Working With Low Back Pain: Workplace and Individual Psychosocial Determinants of Limited Duty and Lost Time

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Background *Few studies have identified the risk factors associated with lost time in employees working with occupational low back pain (OLBP) despite the presence of pain. Such data could assist in the development of evidenced-based secondary prevention programs.*

Methods *The present investigation was a case-control study (n = 421) of demographic, health behavior, ergonomic, workplace and individual psychosocial factors hypothesized to be associated with lost time in young, full-time employees (i.e., soldiers) with OLBP. Analyses of the burden of OLBP in terms of the number of days on limited duty and lost time status were also computed.*

Results *Logistic regression analysis indicated that female gender, education beyond HS/GED, longer time working in military, higher levels of daily life worries, no support from others, higher levels of ergonomic exposure, stressful work, increased peer cohesion, and greater perceived effort at work placed a worker at a greater likelihood for OLBP-related lost work time. Lower levels of innovation, involvement, and supervisor support were also associated with lost time. Linear regression indicated that the number of days of lost time and limited duty was associated with lower levels of physical health and higher levels of symptom severity.*

Conclusions *The results support the potential utility of interventions targeting ergonomic, workplace and individual psychosocial risk factors in secondary prevention.* Am. J. Ind. Med. 40:627–638, 2001. *Published 2001 Wiley-Liss, Inc*†

KEY WORDS: musculoskeletal; low back; pain; occupational stress; ergonomic exposure; lost time; limited duty; psychosocial; military personnel; secondary prevention

INTRODUCTION

While occupational safety and health efforts have mainly focused on the primary prevention of occupational low back pain (OLBP) [Frank et al., 1996a], secondary prevention has received an increasing amount of interest [Linton and Bradley, 1996; Frank et al., 1996b, 1998]. At present, approaches to secondary prevention have targeted

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factors associated with recovery from a compensable lost time injury/illness [Infante-Rivard and Lortie, 1996; Oleinick et al., 1996], predictors or correlates of prolonged work disability [Gatchel et al., 1995; Hazard et al., 1996; Haldorsen et al., 1998; Feuerstein et al., 1999], or recovery following rehabilitation [Hazard et al., 1994; Ash and Goldstein, 1995; Keel et al., 1998; Magnusson et al., 1998; Kankaanpaa et al., 1999]. Notably however, a majority of cases with presumed work-related musculokeletal pain never file a workers' compensation claim [Rosenman et al., 2000] and continue to work with pain. Additionally, there are data to suggest that workers who file workers' compensation claims differ from those who do not in terms of length of employment, dissatisfaction with co-workers, physician restriction of activity, number of days off work, decreased current health status, provider specialty, and illness severity [Rosenman et al., 2000]. While a general cluster of factors has been identified as associated with the outcomes of lost time, limited duty, and prolonged disability, it is currently unclear whether these factors are also related to lost time in employees who have back pain yet continue to work. If a goal of secondary prevention of OLBP is to facilitate the safe and successful return to work for the majority of workers (i.e., workers who never file workers' compensation claims), then efforts to identify the factors related to lost time in such workers is essential for the optimal development of effective programs. [Frank et al., 1998].

A significant body of research indicates that OLBP is influenced by a complex interaction among medical, physical, health behavior, ergonomic, individual psychosocial, workplace psychosocial and workplace organizational factors [Frank et al., 1995; Frank et al., 1996a; U.S. Department of Health and Human Services, 1997; Shelerud, 1998]. Despite acknowledgement of the multivariate nature of OLBP, Frank et al. [1995] point out that historically, these factors have been examined within narrow disciplines (i.e., biomechanical, psychological or compensation factors), thereby limiting our ability to fully understand the combined influences on the natural history of low back pain.

Cross-sectional and prospective studies have found that variables associated with and/or predictive of return to work or functional recovery in OLBP include: older age, female gender, higher number of dependents, type of diagnosis (sprain versus disc disorder), decreased flexibility at baseline, presence of neurological signs, higher pain severity, higher levels of depression, perceived disability, health locus of control, lack of unscheduled breaks, type of occupation and industry, and worker's compensation status [Cheadle et al., 1994; Tarasuk and Eaton, 1994; Ash and Goldstein, 1995; Gatchel et al., 1995; Infante-Rivard and Lortie, 1996; Oleinick et al., 1996; Haldorsen et al., 1998; Tate et al., 1999]. Few studies, however, have identified risk factors that impact the occurrence and/or extent of lost time/limited duty in a group of full-time, employed, symptomatic workers with OLBP. Such information is critical to the development of comprehensive secondary prevention programs directed at enhancing functional recovery and musculoskeletal health that go beyond medical management [Feuerstein, 1996].

