

Physical work load between 1970 and 1993 — did it change?

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Objectives This study investigates changes in self-reported and expert-evaluated physical work loads between 1970 and 1993 in relation to calendar year, birth cohort, and gender in an urban and suburban population sample (232 men and 252 women) born between 1935 and 1952.

Methods A self-administered questionnaire was answered in 1993 concerning different aspects of physical work loads between 1970 and 1993. With the use of a classification matrix, the objective physical work load on different body regions was also assessed.

Results Between 1970 and 1993 the fraction of subjects in blue-collar occupations and the physical work loads decreased among the men, but they both increased among the women. Physical work loads were, in general, higher among the men than among the women at younger ages (below 30 years), but less so at higher ages. Expert evaluations of the musculoskeletal load showed a pattern similar to that of self-reported work loads.

Conclusions The gender difference in work load development with age may have implications for the development of musculoskeletal disorders.

Key terms age, birth cohort, gender, job evaluation, occupational, questionnaire, socioeconomic class.

A life-span perspective of work careers and physical exposures is believed to be of importance for musculoskeletal morbidity in general, and it is probably also related to observed gender differences in musculoskeletal morbidity (1). Moreover, gender differences in career development are an important issue in current discussions on equality worklife. Thus a life-span perspective of load at work is an important parameter for different reasons.

The principal aim of the present study was to investigate possible changes in self-reported physical work loads between 1970 and 1993 in relation to calendar year, birth cohort, and gender in a middle-aged urban and suburban population sample. A further aim was to compare changes in physical work load as based on self-reports with those documented by an expert evaluation system based on occupational codes. Changes in the work-force participation rate, occupational branch, and socioeconomic class during this 24-year period were also addressed.

Subjects and methods

Subjects

In the period 1969—1970, a survey (the REBUS-70 study) of 2500 men and women representing the general population between the ages of 18 and 65 years and living in the county of Stockholm was undertaken. “REBUS” is an acronym for “REhabiliterings-Behovs-Undersökningen i Stockholms län”, a study of the need for medical and social rehabilitation among the general population in the county of Stockholm. The purpose was to investigate the requirements of medical and social services and to measure any discrepancies between the actual needs and the measures taken so far to meet these needs (2).

All the subjects participating in the 1970 survey, and below the age of 59 years in 1993, were identified (783 subjects) and asked to take part in a reexamination (the

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REBUS-93 study) focusing on musculoskeletal capacity and health. Approximately 62%, 232 men and 252 women, agreed to participate. The study group was divided into 4 birth cohorts (born 1935–1939, 1940–1944, 1945–1949, 1950–1952).

The representativeness of the REBUS-93 study group (483 subjects born between 1935 and 1952) in relation to the present Swedish and Stockholm area population born between 1935 and 1952 was assessed by use of a longitudinal national data base provided by Statistics Sweden (the LOUISE data base) (3). The Swedish 1990 census data, a part of the LOUISE data base, was used for assessing the representativeness of the REBUS-93 study group for the distribution of socioeconomic and occupational classes.

The subjects were included in the study after they had been fully informed about all of its parts and had given their informed consent to participate. The study was reviewed and approved by the Ethics Committee of Human Research at the Karolinska Institute, Stockholm, Sweden.

Self-reported work loads

All the subjects were instructed to write down their occupational history at home for the period between 1970 and 1993, comprising dates of entering and leaving each occupation during that period, job titles, main job tasks, and workhours. On the examination day they filled out a self-administered questionnaire on work loads between 1970 and 1993, supported by their own occupational history notes. The questionnaire has been found to be acceptable for further use in the REBUS study (4, 5).

The questionnaire included 12 questions on different kinds of physical activities at work [rate of perceived exertion (RPE) (6), seated work, work with a visual display terminal (VDT), postures, vibration, precision work, repetitive work, manual handling of loads]. (See the appendix.) Physical activities were quantified as the proportion of the workday or the number of days per month spent at a certain activity, as indicated on a 100-mm visual analogue scale (VAS) or on a 4- or 5-degree ordinal scale, respectively. The questions were supplemented by drawings illustrating typical activities. Physical activities during each occupation with a duration of at least 12 months were recorded. Long-term work in the same occupation was divided into 5-year periods, and the questions were answered once for each period, starting with the present work in 1993. Thereafter single-year values were derived from the data on physical work loads.

