

Longitudinal Relationship of Work Hours, Mandatory Overtime, and On-call to Musculoskeletal Problems in Nurses

Alison M. Trinkoff, ScD, RN, FAAN,* Rong Le, PhD, RN, Jeanne Geiger-Brown, PhD, RN, Jane Lipscomb, PhD, RN, FAAN, and Gary Lang, MSN, RN

Background Nurses are at very high risk for work-related musculoskeletal injury/disorders (MSD) with low back pain/injury being the most frequently occurring MSD. Nurses are also likely to work extended schedules (long hours, on-call, mandatory overtime, working on days off). The purpose of this study was to examine the relationship of extended work schedules in nurses to MSD.

Methods Using a longitudinal, three wave survey of 2,617 registered nurses, Wave 1 work schedule data were related to neck, shoulder, and back (MSD) cases occurring in Waves 2 or 3.

Results Schedule characteristics increasing MSD risk included 13+ hour/days, off-shifts, weekend work, work during time off (while sick, on days off, without breaks), and overtime/on-call. These increases in risk were not explained by psychological demands, but were largely explained by physical demands.

Conclusions Adverse schedules are significantly related to nurse MSD. Healthier schedules, less overtime, and reducing work on days off would minimize risk and recovery time. Am. J. Ind. Med. 49:964–971, 2006. © 2006 Wiley-Liss, Inc.

BACKGROUND

Americans are working longer hours and more weeks per year, with average time on the job currently exceeding that for most other industrialized nations [Caruso et al., 2004]. The health care industry is especially affected by the trend toward longer workdays [Landsbergis et al., 1999] because of demands for increased cost efficiencies, accomplished primarily by reducing staffing. As a result, job demands [Bourbonnais et al., 2005] and unhealthy scheduling

practices such as overtime have been increasing [Berney et al., 2005].

Nursing is the largest sector of health care employees, and the changes in work patterns are having a great impact on the nursing profession [Lipscomb et al., 2004]. Many nursing positions now require extended work schedules (>8 hr/day and/or >40 hr/week). These positions also may include mandatory overtime and on-call activities, working on days designated as time off, and working while sick [ANA, 2001] to maintain staff complements.

Recent data indicate that nurses are at high risk for work-related musculoskeletal disorders (MSD) [Ando et al., 2000; Maul et al., 2003; Smedley et al., 2003; Smith et al., 2004]. Low back pain/injury is the most frequent musculoskeletal injury/disorder in nurses, followed by neck and shoulder problems [Alexopoulos et al., 2003]. In 2004, health care ranked second among 15 industry sectors for non-fatal occupational injuries [Bureau of Labor Statistics (BLS), 2005]. Nursing homes and residential care facilities had an incidence rate of 9.7 injuries/100 full-time workers, while

Work and Health Research Center, Department of Family and Community Health, University of Maryland School of Nursing, Baltimore, Maryland

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*Correspondence to: Alison M. Trinkoff, University of Maryland School of Nursing, 655 W. Lombard Street, Baltimore, MD 21201. E-mail: Trinkoff@son.umaryland.edu

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hospitals had an incidence rate of 8.3/100 full-time workers [BLS, 2005].

Nursing work is physically demanding, requiring heavy lifting, bending and twisting, and other awkward postures that are implicated in MSD [Yip, 2001; Trinkoff et al., 2003; Menzel et al., 2004]. Physical demands increase the odds of injury [Fredriksson et al., 2002; Punnett et al., 2004] due to creation of compression, rotation, and shear forces that exceed body tolerances [Marras et al., 1999; Forde et al., 2002; Hoozemans et al., 2002]. Psychological job demands can amplify the effects of physical exertion [Ariens et al., 2002; Davis et al., 2002; Devereux et al., 2002]. Furthermore, lack of ability to control time on and off work—which is inherent in mandatory overtime and on-call work—disproportionately affects women, who may have additional home responsibilities such as child care [Ala-Mursula et al., 2004; Jansen et al., 2004].

Because extended work schedules increase exposure to job demands, while limiting rest and recovery time, such extended hours may result in increased MSD [Spurgeon et al., 1997; Jansen et al., 2003]. Engkvist et al. [2000] found that Swedish nurses working full-time (≥ 35 hr/week) were at increased risk of back injury (OR 2.4, 95% CI 1.6–3.6). Engels et al. [1996] found that back and leg symptoms were positively associated with hours worked per week by nursing home staff, and Lipscomb et al. [2002] found that MSD was related to extended work hours, especially off-shift and weekend hours.

Despite these findings, no research has systematically examined the health impact on nurses of newer scheduling characteristics (mandatory overtime, on-call, working on days off, etc.). The present study evaluates these characteristics in relation to reported neck, shoulder, and back MSD and examines the impact of multiple work schedule characteristics, grouped using factor analysis, on reported MSD.

