Scand J Work Environ Health 2002;28(6):386-393

<https://doi.org/10.5271/sjweh.690>

Issue date: Dec 2002

Time control, catecholamines and back pain among young nurses

by [Elfering A](#), [Grebner S](#), [Semmer NK](#), [Gerber H](#)

Affiliation: Department of Psychology, University of Berne, Muesmattstrasse 45, CH-3000 Bern 9, Switzerland. achim.elfering@psy.unibe.ch

Refers to the following texts of the Journal: [1998;24\(6\):449-464](#)
[1995;21\(6\):435-439](#) [1998;24\(6\):465-472](#)

The following articles refer to this text: [2008;34\(5\):337-344](#);
[2012;38\(3\):282-290](#)

Key terms: [back pain](#); [catecholamines](#); [job beginner](#); [nurse](#); [stressful event](#); [time control](#)

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/12539798

This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

Time control, catecholamines and back pain among young nurses

by Achim Elfering, PhD,¹ Simone Grebner, PhD,¹ Norbert K Semmer, PhD,¹ Hans Gerber, MD²

Elfering A, Grebner S, Semmer NK, Gerber H. Time control, catecholamines and back pain among young nurses. *Scand J Work Environ Health* 2002;28(6):386–393.

Objectives This study had two objectives. First, it addressed concern with the contribution of work stressors and resources to the development of back pain, over and above the influence of biomechanical work factors. Second, using recent models about the role of the sympathetic-adrenal medullar system in musculoskeletal problems as its basis, it tested whether low-back pain is associated with higher levels of catecholamines.

Methods Altogether 114 nurses filled out a questionnaire in their first year of practice and again one year later. In addition, in a subsample of 24 nurses studied intensively at follow-up, urinary catecholamines were assessed at noon, before the end of work, in the evening, and at corresponding times on a day off. Daily stressful experiences and daily mood were also recorded.

Results With control for baseline pain, biomechanical workload, and other potentially confounding variables, time control at the beginning of the study predicted low-back pain a year later. In the subsample, the epinephrine and norepinephrine levels were higher in those reporting more frequent episodes of back pain, the largest differences occurring at the end of work. In addition, control over stressful events at work was lower in this group.

Conclusions Time control is a risk factor for low-back pain among nurses beyond the influence of physical work load. Low control at work may increase the activity of the sympathetic-adrenal medullar system, which seems to play an important role in the development of musculoskeletal pain.

Key terms job beginners, stressful events.

The Bureau of National Affairs in the United States has listed nurses and nurse's aides among the ten professions with the highest risk of low-back pain (1). The physical aspects of nursing comprise heavy lifting, pushing, pulling, and carrying patients and objects. In addition, nurses frequently have to work with forward bent, twisted, or awkward body postures (2). The mechanical load on intervertebral discs is therefore considerably high (3). Nursing is also known to involve psychosocial risk factors such as high demands on concentration, high responsibility, time pressure, and high needs for social support from supervisors and co-workers (4). These psychosocial risk factors have also been shown to predict back pain, although the empirical evidence for them is less consistent than for physical demands (2). Age seems

to be an important factor in the study of risk factors. Nurses at the beginning of their career are at particular risk of work-related low-back pain (5, 6); this risk reaches a prevalence peak at the age of 31–35 years (5). For these reasons, prospective studies on the development of low-back pain among young nurses seem promising.

Psychological stress arises when demands are perceived to exceed the resources to meet the demands (7). Both stressors and resources are important in studies on the effects of stress on health (8). One of the most important resources is control over one's work, the lack of which is a well-established risk factor for psychological well-being and physical health (9). In research on stress at work, several aspects of control are distinguished,

¹ Department of Psychology, University of Berne, Berne, Switzerland.

² Chemical Laboratory of the University Hospital, University of Berne, Berne, Switzerland.

Reprint requests to: Dr Achim Elfering, Department of Psychology, University of Berne, Muesmattstrasse 45, CH-3000 Bern 9, Switzerland. [E-mail: achim.elfering@psy.unibe.ch]

such as control over when to do something (time control) and how to do it (method control) (10). Another aspect, which has received less attention, concerns control over who to work with ("cooperation latitude") (11). Low control can affect the musculoskeletal system indirectly, via incomplete recovery from stress, or directly, influencing mechanical load by making it more difficult to avoid unsuitable and strenuous work positions (12).

