Trinkoff et al., 2011). The proportion of teaching hospitals in the study was significantly greater than the proportion in the states overall (47.9% vs. 31.2% respectively; $\chi^2 = 7.36, p < 0.01$). Study nurses were significantly more diverse and more educated than all hospital nurses in national data (Health Resources and Services Administration, 2006).

Tables 2 and 3 present the findings for job demands and work schedule in relation to hospitals with higher than expected mortality and complication rates, when controlling for staffing, skill mix, state, and teaching status. Outcomes with significant odds ratios greater than 1.0 supported the research hypothesis: Adverse working conditions (higher job demands and unfavorable work schedule) are related to increased odds of patient mortality and complications. Table 2 shows that pneumonia deaths were associated with high psychological demands ($p < 0.05$) and more adverse work schedules ($p < 0.01$). Table 3 shows that postoperative PE/DVT was 70% more likely in hospitals where nurses reported high psychological demands ($p < 0.05$). Contradictory to what was hypothesized, respiratory failure was inversely associated with physical demands, and sepsis was inversely associated with work schedule.

Exploratory analyses using the components of job demands and work schedule extracted from the principal components

| TABLE 2 |
| estimates of the association between job demands (psychological and physical) and work schedule in relation to mortality outcomes (IQIs) |
| | Pneumonia | Acute Myocardial Infarction | Congestive Heart Failure | Stroke | Craniotomy |
| Inpatient Quality Indicators (IQIs) | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| Psychological demands | 1.62* | 1.02 2.57 | 1.53 | 0.96 2.44 | 1.08 | 0.63 1.86 | 1.21 | 0.77 1.90 | 0.89 | 0.56 1.42 |
| Physical demands | 0.76 | 0.44 1.30 | 1.48 | 0.84 2.60 | 1.04 | 0.53 2.01 | 0.82 | 0.46 1.47 | 1.35 | 0.79 2.31 |
| Work schedule | 2.81** | 1.54 5.12 | 0.66 | 0.34 1.28 | 0.93 | 0.43 2.00 | 0.87 | 0.32 2.38 | 0.60 | 0.29 1.24 |

* $p < 0.05$; ** $p < 0.01$; adjusted for state, teaching status, RN proportion, and licensed hours; OR = Odds ratio; CI = Confidence interval.
analysis found that pneumonia deaths were significantly more likely in hospitals where nurses reported working fast and hard and working long shifts (p < 0.05). CHF deaths were also significantly associated with long shifts and nurses working while sick, whereas AMI deaths were associated with frequent awkward postures and heavy weekly burden. Postoperative PE/DVT and hemorrhage were significantly more likely in hospitals where nurses did not have enough time to do their jobs. Frequent interruptions were also significantly associated with postoperative hemorrhage. Repetitive motion was significantly associated with postoperative PE/DVT. Long shifts were associated with respiratory failure, and infections were significantly more likely in hospitals where nurses reported a lack of time away from the job. (Data are available on request.)

To address research question 2, the potential moderating effects of nursing practice environment, we tested the interactions of nursing practice environment with physical demands, psychological demands, and work schedule, controlling for staffing, skill mix, state, and teaching status. The only significant interaction was for postoperative PE/DVT, in which nursing practice environment interacted with psychological demands and work schedule. Therefore, in exploratory models, we tested the impact of the individual nursing practice environment components as covariates on the outcomes. For these analyses, protective associations (i.e., odds ratios significantly less than 1.0) were noted as significant for these outcomes: lower AMI death rates in hospitals where nurses reported staff safety input is encouraged (OR = 0.77; 95% CI = 0.60–0.99); lower CHF death rates when error prevention is important (OR = 0.79, 95% CI = 0.65–1.00); and lower postoperative PE/DVT rates when prevention is important (OR = 0.77; 95% CI = 0.60–0.99).

For the control variables of staffing, skill mix, and teaching status, when job demands and work schedule were in the models, RN proportion was still significantly inversely related to mortality from AMI and craniotomy, and licensed hours were significantly inversely related to pneumonia, CHF, and stroke. On the other hand, staffing and skill mix were not significantly related to any of the PSIs, and hospital teaching status was not significantly related to any of the outcome variables.

**Limitations**

Interpretation of the findings needs to be considered in the context of the limitations of this research. The overall study design was cross-sectional and can limit the ability to make conclusions about temporality of the findings. Also, the nurses’ reports of work environment may not represent the entire hospital. Although 80% of the hospitals had more than four nurse respondents, data from more nurses per hospital might be beneficial. Generalizability also may be a concern because study hospitals tended to be larger and more likely to be teaching facilities. On the other hand, there were no relationships among the study variables and teaching facility status. Assuming small to moderate effect sizes, there were some limitations to the number of predictors that could be included in the equations. Parsimony in measurement of the constructs assisted us in achieving sufficient power to detect significance.