METHODS

Sample and Data Collection Procedure

A three-wave longitudinal survey of nurses as part of the Nurses Worklife and Health Study [Trinkoff et al., 2006] was conducted after obtaining University Institutional Review Board (IRB) approval. Five thousand randomly selected actively licensed nurses from two US states were contacted. Of these nurses, 4229 were sent questionnaires (138 had invalid addresses, and 633 declined to enroll).

In Wave 1, nurses received an optically scannable mailed survey and an introductory letter in November 2002. A \$2 incentive and study logo pencil were included in the first questionnaire packet to encourage response, as recommended by Dillman [2000]. A second and third questionnaire

mailing and a reminder postcard, if needed followed this mailing. Wave 2 and 3 questionnaire mailings used the same procedures, except that the Wave 3 survey contained a \$5 incentive.

The resulting sample had demographic and job distributions (across facility type, position, and specialty areas) that were comparable to the National Sample Survey of Nurses [HRSA, 2000], supporting the generalizability of the sample to US registered nurses.

Study Variables

The following work schedule characteristics were measured at the Wave 1 baseline: hours per day; hours per week; days per week; weekends per month; number of breaks lasting 10 min or more; full-time versus part time status; number of jobs (one vs. more than one); and shifts (straight days vs. other). The frequency with which nurses worked 13 hr or more; with less than 10 hr off between shifts; while sick; or on a day off/vacation day, mandatory overtime, and required on-call (dichotomized as 1 = called into work at least weekly vs. 0 = called in less frequently or not at all); and the longest stretch worked without a day off were measured and dichotomized. Work schedule variables were derived from the Standard Shiftwork Index [Barton et al., 1995; Smith et al., 2001], and three NIOSH experts examined the survey for content validity (Roger Rosa, Clare Caruso, and Steve Sauter; Personal communication, 9/2002). In the Wave 1 survey, nurses were asked to consider their typical work schedule for the past 6 months, for all jobs held. The use of a 6-month period was designed to increase the validity of schedule data, by minimizing the chance that participants would provide responses that covered an unusual or atypical work period [Folkard et al., 1995]. Nurses were asked to report the hours they had actually worked, including overtime, not the hours they were scheduled to work [Folkard et al., 1995]. To compare our findings to earlier cross-sectional findings [Lipscomb et al., 2002], a similar work schedule index (WSI) was constructed using the schedule components listed above. All variables were dichotomized as 0, 1 variables for the WSI, with the exception of hours per day and hours per week which were coded as 0–2. For hours per day: 1 = 9–11 hr, and 2 = 12+ hours per day; for hours per week: 1 = 41 to 49 hr, and 2 = 50+ hours per week, so that WSI scores ranged from 0 to 10.

MSD was measured by reports of neck, shoulder, and/or back symptoms including pain, numbness, tingling, aching, stiffness, or burning, adapted from the Nordic questionnaire of musculoskeletal symptoms [Kuorinka et al., 1987]. An “MSD case” was defined as report of a relevant symptom lasting 1 week or more, or occurring at least monthly, with moderate or more pain on average [Bernard et al., 1994], without a non-work injury/accident within 3 months prior to the onset of musculoskeletal symptoms.

Those at risk for MSD were identified separately for each body part (neck, shoulder, back). For example, nurses reporting neck symptoms that did not meet the neck MSD case definition at Wave 1 (because of insufficient frequency, duration, and/or pain intensity) and nurses reporting no neck symptoms were considered at risk for incident neck MSD at Wave 2 or Wave 3. In addition, nurses who had recovered from a Wave 1 neck MSD or a non-work related neck injury were also included in the group at risk for an incident neck MSD. Nurses reporting no neck, shoulder, or back problems at Wave 3 served as the reference group [Rothman and Greenland, 1998].

The impact of psychological and physical demands on the relationship between schedule characteristics and MSD was examined using scale items that were dichotomized, summed, and treated as continuous variables in the analysis. For psychological demands, 7 items from the job content questionnaire (JCQ) were used [Karasek, 1985]: working very hard, very fast, excessive work, long periods of intense concentration, enough time to get the job done, tasks often interrupted, and waiting on work from other people/departments. These were dichotomized and summed as a continuous variable ranging from 0 to 7 (alpha = 0.76). To measure perceived physical demands, we used the JCQ and incorporated additional occupation-specific physical demand items, as recommended by Karasek [1985] when studying a single occupation. For physical demands, 12 items

measured the frequency of awkward postures, heavy lifting, and pushing and pulling heavy loads on the job (alpha = 0.85). [Karasek, 1985; Karasek and Theorell, 1990; Bernard et al., 1994; NIOSH, 1997; Trinkoff et al., 2003]. It was also assessed whether the respondent changed jobs during the follow-up period.

Data Analysis

Descriptive analyses included the cumulative incidence of reported neck, shoulder, and back MSD occurring by Wave 3. Regression with age-adjustment was used to estimate the impact of each work schedule characteristic on incident neck, shoulder, and back MSD, with the score for number of breaks reversed to reflect consistency in the direction of odds ratios.