The stress response is characterized by the activation of the sympathetic-adrenal medullary system, including increased heart rate, blood pressure, and catecholamine secretion. Stress-induced activation of this system, particularly the secretion of norepinephrine, heightens muscular activity. Norepinephrine promotes motor activity because of an increased sensitivity of the synapses. Furthermore, norepinephrine may increase muscular tension through the recruitment of more muscle fibers during the performance of an activity (13). Psychologically stressful jobs can enhance the risk of musculoskeletal disorders through increased muscular tension, particularly by keeping low threshold motor units active even in the absence of physical load (14), and even after work (15). Chronically elevated muscular tension may cause muscular pain (16). Therefore, catecholamine release may constitute an important link between psychosocial factors at work and musculoskeletal pain (17).

This study concerns the development of low-back pain in beginning nurses. First, we expected work-related stressors and resources to be risk factors beyond the influence of biomechanical factors. Second, we expected catecholamine responses at work and at rest to correlate both with work characteristics and with low-back pain. The latter hypothesis was tested in a subsample.

Subjects and methods

Subjects

The subjects were taken from a longitudinal study investigating the transition into work by young people (18). The first phase took place when the participants were still in vocational training and is not of concern in this instance. (See reference 18 for a description of the sampling procedure and the characteristics of the subjects.) For phases 2 and 3, questionnaires were sent out by mail. The results reported in this paper are based on data from the first and second year of work after the nurses' training was completed (baseline data coming from phase 2 and the follow-up data deriving from phase 3).

In April 1998, questionnaires and a reminding letter were sent out to 186 nurses who had participated in phase 1 of the study. An additional effort was undertaken to motivate nonrespondents by telephone. This effort resulted in 141 questionnaires, representing a participation rate of 75.8%. Those that did not participate but had participated in the first phase (ie, during vocational training) did not differ from those who participated with respect to age, musculoskeletal pain, and neuroticism.

In April 1999 the follow-up questionnaire was sent to the 141 nurses of the baseline sample, resulting in data from 114 participants for a response rate of 80.9%. These 114 nurses constitute the longitudinal sample. Again, the dropouts did not differ from the longitudinal sample in terms of age, musculoskeletal pain, and neuroticism.

At the time the baseline questionnaire was mailed, the nurses were in their first year of practice. Their mean time on the job was 6.8 (SD 2.1) months and their mean age was 23.9 (SD 2.2) years. As in the general population, there were more German-speaking (64%) than French-speaking (36%) participants. Most of the participants worked full-time (N=98), whereas the rest worked a 90% (N=6), 80% (N=9), or 75% (N=1) schedule. There was a 14% turnover rate during the follow-up period, mostly voluntary (82%). Almost all of those who stayed with their employer still held the same position (91%). Employers and locations were distributed widely; working teams consisted of an approximate mean of 20 (SD 6.5) persons. Nearly all the nurses (N=111) reported working overtime during a normal week [mean 2.45 (SD 4.00) hours], and as many worked on a shift schedule, usually including work in the evening or at night.

Among a subsample of 24 nurses, consisting of German-speaking persons only, an in-depth study was conducted around the time of the data collection for the follow-up. It included urinary catecholamine measurements at three measurement points on a workday and at corresponding times on a day off. These nurses had worked an average of 18 (SD 2.3) months in their jobs. The mean time between the catecholamine sampling and the follow-up questionnaire was 77 (SD 61, range 3–211) days. The large range was due to the fact that the nurses worked in many different organizations. Therefore much effort and many personnel resources had to be invested in logistics, and data collection had to be organized sequentially to some extent. Furthermore, the participants' restraints and preferences with regard to the optimal time of collecting physiological data had to be taken into account. It is important to note, however, that the time between the measurements and the questionnaire was not significantly related to the baseline predictor variables or follow-up outcome variables.

Methods

The predictor variables of this study covered the range of potential risk variables within the multicausal biopsychosocial approach to back pain: (i) demographics (age, body mass index measured as kilograms of body weight divided by height squared), (ii) indicators of general health (days off work) and neuroticism, (iii) recreational and risk behavior (sports, smoking), (iv) environmental and biomechanical strain at work, (v) work characteristics (stressors, control), (vi) psychosocial work-related variables (social support, social stressors, job satisfaction), and (vii) additional workload during leisure time. All the predictor scales were tested for reliability with respect to the baseline and follow-up data, and the reliability (Cronbach's alpha) was found to be satisfactory (between 0.70 and 0.90) except for work during leisure time, which had a coefficient of 0.47 for the baseline and follow-up data. However, these items covered various forms of nonoccupational load that are not necessarily correlated (eg, having to care for a household, having to support other people); therefore, a high internal consistency did not seem necessary.

