

Psychosocial and physical risk factors associated with low back pain: a 24 year follow up among women and men in a broad range of occupations

Carina O Bildt Thorbjörnsson, Lars Alfredsson, Kerstin Fredriksson, Max Köster, Hans Michélsen, Eva Vingård, Margareta Torgén, Åsa Kilbom

Abstract

Objectives—To investigate the relation between psychosocial and physical factors at work, as well as conditions during leisure time, and low back pain (LBP) over 24 years.

Methods—The study group consisted of 252 women and 232 men. From a previous study conducted in 1969, data on psychosocial and physical conditions and LBP were available. Data on LBP for 1971–93 were obtained retrospectively in 1993.

Results—The prevalences of LBP in 1969 among women and men were 34% and 24%, the cumulative incidences of LBP during 1970–92 were 38% and 43%, and the prevalences in 1993 of having had LBP during the past 12 months were 44% and 39%, respectively. Monotonous work and few or unsatisfactory social contacts outside work were risk factors for LBP in 1969 among women. LBP in 1969 and dissatisfaction with leisure time were risk factors among both sexes for LBP in 1970–92. LBP in 1969 was a risk factor for LBP in 1993 among women and dissatisfaction with leisure time a risk factor among men. Interactions between few or unsatisfactory social contacts outside work, as well as dissatisfaction with leisure time, and several factors related to work were found to increase the risk of LBP among both sexes during the studied periods.

Conclusions—Conditions in leisure time exert a long term influence on LBP. In this study factors related to work had a long term effect only in interaction with leisure time factors.

(*Occup Environ Med* 1998;55:84–90)

Keywords: interactions; leisure time; sex

Both psychosocial factors and physical factors related to work have been found to be associated with low back pain (LBP) in many cross sectional and some longitudinal studies.^{1–4} In analyses of potential risk factors for LBP related to work, often physical factors only, or psychosocial factors only, have been considered. Less often both types of factors have been studied and analysed simultaneously.⁵ Even less often have conditions outside work been studied in parallel with work related conditions.⁶ Such a parallel approach is necessary for an understanding of the relative significance of different risk factors. One argument for

this approach is that, especially among women, a large part of the total daily physical and psychosocial load derives from tasks outside work,⁷ as pointed out in a review by Frankenhauser.⁸

A second argument is that there might—besides the interaction between work related psychosocial factors which has been demonstrated by Lindström⁹—be an interaction between factors related to work and conditions outside work, especially factors of a psychosocial nature. Such factors might influence each other, as mentioned by both Frankenhauser⁸ and Friedman.¹⁰ Such reciprocal influence complicates analyses of associations between work related psychosocial risk factors and health outcomes, but increases the need for such analyses.

In longitudinal studies psychosocial factors such as job satisfaction, work content, control in the work situation, social relations, and mental overstrain have been found to be associated with LBP.^{11–16} Physical factors in these studies considered to contribute to LBP are physically heavy work and previous back problems.

The aim of the present study was to investigate the relation between psychosocial and physical factors at work, as well as conditions during leisure time, and LBP over 24 years.

Methods

STUDY POPULATION

In 1969 an investigation was undertaken of about 2500 women and men, aged 18 to 65 years and living in the county of Stockholm (the REBUS study). The purpose was to investigate (a) the requirements for medical and social services, (b) differences between subgroups of the population in their actual needs for services, and (c) the steps taken so far to meet these needs.¹⁷ The subjects were randomly selected and stratified by age in which the number of subjects selected from the youngest age groups were enhanced to get enough occurrences of certain disorders. All subjects underwent a medical examination and medical diagnoses were given whenever appropriate. For a musculoskeletal diagnosis, symptoms and signs and also consequences for daily living were required.

During 1993, all REBUS subjects below the age of 59 years in 1993 without a musculoskeletal diagnosis in 1969, living in Sweden and available for contact, were identified and asked to participate in a re-examination (n=783). All

Department of
Ergonomics, National
Institute for Working
Life, S-171 84 Solna,
Sweden

C O Bildt Thorbjörnsson
K Fredriksson
M Torgén
Å Kilbom

Institute of
Environmental
Medicine, Karolinska
Institute, Sweden

L Alfredsson
M Köster

Department of
Occupational
Medicine, Karolinska
Hospital, Sweden

H Michélsen
E Vingård

Correspondence to:
Dr Carina Bildt
Thorbjörnsson, Department
of Ergonomics, National
Institute for Working Life,
S-171 84 Solna, Sweden.

