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Musculoskeletal outcomes in multiple body regions and work effects among nurses: the effects of stressful and stimulating working conditions

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This study investigated the various stressors encountered by the nursing profession. In particular, the following hypotheses were tested: (1) working conditions of nurses significantly affect perceived risk of injury and illness, work dissatisfaction, work satisfaction, energy state at the end of workday, the effort exerted by the registered nurse (RN), psychosomatic outcomes, and musculoskeletal symptoms (in multiple body regions); (2) both intermediate work effects (i.e., effort, perceived risk of injury/illness, work satisfaction/dissatisfaction, energy state at end of workday) and psychosomatic outcomes significantly affect musculoskeletal outcomes (in multiple body regions); (3) both working conditions and effects significantly affect musculoskeletal outcomes. In a preliminary study conducted on 34 registered nurses, results show that: (1) stressful working conditions affect musculoskeletal outcomes in multiple body regions, and (2) physical maladies such as lower back problems are not only associated with physical factors but also with a complex interaction of working conditions. Further research is warranted to obtain a better understanding of the complex interaction and the synergistic effects of the various nursing working conditions.

1. Introduction

Shortage among registered nurses (RNs) is emerging as a serious problem that threatens the quality of care in the US health care delivery system. This nursing shortage has been attributed to several factors, including an aging workforce as well as an aging population, an inadequate supply of young professionals choosing a nursing career, and in large part, to stressful and unsafe working conditions (National Council of State Boards of Nursing 2001). These claims are substantiated

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by statistics published by the US Bureau of Labor Statistics (2001). These reports maintain that incidence rates of musculoskeletal symptoms among nursing personnel are about twice that of the national mean over a 15-year period. Working conditions consist of a web of physical, mental, social, organizational, and technological factors that interact in a complex way leading to individual effects as well as an interactive chain of work effects. For example, working conditions may result in both work dissatisfaction and musculoskeletal symptoms. Alternatively, dissatisfaction with certain working conditions may lead to musculoskeletal symptoms.

The working conditions coupled with their negative effects may ultimately result in frustrating situations or desperate circumstances where the RN decides to leave the practice of nursing. On the other hand, stimulating working conditions together with their positive outcomes may energize the RN's performance at work. This in turn can enhance the retention of qualified RNs in the workplace and ultimately improve the delivery of quality care. Thus it is necessary to adopt a holistic approach to this complex problem to truly understand these complex interrelationships and subsequently develop integrated interventions to improve the working conditions. To the authors' knowledge, most researchers have not considered the synergistic effects of this complex web of working conditions. A summary of relevant literature is provided below.

2. Risk of musculoskeletal disorders in nursing profession

It is commonly reported that nurses are exposed to a high risk of musculoskeletal disorders in the lower back due to patient handling (Jensen 1990, Yassi *et al*. 1995). Recent evidence, however, suggests that nurses are exposed to the risk of musculoskeletal disorders not only in the lower back area but also in other regions of the body (table 1). The three highest prevalence rates of musculoskeletal disorders were found for the neck, shoulders and back, followed by the upper back, hands/wrists and knees/lower legs, then elbows/forearms, hips/thighs and ankles/feet. Based on weighted-mean calculations across the studies (Lagerstrom *et al*. 1995, Engels *et al*. 1996, Josephson *et al*. 1997, Hernandez *et al*. 1998), the prevalence rates for the neck, shoulders and lower back were 40, 42 and 50%, respectively. Although the prevalence rates for the upper back, hands and knees were lower than those for the back, shoulders and neck, the rates for the upper back, hands/wrists and knees/lower legs were considerable in size and 17, 14 and 20%, respectively. Thus, it is critical to identify the risk factors for nurses related to the incidence of musculoskeletal disorders for different body regions in order to prevent or lower their risk, reduce injury incidence and avoid unnecessary loss of these high demand professionals from the workforce.

In addition to the aforementioned results, recent prospective epidemiological studies have found that the physical demands of tasks are not the only factors found significantly associated with musculoskeletal disorders and are summarized in the Appendix. Other demands include mental task demands, social environment demands, organizational environment demands and technological demands. In particular, two cross-sectional epidemiological studies examined the relationship between work-related factors among nurses and the prevalence rates of musculoskeletal disorders for specific body regions (Lagerstrom *et al*. 1995, Engels *et al*. 1996). The main conclusions drawn from the two studies are that the association between both physical and non-physical work-related factors, and musculoskeletal disorders may be different for each body region, and depends on the level of severity

Table 1. Prevalence rates of musculoskeletal complaints among nurses for specific body regions.

Reference	Nursing category	Type of complaints	Lower back	Upper back	Neck	Shoulders	Elbows/ Forearms	Hands/ Wrists	Fingers	Hips/ Thighs	Knees/ lower legs	Ankles/ Feet
Lagerstrom *et al.* (1995)	RNs ($n = 165$)	Ongoing complaint	52	–	44	48	–	17	–	–	27	–
		Severe ongoing complaints	14	–	15	17	–	3	–	–	7	–
	State RNs ($n = 255$)	Ongoing complaints	55	–	46	54	–	22	–	–	31	–
		Severe ongoing complaints	15	–	16	17	–	4	–	–	5	–
	NRNs ($n = 268$)	Ongoing complaints	65	–	59	60	–	30	–	–	35	–
		Severe ongoing complaints	22	–	22	22	–	7	–	–	9	–
Engels *et al.* (1996)	Nurses – 16% managerial positions; 84% non-managerial positions) ($n = 846$)	Overall	33.8	7.9	22.9	19.5	2.3	5.7	–	6.9	10.2	3.7
Josephson *et al.* (1997)	Mixture of RNs,	Overall	64	30	53	60	–	–	–	–	–	–
	State enrolled nurses,	Ongoing complaints	49	24	40	50	–	–	–	–	–	–
	NRN ($n = 565$)	Severe ongoing complaints	16	8	18	20	–	–	–	–	–	–
Hernandez *et al.* (1998)	RNs ($n = 14$)	Overall complaints	93	28	64	64	28	50	–	28	34	40
		Severe ongoing complaints	38	7	21	24	0	34	–	0	0	13
Weighted prevalence rates	RNs & NRNs	Overall	50	17	40	42	3	14	–		20	4

Note:
RNs – registered nurses
NRNs – non-registered nurses
n = sample size
Definition of musculsokeletal complaint—it was defined in all studies as any 'ache', 'pain' or 'discomfort' in a specific body region. In the Lagestrom and Josephson studies, the degree of a complaint was assessed using a 10-point scale with the following endpoint anchors '0 – not all' and '9 – very much'.
Ongoing complaint—the term 'ongoing' was not defined in the Lagerstrom study.
Severe complaint—it was defined as scoring '6' or higher using a 10-point scale in the Lagerstrom and Josephson studies. Hernandez *et al.* defined a severe complaint as lasting more than 30 days.
The weighted prevalence rate across all studies was weighed with reference to the sample size.

of musculoskeletal disorders. However, a major shortcoming of these two studies, as well as other studies in the published literature on lower back complaints among nurses (Heap 1987, Mandel and Lohman 1987, Venning *et al*. 1987, Stobbe *et al*. 1988, Mostardi *et al*. 1992, Ready *et al*. 1993, Klaber Moffett *et al*. 1993, Harber *et al*. 1994, Niedhammer *et al*. 1994, Smedley *et al*. 1995, 1997, Engels *et al*. 1998), is the lack of a construct that identifies the wide range of work demands possibly leading to musculoskeletal disorders among nurses. The lack of such a construct hinders the ability to examine and understand the complex relationship between multiple work demands and the prevalence and incidence of musculoskeletal disorders among nurses.