The present study examined ergonomic, health behavior, workplace and individual psychosocial, and problem-solving orientation factors and their relation to the presence of OLBP with lost time over the previous 12 months. Among the specific variables that were investigated were those found in past research to predict prolonged back-related disability in U.S. Army soldiers [Feuerstein et al., 1999]. These variables were: older age, higher rank, decreased frequency of aerobic exercise, increased frequency of work stress, higher occurrences of worries interfering with daily life, and decreased social support. Additionally, exposure to ergonomic risk factors, perceived physical effort, and soldiers' use of proactive problem solving strategies were examined. Such problem solving abilities have been associated with positive health outcomes [Elliott and Marmarosh, 1994; Wilkinson and Mynors-Wallis, 1994]. It was hypothesized that problem solving orientation could assist an affected worker in reducing levels of workplace ergonomic and workplace and/or individual psychosocial stressors [Nezu and Ronan, 1985; D'Zurilla, 1990; D'Zurilla and Sheedy, 1991; Chang and D'Zurilla, 1996] and therefore reduce the impact of these variables on adverse work and health outcomes.

It was assumed that a sample of active duty soldiers working in jobs that have been identified as high risk for back pain related disability [Berkowitz et al., 1999] would provide a study population of young workers not contaminated by entry into a workers' compensation system. It should be noted that all soldiers receive full medical and lost time wage benefits if off work because of an injury or illness (work-related or not) with no requirement to file a workers' compensation case. Therefore, study findings should be independent of the secondary influences of the factors that contribute to filing a worker's compensation claim.

METHODS

Subjects

Male and female active duty soldiers ranked E1 (Private) to E9 (Sergeant Major) working in military occupational specialities (MOS) at high-risk for back disability [Berkowitz et al., 1999] were included. In this convenience sample, the occupations were (with % total Army): Infantry (11B, 6.9%), Wheeled Vehicle Driver (88M, 3.0%), Heavy Construction Equipment Operator (62E, 0.4%), Construction Equipment Repairer (62B, 0.5%), Wheeled Vehicle Mechanic (63B, 2.7%), Multi-

channel Transmission Systems Operator (31R, 1.6%), and Practical Nurse (91C, 0.7%). Out of approximately 231 military jobs for enlisted personnel, 11B (1st), 88M (7th), and 63B (8th) were three of the eight largest MOSs. The seven MOSs included represent 16% of all soldiers (350,000 +). Excluded from the study were women who were currently pregnant or had been pregnant in the prior 12 months.

A variety of military installations with eligible soldiers were identified from the Military Occupational Specialties division of the U.S. Total Army Personnel Command (PERSCOM). To minimize possible site selection bias, sites were selected to provide a representative sample of different types of installations with varying missions, (i.e., an operational Army division, a major medical center, several training bases, an engineer base, and a communications installation); however, most military bases were in the Eastern US to reduce subject recruitment costs. In order to obtain permission to conduct the study, commanders at each post were provided a briefing regarding the purpose, study activities and participant requirements. Subjects were recruited from: Fort Meade, MD; Walter Reed Army Medical Center, Washington, DC; Fort Myer, VA; Fort Belvior, VA; Fort Eustis, VA; Fort Story, VA; Fort Lee, VA; and Fort Bragg, NC.

Participants were recruited according to MOS and their assigned military unit. Entire units were invited and attended group sessions at their local installation to obtain an overview of the study. At the sessions, offers to participate were extended and informed consent was subsequently obtained from volunteers. Of the 1,093 surveys that were submitted by those who met the inclusion criteria, 1,044 surveys had sufficiently complete responses to be used for the analyses.

Measures

A baseline survey consisting of 281 items was given to assess: demographic characteristics; lifestyle; workplace ergonomic exposure; symptom severity; perceived effort; workplace individual and family psychosocial factors; and social problem solving orientation. Surveys were scored using Teleform (v 5), Cardiff Software, San Marcos, CA.