Accepted 17 July 1997

the subjects in the REBUS study in 1993 belonged to the youngest age groups in 1969 and were then from 18 to 34 years of age. In 1993 they were from 42 to 58 years of age, with a mean age of 48.1 (SD 4.3) among women and 48.5 (SD 4.5) among men. The reason for this restriction in age is that we wanted to study as many subjects as possible who were still professionally active and not retired due to age. People with a diagnosis of LBP—for example, lumbago, sciatica, or lumbago-sciatica—in 1969 were excluded, whereas those who reported low back symptoms of a severity not leading to a diagnosis were included. The reason for this selection is that people with a diagnosis of a more serious nature in 1969 cannot be expected to have been exposed to work related risk factors during the main part of the studied period and therefore to be of less importance as subjects in the present study. As well as serious musculoskeletal diagnoses, serious psychiatric diagnoses—such as schizophrenia and mental retardation—and chronic alcoholism were criteria for exclusion from the study population in 1993. Also excluded were subjects with diagnosed chronic diseases of the nervous or cardiovascular systems, with congenital malformation, and with serious injuries due to external violence or poisoning. To adjust for the influence of undiagnosed symptoms in the analyses of associations 1970–92, LBP in 1969 was treated as a potential confounding factor. The subjects were included in the study after they had been fully informed about all parts of the study and had given their informed consent to participate. The study was reviewed and accepted by the ethics committee of human research. The re-examination focused on musculoskeletal disorders and previous social, psychological, and physical conditions during work and leisure time. Out of the 783 eligible subjects, 62% participated in the re-examination (252 women and 232 men).

MISSING SUBJECTS

To elucidate the characteristics of the drop out group, those who still did not want to participate were asked why and were interviewed about musculoskeletal symptoms over the past 12 months.

DATA COLLECTION

Potential risk factors

At the initial examination in 1969, data on conditions at work and during leisure time were collected by a questionnaire based interview. Answers on a dichotomous scale concerning 11 factors related to work were grouped into eight types of risk factors (*a*) high mental load (both hectic work and mental exhaustion at the end of the working day), (*b*) poor social support from the closest superior (either poor opportunity to discuss work related problems with the closest superior or no consideration was given to the subject's opinions), (*c*) monotonous work, (*d*) full time work, (*e*) night or shift work, (*f*) overtime work, (*g*) high physical load (either lifting 40 kg for women or 60 kg for men or physical exhaustion

in the end of the working day), (*h*) severe vibrations.

Six factors about non-working conditions, also on a dichotomous scale, were grouped into three types of risk factors (*i*) insufficient or unsatisfactory leisure time (either no time for own interests or dissatisfaction with leisure time), (*j*) few or unsatisfactory social contacts (either contacts with friends or relatives once a month or less often, or dissatisfaction with the degree of contacts), (*k*) additional domestic workload (defined as gainfully employed while at the same time being responsible for children and household).

The separation of potential risk factors into work related and leisure time is not absolute and does not exclude the possibility of interaction.

The subjects were classified into socio-economic groups and were roughly divided into white and blue collar workers.¹⁸

Potential risk factors in 1969 and 1993—In 1993 the same questions as in 1969 were put to the subjects about present conditions at work.

OUTCOME DATA

Data on LBP were obtained for three separate periods:

(1) At the examination in 1969, data on undiagnosed low back symptoms at the time of the examination were obtained by a questionnaire based interview. When the prevalence of LBP in 1969 was calculated subjects were considered to be cases of LBP if they reported pain, aching, or stiffness in the lower back at that interview.

(2) At the 1993 re-examination, a retrospective questionnaire about musculoskeletal symptoms during 1971–92 was filled out. When the cumulative incidence of LBP in 1970–92 was calculated a subject was considered to be a case of LBP if she or he had reported in the questionnaire medical consultation and treatment (by doctors, physiotherapists, or chiropractors) for pain in the lower back during that period.

(3) At the 1993 re-examination, data on musculoskeletal disorders during the past 12 months before the re-examination were obtained by a standardised interview. On the basis of this interview, the prevalence of having had LBP defined by pain, aching, or stiffness in the lower back in the past 12 months was calculated.