3. Objectives

In our prior research, the authors have developed a theoretical construct for examining many of the complex relationships between the physical, mental, social, organizational, and technological factors (Genaidy *et al*. 2000). The aims of this present study are to investigate the associations between working conditions, intermediate work effects, and psychosomatic outcomes and the onset of musculoskeletal symptoms. In addition, the following hypotheses were tested: (1) working conditions significantly affect the effort exerted by the RN, perceived risk of injury and illness, work dissatisfaction, work satisfaction, energy state at the end of workday, psychosomatic outcomes, and musculoskeletal symptoms; (2) both intermediate work effects (i.e., effort, perceived risk of injury/illness, work satisfaction and dissatisfaction, energy state at end of workday) and psychosomatic outcomes significantly affect musculoskeletal outcomes; (3) both working conditions and effects significantly affect musculoskeletal outcomes.

4. Methods and research design

4.1. *Participant population*

Thirty-four female registered nurses, recruited from hospitals in the U.S. Midwest, volunteered to participate in this preliminary study. One hospital, a Catholic healthcare system and the other run by a not-for-profit corporation. The nurses ere informed of the research and its objectives by unit managers and encouraged to participate. Due to the preliminary nature of this research, resources were limited and required the investigation to rely on volunteers. No restrictions were placed on the type of wards or units the participants worked in. Their length of employment ranged between 5 and 10 years and their mean age and weight were 30 years and 68 kg, respectively.

4.2. *Working condition variables*

Work demands and work stimuli were the principal working conditions or 'exposure variables' for the nurses. 'Work demand' was defined as the various requirements of the work place (including the work place environment) that place burdens on the nurses requiring the use of muscular, mental, and emotional energy. Work demands were divided into six categories: (1) physical task demands (muscular demands); (2) mental task demands (cognitive requirements); (3) sensory demands (requirements imposed upon the internal and external senses); (4) physical environment demands (physical, chemical, and biological agents as well as workspace configuration); (5) social demands (interpersonal interaction requirements); and (6) organizational demands (burdens of work schedule, work

responsibility, work structure, and managerial procedures). 'Work stimulus' was defined as the characteristic of the work environment that encourages the RN to attain successful and high quality job performance. Positive work stimuli can replenish emotional energy and boost muscular and mental energy reserves. Alternatively, negative work stimuli can deplete emotional, mental, and muscular energy. Work stimuli were divided into two categories: (1) social, that is, conditions of support and encouragement from colleagues, fellow workers, and contacts both inside and outside of the institution (the hospital or health care unit) usually in the form of communicated praise, acknowledgement, and recognition; and (2) organizational, that is, conditions of support form the organization in the form of shared decision making, financial incentives, and opportunities for advancement.

Work demands may be viewed as risk factors while work stimuli may be viewed as either protective or risk factors, depending upon the working conditions. The constructs of work demands and work stimuli are described at length by Genaidy *et al*. (2000), and for the present purposes the demands and stimuli are assessed using a comprehensive questionnaire. The instrument was designed so that it could be applicable to all types of industry in that all questions were stated in a general format. No references were made to a particular industry and items were carefully stated and formatted in manner that captured the fundamental nature of the working condition or environment. In this instrument the demands and stimuli are rated on an 8-point scale as follows: '0' – negligible or not applicable; '1' – very low; '2' – low; '3' – somewhat low; '4' – moderate; '5' – somewhat high; '6' – high; '7' – very high. The higher the value for work demands, the more negative the effect; the higher the value for work stimuli, the more positive the effect.

4.3. *Work effects*

The outcomes collected in this research consist of six general categories: (1) effort extended (i.e., muscular, mental and emotional energy); (2) perceived risk of injury or illness (i.e., level of internal risk associated with the performance of tasks in the working environment); (3) work satisfaction and dissatisfaction (evaluated separately following the guidelines of Herzberg *et al*. (1959); (4) energy state at the end of the workday (i.e., nurse's level of fatigue assessed in terms of physical, mental, and emotional performance); (5) psychosomatic outcomes (measured using an instrument developed by Eriksen *et al*. (1999); consists of gastrointestinal, pseudo-neurologic, allergy, and flu complaints); and (6) musculoskeletal outcomes (i.e., presence of moderate to severe aches, pains, or discomforts in the neck, shoulders, back, arms or legs in the year leading up to the study, as assessed by Kuorinka *et al*. (1987).

Intermediate work effects (i.e., effort, perceived risk, work satisfaction and dissatisfaction, energy state at end of workday) were assessed using an 8-point scale similar to that used to evaluate work demands and stimuli. Psychosomatic outcomes were determined using a 6-point scale and were anchored as follows: '0' – never; '1' – rare; '2' – occasional; '3' – sometimes; '4' – often; '5' – very often. Musculoskeletal outcomes were treated as a dichotomous or binary variable (presence or absence of symptoms).

4.4. *Experimental procedures and statistical analyses*

Following briefings of the participating RNs and their signing of an informed consent form, each participant was given a comprehensive

questionnaire to assess the exposure and outcome measures. They were given one week to complete the questionnaire. The reliability of the instrument was independently assessed in Genaidy *et al*. (2000). The internal consistency of the work demands, work stimuli and outcome measures (using Cronbach alpha) ranged between 0.81 and 0.97. The associations between variables were examined using correlation and multiple logistics regression. All statistical analyses were conducted using the Statistical Analysis System (SAS) software.

5. Results

5.1. *Descriptive statistics for work exposure variables, intermediate work effects and psychosomatic outcomes*

The mean results were obtained for work conditions and effects are shown in table 2.

5.2. *Effects of work exposure variables on intermediate work effects and psychosomatic outcomes*

The results of the correlation analyses (table 3) indicated that:

(1) Effort was significantly associated with physical factors and organizational demands.
(2) Perceived risk was statistically correlated with task as well as physical–organizational environment demands positively; it was negatively correlated with social stimuli.
(3) Dissatisfaction was positively related to work demands and negatively related to socio-organizational stimuli (all correlations were statistically significant).
(4) Satisfaction was positively associated with socio-organizational stimuli, and negatively associated with socio-organizational demands. Its association with socio-organizational stimuli was much more pronounced than that for

Table 2. Descriptive statistics for work exposure variables, intermediate work effects and Psychosomatic outcomes.