Demographic characteristics

Information regarding age, gender, marital status, number of children supported, education, location of military assignment, military rank, length of active duty service, military occupational specialty, and length of time working in military occupation were obtained. These demographic questions were included based on evidence showing an association between these factors and either back disorders or back disability [Bigos, et al., 1986; Cheadle et al., 1994; Lancourt and Kettelhut, 1992; Feuerstein et al., 1997, 1999].

Health behavior

Smoking status was assessed by a single question with ‘‘current,’’ ‘‘former’’ or ‘‘never’’ as the responses. In addition, subjects were asked, ‘‘How often do you do at least 20 min of non-stop aerobic activity?’’ Response options were ‘‘rarely/never,’’ ‘‘1 or 2 times/week,’’ or ‘‘3 or more times per/week.’’ This item was derived from the U.S. Army’s Health Risk Appraisal (HRA) [U.S. Army Center for Health Promotion and Preventive Medicine, 1994] that was developed in conjunction with the Centers for Disease Control and Prevention.

Workplace ergonomic exposure

The inclusion of an assessment of workplace ergonomic exposure was based on evidence indicating that manual materials handling activities involving excessive force, awkward posture, and repetition are consistently related to low back disorders [U.S. Department of Health and Human Services, 1997; Shelerud, 1998; Wickstrom and Pentti, 1998] and low back pain with lost time [Marras et al., 1995]. Self-reported ergonomic exposure was assessed by the Job Factors section (38 items) of the U.S. Air Force Job Requirements and Physical Demands Survey (JRPDS) [Marcotte et al., 1997]. The present data were subjected to a factor analysis ($n = 1{,}044$) resulting in seven factor loadings accounting for 56.4% of the variance in self-reported ergonomic exposure [Haufler et al., personal communication]. The first factor, ‘‘back exposure’’ (eight items), accounted for 13.4% of the variance, and was used in this study to specifically assess back-related ergonomic exposure. The back subscale items included: (1) I lift materials that weigh more than 25 pounds, (2) I lift or handle bulky items, (3) My work requires that I kneel or squat, (4) I repeatedly bend my back (e.g., forward, backward, to the side or twist) in the course of my work, (5) When I lift, my body is twisted and/or I lift quickly, (6) I lift and/or carry items with one hand, (7) When I lift, move components, or do other aspects of my work, my hands are lower than my knees, and (8) I lean forward continually when I work (e.g., when sitting, when standing, when pushing carts, etc.). Response options ranged from ‘‘never’’ to ‘‘more than 4 h per day.’’ The scale measures movements and postures involved in manual materials handing and bending and twisting, risk factors that have been shown in the epidemiological literature to be related to the onset of occupational back pain [Hoogendoorn et al., 1999]. The back exposure score was computed by summing the total of the eight items. A higher score indicates greater exposure.

The reliability and validity of the Job Factors section of the JRPDS and the back exposure subscale has been determined with the present sample. Internal consistency for the back exposure subscale computed on cases only (n = 246), was high (Cronbach's alpha = 0.88). The test-retest reliability of the back exposure subscale was computed on a subset of soldiers (n = 85) who completed the JRPDS on two consecutive occasions 2–3 weeks apart. These analyses indicated a moderate degree of stability ($Eta^2 = 0.57$; $r = 0.67$, $P < 0.01$).

Perceived physical effort

The degree of physical effort at work was assessed by Borg's scale of perceived exertion [Borg, 1990]. The question asked subjects to describe the physical effort required of their job on a "typical day." Response options ranged from 0 = "nothing at all" to 10 = "very, very hard". This measure has been used extensively to assess perceived exertion in exercise tasks [Ceci and Hassman, 1991; Whaley et al., 1997] and manual materials handling tasks [Borg, 1998]. It has also been shown to be significantly correlated with perceived exertion and physiologic exertion measures such as oxygen uptake [Eston and Williams, 1988] and heart rate [Borg, 1998].

Work environment factors

Job stress was assessed by the following HRA [U.S. Army Center for Health Promotion and Preventive Medicine, 1994] item: "How often do you feel that your present work situation is putting you under too much stress?" Response categories were "never," "seldom," "sometimes," and "often."

The Work Environment Scale (WES) [Moos, 1981] was also used to provide a multidimensional assessment of perceived work climate. This measure consists of the following subscales: Involvement, Peer Cohesion, Supervisor Support, Autonomy, Task Orientation, Work Pressure, Clarity, Control, Innovation, and Physical Comfort. The scale has been used in past research on mechanical low back pain and subscales have been associated with increased levels of back pain [Feuerstein et al., 1985].