ANALYSES AND STATISTICAL METHODS

In the analyses of the relations between potential risk factors in 1969 and LBP, prevalence data from 1969 and 1993 were used, as well as data on the cumulative incidence in 1970–92. The occurrence of LBP was calculated among exposed and non-exposed subjects and prevalence ratios (PRs) and cumulative incidence ratios (CIRs) were calculated. In these calculations of PRs and CIRs, adjustments for age and some other potential confounding factors were made, by the method proposed by Mantel-Haenszel,¹⁹ with the module PROC FREQ in the SAS statistical software.²⁰ The precision of the point estimates of PRs and risk

Table 1 Prevalence (%) of exposure to potential risk factors in 1969 and in 1993 among those gainfully employed: by sex

	1969		1993†	
	Women	Men	Women	Men
Number	147	188	225	211
High physical load at work	39	47	29	33
High mental load at work	28	39	38	31
Poor social support at work	15	18	36	25
Vibrations	20	16	12	15
Monotonous work	2	20	6	18
Full time work	19	13	7	7
Shift work	83	98	75	97
Overtime work	11	8	20	18
Unsatisfactory leisure time*	10	44	31	43
Few or unsatisfactory social contacts*	39	31		
Additional domestic work load	21	22		
	36	10		

* Out of 252 women and 232 men, including those not gainfully employed.

† For 1993, only data about work related risk factors were accessible.

Table 2 Subjects (%) gainfully employed in 1969 and in 1969 and 1993 by exposure and by sex (women, n=147; men, n=188)

	1969 and 1993		1969 but not 1993	
	Women	Men	Women	Men
Blue collar work	45	61	48	30
High physical load at work	53	41	33	42
High mental load at work	35	45	60	39
Poor social support at work	22	19	58	62
Vibrations	0	38	100	38
Monotonous work	15	18	73	77
Full time work	72	84	23	3
Shift work	50	27	50	66
Overtime work	21	36	77	51

ratios (RRs) was estimated by test based 95% confidence intervals (95% CIs).²¹ To adjust simultaneously for age, earlier LBP, and the risk factors that in the age adjusted analyses had a lowest confidence interval of 0.8, multivariate analyses were performed (module PROC PHREG in the SAS statistical software) in which PRs and CIRs were used as measures of associations. The precision of the point estimates were also in these analyses estimated by 95% CIs.

In the multivariate analysis the effects of interaction between risk factors at work and during leisure time were analysed with indicator variables, in which the PR and CIR for subjects exposed to risk factors from both work and leisure time (A+B), or only one of these risk factors (A+B̄ or Ā+B) were calculated, with the subjects not exposed to both risk factors as a control group (module PROC PHREG in the SAS statistical software). The PR and CIR for those subjects exposed to both risk factors are reported, as is the proportion of the excess risk due to interaction. The proportion was calculated as:

$((A+B)-(A+B̄)-(\bar{A}+B)+1)/(A+B)$, according to Rothman.²²

Only PRs and CIRs with a lowest 95% CI of 0.9 are discussed, and only when there is an effect of interaction on the PRs and CIRs.

The current information about risk factors in 1969 and in 1993 was used to categorise the subjects into three groups for each risk factor respectively. One group consisted of those subjects who reported exposure to the risk factor both in 1969 and in 1993, one group of those who reported exposure to the risk factor in 1969 but not in 1993, and one of the subjects

who did not report the risk factor in 1969 nor in 1993. The two groups who reported exposure were compared for prevalence of LBP in 1993 with the group that did not report the risk factor in 1969 or in 1993, by calculating age adjusted PRs with corresponding 95% CIs, in the same manner as earlier described. This procedure was done for the work related risk factors in 1969 found to be associated with cumulative incidence of LBP during 1979–92 and prevalence of LBP in 1993. In these analyses only those who were gainfully employed in 1969 were included.

Results

The prevalence of LBP in 1969 was 34% among women and 24% among men. The cumulative incidence of LBP in the period 1970–92 were 38% and 43% among women and men respectively. In 1993 the prevalence of having had LBP during the past 12 months was 44% among women and 39% among men.