For the subsample of 24 nurses, additional measures were available, including urinary catecholamine release and reports of stressful events [using a diary-type method, see reference (19)] and daily mood (20).

The indicators of general health referred to the number of days off work because of health reasons. The measurement of neuroticism was based on the five-factor model of personality (21). It consisted of six bipolar items on a 6-point scale, with each pole ranging from "very" (1 and 6) to "quite" (2, 5), and "rather" (3, 4) (22).

Recreational and risk behavior was assessed by asking about the frequency of sports (never, less than once a month, once a month, once a week, daily) and smoking (number of cigarettes per day).

Environmental and biomechanical strain at work was measured by scales from the Instrument for Stress Oriented Task Analysis (ISTA) (11, 23). The scales cover physical conditions (eg, noise, inadequate lighting, inadequate temperature, dust, toxic substances, draft, and dry, smoky or malodorous climate) and unbalanced load as the need to keep unfavorable postures at work over extended periods of time (eg, "twisted" position, continuous sitting, and continuous standing, low variety in terms of physical movement). In addition, participants rated the change in physical strain at follow-up ["far worse" (1), "worse" (2), "same" (3), "better" (4), "far better" (5)].

Work characteristics were measured with a short version of ISTA, assessing method control (eg, independent planning and organization of one's own work), time control (eg, influence on workplace and schedule),

cooperation latitude (influence on who to collaborate with), and qualitative requirements (task variety, complexity). Task stressors were assessed as an index of the following five scales (each with 4 items): uncertainty (eg, unclear instructions and decisions based on insufficient information), problems with work organization (eg, having to work with unsuitable materials or tools), interruptions at work, concentration demands, and time pressure. The response categories were standardized 5-point Likert scales.

Psychosocial work-related variables concerned social support, assessed with items from Caplan et al [24, German translation (25)]. The item "How much can you rely on each of the following people when things get tough at work?" had to be answered with reference to a supervisor, closest colleague, other colleagues, spouse or partner, family, and friends. The answering format was a 5-point scale ranging from 1 (not at all) to 5 (absolutely). Social stressors assessed difficulties with colleagues or superiors [8 items (26)]. Job satisfaction was measured by four items, three of which were developed by Oegerli (27), the fourth being an item from Kunin, "How satisfied are you in general with your work?" (28). The scale has been successfully employed in previous research (29) and has been shown to predict indicators of low-back pain in initially asymptomatic persons (30).

Workload during leisure time was assessed with items from a scale by Bamberg (31) on stressors in leisure time, such as financial constraints, liabilities, or social conflicts. We used the four (of initially 11) items that focus on workload during leisure time (eg, "I have so many things to do that I can't spend time on my hobby").

Musculoskeletal problems at the time of the baseline questionnaire were assessed with an item that addressed musculoskeletal pain in the back or neck or shoulders in the last 12 months (never, less than monthly, less than weekly, less than daily, daily). It is part of a scale developed by Mohr to measure psychosomatic complaints (32) on the basis of work by Fahrenberg (33). Note that this item served as a baseline measurement in the multiple regression analyses.

In the follow-up, pain intensity and behavior was assessed with the Nordic questionnaire (34). The questions included (i) occurrence of low-back pain (yes, no), (ii) duration of low-back pain episodes (none, 1–7 days, 8–30 days, more than 30 days but not every day, every day), (iii) frequency of low-back pain episodes (none or once a year, less than once a month, once a month, once a week, daily), (iv) medical consultation because of low-back pain (yes, no), and (v) low-back pain-related absence from work (yes, no). The last year was indicated as the relevant time frame. Note that participants in the in-depth study filled out

the Nordic items at the time of the catecholamine measurement.

Over 1 week, the 24 participants in the in-depth study filled out four mood scales (20) every morning and evening, on workdays immediately after work. The questionnaire consisted of 19 adjectives and asked for the current state of recovery, tension, mood, and self-assurance (6-point scales). A single item addressed exhaustion on the evening of the days on which catecholamines were measured.