Family environment

The Family Environment Scale (FES) [Moos and Moos, 1981] was used to assess the effects of both stressors and social support in the family environment. The Conflict, Cohesion, and Expressiveness subscales were computed. Dimensions of this measure have also been correlated with increased levels of back pain [Feuerstein et al., 1985]

Interference from worries

A measure from the HRA [U.S. Army Center for Health Promotion and Preventive Medicine, 1994] that assesses interference from worries ("In the past year, how often have worries interfered with your daily life?") was used as a general measure of psychological distress. Response categories were "never," "seldom," "sometimes," or "often." Self-reported "worries" were shown to significantly predict back disability 1–3 years prior to a disability determination in U.S. Army soldiers [Feuerstein et al., 1999].

Perceived support

Since support can act as a potential buffer from exposure to stress [Ingledew et al., 1997; Griffith, 1999] support from others was assessed by asking, "How often are there people available that you can turn to for support in bad moments or illness?" [U.S. Army Center for Health Promotion and Preventive Medicine, 1994]. Response categories were "never," "seldom," "sometimes," or "often." This measure also predicted disability in a subsequent study of U.S. Army soldiers [Feuerstein et al., 1999].

Social problem solving

The Social Problem Solving Inventory-Revised (SPSI-R) [D'Zurilla et al., 1997; Maydeu-Olivares and D'Zurilla, 1996] was used to measure problem solving style or how an individual reports how they approach problems. The SPSI-R (52 items) includes the following subscales: Positive Problem Orientation, Negative Problem Orientation, Rational Problem Solving, Impulsivity/Carelessness Style, and Avoidance Style. A total social problem solving score was also computed [D'Zurilla and Chang, 1995]. Measures of problem solving have been shown to be predictive of adaptive coping to stressful events [D'Zurilla and Chang, 1995] as well as level of psychological stress [D'Zurilla and Sheedy, 1991].

Identifying Factors Related to Occurrence of OLBP With Lost Time

Case definition

Subjects were classified as cases based on the self-report of low back symptoms on a modified NIOSH symptom survey [Hales et al., 1994] and at least one episode of low back pain associated with their job in the past 12 months that also resulted in a minimum of one episode of lost/limited duty. Of the soldiers who were given the survey, 246 (58.6%) met the case definition. Subjects who did not

report any of these items (n = 175 or 41.6%) were placed into the comparison group.

Determinants of case status

Each independent variable was first entered into a univariable logistic regression (n = 421) to determine the association of that variable to low back symptoms and lost time. Those variables reaching a significance level of $P < 0.1$ were entered into the final hierarchical multiple logistic regression with case status as the dependent variable. Variables were entered in the following functional sets based on apriori hypotheses using an enter procedure: (1) age, gender, education, rank, marital status, length of time in service, length of time in military job, (2) frequency of aerobic/exercise, (3) interference from worries, (4) support from others, (5) JRPD back subscale, (6) job stress and the autonomy, clarity, innovation, involvement, peer cohesion, physical comfort, supervisor support and task orientation subscales of the WES, and (7) perceived physical effort.

Identifying Factors Related to Burden of Lost Time and Limited Duty

Lost work/limited duty measures

In order to determine whether the various measures described above are related in any way to the severity or burden of OLBP/lost time case status, data regarding limited duty, lost time, symptom severity, physical health, and mental health were obtained for cases only. Time lost from work was determined by the following questions: "How much "limited duty" or "profile" have you been assigned in the past 12 months due to back pain?" Subjects were also asked, "How much work did you miss (i.e., "no duty" or "no quarters") in the past 12 months due to back pain?" Response categories were, "no limited duty/time lost," "1–10 days," "11–30 days," "31–90 days" and "more than 90 days" for both questions.

Composite symptom severity

To measure symptom severity, a composite symptom severity score was computed (i.e., frequency × duration × intensity) based on a modified NIOSH symptom survey [Hales et al., 1994]. Ratings on this scale have been correlated with physical exam findings [Barron et al., 1996].

General physical and mental health

The Physical and Mental Health subscales of the SF-12 [Ware et al., 1995] were measured to provide a generic index of general physical and mental health, respectively. For both general and specific populations, these subscales have been shown to be useful in measuring and interpreting generic health outcomes and to have sound psychometric properties.