Principal components analysis on 15 Wave 1 work-schedule items were assessed for underlying patterns, extracting factors with eigenvalues ≥ 1.0 . Five factors assessing groupings of multiple work schedule characteristics were created (Table I). The regression method was used to compute factor scores, which were then regressed on neck, shoulder, and back MSD. Finally, the potential impact of psychological and physical demands on the relationship between schedule factors and MSD was examined. Because job change (occurring after baseline) had no effect on the relation between schedule and MSD in the regression models, the results presented do not include this variable.

TABLE I. Factor Analysis for the Work-Schedule Variables, ^aEigenvalues for Nurses Working in Nursing in the Past Year at Baseline (N = 2273)

Factor	Workday	Week	Mandatory overtime and on-call	Number of jobs/most days in a row	Work on time off
Hours/day	0.782				
Weekends/month	0.671				
Work 13 hr or more	0.694				
Shift	0.627				
<10 hr off between shifts	0.615				
Hours/week		0.840			
Full time versus Part time Status		0.840			
Days/week		0.786			
Required On-call			0.755		
Mandatory overtime			0.697		
Number of jobs				0.762	
Most days worked in a row				0.536	
Work while sick					0.727
Breaks/day					0.523
Work on a day off/vacation day					0.569

^aRotated component matrix, factors with eigenvalues of 1.0 or higher were extracted using a principal component analysis as the extraction method with Varimax rotation.

RESULTS

In Wave 1, returned questionnaires were received from 2,624 nurses, for a 62% enrollment rate. Follow-up rates for Waves 2 and 3 were 85% and 86%, respectively. The average time between questionnaire returns from Wave 1 to 2 was 6 months (180 days) and from Wave 1 to 3, 15 months (454 days). The mean age for the sample was 45 years and the sample was 95% female. For the analysis reported here, respondents had to have worked in nursing during the year prior to Wave 1.

The cumulative incidence of MSD was 14.0% for neck, 17.3% for shoulder, and 21.1% for back problems. Regression of the work schedule characteristics, with age-adjustment revealed that many of these characteristics were significantly associated with all three types of MSD (hours/day; hours/week; >13 hr/day; less than 10 hr off between shifts, work while sick, on days off, and mandatory overtime (Table II). On-call involving weekly or more call-ins to work was significantly associated with back and shoulder MSD. The work schedule index (WSI) was significantly associated with all three types of MSD.

Analysis of work schedule factors showed that the workday factor (hours/day, working 13+ hours/day, non dayshifts, weekends, working with less than 10 hr off) and working on time off (working while sick, on days off, instead of taking breaks) were significantly related to neck, shoulder, and back MSD, when the other work schedule factors were taken into account (Table III). Mandatory overtime/ on-call was significantly related to shoulder MSD. These findings remained significant after adjusting for psychological demands. Except for back MSD, the effects of the workday factor was largely explained by physical demands, as were the effects of the overtime/on-call factor.

DISCUSSION

Using a longitudinal study design, we found that work schedule independently increased nurses' risk of developing an MSD. This was not explained by psychological demands, though physical demands (such as lifting) explained the effects of some work schedule characteristics. We found similar effects in a previous cross-sectional examination of these variables [Lipscomb et al., 2002]. The effect of the workday factor on MSD is also consistent with other studies showing increased MSD and other health problems for those working longer days, off-shifts and weekends [Smith et al., 1998; Schernhammer et al., 2003; van der Hulst, 2003; Horwitz and McCall, 2004]. The present study is the first to examine the impact of mandatory overtime, being on-call, working while sick or on a day off, and with less than 10 hr off. All of these scheduling practices were related to increased risk of MSD. In a recent study of male civil servants, working while sick was related to increased risk of

adverse cardiac events [Kivimaki et al., 2005]. Working while sick among nurses has been increasing in work settings with limited staffing, due to pressure from supervisors and loyalty to co-workers [Crout et al., 2004]. The adverse health effects of working during time off may be related to encroachment on recovery and recuperation time during and between workdays [Sluiter et al., 2003; Hughes and Stone, 2004]. As time off diminishes, for example, workdays with less than 10 hr off in between, nurses have fewer opportunities to heal or recover to baseline. In one intervention study, shorter work hours markedly decreased neck, shoulder, and back pain [Wergeland et al., 2003].

An important finding in our study was the impact of mandatory overtime and on-call on all types of MSD, indicating that this is not a healthful practice. The relationship of overtime to injury has been reported for many industry sectors, with injury risks increasing as hours increased [Dembe et al., 2005; Dong, 2005]. Professional nursing advocacy groups have suspected this, though reports of adverse health effects to date have been limited [Nicol and Botterill, 2004]. In this sample, 16.7% had jobs with mandatory overtime and 38.6% had required on-call hours [Trinkoff et al., 2006]. There is anecdotal evidence that employers are removing mandatory overtime from nurse schedules and increasingly substituting on-call requirements. This practice will not provide any safety benefit to nurses if it still leads to extra hours in the workplace, and it may signal a need to incorporate on-call work into mandatory overtime prohibition laws. There are also potential consequences for the quality of care provided, as Rogers et al. [2004] found that nurses working more hours reported greater likelihood of making an error.