Many of the subjects who reported exposure to the potential risk factors analysed in 1969 also reported them in 1993. The proportion of subjects exposed to the different potential risk factors differed substantially between the potential risk factors and between the sexes. Almost no women reported severe vibrations at work and almost all gainfully employed men reported full time work at both occasions. The proportions of subjects exposed to the factors varied from 8% to 48% in 1969 and from 6% to 38% in 1993 (table 1).

Two thirds of the subjects were gainfully employed in 1969 (147 women and 188 men) and 90% in 1993 (225 women and 211 men), in many professions (table 2). Those not gainfully employed in 1969 were considered as not exposed to the work related potential risk factors. No differences between those gainfully employed and those not exposed to the risk factors outside work studied in 1969 were found in the occurrence of LBP during the studied periods. Several of the subjects were not gainfully employed in 1969 but were in 1993, 37% among the women and 18% among the men. The main reasons for not being employed in 1969 were studies, or for the women, being at home with children.

ASSOCIATIONS BETWEEN POTENTIAL RISK FACTORS IN 1969 AND LBP IN 1969

Women who reported monotonous work, a high physical load, or dissatisfaction with their leisure time reported LBP in 1969 about 1.5 times more often than those who did not (table 3). Men with full time work reported LBP less often than men who did not (table 4). When high physical load, monotonous work, unsatisfactory leisure time, few or unsatisfactory social contacts in leisure time in 1969, and age were included in the multivariate analysis for the women, monotonous work (PR 1.7, 95% CI 0.9 to 3.2) and few or unsatisfactory social contacts (PR 1.5, 95% CI 0.9 to 2.7) remained associated with an increased risk of reporting LBP. Among men, age, high physical load, and additional domestic workload in 1969 were included in the multivariate analysis, and none

Table 3 Associations between potential risk factors in 1969 and low back pain (LBP) in 1969, in 1970–92, and in 1993: women

Potential risk factors	LBP in 1969		LBP in 1970–92		LBP in 1993	
	PR	(95% CI)	CIR	(95% CI)	PR	(95% CI)
LBP in 1969					1.6	(1.2 to 2.2)
Work related factors:						
Blue collar work	0.9	(0.6 to 1.4)	0.9	(0.6 to 1.2)	1.1	(0.8 to 1.5)
High physical load	1.4	(0.9 to 2.1)	1.1	(0.7 to 1.7)	1.0	(0.9 to 1.5)
High mental load	0.8	(0.4 to 1.6)	1.4	(0.8 to 2.3)	1.1	(0.7 to 1.8)
Poor social support	1.2	(0.7 to 2.0)	1.2	(0.8 to 2.0)	1.2	(0.8 to 1.9)
Vibrations*	—	—	—	—	—	—
Monotonous work	1.6	(1.0 to 2.6)	1.1	(0.7 to 1.9)	0.9	(0.5 to 1.5)
Full time work	0.8	(0.5 to 1.1)	1.0	(0.7 to 1.4)	1.1	(0.8 to 1.4)
Shift work	0.9	(0.4 to 1.9)	0.9	(0.4 to 1.8)	0.5	(0.2 to 1.1)
Overtime work	0.6	(0.2 to 1.5)	1.2	(0.6 to 2.1)	1.0	(0.7 to 2.1)
Factors in leisure time:						
Unsatisfactory leisure time	1.6	(1.1 to 2.2)	1.5	(1.1 to 2.0)	1.2	(0.9 to 1.7)
Few or unsatisfactory social contacts	1.2	(0.8 to 1.8)	0.9	(0.6 to 1.3)	1.1	(0.8 to 1.6)
Additional domestic workload	1.1	(0.7 to 1.7)	1.0	(0.6 to 1.4)	1.3	(0.9 to 1.7)

* Too few subjects to make analyses possible.

PR=prevalence ratio adjusted for age; CIR=cumulative incidence ratio adjusted for age.