Variable	Result
PTD	Moderate (3.81 ± 1.21)
MTD	Somewhat high (5.28 ± 0.95)
PED	Somewhat low (2.57 ± 0.99)
SED	Moderate (3.83 ± 1.11)
OED	Moderate (4.23 ± 0.73)
EF	High (5.80 ± 1.09)
PR	Moderate (3.91 ± 1.40)
DIS	Moderate (4.04 ± 1.38)
SAT	Moderate (4.13 ± 1.02)
ESE	Somewhat high (5.12 ± 1.23)
PS	Rare (1.04 ± 0.76)

PTD – Physical task demands
MTD – Mental task demands
PED – Physical environment demands
SED – Social environment demands
OED – Organizational environment demands
EF – Effort exerted
PR – Perceived risk of injury and illness
DIS – Dissatisfaction
SAT – Satisfaction
ESE – Energy state at end of workday
PS – Psychosomatic outcomes

Table 3. Correlation among intermediate work effects, psychosomatic outcomes and work exposure variables.

	PTD	MTD	PED	SED	OED	SS	OS
EF	0.53	0.33	0.36	0.27	0.41	− 0.49	− 0.10
	$p < 0.01$	*ns*	$p < 0.05$	*ns*	$p < 0.02$	$p < 0.01$	*ns*
PR	0.45	0.51	0.47	0.24	0.47	− 0.36	− 0.34
	$p < 0.01$	$p < 0.01$	$p < 0.01$	*ns*	$p < 0.01$	$p < 0.05$	*ns*
DIS	0.55	0.46	0.37	0.47	0.57	− 0.62	− 0.43
	$p < 0.01$	$p < 0.01$	$p < 0.04$	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.02$
SAT	− 0.20	− 0.31	− 0.24	− 0.58	− 0.56	0.71	0.64
	ns	*ns*	*ns*	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
ESE	0.52	0.57	0.27	0.18	0.30	− 0.25	− 0.31
	$p < 0.01$	$p < 0.01$	*ns*	*ns*	*ns*	*ns*	*ns*
PS	0.21	0.18	0.36	0.39	0.49	− 0.41	− 0.40
	ns	*ns*	$p < 0.05$	$p < 0.04$	$p < 0.01$	$p < 0.02$	$p < 0.02$

PTD, Physical task demands
MTD, Mental task demands
PED, Physical environment demands
SED, Social environment demands
OED, Organizational environment demands
SS, Social environment stimuli
OS, Organizational stimuli
EF, Effort exerted
PR, Perceived risk of injury and illness
DIS, Dissatisfaction
SAT, Satisfaction
ESE, Energy state at end of workday
PS, Psychosomatic outcomes
p, probability
ns, non-significant at the 5% level

dissatisfaction. Satisfaction was not significantly associated with task and physical environment demands.

(5) Energy state at the end of the workday was significantly associated with both physical and mental task demands.

(6) Psychosomatic outcomes were positively correlated with environmental demands and negatively correlated with social environment and organizational stimuli. No significant relationship was found between psychosomatic outcomes and task demands (both physical and mental).

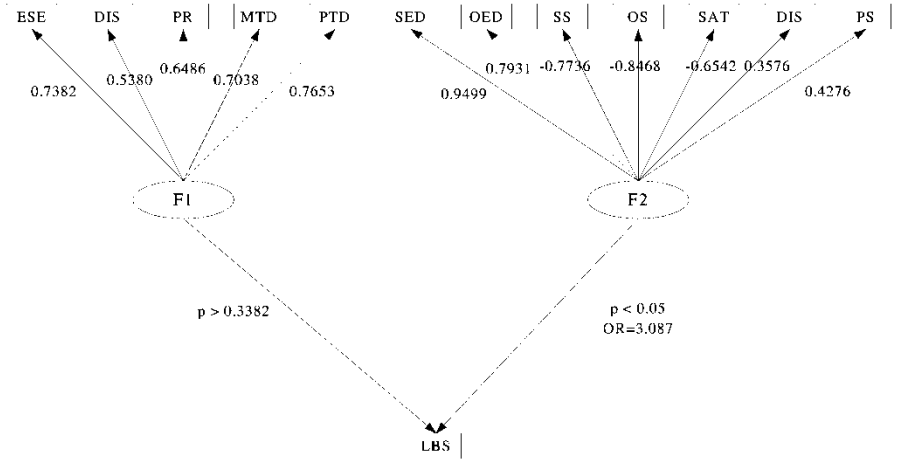
5.3. *Prevalence of musculoskeletal symptoms in individual and multiple body regions*

Musculoskeletal symptoms were prevalent for the following individual body regions: lower back (24%), neck (24%), shoulders (18%) and hips/thighs (15%). These symptoms were not as prevalent (under 10%) for the upper back (9%), elbows/forearms (6%), wrists/hands (6%), fingers (6%), knees/lower legs (9%) and ankles/feet (9%). Thirty percent of the RNs reported musculoskeletal symptoms in multiple body regions (two or more). Of these cases, about 50 and 25% were obtained for two and three body regions, respectively. About 35% of the RNs reported no musculoskeletal symptoms and the remaining 35% had symptoms in only one body region.

5.4. *Relationship between musculoskeletal symptoms and work exposure variables, intermediate work effects, and psychosomatic outcomes*

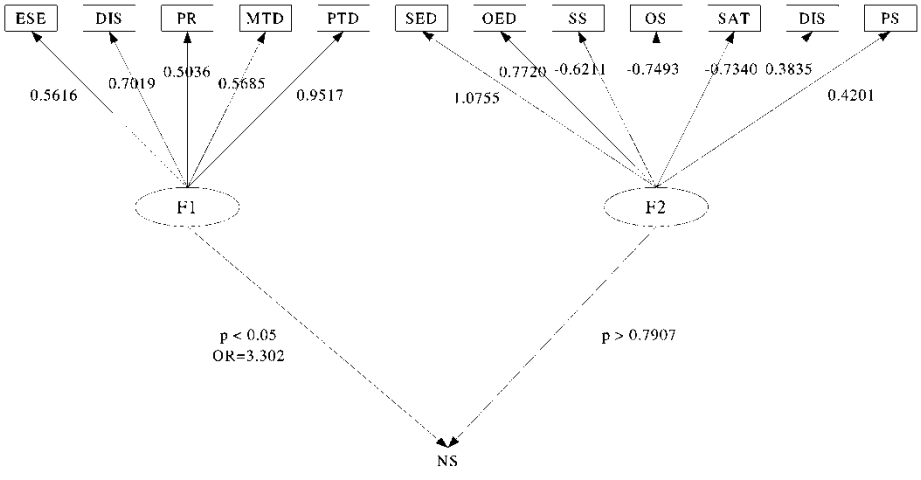
Logistic regression analyses demonstrated the following significant associations: (1) work exposure variables and lower back or neck symptoms; (2) both intermediate work effects and psychosomatic outcomes and, lower back symptoms; (3) lower back or neck symptoms and, combined work exposure variables, intermediate work effects and psychosomatic outcomes.