Mandatory overtime has now been prohibited in many US states, is disliked by nurses [Jacobsen et al., 2002] and is related to lower job satisfaction among workers in general [Golden and Wiens-Tuers, 2005]. On the other hand, some nurses voluntarily request long work hours, a practice that is not limited by mandatory overtime laws, despite the health consequences of long work hours. Without controls on unhealthy scheduling practices, the risk for nurse injury is high [Spurgeon et al., 1997] as is turnover of nurses [Aiken et al., 2001]. In California, which has minimum nurse staffing requirements, shortages have been diminishing due to an influx of nurses into the state seeking the improved working conditions that have resulted [Robertson, 2004; Spetz, 2004; Spetz et al., 2004]. The introduction of more healthful scheduling thus not only can protect the health of working nurses but also provide incentives for nurses to remain on the job, saving costs and relieving shortages for health care facilities [Shader et al., 2001; Reineck and Furino, 2005].

The longitudinal design of the study made it possible to assess the temporal sequence of work schedule components and MSD. A high rate of follow-up of the baseline sample in Waves 2 and 3 (85% and 86%, respectively) increased the

TABLE II. Age Adjusted Odds Ratios (OR) for Reported Incident Cases of Musculoskeletal Disorders by Work-Schedule Characteristic, for Nurses with ≥ 1 Year Worked in Nursing at Baseline, 2003–2004

Work-schedule variable	Musculoskeletal disorder					
	Neck* (N = 226)		Shoulder** (N = 281)		Back*** (N = 308)	
	OR	95% CI	OR	95% CI	OR	95% CI
Hours/day	1.07	0.99–1.16	1.08 ^a	1.01–1.16	1.08 ^a	1.01–1.16
Hours/week	1.01 ^a	1.00–1.03	1.01 ^a	1.00–1.03	1.01 ^a	1.00–1.02
Days/week	1.01	0.88–1.15	1.00	0.89–1.14	0.97	0.86–1.09
Weekends/month	1.10	0.96–1.26	1.06	0.93–1.21	1.18 ^b	1.05–1.34
Breaks/day	1.11	0.90–1.36	1.13	0.93–1.36	1.32 ^b	1.10–1.59
Status						
Part-time	1.00	—	1.00	—	1.00	—
Full-time	1.42	0.97–2.08	1.38	0.97–1.95	1.26	0.90–1.76
Number of jobs						
One	1.00	—	1.00	—	1.00	—
More than one	1.15	0.77–1.72	1.11	0.75–1.62	1.03	0.71–1.50
Shift						
Straight Days	1.00	—	1.00	—	1.00	—
Other	1.18	0.84–1.65	1.29	0.94–1.77	1.27	0.94–1.72
Work 13+ hrs						
No	1.00	—	1.00	—	1.00	—
Yes	1.94 ^c	1.38–2.74	1.87 ^c	1.35–2.58	1.87 ^c	1.37–2.55
Less than 10 hr off between shifts						
No	1.00	—	1.00	—	1.00	—
Yes	1.58 ^b	1.12–2.23	1.92 ^c	1.39–2.64	1.55 ^b	1.13–2.11
Work While Sick						
No	1.00	—	1.00	—	1.00	—
Yes	2.40 ^c	1.47–3.91	1.84 ^b	1.21–2.80	1.48 ^a	1.01–2.17
Work on a day off/vacation day						
No	1.00	—	1.00	—	1.00	—
Yes	1.89 ^c	1.28–2.80	1.89 ^c	1.32–2.72	1.41 ^a	1.01–1.97
Mandatory overtime						
No	1.00	—	1.00	—	1.00	—
Yes	1.56 ^a	1.00–2.42	2.17 ^c	1.46–3.23	1.55 ^a	1.03–2.31
On-call						
None-monthly	1.00	—	1.00	—	1.00	—
Weekly or more	1.41	0.77–2.56	1.99 ^a	1.16–3.38	1.88 ^a	1.16–3.16
Most days worked in a row						
0–5 days	1.00	—	1.00	—	1.00	—
6+ days	1.42	0.99–2.04	1.42 ^a	1.01–2.00	1.01	0.71–1.42
Work Schedule Index	1.08	0.99–1.17	1.09 ^a	1.01–1.19	1.12 ^b	1.03–1.22

Reference group, respondents who were completely asymptomatic in all body parts at wave 3 (*N = 481, **N = 483, ***N = 487).
95% CI, 95% Confidence Interval.