Table 4 Associations between potential risk factors in 1969 and low back pain (LBP) in 1969, in 1970–92, and in 1993: men

Potential risk factors	LBP in 1969		LBP in 1970–92		LBP in 1993	
	PR	(95% CI)	CIR	(95% CI)	PR	(95% CI)
LBP in 1969					1.7	(1.2 to 2.3)
Work related factors:						
Blue collar work	1.2	(0.8 to 2.0)	1.0	(0.7 to 1.4)	1.0	(0.7 to 1.4)
High physical load	1.4	(0.8 to 2.4)	1.4	(1.0 to 2.0)	1.1	(0.8 to 1.6)
High mental load	1.2	(0.6 to 2.4)	1.0	(0.6 to 1.5)	1.1	(0.6 to 1.8)
Poor social support	0.6	(0.2 to 1.6)	0.7	(0.4 to 1.2)	1.1	(0.6 to 1.8)
Vibrations	0.9	(0.5 to 1.8)	1.4	(1.0 to 1.1)	1.3	(0.8 to 2.0)
Monotonous work	0.8	(0.3 to 1.9)	1.0	(0.6 to 1.7)	1.5	(0.9 to 2.4)
Full time work	0.4	(0.1 to 1.0)	2.1	(0.5 to 8.4)	—	—
Shift work	1.2	(0.5 to 2.7)	0.5	(0.2 to 1.0)	0.6	(0.3 to 1.3)
Overtime work	0.9	(0.5 to 1.5)	1.1	(0.8 to 1.5)	0.6	(0.4 to 0.9)
Factors in leisure time:						
Unsatisfactory leisure time	1.1	(0.7 to 1.9)	1.5	(1.1 to 2.0)	1.5	(1.0 to 2.1)
Few or unsatisfactory social contacts	1.2	(0.7 to 2.0)	1.4	(1.0 to 1.9)	1.5	(1.0 to 2.1)
Additional domestic workload	1.8	(0.8 to 4.1)	1.7	(1.0 to 2.9)	1.5	(0.9 to 2.7)

—Too few subjects to make analyses possible

PR=prevalence ratio adjusted for age; CIR=cumulative incidence ratio adjusted for age.

of these remained associated with an increased risk of reporting LBP. Among subjects who reported both work related and not work related factors, several interaction effects could be found among women but not among men. Few or unsatisfactory social contacts outside work in 1969 interacted with shift work (PR 3.1*, proportion 0.7), high mental load (PR 2.5*, proportion 0.8), high physical load (PR 2.3*, proportion 0.4), monotonous work (PR 2.7*, proportion 0.2), and poor social support at work (PR 1.4, proportion 0.2) among women. (*=whole CI>1.)

ASSOCIATIONS BETWEEN POTENTIAL RISK FACTORS IN 1969 AND LBP IN 1970–92

In both sexes a 1.5 times higher risk of reporting LBP during 1970–92 was found in subjects who reported dissatisfaction with their leisure time in 1969 (tables 3 and 4). Among men with a high physical load, severe vibrations, additional domestic workload, or having few or unsatisfactory social contacts outside work in 1969, the risk of reporting LBP during 1970–92 was about 1.5 times higher than among those who did not report these circumstances. When age, LBP in 1969, high mental load, poor social support at work, and unsatisfactory leisure time in 1969 were included in the multivariate analysis for the women, LBP

(CIR 1.7, 95% CI 1.1 to 2.7), and unsatisfactory leisure time (CIR 1.4, 95% CI 0.9 to 2.3) remained associated with an increased risk for LBP. Among men age, LBP in 1969, high physical load, whole body vibrations, overtime work, unsatisfactory leisure time, additional domestic workload, and few or unsatisfactory social contacts in 1969 were included in the multivariate analysis, but only LBP in 1969 (CIR 1.5, 95% CI 0.9 to 2.5) and unsatisfactory leisure time (CIR 1.6, 95% CI 1.0 to 2.3) remained associated with an increased risk for LBP in 1970–92. No interaction effects were found among women in these analyses. Among men, few or unsatisfactory social contacts outside work in 1969 interacted with high physical load in 1969 (CIR 1.9*, proportion 0.3), whole body vibrations (CIR 1.9, proportion 0.2), and poor social support at work (CIR 1.5, proportion 0.5). Unsatisfactory leisure time in 1969 interacted with high physical load in 1969 (CIR 1.8*, proportion 0.3) among men.