Data Analyses

Logistic and linear regression analyses were conducted using SPSS (v 9.0), Chicago, IL. A significance level of 0.05 was used unless otherwise specified.

RESULTS

Sample

On average, subjects were 25.6 (± 5.9) years of age, had served in the military for 5.0 (± 4.6) years, and worked in their present military jobs for 4.0 (± 3.7) years. The sample consisted of 386 (91.7%) males and 35 (8.3%) females. The gender distribution of the U.S. Army overall is 13.8% female. Subjects were recruited from Fort Myer (n = 151, 35.9%), Fort Bragg (n = 135, 32.1%), Fort Eustis (n = 61, 14.5%), Walter Reed Army Medical Center (n = 43, 10.2), Fort Belvoir (n = 15, 3.6%), Fort Lee (n = 9, 2.1%), Fort Story (n = 4, 1.0%), and Fort Meade (n = 3, 0.7%). Cases (M = 26.17, SD = 6.27) were slightly older than the comparison group (M = 24.72 years, SD = 5.29), t (414) = −2.48, $P < 0.05$ and had served in the military (M = 5.67 years, SD = 4.93) and worked in their military job longer (M = 4.66 years, SD = 3.83) than the comparison group (M = 4.16 years, SD = 3.84), t (416) = −3.38, $P < 0.01$, (M = 3.10 years, SD = 3.20), t (407) = −4.36, $P < 0.01$, respectively. Cases also differed from the comparison group on military job, education level, rank, and gender distribution but not on marital status, smoking behavior, number of children supported and base distribution as determined by χ^2-analyses. Table I presents descriptive data on the demographic characteristics for both the case and the comparison groups.

Determinants of case status

For the final multivariable logistic regression model, significant correlates of low back pain with lost time in the past 12 months were female gender (OR = 6.59, CI = 1.79–24.24, $P < 0.01$), education beyond HS/GED (OR = 3.60, CI = 1.77–7.32, $P < 0.001$), longer time working in military job (OR = 1.29, CI = 1.08–1.54, $P < 0.01$), rarely/never participating in aerobic exercise (OR = 4.39, CI = 1.53–12.57, $P < 0.01$), higher levels of interference from worries in daily life (OR = 5.47, CI = 1.70–17.62, $P < 0.01$), no support from others (OR = 4.01, CI = 1.31–12.34, $P < 0.05$) higher levels of ergonomic exposure (OR = 1.08,

TABLE I. Demographic Characteristics

	Cases			Comparison Group		
Variable	**n**	**M**	**SD**	**n**	**M**	**SD**
Age	244	26.2	6.3	172	24.7	5.3
Time in service	243	5.7	4.9	175	4.2	3.8
Time in military job	237	4.7	3.8	172	3.1	3.2
		n (%)			n (%)	
Gender						
Male		219 (89.0)			167 (95.4)	
Female		27 (11.0)			8 (4.6)	
Military job						
Infantryman		140 (56.9)			76 (43.4)	
Construction equipment repairer		3 (1.2)			10 (5.7)	
Heavy construction equipment operator		6 (2.4)			7 (4.0)	
Unit-level wheeled vehicle mechanic		15 (6.1)			17 (9.7)	
Wheeled vehicle driver		39 (15.9)			27 (15.4)	
Practical nurse		31 (12.6)			21 (12.0)	
Other		11 (4.5)			15 (8.6)	
Rank						
Private (E1) to private first class (E3)		70 (28.5)			83 (47.4)	
Specialist/corporal (E4)		100 (40.7)			45 (25.7)	
Sergeant (E5) to master sergeant (E8)		74 (30.1)			45 (25.7)	
Education						
High school graduate/GED		100 (40.7)			104 (59.4)	
Some college to graduate work		143 (58.1)			71 (40.6)	
Marital						
Single		105 (42.7)			95 (54.3)	
Married		101 (41.1)			60 (34.3)	
Separated		12 (4.9)			7 (4.0)	
Divorced		16 (6.5)			5 (2.9)	

n = 421. For certain variables, categories do not total 100% due to missing data.