^aTwo tailed significance at 0.05 level.; ^b0.01 level.; ^c0.001 level.

credibility of the findings. The limitations of our study stem from self-report, which can be affected by recollection and recall. Use of typical and average schedule descriptors in collecting schedule characteristics, increases the validity of

the findings, since average reported schedules are less likely to reflect an unusual time period [Folkard et al., 1995]. Others have measured typical work schedules [Bureau of Labor Statistics, 2002] and number of years that nurses

TABLE III. Age Adjusted Odds Ratios (OR) of Reported Incident Cases of Musculoskeletal Disorders by Baseline Work-Schedule Factor Scores, for Nurses with ≥ 1 year Worked in Nursing at Baseline, 2003–2004

Work-schedule factor	Musculoskeletal disorder					
	Neck* (N = 226)		Shoulder** (N = 281)		Back*** (N = 308)	
	OR	95% CI	OR	95% CI	OR	95% CI
Age adjusted model						
Workday factor [†]	1.30 ^b	1.06–1.59	1.37 ^c	1.13–1.67	1.34 ^b	1.11–1.62
Week factor	1.05	0.86–1.30	1.09	0.89–1.33	0.95	0.79–1.13
Mandatory overtime and on-call factor	1.07	0.87–1.32	1.24 ^a	1.03–1.49	1.15	0.95–1.38
Number of jobs/most days worked in a row	1.05	0.85–1.28	1.05	0.86–1.28	1.11	0.92–1.35
Working on time off factor	1.39 ^b	1.12–1.71	1.29 ^b	1.07–1.56	1.18	0.99–1.40
Model adjusted for all of the above plus psychological demands						
Workday factor	1.26 ^a	1.03–1.55	1.34 ^b	1.10–1.63	1.30 ^b	1.08–1.58
Week factor	1.05	0.85–1.29	1.08	0.89–1.32	0.93	0.78–1.12
Mandatory overtime and on-call factor	1.05	0.85–1.29	1.22 ^a	1.01–1.47	1.12	0.93–1.36
Number of jobs/most days worked in a row	1.06	0.86–1.30	1.05	0.86–1.28	1.12	0.92–1.35
Work on time off factor	1.33 ^a	1.07–1.66	1.25 ^a	1.03–1.52	1.13	0.94–1.36
Psychological demands	1.09	0.98–1.22	1.07	0.96–1.18	1.09	0.99–1.20
Model adjusted for all of the above plus physical demands						
Workday factor	1.19	0.95–1.49	1.19	0.96–1.48	1.22	0.99–1.51
Week factor	1.05	0.85–1.29	1.10	0.90–1.35	0.94	0.78–1.13
Mandatory overtime and on-call factor	1.03	0.83–1.27	1.19	0.98–1.43	1.10	0.91–1.33
Number of jobs/most days worked in a row	1.05	0.85–1.29	1.03	0.84–1.27	1.11	0.91–1.34
Working on time off factor	1.32 ^a	1.06–1.64	1.23 ^a	1.01–1.50	1.12	0.93–1.35
Psychological demands	1.06	0.94–1.19	1.01	0.90–1.13	1.05	0.95–1.17
Physical demands	1.05	0.97–1.12	1.09 ^a	1.02–1.17	1.05	0.98–1.12

95% CI, 95% Confidence Interval.

^aTwo tailed significance at 0.05 level.; ^b0.01 level.; ^c0.001 level

Reference group, respondents who were completely asymptomatic in all body parts at wave 3 (*N = 481, **N = 483, ***N = 487).

[†]Workday factor—hours/day, weekends/month, shift, 13+ hr days, <10 hr off between shifts; Week factor—hours/week, full versus part-time; Working on time off factor—work while sick, on a day off or vacation day, breaks taken.

worked off-shifts [Kawachi et al., 1995; Schernhammer et al., 2001]. Furthermore, researchers have found survey questionnaires measuring work demands to have acceptable reproducibility over time [Torgen et al., 1999] and when compared to observations [Pope et al., 1998]. The reliability and validity of self-reported MSD assessed by survey method has also been found acceptable for the purposes of assessing risk factors [Bjorksten et al., 1999; Kaergaard et al., 2000] and as a screening tool [Baron et al., 1996]. Survey data generally correlates well with physical findings [Punnett and Wegman, 2004].

The present study provides evidence that adverse work schedules are related to reported incident nurse MSD. Prevention efforts should include movement to more healthful and reasonable scheduling practices. Although schedule modifications may initially require

additional nursing staff, retention of a stable and healthier workforce will ultimately benefit nurses, workplaces and patients.