ASSOCIATIONS BETWEEN POTENTIAL RISK FACTORS IN 1969 AND LBP IN 1993

Men with few or unsatisfactory social contacts and dissatisfaction with their leisure time in 1969 reported LBP in 1993 1.5 times more commonly than those without these circumstances (table 4). Reports of LBP in 1993 were

about 1.6 times more common among subjects of both sexes who reported LBP in 1969 than among those who did not report LBP in 1969 (tables 3 and 4). Women and men with additional domestic workload in 1969 more often reported LBP in 1993 than those who did not. In the logistic regression analyses, earlier LBP remained an important risk factor among women in 1993. When age, LBP in 1969, poor social support at work, full time work, unsatisfactory leisure time, and few or unsatisfactory social contacts and additional domestic workload in 1969 were included in the multivariate analysis for the women, only LBP in 1969 remained associated with an increased risk for LBP in 1993 (PR 1.6, 95% CI 1.0 to 2.4). Among men age, LBP in 1969, high physical load, monotonous work, unsatisfactory leisure time, few or unsatisfactory social contacts, and additional domestic workload in 1969 were included in the multivariate analysis for the men, only unsatisfactory leisure time remained associated with an increased risk for LBP in 1993 (PR 1.8, 95% CI 1.0 to 3.4). Among women, few or unsatisfactory social contacts outside work in 1969 interacted with full time work in 1969 (PR 1.7, proportion 0.6), high mental load (PR 2.1, proportion 0.6), and high physical load (PR 2.0, proportion 0.8). Unsatisfactory leisure time in 1969 interacted with overtime work (PR 2.2*, proportion 0.7) and high mental load in 1969 (PR 2.1, proportion 0.6) among women. Among men, few or unsatisfactory social contacts outside work in 1969 interacted with high physical load (PR 1.7, proportion 0.2). Unsatisfactory leisure time in 1969 interacted with whole body vibrations (PR 2.0*, proportion 0.1), monotonous work (PR 2.3*, proportion 0.3), and high physical load (PR 1.9, proportion 0.4) among men.

COMPARISON BETWEEN THE SUBJECTS EXPOSED BOTH IN 1969 AND IN 1993 AND THOSE ONLY EXPOSED IN 1969

High physical load in both 1969 and 1993 was a considerably stronger risk factor for LBP in 1970-92 among men (CIR 2.4, 95% CI 0.9 to 6.1) than high physical load in 1969 and not in 1993 (CIR 1.6, 95% CI 0.8 to 3.1). Severe vibrations in both 1969 and 1993 was a risk factor for LBP in 1970-92 (CIR 1.9, 95% CI 0.9 to 3.6) but severe vibrations in 1969 and not in 1993 was not (CIR 0.8, 95% CI 0.3 to 2.0). In the analyses of association between the combined risk factors and LBP in 1993 monotonous work in both 1969 and 1993 was a stronger risk factor for LBP in 1993 (PR 2.4, 95% CI 0.9 to 6.1) among men than monotonous work in 1969 and not in 1993 (PR 1.6, 95% CI 0.8 to 3.1).

ANALYSES OF MISSING DATA

Of women 20%–52% and of men 32%–61% missed answering a question on work related conditions in 1969. For the leisure time questions, the corresponding ranges were 5%–24% and 4%–57% respectively. No subject had missed answering all the work related questions or all the leisure time questions.

DROP OUT SUBJECTS

Fewer women in the study group (10%) than in the drop out group (17%) reported monotonous work in 1969. More men in the study group (21%) than in the drop out group (13%) reported few or unsatisfactory social contacts. A telephone interview was carried out with 173 drop outs, 98 women and 75 men. The reasons for not participating in the re-examination were; lack of time, illness, forgetting the invitation, and refusal to participate (12%). Of the 173 subjects interviewed by telephone, 97 women and 75 men answered the question about pain, aching, or discomfort in the lower back during the past 12 months. Among those, 33% of the women and 39% of the men reported some symptoms in the lower back.

Discussion

In the present study, factors outside work in 1969 were found to be risk factors for subsequent LBP during 1970–93. Factors at work were related to subsequent LBP only in interaction with risk factors outside work.