Daily stressful events were assessed through a diary event-sampling method (19). Over 1 week (Monday to Sunday), the nurses were asked to describe briefly stressful events (at work and during leisure time) immediately after they occurred. Additional items concerned situational appraisals, emotional stress reactions, goals, coping behavior, coping success, and the like.

The urinary catecholamine samples were collected on a day at work before the lunch break (time 1200), before the end of the workday (time 1715), and in the evening (time 2100) by trained collectors. The participants were asked to refrain from consuming food and beverages (except water) 1 hour before each assessment. The measurements were repeated at home on a day off (typically a Sunday) at corresponding times. On the day off, the participants were asked to avoid physical activity (such as sports, housework or gardening) or heavy mental work in order to obtain valid physiological reference values. The participants were asked to empty their bladder at the time indicated, to measure the volume of urine with a metering box, and to keep a record of each voiding time and volume that occurred between the measurement points. The urine samples (100 ml) were acidified immediately by hydrochloride acid to a pH level of 3. Each sample was then divided into two aliquots of 15 ml each. The aliquots were frozen (-20°C) for analysis by high-performance liquid chromatography. The level of epinephrine and norepinephrine was expressed as picomole (10^{-12} moles per liter of urine) per the minutes since the last voiding per kilogram of body weight. The participants recorded their consumption of alcohol, nicotine, caffeine, medication, and additional workload (eg, hours of housekeeping, child care, etc) in a diary each evening over seven consecutive days. This interval included both physiological measurement days (workday and day off). The accuracy and robustness of the measurements with respect to the collecting schedule, acidification, storing conditions, and comparison of the time-related index with the ratio of creatinine were highly satisfying (detailed information available from the authors).

The aliquots were analyzed in the Chemical Laboratory of the University Hospital in Berne by high-performance liquid chromatography.

Data analysis

To predict the development of low-back pain, we conducted hierarchical multiple regression analyses. Musculoskeletal problems in the baseline phase were entered first. Next, we entered age, body mass index, smoking, days off work as an indicator of general health, and neuroticism. Unbalanced physical load in the baseline phase and the change in physical strain, as rated at the time of the follow-up, were entered in a third step, as they appear to be reliably associated to low-back pain (2). All the other predictors, which were mainly psychosocial and work-related, were added to the model only when they explained additional variance by a statistically significant amount ($P < 0.05$), with the use of a forward stepwise procedure. For predicting the categorical outcome variables, we ran multiple logistic regressions following the same procedure. All of the P-values are two-sided.

Results

Both the qualitative requirements (variety, complexity) and the stressors proved to be rather high for this sample. Method control was higher than time control. The level of social support reported was high as well, as was the level of job satisfaction (detailed information available from the authors). The nurses tended to engage frequently in work during their leisure time, especially at the time of the follow-up.

Table 1 shows the frequency of low-back pain at the time of the follow-up. Bivariate correlations between the work characteristics and the indicators of low-back pain were low to moderate and in the expected directions (all correlations available from the authors).

As table 2 shows, back pain in the baseline phase was the strongest predictor of the frequency of episodes of low-back pain. Of the other variables forced into the model, only change in physical strain proved to be predictive.

From the psychosocial variables that were tested by the hierarchical forward procedure, time control emerged as a significant predictor. In a multiple logistic regression analysis with the same hierarchical regression approach, the frequency of low-back pain was recoded as infrequent (up to once a month) and frequent (more than once a month). The analysis yielded an elevated odds ratio (OR) for the increase in physical strain [OR 6.00, 95% confidence interval (95% CI) 1.68–21.44] and for time control (OR 4.61, 95% CI 1.42–15.03). The results for the duration of the low-back pain episodes (>7 days) during the follow-up also showed a higher risk for time control (OR 2.19, 95% CI

1.04–4.61). Medical consultation because of low-back pain was predicted by a lack of social support from best colleague (OR 5.75, 95% CI 1.27–25.97). The number of nurses absent from work because of low-back pain (N=3) was too small for reliable prediction.

Table 1. Low-back pain at follow-up (N=114).