REFERENCES

- Aiken LH, Clarke SP, Sloane DM, Sochalski JA, Busse R, Clarke H, Giovannetti P, Hunt J, Rafferty AM, Shamian J. 2001. Nurses' report on hospital care in five countries. *Health Aff* 20:43–53.
- Ala-Mursula L, Vahtera J, Pentti J, Kivimaki M. 2004. Effect of employee worktime control on health: A prospective cohort study. *Occup Environ Med* 61:254–261.
- Alexopoulos E, Burdorf A, Kalokerinou A. 2003. Risk factors for musculoskeletal disorders among nursing personnel in Greek hospitals. *Int Arch Occup Environ Health* 76:289–294.
- American Nurses Association (ANA). 2001. Nurses concerned over working conditions, decline in quality of care ANA survey reveals.

- Retrieved from <http://nursingworld.org/pressrel/2001/pr0206.htm> on May 13th 2005.
- Ando S, Yuichiro O, Shimaoka M, Hattori S, Hori F, Takeuchi Y. 2000. Associations of self estimated workloads with musculoskeletal symptoms among hospital nurses. *Occup Environ Med* 57:211–216.
- Ariens GA, Bongers PM, Hoogendoorn WE, van der Wal G, van Mechelen W. 2002. High physical and psychosocial load at work and sickness absence due to neck pain. *Scand J Work Environ Health* 28(4):222–231.
- Baron S, Hales T, Hurrell J. 1996. Evaluation of symptom surveys for occupational musculoskeletal disorders. *Am J Ind Med* 29:609–617.
- Barton J, Spelten E, Totterdell P, Smith L, Folkard S. 1995. Is there an optimum number of night shifts? Relationship between sleep, health and well-being. *Work Stress* 9(2–3):109–123.
- Bernard B, Sauter S, Fine L, Petersen M, Hales T. 1994. Job task and psychosocial risk factors for work-related musculoskeletal disorders among newspaper employees. *Scand J Work Environ Health* 20(6):417–426.
- Berney B, Needleman J, Kovner C. 2005. Factors influencing the use of Registered Nurse overtime in hospitals, 1995–2000. *J Nsg Scholarship* 37(2):165–172.
- Bjorksten MG, Boquist B, Talback M, Edling C. 1999. The validity of reported musculoskeletal problems. A study of questionnaire answers in relation to diagnosed disorders and perception of pain. *Appl Ergon* 30(4):325–330.
- Bourbonnais R, Brisson C, Malenfant R, Vezina M. 2005. Health care restructuring, work environment and health of nurses. *Am J Ind Med* 47:54–64.
- Bureau of Labor Statistics. 2002. Workers on flexible and shift schedules technical note. Retrieved from <http://www.bls.gov/news-release/flex.tn.htm> on May 17, 2005.
- Bureau of Labor Statistics. 2005. Workplace injuries and illnesses in 2004. US Department of Labor. Washington, DC. Release date: November 17, 2005. USDL 05-2195. Retrieved from <http://www.bls.gov/news.release/pdf/osh.pdf> on March 17, 2006.
- Caruso C, Hitchcock E, Dick R, Russo J, Schmidt J. 2004. Overtime and extended work shifts: Recent findings on illnesses, injuries and health behaviors. DHHS Publication number 2004-143; NIOSH Publications Dissemination: Cincinnati.
- Crout LA, Chang E, Cioffi J. 2004. Why do registered nurses work when ill? *J Nurs Admin* 35(1):23–28.
- Davis KG, Marras WS, Heaney CA, Waters TR, Gupta P. 2002. The impact of mental processing and pacing on spine loading: 2002 Volvo Award in biomechanics. *Spine* 27(23):2645–2653.
- Dembe AE, Erickson JB, Delbos RG, Banks SM. 2005. The impact of overtime and long work hours on occupational injuries and illnesses: New evidence from the United States. *Occup Environ Med* 62:588–597.
- Devereux JJ, Vlachonikolis IG, Buckle PW. 2002. Epidemiological study to investigate potential interaction between physical and psychosocial factors at work that may increase the risk of symptoms of musculoskeletal disorder of the neck and upper limb. *Occup Environ Med* 59(4):269–277.