Thus interactions between few or unsatisfactory social contacts outside work, as well as dissatisfaction with leisure time, and several factors related to work were found to increase the risk for LBP among both sexes during the studied periods. Among women most interactions were found between few or unsatisfactory social contacts and shift work, high mental load at work, and high physical load at work. These interactions contributed to a high proportion of the excess risk for LBP in 1969 and 1993 among women. Among men, interactions were found between both few or unsatisfactory social contacts or unsatisfactory leisure time and high physical load, whole body vibrations, and monotonous work, but did not account for such a high proportion of excess risk as among women. In both sexes, previous LBP was an important risk factor for LBP later in life, as could be expected from the literature.²³

Some main trends can be found in this study. The effects on LBP during the follow up period of few or unsatisfactory social contacts outside work and unsatisfactory leisure time in 1969 seem to be more long term than the effects of working conditions in 1969. When interactions between these risk factors in leisure time and at work were studied, associations with subsequent LBP emerged among both sexes. Among women, working hours and high mental and physical load were the factors related to work that contributed to the highest proportion of the excess risk for LBP by interaction with leisure time. This seems to reflect women's total workload, rather than being a result of personality traits or conflicting demands from work and family life. This assumption is supported by the low interaction effect between few or unsatisfactory social contacts in leisure time and poor social support at work. Among men, the pattern of interaction between work and leisure time is more diverse. The high interaction between few or unsatisfactory social contacts in leisure time and poor social support at work may thus indicate the effect of personality traits. Above all, the proportion of the

excess risk due to this interaction among men is low, indicating that men's life at work and outside does not interact in such a way that LBP is affected.

To our knowledge, these leisure time factors have not previously been studied relative to LBP, nor have their interactions with factors related to work.

In this study very crude measures of exposure to different risk factors at work and during leisure time have been used (yes or no answers to the questions). Despite this, factors both at work and during leisure time in 1969 were found to be risk factors for subsequent LBP, either on their own or by interaction.

Since the examination in 1969, all of the studied subjects have been exposed to risk factors at work and during leisure time. During this large part of their working life some, if not all, of the subjects are likely to have changed their exposure to risk factors at work, perhaps several times. This may have diluted the associations between the risk factors at work in 1969 and LBP later on and may be the reason for the few associations found between risk factors at work and LBP found in the age adjusted analyses, and especially in the multivariate analyses. In the present study, no information about the subjects' exposure to different risk factors during the intermediate period was accessible and the information about risk factors at work at the beginning as well as the end of the study period will have to be relied on as the sources from which to draw conclusions. We think that these conclusions are more stable and valid than if only data from 1969 had been used. To improve the validity of the exposure assessments for risk factors at work, associations were analysed with the risk factors from 1993 included—that is, the combined risk factors. These analyses showed that combined exposure, both in 1969 and 1993, further increased the risk estimates. Complementary analyses of associations between LBP and risk factors at work in 1993 showed that exposure to recent risk factors was not the sole reason for the PRs in the analyses in which the combined risk factors were used. Thus combined risk factors always yielded higher risk estimates than analyses based on risk factors only in 1969 or only in 1993. Rather than being a result of present exposure, there seems to be an accumulated effect of years of exposure to the risk factors. Unfortunately, the same information of the conditions outside work was not gathered in 1993. This, however, will probably not seriously affect the conclusions drawn in the study as unsatisfactory leisure time and few or unsatisfactory social contacts in leisure time can be assumed to be more stable over time, to a large extent because of personality traits.

OCCURRENCE OF LBP IN THE STUDY

The prevalence and the cumulative incidence of LBP found in this study agree with findings in other studies. In a Danish study of LBP in the general population, the cumulative incidence during a lifetime was found to be 61%–80% among women and men in different occupations and of different ages.²³ From an

earlier population study the lifetime incidences of LBP were reported to be 51%–80% among both sexes.²⁴ In the general population LBP is most common among people about 40 years of age. The cumulative incidence of LBP in our study was 38% among women and 43% among men, which seems reasonable for a 25 year period covering that part of life when all of the studied subjects had turned 40.

When obtaining information about the incidence of a condition such as LBP retrospectively, the reports will be affected by the subjects' ability to recall the events. One way to facilitate the recall of episodes of LBP is to try to sharpen the definition criteria for LBP when collecting the retrospective data. In the present study, this was done with a medical consultation and treatment for LBP as a definition of a case of LBP during 1970–92. These criteria to define LBP probably resulted in cases being considerably effected in daily life. In this way it was hoped that the subjects' ability to recall episodes of LBP during the investigated period would increase. Underreporting of LBP therefore is probably not different for different exposures to the studied risk factors.