Outcome variable	N	%
Deterioration of low-back pain		
Yes	23	20.2
No	91	79.8
Frequency		
None or once a year	21	18.4
Less than once a month	29	25.4
Once a month	39	34.2
Every week	23	20.2
Steadily	2	1.8
Duration		
None	14	12.3
1–7 days	49	43.0
8–30 days	33	28.9
> 30 days	17	14.9
Daily	1	0.9
Medical consultation for low-back pain		
Yes	15	13.3
No	98	86.7
Work absence due to low-back pain		
Yes	3	2.7
No	110	97.3

As has already been described, for a subsample of 24 nurses, additional data were available concerning urinary catecholamine release, stressful events at work, and mood. The level of catecholamine release among the nurses reporting more frequent episodes of low-back pain (ie, at least once a month, N=12) was higher than for those who did not, or only rarely, experience such episodes (“none” or “less than once a month”, N=12). The differences were highest for the measurement at the end of work. Furthermore, although the nurses who reported more frequent episodes of low-back pain did not differ from the other group in terms of number (mean 7.38 over 5 workdays for both groups) or content of stress episodes at work, they did rate these episodes as less controllable (ie, had lower scores on the item “my chances to turn the situation to good were...”). In addition, the nurses with low-back pain reported more exhaustion at the end of the workday and higher feelings of tension after work. Three of these differences were statistically significant, and three were marginally significant (table 3). The differences between the groups with regard to private stressful events and mood on rest days were in the same direction, but less pronounced. With respect to the control variables, the results showed that, in both groups, the vast majority did not smoke or drink any alcohol during the week of the in-depth assessment. The only difference was that the high pain group drank significantly less

Table 2. Prediction of the frequency of back pain episodes (stepwise linear multiple regression analysis).^a [Beta (ln) = standardized regression coefficient when the variable was entered, Final beta = beta after all the variables had been entered, t = test of significance for final beta, R²_{change} = increase in explained variance, F_{change} = significance of R²_{change}, R = multiple correlation, R² = variance explained; Adj R² = adjusted R², F = test of significance for multiple correlation coefficient, df = degrees of freedom, sign F = level of significance of the F-test]

Predictor	Beta (ln)	R ² _{change}	F _{change}	P-value ^b	Final beta	t	P-value ^c
Step 1							
Back pain at baseline	0.51	0.26	36.44	0.000	0.48	5.76	0.000
Step 2							
Control variables		0.05	1.29	0.276			
Age	0.04				0.04	0.46	0.648
Body mass index (t2)	0.15				0.12	1.38	0.170
Work absence	0.12				0.13	1.54	0.128
Neuroticism	0.03				−0.01	−0.13	0.895
Smoking	−0.03				0.04	0.42	0.673
Step 3							
Physical load		0.03	2.51	0.086			
Unbalanced load	0.11				0.13	1.51	0.134
Change in physical strain ^d	−0.16				−0.17	−2.11	0.038
Step 4							
Time control	−0.21	0.04	6.44	0.013	−0.21	−2.54	0.013
Final regression model:	Mult R: .62 F: 6.54	R ² : 0.38 df: 9/97	Adj R ² : 0.32 Sign F: <0.001				

^a In steps 1 to 3, the variables were forced into the equation. For step 4, a stepwise procedure was applied. (See the paragraph on the data analysis in the text.)

^b P-value for the F_{change}.

^c P-value for the t.

^d Higher values indicate improvement.

Table 3. Low-back pain, control over stressful events at work, exhaustion, mood, and level of catecholamine release.

Variable	Frequency of low-back pain				t ^a	P-value
	Low (less than once a month) (N = 12)		High (at least once a month) (N = 12)			
	Mean	SD	Mean	SD		
Epinephrine level on workday [pmol(min/kg)]						
Noon	0.59	0.26	1.07	0.76	-2.07	0.058 ^b
End of work	0.67	0.36	1.15	0.50	-2.56	0.019
Evening	0.59	0.41	0.76	0.54	-0.89	0.384
Epinephrine level on day off [pmol(min/kg)]						
Noon	0.41	0.32	0.65	0.53	-1.35	0.190
Afternoon	0.53	0.35	1.11	0.89	-2.11	0.053 ^b
Evening	0.43	0.22	0.56	0.40	-0.97	0.345
Norepinephrine level on workday [pmol(min/kg)]						
Noon	3.75	1.13	4.58	2.44	-1.07	0.295
End of work	3.18	0.83	5.17	1.86	-3.24	0.006 ^b
Evening	3.79	2.21	4.59	2.95	-0.75	0.461
Norepinephrine level on day off [pmol(min/kg)]						
Noon	2.95	1.25	3.35	1.56	-0.71	0.489
Afternoon	4.00	2.76	4.82	3.02	-0.70	0.496
Evening	3.39	1.45	2.72	1.04	1.22	0.237
Control over stressful events at work ^c	4.15	0.84	3.50	0.89	1.80	0.086
Exhaustion in the evening of workdays ^d	3.13	0.70	3.64	0.68	-1.82	0.082
Mood after work						
Recovery	3.46	0.75	2.75	0.85	2.17	0.041
Relaxation	4.74	0.53	4.06	0.59	2.94	0.008
Mood	4.13	1.15	3.46	0.68	1.74	0.097
Self-assurance	4.37	0.54	3.87	0.59	2.16	0.041