CI = 1.03–1.13, $P < 0.01$), work situation perceived as sometimes stressful (OR = 3.47, CI = 1.24–9.74, $P < 0.05$), lower levels of innovation (OR = 0.76, CI = 0.64–0.90, $P < 0.05$), involvement (OR = 0.81, CI = 0.66–0.99, $P < 0.05$), and supervisor support (OR = 0.78, CI = 0.64–0.95, $P < 0.05$), increased peer cohesion (OR = 1.22, CI = 1.01–1.47, $P < 0.05$), and greater perceived effort at work (OR = 1.48, CI = 1.27–1.73, $P < 0.001$). This model correctly classified 82.71% of the sample ($\chi^2 = 208.68$, $P < 000$). Table II presents the results from the multiple logistic regression analysis.

Factors Related to Limited Duty and Lost Time Burden

Limited duty

The number of limited duty days in the past 12 months was associated with higher levels of symptom severity and lower levels of physical health. This model accounted for 26.1% of the variance in limited duty (Table III).

Lost time

Poorer physical health and higher levels of symptom severity were significant correlates of lost time due to OLBP. This model accounted for only 14.3% of the variance in lost time (Table III).

DISCUSSION

The results indicate that young, full-time soldiers engaged in jobs requiring a range of physical demands and who had lost time associated with occupational low back pain in the past 12 months, were more likely to be female and have a combination of higher education, frequency of worries, peer support, ergonomic exposures,

TABLE II. Determinamts of Occurrence of Occupational Low Back Pain With Lost Time

						95%CI	
Variable	**B**	**SE**	**Wald**	**R**	**OR**	**Lower**	**Upper**
Gender (female)	1.89	0.66	8.05	0.14	6.59***	1.79	24.24
Education (some college +)	1.28	0.36	12.54	0.18	3.60***	1.77	7.32
Time worked in job	0.25	0.09	7.72	0.13	1.29**	1.08	1.54
Aerobic activity/exercise			7.77	0.11			
(rarely/never)	1.48	0.54	7.59	0.13	4.39**	1.53	12.57
Interference from worries			9.70	0.11			
Seldom	1.46	0.53	7.64	0.13	4.29**	1.53	12.06
Sometimes	1.16	0.52	4.94	0.09	3.18*	1.15	8.80
Often	1.70	0.60	8.09	0.14	5.47***	1.70	17.62
Support from others (never)	1.39	0.57	5.89	0.11	4.01*	1.31	12.34
Ergonomic exposure	0.08	0.02	10.59	0.16	1.08***	1.03	1.13
Job stress			8.06	0.08			
Sometimes	1.24	0.53	5.60	0.10	3.47*	1.24	9.74
Innovation	−0.28	0.09	10.06	−0.16	0.76***	0.64	0.90
Involvement	−0.21	0.10	4.44	−0.09	0.81*	0.66	0.99
Peer cohesion	0.20	0.10	4.33	0.08	1.22*	1.01	1.47
Supervisor support	−0.25	0.10	6.18	−0.11	0.78**	0.64	0.95
Perceived effort	0.39	0.08	24.07	0.26	1.48***	1.27	1.73

The total number of subjects included in this analysis was 376 due to missing data on certain variables.
*$P < .05$.
**$P < .01$.
***$P < .001$.

levels of job stress, perceived effort at work, longer time worked on job, as well as lower frequency of aerobic exercise and support from others (non work). Higher levels of work involvement, innovation and supervisor support were related to reduced risk for lost time due to back pain. Lower levels of physical health and higher levels of symptom severity were associated with a greater frequency of limited duty and lost time.

The present findings are consistent with prior research on predictors of occurrence, exacerbation and recovery from occupational low back pain and disability. These results replicate prior research on factors related to disability in U.S. Army soldiers [Feuerstein et al., 1999] and extend the findings to a group of actively working soldiers. These findings provide evidence for the role of ergonomic and workplace and individual psychosocial factors in the maintenance of lost time in symptomatic employees.