Figures 1 and 2 provide the relationship details of lower back or neck symptoms, and combined work exposure variables, intermediate work effects and psychosomatic outcomes. Lower back symptoms were significantly associated with the socio-organizational demand-stimulus factor, satisfaction-dissatisfaction measures, and



Note: The acronyms are: PTD – Physical task demands; MTD – Mental task demands; PED – Physical environment demands; SED – Social environment demands; OED – Organizational environment demands; SS – Social environment stimuli; OS – Organizational environment stimuli; F1 – Work demand latent variable; F2 – Work demand / stimulus latent variable; PR – Perceived risk of injury & illness; DIS – Dissatisfaction; SAT – Satisfaction; ESE – Energy state at end of workday; PS – Psychosomatic outcomes; LBS – Lower back symptoms; OR – Odds ratio.

Figure 1. Relationship between lower back symptoms and work exposure variables/ intermediate work effects/psychosomatic outcomes



Note: The acronyms are: PTD – Physical task demands; MTD – Mental task demands; PED – Physical environment demands; SED – Social environment demands; OED – Organizational environment demands; SS – Social environment stimuli; OS – Organizational environment stimuli; F1 – Work demand latent variable; F2 – Work demand / stimulus latent variable; PR – Perceived risk of injury & illness; DIS – Dissatisfaction; SAT – Satisfaction; ESE – Energy state at end of workday; PS – Psychosomatic outcomes; NS – Neck symptoms; OR – Odds ratio.

Figure 2. Relationship between neck back symptoms and work exposure variables/ intermediate work effects/psychosomatic outcomes

psychosomatic outcomes. The relative contribution of work exposure variables to lower back symptoms was much more pronounced (up to 2½ times) than either intermediate work effects or psychosomatic outcomes and the odds ratio was equal to 3.09 (figure 1). The combined task demands and intermediate work effects (i.e., dissatisfaction, perceived risk and energy level at end of work day) did not have a significant impact upon lower back symptoms at the 5% level.

Neck symptoms were statistically associated with both task demands and intermediate work effects (odds ratio = 3.30). Psychosomatic outcomes and socio-organizational demand-stimulus factor did not contribute to this association as they did in the case of lower back relationship. Physical task demands contributed the most to neck symptoms. Its contribution ranged from 36 to 89% relative to other factors. The effect of mental task demands was almost similar to those of intermediate work effects.

6. Discussion and concluding remarks

In the search for answers to the problem of nursing shortage in the workplace, the nursing administrator may ask the questions: 'What factors cause the RNs to leave the practice of nursing and to pursue other careers or prevent the entry of new graduates into the profession?' and 'What factors can assist in the retention of RNs in the healthcare industry?' These two major questions are directly linked to the dual role of work characteristics.

As early as 1959, Herzberg and coworkers determined that there were two sets of working conditions. One set, coined as 'hygiene factors', can lead to work dissatisfaction. This set of working conditions is quite distinct and independent from the other set of work factors, termed 'motivators', which can lead to work satisfaction. Although the findings of Herzberg's work has been replicated in several countries (Herzberg, 1987), this work has been criticized (Hackman and Oldham 1975, 1976) on the grounds that researchers have been unable to provide empirical support for the major tenets of the theory and lacked adequate statistical design and analysis in order to draw firm conclusions.

In the research, the work of Herzberg and co-workers was validated and the authors developed a construct that is heavily entrenched in theory and is based on a synthesis of the most up-to-date research in the fields of psycho-sociology, work stress, industrial psychology, ergonomics, human factors, and occupational health (Vroom 1964, McCormick *et al.* 1969, Walton 1973, Caplan *et al.* 1975, Hackman and Oldham 1975, 1976, Cooper and Marshall 1976, McCormick 1979, Kahn 1981, Moos 1981, Karasek *et al.* 1983, Rasmussen 1983, Rohmert and Landau 1983, Herzberg 1987, Hart and Staveland 1988, Hurrell and Mclaney 1988, Reid and Nygren 1988, Fraser 1989, Karasek and Theorell 1990, Porras and Silvers 1991, McAtamney and Corlet 1993, Rummler and Brache 1995, Neerincx and Griffioen 1996).

The findings indicated that the socio-organizational environment played a key role in the nurses' performance. Work satisfaction was positively associated with socio-organizational stimuli and negatively associated with socio-organizational demands. Furthermore, work satisfaction was not significantly associated with both physical and mental task demands nor with physical environment demands. On the other hand, work dissatisfaction was negatively associated with socio-organizational stimuli and positively associated with socio-organizational demands. In addition, work dissatisfaction was significantly associated with physical factors as well as

Table 4. Description of evidence in cohort studies

References	Exposure	Outcome	Study design	Study population	Main results & conclusions
Heap (1987)	• Risk factors – job category, age, weight, stature, training experience, prior history of back injury. • Method of measurement – A questionnaire was probably used coupled with interview but not explicitly stated.	• Back injury was defined as an injury affecting the lower part of the back, directly attributable to patient handling & resulting in 3 or more days of absence from work. • A patient handling incident was one in which a patient was lifted, carried or supported as part of a normal nursing procedure • The lower part of the back was considered the area between the lower border of D12 and the inferior gluteal folds including the sacrum and sacroiliac joints but excluding the coccyx or hip joints. • Absence was counted in calendar days commencing on the first day absent from work due to injury.	• Prospective cohort design with 5-year follow-up. • Single cohort	• 3778 sisters & senior nurses, staff nurses, nurses in training & nursing auxiliaries in a large health district in the UK.	• 32% of all cases had prior history of back injuries (defined as injury affecting the lower part of the back which had resulted in absence from work for six or more weeks after the age of 16 years). • The mean lower back injury rates (over a 5-year period) were 2.2% for nursing auxiliaries and 0.82% for staff nurses. • The cumulative number of injuries (over a two-year period) was very close for three middle age groups (22 for 20-29 yr; 20 for 30-39 yr; 21 for 40 – 49 yr), and lower for younger (7 for < 20 yr) and older (7 for 50 – 59 yr) groups; the age distribution was not reported. • Although no data were presented, the author reported that there was no evidence of relation between stature/weight ratio and back injury cases.
Venning et al. (1987)	• Risk factors – job category, work area, lifting requirement, hours & type of shift, length of employment, availability of lifting aids, team lifting, gender, age, marital status, stature, weight, prior history of back complaint. • Method of measurement – questionnaire.	• A back complaint was defined as work-related injury or complaints of discomfort identifying the back as the site of complaint and reported through an employee health office.	• Prospective cohort with 12-month follow-up. • Single cohort categorized into groups according to factors of interest.	• 4024 nursing aides & orderlies, registered nurses from five teaching hospitals in Canada; 71% participation rate	• Based on logistic regression analyses, the following OR values were obtained ($p < 1\%$): 4.26 for service areas where lifting occurred most vs areas where lifting occurred least; 2.19 for daily lifting of patients vs light, occasional & nonlifters; 1.77 for nursing aides vs registered nurses & supervising personnel; 1.73 for reporting previous injury vs none. • Age, physical activity pattern, availability of lifting aids, stature, weight, instruction in back care & lifting procedures were NS. • Annual injury rate of 4.9% (95% CI: 4.4% – 5.7%).