^a Students t-test.^b Corrected for unequal variances.^c Code: 1 = very low – 6 = very high.^d Code: 1 = very little – 5 = very much.

caffeine-containing liquids on the rest day. There were no differences with respect to neuroticism in the baseline phase. There was no meaningful association between these variables and control over stressful events at work, mood, or catecholamines. The analyses of covariance that controlled for the consumption of alcohol, nicotine, caffeine on a workday or the day of rest, and neuroticism in the baseline phase showed an unchanged pattern of results.

Discussion

As was to be expected (2), the baseline measurements were the strongest predictors of low-back pain at follow-up. Changes in physical strain were also predictive. Over and above these influences, however, time control predicted the frequency of low-back pain at the time of the follow-up. Because physical load was controlled

in these analyses, the effect of time control was not likely due to an accumulation of strenuous work positions that could not be avoided because of low control (12). And since several potentially confounding variables, such as body mass index, smoking, and neuroticism, were controlled as well, these longitudinal findings indicate that the psychosocial aspects of work are independently involved in the development of low-back pain (30). That time control emerged as a predictor underscores the value of distinguishing various facets of control (10). Time control may be especially important for nurses, since their activities involve responding to the needs of patients, the hospital schedule, and the orders of doctors. Low control over time implies that one's work is externally paced, a factor which has been shown to be related to impaired health in general and to musculoskeletal disorders in particular (35). For nurses, this external pacing is not due to machines, as in many production jobs, but to other people, analogous to what Lundberg & Melin (35) call "customer paced".

The additional assessments in the subsample enabled us to test the hypothesis that activation of the sympathetic-adrenal medullar system may be involved in the processes that are responsible for our findings. This assumption is based on models postulating that increased muscular tension, even in the absence of physical demands, may play a role in the development of musculoskeletal disorders and that (sustained) activation of the sympathetic-adrenal medullar system is involved (15, 17, 35). The pattern of our results is in line with these expectations. Catecholamine release was higher in the nurses with more frequent low-back pain, and this group also experienced less control over stressful events at work and reported more exhaustion and worse mood after work. These results, therefore, are in agreement with etiologic models of musculoskeletal disorders that emphasize activity of the sympathetic-adrenal medullar system as a mediator between unfavorable work conditions and pain (17, 35).

The rather small sample in the in-depth study in which catecholamine measurements were available certainly constitutes a weakness of our study. In addition, since the scope of the entire project was broad (18), many measures had to be rather short. Measurement of the baseline level of back pain, and of physical load, was less detailed than is typical for studies on back pain. The fact that both of these variables were predictive of low-back pain in the follow-up speaks in favor of the validity of these measures. Nevertheless, it cannot be ruled out that the influence of psychosocial factors may have been reduced somewhat if these measures had been more detailed. However, the frequency of low-back pain, as measured with the item from the Nordic questionnaire and the single item measure, which were both available in the follow up, were highly correlated ($R=0.79$). Furthermore, the analyses with the single-item measure of back pain in the follow up as a dependent variable showed the same pattern of relationships found with the Nordic items, and this finding includes relationships with the catecholamine level. This result and the inclusion of several important control variables in the models supports the role of the psychosocial variables, another finding which is also in line with previous results (30, 35, 36).