While the mandate for occupational health providers should be to eliminate the sources of pain from both a medical and environmental health perspective, it is well

TABLE III. Factors Associated With Work Outcomes in Symptomatic Soldiers

	Limited Duty		Lost Time	
Correlates	ΔR^2	β	ΔR^2	β
Physical health	0.154**	−0.227**	0.090**	−0.166*
Symptom severity	0.089**	0.344**	0.053**	0.266**
Total R^2	0.261**		0.143**	
Total F (final model)	(3, 226) = 26.619** n = 229		(2,228) = 18.965** n = 230	

Data provided for significant variables only.
*$P < 01$.
**$P < 001$.

recognized that this is frequently not possible with OLBP, particularly given the etiological uncertainty of the various disorders that comprise OLBP [Katz and Gall, 1995; Atlas et al., 1996]. As an alternative to seeking and treating the primary cause of OLBP, a focus on recovery of function and symptom relief has been the mainstay of recent medical management [Dionne et al., 1999; Rossignol, 2000]. The present findings provide insight into factors that may help explain why lost time in OLBP may occur initially and continue to impact long-term work and health outcomes. Such information should help inform approaches that focus on recovery of function in the management of OLBP and be incorporated in the development of comprehensive secondary prevention approaches that target OLBP and lost time.

The finding that females were at higher risk for OLBP with lost time is consistent with previous research on predictors of back pain [Thomas et al., 1999] and disability [Feuerstein et al., 1997; Berkowitz et al., 1999; Dixon and Gatchel, 1999]. This increased risk may be related in part to total workload or the combination of work responsibilities for pay as well as for unpaid work (e.g., household duties, child care) [Lundberg et al., 1994; Lundberg and Frankenhaeuser, 1999]. A more accurate reflection of workload would consider both work completed at work and work conducted at home. Indeed, research indicates that the catecholamine levels of women (index of stress) continue to increase after work while those of men decrease, suggesting that recovery from the demands of work does not occur once at home [Lundberg, 1996]. This prolonged physiological arousal could impact pain, fatigue and residual energy levels and the ability to work with pain. It is also possible that males and females working in the same jobs experience different levels of biomechanical and psychosocial stressors [Messing et al., 1998]. Given the limited number of females it was not possible to stratify the analyses by gender for each of the independent variables.

The present findings support the role of ergonomic stressors in OLBP with lost time and are consistent with a recent review of the epidemiological literature on physical load and OLBP [Hoogendoorn et al., 1999]. The self-report measure of ergonomic exposure used in the present study assessed the duration of exposure to multiple aspects of physical load during work (manual materials handing, bending and twisting, and whole body vibration). A critical review of the most methodically sound studies with an exclusive focus on case reference or cohort designs (prospective or historical with a minimum of 1-year follow-up) found strong evidence linking these ergonomic risk factors to the onset of low back pain. The present study extends these conclusions to the occurrence of lost time in OLBP and to the use of self-report measures since the majority of the studies reviewed used direct measurement of ergonomic exposure. Although as with all the results in the present study, no conclusions regarding causality can be made due to the cross sectional nature of the design.

The results indicate that higher levels of ergonomic exposure not only were associated with the occurrence of lost time over the past 12 months (case status) but were also related to increased physical exertion at work. Perceived exertion and lower frequency of aerobic activity also contributed to the determination of OLBP with lost time. Lower levels of self-reported physical activity have recently been shown to be predictive of new episodes of back pain (lost time not examined) Croft et al. [1999]. It is possible that increased ergonomic exposure contributes to increased perceived exertion, which in turn may be influenced by aerobic capacity to result in heightened risk for lost time. An association between exposure to awkward postures and higher perceived workload has been observed in workers with intermittent and chronic low back pain [Hultman et al., 1995]. Perceived physical exertion has also been shown to predict the occurrence of low back pain in nursing personnel in association with psychological demands [Josephson et al., 1996] and job strain [Josephson et al., 1997].

Although participants were relatively young and employed in a work place where exercise is required, low levels of aerobic activity were found to be associated with OLBP lost time. Whether these low levels preceded or followed the onset of back pain is presently unclear. It has been reported that cessation of physical activity post-injury, low energy/high fatigue, poorer general health and attorney involvement predicted 42% of the variation in low back symptoms in a sample of workers' compensation claimants [Butterfield et al., 1998]. Further, the duration of claims was shown to be significantly longer in those workers who discontinued physical fitness activities post-injury when compared to those to who did not. It is possible that workers with insufficient aerobic conditioning may be at higher risk for lost time due to an inability to sustain the rigors of a full day's work and the concomitant exposure to ergonomic and psychosocial stressors. Lastly, the experience of pain may exacerbate feelings of fatigue or exhaustion, drain physical reserves, and result in greater susceptibility to psychosocial stressors resulting in increased risk for OLBP with lost time. Future research should investigate the association among ergonomic stressors, perceived exertion, aerobic exercise/fitness and pain in symptomatic workers in and out of the workers' compensation system. It would also be important for future studies to include more direct measurement of ergonomic exposure, exercise behavior and aerobic fitness. The analyses of these associations should assist in identifying potential biobehavioral mechanisms linking these factors with lost time associated with OLBP.