For patient-level databases, outcome and risk-adjustment information is primarily reflected in secondary diagnosis and procedure codes, which can be underused or inaccurately applied. Adjustment for case mix of patients is important, and risk adjustment is built into the AHRQ programs. Concerns about comparability across facilities were also addressed by adjusting for state and teaching status. Limitations of the ICD-9-CM codes—lack of precise definitions, inconsistencies, and varying specificity across systems—can lead to further variation. Fortunately, consistency in secondary diagnoses is increasing, and the selected outcomes have undergone extensive testing to examine coding bias. Since we selected outcomes with adequate rates across hospitals, this minimized problems related to low complication rates.

In addition, some PSIs have been found largely to be present on admission, so they may not be valid as outcomes for many hospital stays (Bahl, Thompson, Kau, & Campbell Jr, 2008). Unfortunately, the 2004 discharge data do not have a “present on admission” indicator for each diagnosis. Actual observed patient-care hours were not available from administrative data.

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**TABLE 3**

<table>
<thead>
<tr>
<th>Patient Safety Indicators</th>
<th>Postoperative PE/DVT</th>
<th>Postoperative Hemorrhage</th>
<th>Selected Infections from Medical Care</th>
<th>Respiratory Failure</th>
<th>Sepsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological demands</td>
<td>1.70*</td>
<td>1.04</td>
<td>2.75</td>
<td>0.81</td>
<td>1.32</td>
</tr>
<tr>
<td>Physical demands</td>
<td>0.68</td>
<td>0.42</td>
<td>1.11</td>
<td>0.99</td>
<td>1.60</td>
</tr>
<tr>
<td>Work schedule</td>
<td>1.71</td>
<td>0.78</td>
<td>3.72</td>
<td>0.62</td>
<td>1.33</td>
</tr>
</tbody>
</table>

* p < 0.05; ** p < 0.01; adjusted for state, teaching status, RN proportion, and licensed hours; PE/DVT = pulmonary embolism/deep vein thrombosis; OR = Odds ratio; CI = Confidence interval.
sources, and AHA public use data did not record staffing for nurse aides in 2004 data, though these data have been used successfully by other researchers (Kane et al., 2007; Mark, 2006). Better measures may be needed, such as from unit-level data, to increase the level of precision.

As with most survey data, the nurse data were based on self-report and thus can lead to problems of recall, denial, and deception. Despite these concerns, a high correlation existed between self-reports and rater assessments of job demands (Muntaner & Schoenbach, 1994). We used only selected work environment measures from the NWI-R, and not the complete instrument, which may affect our findings. Nonetheless, our nursing practice environment measure had good internal consistency and performed well in the principal components analysis.

Implications

Study findings that selected job demands and schedules are associated with adverse patient outcomes make an important contribution. We found some support for our hypothesis that hospitals where nurses reported more job demands and adverse work schedules would have higher than expected patient mortality or complication rates, when controlling for staffing. For example, psychological demands and work schedule adversity were greater in hospitals with higher pneumonia rates. Other researchers have identified the specific psychological demands of fast and hard work and too little time to do one’s job as concerns for nurses (Winwood & Lushington, 2006), but they had not been previously linked to patient mortality and complications. Similarly, although awkward postures and repetitive motion have been associated with health problems and injury for nurses (Trinkoff et al., 2003), they had not been shown to be related to adverse outcomes for patients.

Evidence indicated that the nursing practice environment may have only a limited moderating effect, suggesting that better environments cannot balance the adverse effects of job demands and schedules on patient outcomes. Nonetheless, focusing on patient-safety priorities and promoting input from nurses regarding potential errors was shown to be related to some mortality outcomes, suggesting that an emphasis on patient safety is beneficial. We also included staffing and skill-mix measures in all analyses because our objective was to assess constructs in addition to staffing that need to be studied for their impact on outcomes. Our findings, as well as previous research (Kane et al., 2007), suggest that increases in staffing and skill mix could contribute to improved patient outcomes.

In conclusion, the findings suggest that job demands and work schedules need to be considered as modifiable aspects of the nursing work environment, along with staffing, to improve outcomes for nurses and patients. Though the practice environment showed a limited moderating effect, a positive environment could increase retention and job satisfaction and thus improve the stability and quality of the workforce and, in turn, improve outcomes. Nursing work environments have been shown to be important factors in nurse retention (McIntosh, Palumbo, & Rambur, 2006) and have been identified as major reasons why nurses leave their jobs. When McIntosh, Palumbo, & Rambur (2006) asked nurses to report all reasons why they left a nursing job, the top responses included the stressful environment, physical demands, paperwork, and scheduling. Nurses prefer facilities with humane schedules, supportive climates, and reasonable workloads (Elovainio, Kuusio, Aalto, Sinervo, & Heponiemi, 2010; Stordeur, D’Hoore, NEXT-Study Group, 2007). Future research should address these factors and their impact on patients, using more sophisticated designs and incorporating a unit-level perspective.

References