On the other hand, this study had several strengths. First, it was prospective and allowed the prediction of symptoms over time, while controlling for initial symptom status. Second, in addressing job beginners, it monitored a period of increased risk for back pain and back injuries (6), and it avoided the "survivor bias" (37). Third, the inclusion of catecholamine measurements and a micro-level approach to stressful events at work strengthened the findings and spoke against effects of common method variance, which otherwise might have weakened the results based on traditional questionnaires

only. Control at work—both in terms of time control in the general questionnaire and in terms of situational control in the diary study—was related to low-back pain. This result underscores the importance of control at work for well-being (10) and health (9) in general, and for the development of musculoskeletal problems in particular (35, 38).

References

1. Bureau of National Affairs, Inc. Back injuries: costs, causes, cases & prevention. Washington (DC): Bureau of National Affairs, 1988.
2. Lagerstrom M, Hansson T, Hagberg M. Work-related low-back problems in nursing [review]. *Scand J Work Environ Health* 1998;24:449–64.
3. Morlock MM, Bonin V, Deuretzbacher G, Müller G, Honl M, Schneider E. Determination of the in vivo loading of the lumbar spine with a new approach directly at the workplace—first results for nurses. *Clin Biomech* 2000;15:549–58.
4. Ahlberg-Hultén GK, Theorell T, Sigala F. Social support, job strain and musculoskeletal pain among female health care personnel. *Scand J Work Environ Health* 1995;21:435–9.
5. Cust G, Pearson JCG, Mair A. The prevalence of low back pain in nurses. *Int Nurs Rev* 1972;19:169–79.
6. Garrett B, Singiser D, Banks SM. Back injuries among nursing personnel: the relationship of personal characteristics, risk factors, and nursing practices. *AAOHN J* 1992;40:510–6.
7. Frankenhaeuser M. A biopsychosocial approach to work life issues. In: Johnson JV, Johansson G, editors. *Work organization, democratisation and health*. Baltimore (MD): Baywood Publications, 1991:49–60.
8. Sonnentag S, Frese M. Stress in organizations. In: Borman WC, Ilgen DR, Klimoski RJ, editors. *Comprehensive handbook of psychology; vol 12 (Industrial and organizational psychology)*. New York (NY): Wiley. In press.
9. Marmot M, Siegrist J, Theorell T, Feeney A. Health and the psychosocial environment at work. In: Marmot M, Wilkinson RG, editors. *Social determinants of health*. Oxford: Oxford University Press, 1999:105–31.
10. Terry DJ, Jimmieson NL. Work control and employee well-being: a decade review. In: Cooper CL, Robertson IT, editors. *International review of industrial and organizational psychology; vol 14*. Chichester: Wiley, 1999:95–148.
11. Semmer NK, Zapf D, Dunckel H. Instrument zur Stressbezogenen Tätigkeitsanalyse (ISTA) [Instrument for Stress Oriented Task Analysis (ISTA)]. In: Dunckel H, editor. *Handbuch psychologischer Arbeitsanalyseverfahren [Handbook of psychological job analysis]*. Zürich: vdf Hochschulverlag, 1999:179–204.
12. Josephson M, Vingard, E. Workplace factors and care seeking for low-back pain among female nursing personnel. *Scand J Work Environ Health* 1998;24:465–72.
13. Westgaard RH. Effects of psychological demand and stress on neuromuscular function. In: Moon SD, Sauter SL, editors. *Beyond biomechanics: psychosocial aspects of musculoskeletal disorders in office work*. London: Taylor & Francis, 1996:75–89.