In order to find a physical work load factor suitable for both men and women, stable between 1970 and 1993, and to reduce the number of independent variables, a factor analysis was performed on 6 of the 12 questions on physical activities at work (sitting, hands high, forward bending, bent or twisted body postures, and 2 items on

lifting). For standardization of the variables for this procedure, the proportion of the workday spent sitting was inverted to indicate time standing or walking, and the VAS (0–100 mm) scale was converted to a 5-degree ordinal scale (0–20 mm=5, >20–40 mm=4, etc). The initial factor analysis for work activities was performed on the 1993 data, and all 6 variables fit into 1 factor, a “physically demanding work” dimension with most variable loadings exceeding 0.4 among both genders (corresponding to a significance level of 1% in case of N=200). A physical work load (PWL) score was calculated as the sum of the single-year values of the variables in the factor, resulting in 1 PWL score for each subject and calendar year between 1970 and 1993. Details about the factor analyses have been described elsewhere (7). The PWL scores were calculated in relation to gender, birth cohort, and age (20, 25, 30, 35, 40, 45, 50 and 55 years of age). The remaining 6 items (use of VDT, whole-body vibration, hand vibration, precision work, and repetitive work and perceived general exertion) were treated as separate variables.

Questions on basic educational background and additional theoretical and practical education were also answered in 1993.

Work loads as assessed by an expert instrument

Almost all the job titles in the Nordic Occupational Classification system (NYK “Nordisk Yrkesklassifikation” codes at the 3-digit level (8) have been scored by an expert panel for possibly harmful physical work loads on different body regions (low back, neck or shoulder, hip and knee). The panel consisted of 4 professionals in ergonomics (2 physicians, 1 physiotherapist, and 1 occupational health nurse), making judgments based on their own experience on each occupation without knowledge of the results from the other 3 members of the panel. A 4-level ordinal scale was used (1=low load, 2=rather low load, 3=rather high load, and 4=high load). The scores for different body parts and occupations were calculated as the average of the scores given by members of the panel (9). The expert matrix scores on low back and neck or shoulder loads were used in the present study.

Calculations

For descriptions of variables, mean values, standard deviations and percentiles (P10, P50, P90) were used. The distribution of the workload variables in the study was related to gender (men, women), birth cohort (born 1935–1939, 1940–1944, 1945–1949, 1950–1952), age (20, 25, 30, 35, 40, 45, 50, 55 years), occupational class (NYK class) (professional work, health or social work, administrative work, sales work, agricultural work, mining, transport work, production work, service work), and socioeconomic class (SEI class) [blue-collar

(including farmers), white-collar, self-employed, and not employed].

The variation of work loads during the follow-up period was expressed as the coefficient of variance (CV%) for PWL, low-back load (LBL) and neck or shoulder load (NSL) scores and calculated as the standard deviation in the percentage of mean values, based on all nonmissing annual values.

All statistical analyses were performed with the SAS program (10).

Results

Physical work loads in relation to gender, birth cohort and age

When the intensity of the occupational physical activity was compared between 1970 and 1993 for the men, the most marked changes observed were less exposure to hand vibration, less lifting or carrying of loads, and a

larger part of the workday spent sitting down in 1993 than in 1970. Corresponding changes were not seen among the women.

The proportion of the workday spent sitting increased among the men, most markedly among those born between 1950 and 1952 (1970 mean 39% of the workday, 1993 mean 60% of the workday). In contrast, the proportion of the workday spent sitting decreased among the women, most markedly among those born between 1940 and 1944 (1970 mean 57%, 1993 mean 47%). The proportion of the workday spent using a VDT increased substantially between 1970 and 1993, among both the men and the women (table 1). The proportions of the workday with whole-body vibration, precision work, and repetitive finger or hand work were low and approximately unchanged between 1970 and 1993 for both genders.