(*continued overleaf*)

Table 4. (*continued*)

References	Exposure	Outcome	Study design	Study population	Main results & conclusions
Mostardi et al. (1992)	• Risk factors – isokinetic lifting strength, prior history of back pain or injury. • Method of measurement – equipment and questionnaire.	• Self-reported pain or injury within 2 years after being enrolled in the study.	• Prospective cohort design with 2-year follow-up. • Single cohort grouped into injured and non-injured	• 171 nurses from a community hospital in the US and free of back pain or injury at the time of the study.	• Based on discriminate analysis, isokinetic strength did not distinguish between the two groups; some questions of prior history of back problems explained only 14.6% of the variance between the two groups. • The annual incidence rate was 4.7%
Ready et al. (1993)	• Risk factors – demographic data, employment history, lifestyle characteristics, physical activity pattern, history of back pain, back strength and flexibility. • Method of measurement – questionnaire and equipment.	• A back injury was identified and self-reported by a nurse or nurse assistant on an employee accident report. • An injury was self-diagnosed as muscle pulls, spasms or pain in any area of the back (upper, middle, lower). • Only injuries that the nurses believed severe enough to be reported on an employee accident report were included in the study.	• Prospective cohort design with 18-month follow-up. • Single cohort classified into three risk groups: low (45), moderate (47) & high (27) risk wards	• 119 nurses and nurse assistants in a large Canadian health care centre.	• Prior compensation pay, smoking status & job satisfaction were the most useful discriminators among the three risk groups accounting for 41% of the variability among the three groups and predicted 67% of those injured. • Fitness (e.g., back strength & flexibility) & lifestyle parameters (types of variables not reported) did not significantly predict back injury among nurses. • 22% sustained injuries during the follow-up.
Klaber Moffett et al. (1993)	• Risk factors – sitting and standing height, weight, hamstring length, endurance of oblique abdominal/spinal extensor/quadriceps musceps, extraversion & neurotocism (personality measures), anxiety, health locus of control, general health. • Method of measurement – questionnaire and equipment.	• Lower back pain was defined as any pain below the 12th thoracic vertebrae according to a body chart provided (i.e., emanating from the lumbar region) and lasting at least 3 days or 21 days.	• Prospective cohort design with 20-month follow-up. • Single cohort categorized into injured or non-injured groups. • Injured group: group A – injuries lasting at least 3 days; group B – injuries lasting at least 21 days.	• 199 young student nurses upon entry to 2 nursing schools in the UK.	• Attitudes to health, low levels of trait anxiety, increased neurotocism & emotional disturbance discriminated between the injured "A" or "B" and non-injured groups (at the 0.001 level). • Standing and sitting heights, endurance of quadriceps further differentiated between group A & the non-injured. • 37% reported back pain lasting at least 3 consecutive days. • The first incidence peaked markedly between 9 and 12 months and coincided with work in wards described as "heavy".

(*continued overleaf*)

Table 4. (*continued*)

References	Exposure	Outcome	Study design	Study population	Main results & conclusions
Harber et al. (1994)	• Risk factors – prior history of back pain, training in nursing school. • Method of measurement – questionnaires and interviews.	• Back injury was identified if the respondent answered positive to the following questions: 'Have you had back pain requiring you to miss work?' or 'Have you significantly changed what you do at work because of back pain?'	• Prospective cohort design with 18-month follow-up (mean of 10-month follow-up). • Single cohort categorized into groups according to factors of interest.	• 179 registered nurses and licenced vocational nurse diplomas, newly entering professional careers In LA and Orange Counties in California, were used in the study.	• Prior significant history of back pain (evidenced by previous job changes because of back pain, frequent medication use, etc.) was associated with increased future prevalence of back injuries. • Training at nursing school or on the job did not have a protective effect.
Niedhammer et al. (1994)	• Risk factors – age, weight, stature, number of children, tobacco consumption, sports activities, commuting time to work, work interest; psychological load (relationships with colleagues, superiors, patients, confrontation with suffering & death, etc.); mental load (monotonous work, work stress, isolation, etc.); physical load (patient transfer, standing, etc.); work ambience (temperature, light, noise, dust, etc.); shift work, shortage of staff; symptoms of psychological disorders. • Method of measurement – questionnaire and interview (those who dropped out from the study).	• Back pain was defined as any musculoskeletal complaint affecting the entire spine. • Six indicators of back pain: back pain, chronic or recurring back pain (i.e., lasting more than 3 months), cervical/dorsal/lumbar pain & medical treatment for back pain.	• Prospective cohort design with 10-year follow-up. • Single cohort.	• 469 out of eligible 600 nurses participated in 1980 from 6 hospitals in France. • In 1985, 23 nurses were lost to follow-up and 68 left hospital work. • In 1990, a total of 74 nurses (since 1980) were lost to follow-up and a total of 67 (since 1980) left hospital work. • Longitudinal analyses were conducted on a subset of 210 nurses who did not suffer from musculoskeletal problems in 1980 and 1985.	• Age was associated with cervical pain (OR = 6.05 to 12.6 depending on age classification, $\alpha = 4\% - 1\%$). • Psychosocial factors were related to cervical pain (OR = 2.7 for highest level of psychosocial load, $\alpha = 5\%$) • Physical workload was associated with chronic or recurring back pain (OR = 2.48, $\alpha = 8\%$). • Tobacco consumption increased the frequency of back pain (OR = 1.79, $\alpha = 10\%$) & dorsal pain (OR = 1.89, $\alpha = 9\%$). • Commuting time to work (> = 1 hr/day) was associated with both cervical (OR = 2.81, $\alpha = 3\%$) & lumbar pain (OR = 2.00, $\alpha = 8\%$). • CI for OR were not reported. • Symptoms of psychological disorders, # of children & sports activities were not significantly associated with back pain outcomes at the 10% level.

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Table 4. (*continued*)

References	Exposure	Outcome	Study design	Study population	Main results & conclusions
Smedley et al. (1997)	• Risk factors – stature, weight, prior history of lower back pain, symptoms other than back pain at baseline (i.e., headache, fatigue, mood, stress), patient handling. • Method of measurement – questionnaire.	• Back pain was defined as any pain in an area (illustrated in a diagram) between the 12th ribs and the gluteal folds that lasted for longer than a day and occurred other than in association with pregnancy, menstruation or febrile-illness.	• Prospective cohort design with 24-month follow-up. • Single cohort categorized into groups according to factors of interest.	• A subbset of 961 nurses (out of 1336 agreed to participate in the study & representing 56% of eligible population) without lower back pain in the last month in the UK. • Study population included auxiliary or enrolled nurses, staff nurses or sisters and administrative or special posts.	• Adjusted OR (for age, stature & earlier history of lower back pain): 3.4 (95% CI: 1.4 – 8.2) for frequent vs never or occasional low mood; 2.0 (95% CI: 1.2 – 3.3) for lifting patient in or out of bath with hoist 1 – 4 times/day vs no patient handling. • 38% developed back pain including 11% whose pain led to absence from work
Josephson et al. (1997)	• Risk factors – job strain, perceived exertion. • Method of measurement – questionnaire	• Musculoskeletal problems were assessed in terms of ongoing symptoms for the neck, shoulder & back by a 10-point (0 – 9) scale with 'no symptoms' and 'very intense symptoms' anchors at both ends. • A musculoskeletal problem was identified as a case if the individual scored "6" or more from at least one of the body regions.	• Prospective cohort design with 3-yr follow-up. • Single cohort categorized by job strain and perceived exertion.	• 172 registered nurses, state enrolled nurses, and auxiliary nurses were free of musculoskeletal symptoms at baseline. • The nurses were located in a hospital in Northern Sweden.	After adjusting for age and job category: • RR for job strain groups – 1) 2.2 (0.8 – 6.0) for 1-yr follow-up; 2) 1.4 (0.5 – 4.0) for 2-yr follow-up; 3) 1.5 (0.6 – 3.5) for 3-yr follow-up. • RR for perceived exertion groups – 1) 1.3 (0.5 – 3.3) for 1-yr follow-up; 2) 1.4 (0.6 – 3.3); 3) 1.6 (0.8 – 3.4) for 3-yr follow-up. • Based on the 95% CI, it appears that the reported RR values are not significant at the 5% level.