In the present study, lower levels of supervisor support were consistently related to case status. A potential strategy that could impact perceived levels of supervisor support would be to increase the role of the supervisor in the job

accommodation/modified duty process. This could have a significant effect on lost time outcomes. It has been estimated that providing modified duties in a timely manner could potentially reduce time lost per episode of back pain by at least 30% percent [Frank et al., 1998]. Interestingly, lower levels of worker involvement and innovation were also related to the occurrence of lost time with OLBP. Some work environment factors that have been shown to correlate with job involvement are: cohesiveness, recognition, fairness, innovation, variety, autonomy, feedback, significance of the work, interaction, and lower levels of role ambiguity and role conflict [Elloy et al., 1995]. These correlates suggest that one approach to improving job involvement would be to train supervisors to facilitate a work climate with these characteristics. It is likely that supervisor support would increase along with job involvement as a consequence of such training. Some of the correlates of job involvement listed above are related to increased control by the worker. Decades of research have indicated that higher levels of perceived control at work are associated with higher levels of job satisfaction, involvement, performance, and lower levels of physical symptoms, emotional distress and lost time [Spector, 1986; Terry and Jimmieson, 1999]. This area represents an important avenue for future secondary prevention efforts related to occupational low back pain [Linton and Bradley, 1992]. Improving employees levels of control in the workplace can be accomplished through individual training as well as modification of organizational policies and practices regarding workplace safety and return to work practices [Habeck et al., 1991, 1998; Amick et al., 2000].

Individual and workplace psychosocial factors such as perceived levels of support from others, frequency of worries that interfere with daily activities and a general index of job stress all had relatively high odds ratios in the determination of OLBP with lost time case status. These findings are consistent with past research on predictors of longer term OLBP disability where it was observed that these identical variables predicted disability discharge from the U.S. Army [Feuerstein et al., 1999]. These results highlight the importance of considering the psychological well being of an individual worker while he or she remains at work. Interference from worries was a major factor associated with the occurrence of OLBP with lost time. These findings suggest that strategies directed at reducing the impact of stressors (both physical and psychosocial), increasing levels of support, providing specific training in approaches to eliminate the sources of physical and psychosocial stress, should reduce work disability. Administrative control measures including engineering interventions to reduce ergonomic exposure should also be considered, when feasible. Organizational support for such initiatives should be explicitly and repeatedly communicated to the individual worker, work unit and supervisor.

The present findings are limited by the exclusive use of self-report measures of exposure and outcomes. It would be useful in future research to incorporate, when possible, efficient observational measures of ergonomic exposure [Latko et al., 1999] and occupational stressors [Tepper and Hurell, 1995] in addition to the use of administrative data on lost time. This study involved active duty soldiers in the U.S. Army. While the nature of many jobs in the Army is equivalent to occupations in the civilian workforce [Department of the Army (DAPE-MB), 1994], differences remain. Consequently, generalizations to workforces outside of the military should be made with caution. A final limitation was the use of a cross-sectional design. It was reasoned that since no study to date investigated the combination of variables examined in relation to OLBP with lost time that such a design was justified as a first step. These results provide a basis for future studies to determine whether the variables identified in the cross-sectional analyses prospectively predict the onset of lost time in OLBP as well as the other outcomes reported in this study.

Despite the limitations described above, the findings support the importance of early evaluation of ergonomic, workplace psychosocial and individual psychosocial variables that can affect the recovery process. The authors have created a screening tool based on the logistic regression model in the present study.[1] This screen could be used in future secondary prevention efforts to identify individuals who may be at increased risk for OLBP with lost time. The results also suggest that effective interventions should be directed at reducing or eliminating ergonomic stressors, improving work climate through efforts at supervisor training as well as providing training to employees targeted at assisting them in reducing or eliminating the sources of both job and life stressors. Such an approach should positively impact lost time and reduce the burden of OLBP on both the worker and employer. The findings clearly indicate the need for a controlled trial of a secondary prevention intervention that addresses many of the problem areas identified in this study.

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[1] The ergonomic risk screening tool and computerized algorithm to compute risk for OLBP with lost time are available from the corresponding author.

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