- Dillman DA. 2000. *Mail and Internet Surveys: The Tailored Design Method*, 2nd ed. New York, NY: John Wiley & Sons.
- Dong X. 2005. Long workhours, work scheduling and work-related injuries among construction workers in the United States. *Scand J Work Environ Health* 31:329–335.
- Engels J, van der Gulden J, Senden T, van't Hof B. 1996. Work related risk factors for musculoskeletal complaints in the nursing profession: Results of a questionnaire survey. *Occ Environ Med* 53:636–641.
- Engkvist IL, Hjelm EW, Hagberg M, Menckel E, Ekenvall L. 2000. Risk indicators for reported over-exertion back injuries among female nursing personnel. *Epidem* 11(5):519–522.
- Folkard S, Spelten E, Totterdell P, Barton J, Smith L. 1995. The use of survey measures to assess circadian variations in alertness. *Sleep* 18:355–361.
- Forde MS, Punnett L, Wegman DH. 2002. Pathomechanisms of work-related musculoskeletal disorders: Conceptual issues. *Ergonomics* 45(9):619–630.
- Fredriksson K, Alfredsson L, Ahlberg G, Josephson M, Kilbom A, Wigaeus-Hjelm E, Wiktorin C, Vingard E. 2002. Work environment and neck and shoulder pain: The influence of exposure time. Results from a population based case-control study. *Occup Environ Med* 59(3):182–188.
- Golden L, Wiens-Tuers B. 2005. Mandatory overtime work in the United States: Who, where and what? *Labor Studies J* 30:1–26.
- Health Research and Services Administration (HRSA) 2000. *The Registered Nurse Population. Findings from the National Sample Survey of Registered Nurses*. U.S. Department of Health and Human Services. Bureau of Health Professions. Division of Nursing.
- Hoozemans M, van der Beek A, Frings-Dresen MH, van der Woude LH, van Dijk FG. 2002. Pushing and pulling in association with low back and shoulder complaints. *Occup Med* 59:696–702.
- Horwitz IB, McCall BP. 2004. The impact of shift work on the risk and severity of injuries for hospital employees: An analysis using Oregon workers' compensation data. *Occup Med (Lond)* 54(8):556–563.
- Hughes R, Stone P. 2004. The perils of shift work: Evening shift, night shift, and rotating shifts: Are they for you? *Am J Nurs* 104(9):60–63.
- Jacobsen C, Holson D, Farley J, Charles J, Suel P. 2002. Surviving the perfect storm: Staff perceptions of mandatory overtime. *JONAS Healthcare Law Ethics Regul* 4(3):57–66.
- Jansen N, Kant I, van Amelsvoort L, Nijhuis F, van den Brandt P. 2003. Need for recovery from work: Evaluating short-term effects of working hours, patterns and schedules. *Ergonomics* 46(7):664–680.
- Jansen NW, Kant I, Nijhuis FJ, Swaen GM, Kristensen TS. 2004. Impact of worktime arrangements on work-home interference among Dutch employees. *Scand J Work Environ Health* 30(2):139–148.
- Kaergaard A, Andersen JH, Rasmussen K, Mikkelsen S. 2000. Identification of neck-shoulder disorders in a 10-year follow-up study. Validation of a questionnaire-based method. *Pain* 86:305–310.
- Karasek RA. 1985. *Job content questionnaire and user's guide*. Lowell (MA): University of Massachusetts Lowell, Department of Work Environment.
- Karasek RA, Theorell T. 1990. *Healthy work: Stress Productivity, and the Reconstruction of Working Life*. New York, NY: Basic Books. 381p.
- Kawachi I, Colditz G, Stampfer M, Willett W, Manson J, Speizer F, Hennekens C. 1995. Prospective study of shift work and risk of coronary heart disease in women. *Circulation* 92:3178–3182.
- Kivimaki M, Head J, Ferrie JE, Hemingway H, Shipley MJ, Vahtera J, Marmot MG. 2005. Working while ill as a risk factor for serious coronary events: The Whitehall II study. *Am J Public Health* 95(1):98–102.
- Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sorensen F, Andersson G, Jorgensen K. 1987. Standardized Nordic questionnaires