14. Hägg, GM. Static work loads and occupational myalgia—a new explanation model. In: Anderson PA, Hobart DJ, Danhoff JV, editors. *Electromyographical kinesiology*. Amsterdam: Elsevier, 1991:141–4.
15. Melin B, Lundberg U. A biopsychosocial approach to work-stress and musculoskeletal disorders. *J Psychophysiol* 1997;11:238–47.
16. Veiersted KB, Westgaard RH, Andersen P. Electromyographic evaluation of muscular work pattern as a predictor of trapezius myalgia. *Scand J Work Environ Health* 1993;19:284–90.
17. Lundberg U, Elfsberg Dohns I, Melin B, Sandsjö L, Palmerud G, Kadefors R, et al. Psychophysiological stress responses, muscle tension, and neck and shoulder pain among supermarket cashiers. *J Occup Health Psychol* 1999;4:245–55.
18. Kälén W, Semmer NK, Elfering A, Dauwalder J-P, Tschann F, Heunert S, et al. Work characteristics and well-being of Swiss apprentices entering the labor market. *Swiss J Psychol* 2000;59:272–90.
19. Reicherts M, Pihet S. Job newcomers coping with stressful situations: a micro-analysis of adequate coping and well-being. *Swiss J Psychol* 2000;59:303–16.
20. Apenburg, E. Befindlichkeitsbeschreibung als Methode der Beanspruchungsmessung [Description of mood as a measure of strain]. *Z Arb Organisationspsychol* 1996;30:3–14.
21. Costa PT Jr, McCrae RR. The NEO personality inventory manual. Odessa (FL): Psychological Assessment Resources, 1985.
22. Schallberger U, Venetz, M. Kurzversionen des MRS-Inventars von Ostendorf (1990) zur Erfassung der fünf “grossen” Persönlichkeitsfaktoren [Brief versions of Ostendorf’s MRS inventory for the assessment of the Big-Five personality factors]. Zürich: Universität Zürich, 1999:1–50. Berichte aus der Abteilung Angewandte Psychologie, no 30.
23. Semmer NK, Zapf D, Dunckel H. Assessing stress at work: a framework and an instrument. In: Svane O, Johansen C, editors. *Work and health—scientific basis of progress in the working environment*. Luxembourg: Office for Official Publications of the European Communities, 1995:105–13.
24. Caplan RD, Cobb S, French JRP, Harrison RV, Pinneau SR. *Job demands and worker health*. Cincinnati (OH): National Institute for Occupational Safety and Health, 1975.
25. Frese M. Gütekriterien der Operationalisierung von sozialer Unterstützung am Arbeitsplatz [Reliability and validity of an operationalization of social support at work]. *Z Arbeitswiss* 1989;43:112–21.
26. Frese M, Zapf D. Eine Skala zur Erfassung von sozialen Stressoren am Arbeitsplatz [An instrument for assessing social stressors at work]. *Z Arbeitswiss* 1987; 41:134–42.
27. Oegerli K. Arbeitszufriedenheit. Versuch einer quantitativen Bestimmung [Job satisfaction: a qualitative analysis] [dissertation]. Berne: University of Berne, 1984.
28. Kunin T. The construction of a new type of job satisfaction measure. *Pers Psychol* 1955;8:65–77.
29. Elfering A, Kälén W, Semmer N. Stability and change in job satisfaction at the transition from vocational training into “real work”. *Swiss J Psychol* 2000;59:256–71.
30. Boos N, Semmer N, Elfering A, Schade V, Gal I, Zanetti M, et al. Natural history of individuals with asymptomatic disc abnormalities in magnetic resonance imaging: predictors of low back pain-related medical consultation and work incapacity. *Spine* 2000;25:1484–92.
31. Bamberg E. Stressoren in der Erwerbsarbeit und in der Freizeit: Zusammenhänge mit psychischen Befindensbeeinträchtigungen [Stressors at work and at leisure time: correlations with well-being]. *Z Arb Organisationspsychol* 1992;36:84–91.
32. Mohr G. Die Erfassung psychischer Befindensbeeinträchtigung bei Industriearbeitern [Assessment of strain in industrial workers]. Frankfurt: Lang, 1986.
33. Fahrenberg, J. Die Freiburger Beschwerdeliste FBL [The Freiburg symptom list]. *Z Klin Psychol Psychother* 1975;4: 49–100.
34. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaire for the analysis of musculoskeletal symptoms. *Appl Ergon* 1987;18:233–7.
35. Lundberg U, Melin B. Stress in the development of musculoskeletal pain. In: Linton S, editor. *Avenues for the prevention of chronic musculoskeletal pain and disability*. Amsterdam: Elsevier. In press.
36. Schade V, Semmer N, Main CJ, Hora J, Boos N. The impact of clinical, morphological, psychosocial and work-related factors on the outcome of lumbar discectomy. *Pain* 1999;80:239–49.
37. Harber P, Pena L, Hsu P, Billet E, Greer D, Kim, K. Personal history, training, and worksite as predictors of back pain of nurses. *Am J Ind Med* 1994;25:519–26.
38. Hollmann S, Heuer H, Schmidt KH. Control at work: a generalized resource factor for the prevention of musculoskeletal symptoms? *Work Stress* 2001;15:29–39.

Received for publication: 4 April 2002