The result of the present study elucidates the need for including both work and non-work factors in studies of risk factors for LBP and for investigating the interaction effects among them. Further studies within the REBUS study, where a new follow up is ongoing, will emphasise the analyses of the interaction between physical and psychosocial risk factors at work, and between risk factors related to work or leisure time.

This study was supported by a grant from the Swedish Council for Work Life Research.

- Bongers P, de Winter R, Kompier M, *et al.* Psychosocial factors at work and musculoskeletal disease. *Scand J Work Environ Health* 1993;19:297–312.
- Frank JW, Pulcins IR, Kerr MS, *et al.* Occupational back pain—an unhelpful polemic. *Scand J Work Environ Health* 1995;21:3–14.
- Kelsey J, Gordon A. Occupational and workplace factors associated with low back problems. State of the art reviews. *Occup Med* 1988;3:7–16.
- Riihimäki H. Low-back problems, its origin and risk indicators. *Scand J Work Environ Health* 1991;17:81–90.
- Heliövaara M, Mäkelä M, Knekt P. Determinants of sciatica and low-back pain. *Spine* 1991;16:608–14.
- Feurstein M, Sult S, Houle M. Environment stressors and chronic low back pain: life events, family and work environment. *Pain* 1985;22:295–307.
- Lundberg U, Mårdberg B, Frankenhauser M. The total workload of male and female white collar workers as related to age, occupational level, and number of children. *Scand J Psychol* 1994;35:315–27.
- Frankenhauser M. The psychophysiology of sex differences as related to occupational status. In: Frankenhauser M, Lundberg U, Chesney M, eds. *Women, work and health. Stress and opportunities*. New York: Plenum Press, 1991.
- Lindström K. Psychosocial criteria for good work organization. *Scand J Work Environ Health* 1994;20(special):123–33.
- Friedman G. *The anatomy of work. Labor, leisure, and the implications of automation*. New Brunswick: Transaction Publishers, 1992.
- Bergenudd H, Nilsson B. Back pain in middle age; occupational workload and psychologic factors: an epidemiologic survey. *Spine* 1988;13:58–60.
- Bigos SJ, Battie MC, Spengler DM, *et al.* A longitudinal, prospective study of industrial back injury reporting. *Clin Orthop* 1992;279:21–34.
- Leino P, Hänninen V. Psychosocial factors in association to back and limb disorders. *Scand J Work Environ Health* 1995;21:134–42.
- Riihimäki H, Viikari-Juntura E, Moneta G, *et al.* Incidence of sciatica pain among men in machine operating, dynamic physical work, and sedentary work. A three-year follow-up. *Spine* 1994;19:138–42.

- 15 Viikari-Juntura E, Jouri J, Silverstein BA, et al. A lifelong prospective study on the role of psychosocial factors in neck-shoulder and low-back pain. *Spine* 1991;**16**:1056–61.
- 16 Åstrand N-E, Isacson S-O. Back pain, back abnormalities, and competing medical, psychological, and social factors as predictors of sick leave, early retirement, unemployment, labour turnover, and mortality: a 22 year follow up of male employees in a Swedish pulp and paper company. *Br J Ind Med* 1988;**45**:387–95.
- 17 Bygren LO. Met and unmet needs for medical and social services. *Scand J Soc Med* 1974;(suppl 8):1–135.
- 18 Statistiska centralbyrån (Statistics Sweden). *Meddelanden i samordningsfrågor* (Reports on statistical co-ordinations.) Stockholm: Statistics Sweden, 1982;4:6–8. (Summary in English.)
- 19 Fleiss IL. *Statistical methods for rates and proportions*. New York: Wiley, 1981.
- 20 SAS Institute. *SAS/STAT user's guide*, version 6 4th ed. Cary, New York: SAS Institute, 1989.
- 21 Miettinen O. Estimability and estimation in case-referent studies. *Am J Epidemiol* 1976;**103**:226–35.
- 22 Rothman K. *Modern epidemiology*. Boston: Little Brown, 1986.
- 23 Biering-Sørensen F. A prospective study of low back pain in a general population. *Scand J Rehab Med* 1983;**15**:71–9.
- 24 Abrahamson JH, Terespolsky L, Brook JG, et al. Cornell medical index as a health measure in epidemiological studies. A test of the validity of a health questionnaire. *Br J Prev Soc Med* 1965;**19**:103–10.