- for the analysis of musculoskeletal symptoms. *Appl Ergon* 18(3):233–237.
- Landsbergis PA, Cahill J, Schnall P. 1999. The impact of lean production and related new systems of work organization on worker health. *J Occup Health Psychol* 2:108–130.
- Lipscomb J, Trinkoff AM, Geiger-Brown J, Brady B. 2002. Work-schedule characteristics and reported musculoskeletal disorders of registered nurses. *Scand J Work Environ Health* 28(6):394–401.
- Lipscomb J, Trinkoff A, Brady B, Geiger-Brown J. 2004. Health care system changes and reported musculoskeletal disorders among registered nurses. *Am J Public Health* 94(8):1431–1435.
- Marras WS, Davis KG, Kirking BC, Bertsche PK. 1999. A comprehensive analysis of low-back disorder risk and spinal loading during the transferring and repositioning of patients using different techniques. *Ergonomics* 42:904–926.
- Maul I, Laubli T, Klipstein A, Krueger H. 2003. Course of low back pain among nurses: A longitudinal study across eight years. *Occup Environ Med* 60:497–503.
- Menzel NN, Brooks SM, Bernard TE, Nelson A. 2004. The physical workload of nursing personnel: Association with musculoskeletal discomfort. *Int J Nurs Studies* 41:859–867.
- National Institute for Occupational Safety and Health. 1997. Musculoskeletal disorders (MSDs) and workplace factors: A critical review of the epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity and low back. Washington (DC): US Government Printing Office.
- Nicol AM, Botterill JS. 2004. On-call work and health: A review. *Environ Health* 3(1):15.
- Pope DP, Silman AJ, Cherry NM, Pritchard C, Macfarlane GJ. 1998. Validity of a self-completed questionnaire measuring the physical demands of work. *Scand J Work Environ Health* 24:376–385.
- Punnett L, Wegman DH. 2004. Work-related musculoskeletal disorders: The epidemiologic evidence and the debate. *J Electromyogr Kinesiol* 14(1):13–23.
- Punnett L, Gold J, Katz JN, Gore R, Wegman DH. 2004. Ergonomic stressors and upper extremity musculoskeletal disorders in automobile manufacturing: A one year follow up study. *Occup Environ Med* 61:668–674.
- Reineck C, Furino A. 2005. Nursing career fulfillment: Statistics and statements from registered nurses. *Nurs Economics* 23(1):25–30.
- Robertson K. 2004. Agency bogs down as nurses rush to register. *Sacramento Business Journal*. From the January 16, 2004 print edition. Retrieved from <http://sacramento.bizjournals.com/sacramento/stories/2004/01/19/story6.html> on May 13, 2005.
- Rogers AE, Hwang WT, Scott LD, Aiken LH, Dinges DF. 2004. The working hours of hospital staff nurses and patient safety. *Health Affairs* 23:202–212.
- Rothman KJ, Greenland S. 1998. *Modern Epidemiology*, 2nd ed. Philadelphia: Lippincott Williams & Wilkins.
- Schernhammer ES, Laden F, Speizer FE, Willett WC, Hunter DJ, Kawachi I, Colditz GA. 2001. Rotating night shifts and risk of breast cancer in women participating in the nurses' health study. *J Natl Cancer Inst* 93(20):1563–1568.
- Schernhammer ES, Laden F, Speizer FE, Willett WC, Hunter DJ, Kawachi I, Fuchs CS, Colditz GA. 2003. Night-shift work and risk of colorectal cancer in the nurses' health study. *J Natl Cancer Inst* 95(11):825–828.
- Shader K, Broome ME, Broome CD, West ME, Nash M. 2001. Factors influencing satisfaction and anticipated turnover for nurses in an academic medical center. *J Nurs Adm* 31(4):210–216.
- Sluiter JK, de Croon EM, Meijman TF, Frings-Dresen MH. 2003. Need for recovery from work related fatigue and its role in the development and prediction of subjective health complaints. *Occup Environ Med* 60(Suppl 1):62–70.
- Smedley J, Inskip H, Trevelyan F, Buckle P, Cooper C, Coggon D. 2003. Risk factors for incident neck and shoulder pain in hospital nurses. *Occup Environ Med* 60:864–869.
- Smith C, Gibby R, Zickar M, Crossley C, Robie C, Folkard S, Tucker P, Barton J. 2001. Measurement properties of the Shiftwork Survey and Standard Shiftwork Index. *J Hum Ergol* 30(1–2):191–196.
- Smith D, Wei N, Kang L, Wang R. 2004. Musculoskeletal disorders among professional nurses in mainland China. *J Profess Nurs* 20(6):390–395.
- Smith L, Folkard S, Tucker P, Macdonald I. 1998. Work shift duration: A review comparing eight hour and 12 hour shift systems. *Occup Environ Med* 55(4):217–229.
- Spetz J. 2004. California's minimal nurse-to-patient ratios: The first few months. *J Nurs Admin* 34(12):571–578.
- Spetz J, Rickles J, Ong PM. 2004. California's nursing labor force: Demand, supply, and shortages. *First Labor Market Report*. January 30, 2004. Retrieved from <http://www.calmis.ca.gov/specialreports/NWI-EarlyLaborMarketReportFINAL.pdf> pp.26–27 on May 13, 2005.
- Spurgeon A, Harrington JM, Cooper CL. 1997. Health and safety problems associated with long working hours: A review of the current position. *Occup Environ Med* 54(6):367–375.
- Torgen M, Winkel J, Alfredsson L, Kilbom A. 1999. Evaluation of questionnaire-based information on previous physical workloads. *Scand J Work Environ Health* 25:246–254.
- Trinkoff AM, Lipscomb JA, Geiger-Brown J, Storr CL, Brady BA. 2003. Perceived physical demands and reported musculoskeletal problems in registered nurses. *Am J Prev Med* 24(3):270–275.
- Trinkoff AM, Geiger-Brown J, Brady B, Lipscomb JA, Muntaner C. 2006. How long and how much are nurses now working? *Am J Nurs* 106:60–71.
- van der Hulst M. 2003. Long workhours and health. *Scand J Work Environ Health* 29(3):171–188.
- Wergeland EL, Veiersted B, Ingre M, Olsson B, Akerstedt T, Bjornskau T, Varg N. 2003. A shorter workday as a means of reducing the occurrence of musculoskeletal disorders. *Scand J Work Environ Health* 29(1):27–34.
- Yip YB. 2001. A study of work stress, patient handling activities and the risk of low back pain among nurses in Hong Kong. *J Adv Nursing* 36(6):794–804.