(*continued overleaf*)

Table 4. (*continued*)

References	Exposure	Outcome	Study design	Study population	Main results & conclusions
Yassi et al. (1995)	• Risk factors – type of ward, age, gender, experience, seniority, time during the shift or working week at highest risk, inadequate number of staff, inadequate training, faulty equipment, layout. • Method of measurement: interviews with open ended questions.	• All nurses sustaining a back injury filed an injury report. • The injury report included demographic data, occupational history and mechanisms/ circumstances of injury.	• Prospective cohort with 2 yr follow-up. • High risk or study groups: surgical (surgery, orthopedic, neurosurgery, urology) & medical (medicine, spinal, neurology, rheumatology) wards. • Low risk or control groups: children's, general, psychiatry, respiratory & women's.	• 1645 nurses employed in a hospital in Canada.	• *Where injuries occurred?* The surgical and medical departments reported the highest injury rates (39%) relative to the control groups (16%); surgery (40%), orthopedic (51%), medicine (32%), spinal (48%) & neurology (42%). • *Who was injured?* 37.5% and 38.9% of all injury cases were males and females, respectively with overall rates of 15.5% & 19.7%. The injured nurses in both groups were at least 2 yr younger than those non-injured. The average seniority for injured was comparable in both groups. 37.4% of all cases were full-time and 31.6% part-time. • *When injuries occurred?* 52.6% of all injuries occurred in the first two hr of 8-hr shift (due to the fact that patient handling is done during this time). • *Why injury occurred?* The two most frequent mechanisms were lifting and transferring patients (45% of all injuries). 52.3% of all cases were attributed to training in both groups, with 13.8% due to inadequate staffing, faulty equipment – 8.3%, poor housekeeping – 5% & physical layout – 3.7%.
Stobbe et al. (1988)	• Risk factors – job category, frequency of patient handling, employment time. • Method of measurement – hospital records and interviews.	• A back injury was defined as an injury impacting the back and resulting in lost time or non-lost time.	• Retrospective cohort design with at least 12-month follow-up within a 40-month period. • Exposure group – lifting patients more than 5 times/shift. • Control group – handling patients less than 2 lifts per shift. • Patient handling was confined to the situation where the nurse must support one half or more of the patient's weight while helping the patient from a bed to a chair (i.e., wheelchair, toilet or conventional chair), a chair to a bed, or a chair to a chair.	• 415 nurses from a medical centre in the US (143 licensed practical nurses, 252 nurse aides & 20 attendants).	• Significant associations were found between lifting frequency or length of employment and total incidence density of back injuries (number of back injuries reported by specific employee group divided by the sum of the person-months of employment of group members). • No significant association was found with job category. • The incidence density ratio was 2.35.

Table 5. Description of evidence in cross-sectional studies conducted within the context of or followed by prospective studies

References	Exposure	Outcome	Study population	Main results & conclusions
Niedhammer et al. (1994)	• Risk factors – age, weight, stature, number of children, tobacco consumption, sports activities, commuting time to work, work interest; psychological load (relationships with colleagues, superiors, patients, confrontation with suffering & death, etc.); mental load (monotonous work, work stress, isolation, etc.); physical load (patient transfer, standing, etc.); work ambience (temperature, light, noise, dust, etc.); shift work, shortage of staff; symptoms of psychological disorders. • Method of measurement – questionnaire and interview (those who dropped out from the study).	• Back pain was defined as any musculoskeletal complaint affecting the entire spine. • Six indicators of back pain: back pain, chronic or recurring back pain (i.e., lasting more than 3 months), cervical/dorsal/lumbar pain, & medical treatment for back pain.	• 310 nurses from 6 hospitals in France. • This cross-sectional study was examined in the final year of the prospective study reported in table 1.	• 57.9% suffered from back pain within the last 12 – month: 23.6% had experienced cervical pain, 23.0% dorsal pain & 41.1% lumbar pain. • 40.5% suffered from chronic or recurring back pain, 31.1% had been treated and 7.4% had taken sick leave for back pain. • Back pain was more frequent among nurses who smoked (OR = 1.97, α = 4%), experienced symptoms of psychological disorders (OR = 2.82, α = 1%) and had reported stressful factors related to physical workload (OR = 2.11, α = 8%). • Chronic or recurring back pain was associated with symptoms of psychological disorders (OR = 2.98, α = 1%). • Cervical pain increased with age (OR = 2.59 – 3.17, α = 3% – 7%) and previous musculoskeletal disorders (OR = 1.98, α = 3%). • Dorsal pain was more frequent among nurses with children under 3 years (OR = 2.8, α = 2%) and was related to tobacco consumption (OR = 1.87, α = 6%). • Lumbar pain was associated with symptoms of psychological disorders (OR = 2.64, α = 1%) and physical workload (OR = 2.23, α = 4%). • CI for OR were not reported. • Treatment for back pain was related to symptoms of psychological disorders.
Smedley et al. (1995)	• Risk factors – stature, weight, prior history of lower back pain, symptoms other than back pain at baseline (i.e., headache, fatigue, mood, stress), patient handling. • Method of measurement – questionnaire.	• Back pain was defined as any pain in an area (illustrated in a diagram) between the 12th ribs and the gluteal folds that lasted for longer than a day and occurred other than in association with pregnancy, menstruation or febrile-illness.	• 1659 auxiliary or enrolled nurses, staff nurses or sisters, & administrative/special posts from a hospital in the UK. • 69% participation rate. • A subset of this sample was followed-up in a prospective cohort as described in table 1.	• After adjusting for age, stature and non-musculoskeletal symptoms, significant associations were found with the following activities: patient handling between bed and chair (OR = 1.5; 95% CI = 1.1 – 2.1), patient handling around the bed (OR = 1.7, 95% CI = 1.2 – 2.4). • After adjusting for age, significant associations were found with non-musculoskeletal symptoms: headache (OR = 1.7, 95% CI = 1.3 – 2.3), fatigue (OR = 1.4, 95% CI = 1.1 – 1.9), low mood (OR = 2.0, 95% CI = 1.2 – 3.1). • No significant associations with sports activities, smoking & # of children. • 1-yr prevalence = 45% and 10% absence from work for a cumulative period exceeding 4 weeks.

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Table 5. (*continued*)

References	Exposure	Outcome	Study population	Main results & conclusions
Josephson et al. (1997)	• Risk factors – job strain, perceived exertion. • Method of measurement – questionnaire.	• Musculoskeletal problems were assessed in terms of ongoing symptoms for the neck, shoulder & back by a 10-point (0 – 9) scale with 'no symptoms' and 'very intense symptoms' anchors at both ends. • A musculoskeletal problem was identified as a case if the individual scored "6" or more from at least one of the body regions.	• Four cross sectional surveys separated by 1-yr intervals. • 565 nurses participated in 1st survey; 553 in 2nd survey; 563 in 3rd survey; 419 in 4th survey (smaller # dues to changing jobs & retirement). • Only 282, out of the 565 participating in the first survey, completed the three remaining surveys. • Nursing personnel included registered nurses, state enrolled nurses and auxiliary nurses. From a hospital in northern Sweden.	• RR for job strain groups (adjusted for age, job category & physical exertion): 1.5 (1.1 – 2.1) for 1st survey; 1.1 (0.8 – 1.6) for 2nd survey; 1.5 (1.2 – 2.0) for 3rd survey; 1.1 (0.8 – 1.6) for 4th survey. • RR for physical exertion groups (adjusted for age, job category & job strain): 1.5 (1.1 – 2.1) for 1st survey; 1.5 (1.2 – 2.1) for 2nd survey; 1.4 (1.1 – 1.8) for 3rd survey; 1.8 (1.4 – 2.4) for 4th survey. • RR for combined job strain and physical exertion groups (adjusted for age & job category): 2.1 (1.4 – 3.3) for 1st survey; 2.0 (1.3 – 3.0) for 2nd survey; 1.5 (1.0 – 2.3) for 3rd survey; 1.6 (1.0 – 2.5) in 4th survey. • Based on the above 95% CI, it appears that some RR values were not significant at the 5% level (2nd & 4th surveys for job strain groups; 3rd & 4th surveys for combined job strain and physical exertion groups. • The prevalence of musculoskeletal problems was 18% for neck, 20% for shoulders, 8% for upper back, 16% for lower back and 33% for combined neck/shoulders/upper back/lower back.

Table 6. Description of evidence in cross-sectional studies

References	Exposure	Outcome	Study population	Main results & conclusions
Lagerstrom et al. (1995)	• Risk factors – individual and life-style factors (age; BMI: $< = 26\ km^{-2}$, > 26; perceived physical fitness: low/somewhat low, average/high/very high; smoking: yes, no); physical exposure (type of ward: medical/geriatric/surgical 'more patient handling', eye & children's ward/policlinics; work category: reg. nurses, state-enrolled nurses, auxiliary nurses); psychosocial factors (work commitment; support & help from superiors; work demand; intellectual discretion or stimulation at work; authority over decisions or work control). • number of years of employment at hospital was omitted because of high correlation with age. • Method of measurement – questionnaire.	• Symptom variable: ongoing musculoskeletal symptoms. • Ten-point scale '0 to 9' with 'not at all' and 'very much' anchors at both ends for the neck, shoulders, lower back, hands & knees. • The symptom variable is dichotomized into symptoms (1 – 9) or no symptoms (0). • Six or more was considered 'severe symptoms'.	• 688 female nurses from a hospital in northern Sweden.	Multivariate logistics analyses showed: • Symptoms for neck: age (1.31, 1.14 – 1.52 per 10 yr), low physical fitness (1.42, 1.00 – 2.02), low commitment (1.65, 1.07 – 2.54) & low support (2.03, 1.28 – 3.16). • Severe symptoms for neck: age (0.07, 0.81 – 1.44), low physical fitness (1.68, 1.09 – 2.59), type of ward (2.77, 0.56 – 13.97), high work demand (1.82, 1.14 – 2.92) & age*type of ward (1.48, 1.02 – 2.14). • Symptoms for shoulders: age (1.23, 1.08 – 1.42), low physical fitness (1.75, 1.25 – 2.49) & low work control (1.73, 1.13 – 2.67). • Severe symptoms for shoulders: age (1.22, 1.02 – 1.46), low physical fitness (2.22, 1.47 – 3.36) & high work demand (1.65, 1.05 – 2.59). • Symptoms for lower back: low physical fitness (1.79, 1.26 – 2.54), work category 'RN versus AN' (1.70, 1.13 – 2.56) & low support from superiors (1.80, 1.13 – 2.83). • Severe symptoms for lower back: low physical fitness (1.60, 1.04 – 2.46). • Symptoms for hands: age (1.42, 1.19 – 8.28) & lack of stimulation (1.62, 1.09 – 2.39). • Severe symptoms for hands: type of ward (2.84, 1.25 – 6.49). • Symptoms for knees: age (1.28, 1.12 – 1.47). • Severe symptoms for knees: age (1.46, 1.11 – 1.92) & high BMI (3.16, 1.69 – 5.87) • Although some risk factors were adjusted for age and were significant at the 5% level, they did contribute significantly to the multivariate analyses; those factors can be found under risk factors if not included above with each type of symptom and body region. Prevalence of symptoms for different body regions: • The neck, shoulder & lower back recorded the highest prevalence rates (symptoms: 44 – 65%; severe symptoms: 14 – 22%). • The hands and knees had the lowest values (symptoms: 14 – 22%; severe symptoms: 3 – 9%). • Mean values for severe symptoms: neck (16%), shoulders (18%), back (16%), hands (4%) & knees (7%). • Mean values for symptoms: neck (48%), shoulders (53%), back (56%), hands (22%) & knees (30%).

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Table 6. (*continued*)

References	Exposure	Outcome	Study population	Main results & conclusions
Engels et al. (1996)	• Risk factors – physical factors (standing, walking, awkward posture, work long in same posture, stooping, reaching, lifting heavy burdens), ergonomics of wards (layout, walking distance, adjustable bed, distance between beds, insufficient equipment) & work pressure (time pressure, inability to interrupt work, work too tiring, slowing down at work, increased work pressure, work adjusted by unforeseen events). • Method of measurement – questionnaire.	• A musculoskeletal complaint was reported if the participant answered 'yes' to the question 'do you have regular back, arm or neck or leg complaints?'	• 846 nurses (out of a total of 890) provided complete information about the data gathered in the study. • They participated from four Dutch nursing homes.	Statistics about musculoskeletal complaints: • 36% of the nurses had back complaints with 30% of arm/neck complaints as well as 16% leg complaints. • 47.4 – 61.1% of those reporting musculoskeletal complaints were under treatment by doctors, physiotherapists or specialists. • 21.8 – 39.8% of those reporting musculoskeletal complaints could no longer perform daily activities as usual, had to stop work, and had to take medicine. Based on multivariate logistic regression, the following odds ratios (with 95% CI) were obtained after being adjusted for age, gender, duration of employment, working hr/wk, managerial responsibility and all other work-related factors showing significance in univariate analyses: • Awkward posture: back (2.99, 1.30 – 3.04), arm/neck (1.74, 1.10 – 2.75) & leg (1.87, 1.06 – 3.30). • Stooping: back (2.22, 1.46 – 3.40) & arm/neck (1.63, 1.03 – 2.59). • Lifting heavy burdens: back (2.20, 1.38 – 3.50) & arm/neck (3.33, 2.04 – 5.45). • Standing: leg (2.47, 1.17 – 5.24). • Walking: leg (2.49, 1.33 – 4.65). • Difficult work rate: arm/neck (1.68, 1.05 – 2.70). • Ought to slow down at work: back (1.94, 1.20 – 3.14), arm/neck (2.71, 1.62 – 4.53) & leg (2.37, 1.20 – 4.68). • Work adjusted for unforeseen events: leg (2.43, 1.46 – 4.22).
Engels et al. (1998)	• Risk factors – working postures (two observed variables: discomfort from working postures & standing/sitting), ergonomic layout of ward, psychosocial work demands (perceived work pressure, relationship with colleagues) & job satisfaction (daily leadership, job appreciation). • Method of measurement – questionnaire.	• Musculoskeletal complaints (one observed measure for back/shoulder/legs). • Psychosomatic complaints (three observed measures: psychological, sleep-related, somatized).	• 846 out of 890 staff nurses participated from four Dutch nursing homes. • 718 nurses provided complete information about the questionnaires.	• Based on structural equation analyses of the full model (i.e., all work-related variables loaded on both types of outcome measures with both outcomes correlated): work postures was the only significant variable with musculoskeletal complaint; working postures, ergonomic layout & psychosocial work demands were significantly associated with psychosomatic complaints. • Based on individual analyses (i.e., outcomes were not correlated): similar results were obtained. • Based on modification indices in which somatized complaints are loaded onto musculoskeletal and psychosomatic complaints, similar results were obtained for the full model (except that work postures were not significantly associated with psychosomatic complaints). • Based on modification indices, it was hypothesized that the prevalence of musculoskeletal complaints is not only attributed to physical load but to also nonspecific health complaints; if this is correct, ergonomics improvement will not be the only solution.

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Table 6. (*continued*)

References	Exposure	Outcome	Study population	Main results & conclusions
Coggan et al. (1994)	• Risk factors – gender, age, nurse category & work area. • Method of measurement – questionnaire.	• Back pain was measured in terms of point (PP), annual (AP) and lifetime prevalence.	• 3650 registered & non-registered nurses from the public sector in New Zealand.	• Four areas had the highest AP and PP rates: geriatric, AP (47.7%, 41.3 – 54%), PP (19%, 14 – 24%); medical, AP (44.3%, 39.6 – 49%), PP (14.4%, 11.1 – 17%); orthopedic, AP (54.3%, 47.2 – 62.5%), PP (13%, 8.2 – 17.9%); rehabilitation, AP (52.7%, 44.7 – 60.7%), PP (18.7%, 12.4% – 24.9%). • Among the lowest work areas: psychiatric, AP (24.3%, 19.5 – 29.1%), PP (10.8, 7.3 – 14.3%); pediatric, AP (26.4%, 21.2 – 31.5%); administration, AP (12.3%, 4.8 – 19.9%), PP (6.8%, 1.1 – 12.6%). • Community, obstetrics & gynaecology, and surgical scored prevalence rates in the middle. • Registered nurses experienced slightly lower AP rates (36.5%, 34.5 – 38.2%) and much lower PP rates (10.5%, 9.4 – 11.6%) than non-registered nurses (AP: 39.4%, 35.7 – 43.0%; PP: 16.3%, 13.5 – 19.0%). • Female nurses experienced higher AP rates (37.6%, 36.0 – 39.2%) and comparable PP rates relative to male nurses (AP: 28.4%, 22.5 – 34.3%; PP: 10.7%, 6.6 – 14.7%).
Mandel and Lohman (1987)	• Risk factors – demographic (age, gender, BMI); medical (prior lower back pain, pain in other parts of spine, use of medication, pregnancy, medical conditions, children < 5 yr); sports (exercise 3 times/wk during & before study period; use of body building machine during & before study period); work (work area, length of employment, full vs part-time, lifting over 10 patients/wk, missing work because of lower back pain, physically demanding jobs before nursing). • Method of measurement – questionnaire.	• Lower back pain lasting 48 hr at any time during the previous 12 months.	• 428 registered nurses from a hospital in the Midwest US. • 65% response rate.	• Based on logistic regression analyses, the only significant variables were: lower back pain prior to study (4.43, 3.34 – 5.87), pain in other parts of the spine (1.75, 1.25 – 2.47), aerobic exercise 3 times/wk during study period (1.45, 1.10 – 1.92) & lifting over 10 patients/wk (1.39, 1.05 – 1.84). • The remaining factors reported under risk factors did not show statistical significance with the outcome measure and did not enter the regression equation.

mental task demands. It should be noted that the association between work satisfaction and socio-organization stimuli was more pronounced than that for work dissatisfaction. This indicates that, overall, the RN's level of satisfaction with the socio-organizational stimuli was higher than the level of dissatisfaction. The socio-organizational demand-stimulus factor was also significantly associated with lower back symptoms. This is contrary to the general belief that lower back symptoms are primarily due to physical factors (Heap 1987, Mandel and Lohman 1987, Venning *et al*. 1987, Jensen 1990, Harber *et al*. 1994, Niedhammer *et al*. 1994, Yassi *et al*. 1995, Smedley *et al*. 1997). The findings of this research confirm the authors' viewpoint that a holistic approach should be considered in addressing this complex problem.

In general, the outcome of this research suggests the importance of working conditions impact upon the performance of the RNs. Working conditions had multiple effects: In particular, they significantly affected the level of effort exerted, perceived risk, satisfaction and dissatisfaction, energy level at the end of the workday, psychosomatic outcomes, and musculoskeletal symptoms. In addition, intermediate work effects and psychosomatic outcomes were significantly associated with lower back symptoms; no association, however, was found with neck symptoms. Taken together, working conditions and their intermediate effects had slightly stronger associations with both lower back and neck symptoms.

The formulated work demand-stimulus construct is hierarchical in nature and can be traced back to individual work factors. Such information would be extremely valuable to nursing administrators in attempting to evaluate the factors that may lead to the loss and retention of qualified RNs. In conclusion, it can be asked: Are nursing shortages linked to stressful and unsafe working conditions? The findings of the research reported herein clearly suggest that a strong association is highly likely. There are also several factors that need to be taken into consideration in future studies to increase generalizability such as the participant's unit or ward and the characteristics of their lifestyle which could have a considerable impact on their worklife. A considerable increase in the number of participants for a large scale investigation is also required for increased power and generalizability . Thus, additional research is warranted to obtain a better understanding of the complex interaction and the synergistic effects of the various nursing working conditions.

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