The PWL scores decreased during the period 1970 to 1993 among the men, but not among the women. On the contrary, a slow increase in the PWL scores with the highest values in the beginning of the 1980s was found for the women (figure 1). The men working all years between 1970 and 1993 showed slightly higher PWL scores

Table 1. Number of gainfully employed subjects in 1970 and 1993, their age, and measures of physical work loads [rate of perceived exertion (RPE)], proportion of workday spent sitting, work with visual display terminal (VDT), and physical work load (PWL) score^a in 1970 and 1993 by occupational class^b (NYK class). A total of 232 men and 252 women participated in the study.

NYK class ^b	1970												1993									
	N	Age (years) (18-35)		RPE (6-20)		Sitting (0-100)		VDT (0-100)		PWL score (6-30)		N	RPE (6-20)		Sitting (0-100)		VDT (0-100)		PWL score (6-30)			
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD	Mean	SD		
<i>Men</i>																						
0	52	27	4	10	2	50	33	3	3	12	6	66	10	2	65	28	23	26	10	4		
1	2	24	2	12	1	40	26	2	2	11	1	3	12	2	78	15	44	42	10	2		
2	21	27	5	9	2	72	29	4	10	9	4	43	9	2	73	28	46	29	8	3		
3	14	29	4	11	3	51	32	0	1	12	5	27	10	3	63	30	24	27	11	5		
4	2	20	1	16	1	24	7	0	0	27	1	2	13	0	9	12	0	0	26	3		
5	2	23	1	16	2	4	5	0	0	25	4	1	15	.	0	.	0	.	30	.		
6	13	27	4	14	2	40	40	1	2	19	8	14	12	3	69	33	9	24	15	6		
7+8	70	26	4	14	2	26	33	1	3	22	7	50	13	2	25	31	8	16	21	7		
9	10	25	5	13	3	31	37	0	0	18	7	5	13	1	51	38	26	21	18	7		
0—9	186	26	4	12	3	41	36	2	7	16	8	211	11	3	56	35	23	28	13	7		
<i>Women</i>																						
0	24	28	5	10	2	55	38	5	21	12	6	52	10	3	48	34	10	19	12	6		
1	32	25	4	13	3	30	32	3	14	16	5	51	13	2	30	31	6	16	16	7		
2	50	25	4	10	2	82	17	5	16	8	3	65	10	2	75	24	52	29	9	3		
3	9	26	4	11	2	46	32	5	13	13	4	18	11	3	50	36	18	23	12	5		
4	1	25	.	8	.	97	.	0	.	10	.	3	15	2	39	34	1	1	20	0		
5	-	.	.	.	.	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.		
6	14	22	3	11	2	55	40	5	14	14	5	11	11	3	56	43	46	41	15	7		
7+8	6	24	2	14	3	77	25	2	2	12	4	5	13	1	51	45	4	3	12	4		
9	17	26	3	12	3	25	39	1	1	17	4	20	13	3	26	38	8	22	17	6		
0—9	153	25	4	11	3	56	37	4	14	12	5	225	11	3	50	36	23	31	12	6		

^a PWL score based on items on standing or walking, hands high, forward bending, twisted trunk postures, and manual handling of loads.

^b 0 = professional, technical and related work; 1 = health and nursing work, social work; 2 = administrative, managerial and clerical work; 3 = sales work; 4 = agricultural, forestry and fishing work; 5 = mining, quarrying and petroleum extraction work; 6 = transport and communication work; 7+8 = production work; 9 = service work.

than the whole male group, in contrast to women working all years, whose PWL scores were lower than those of the whole female group (figure 1). The PWL scores were, in general, higher for the men than for the women at younger ages, but the difference was less pronounced at higher ages. The gender difference in PWL scores was most marked in the youngest birth cohort (born 1950–1952) and least marked for those born between 1940 and 1944 (figure 2).

The LBL scores decreased during the follow-up period for the men but not for the women (figure 3), in contrast to the NSL scores, which decreased for both

genders. The men showed higher LBL scores than the women in the beginning of the follow-up period, but thereafter the scores were approximately equal.

Higher variance (CV%) was found for the self-reports of physical work load (PWL scores) than for the expert evaluations based on job titles (LBL and NSL scores), especially in the oldest female birth cohort (table 2).

The rate of perceived exertion (RPE) was similar for the men and women, with only minor changes between 1970 and 1993 (table 1), except for decreasing RPE values for the men of the youngest birth cohort (1970 mean 13, 1993 mean 10).

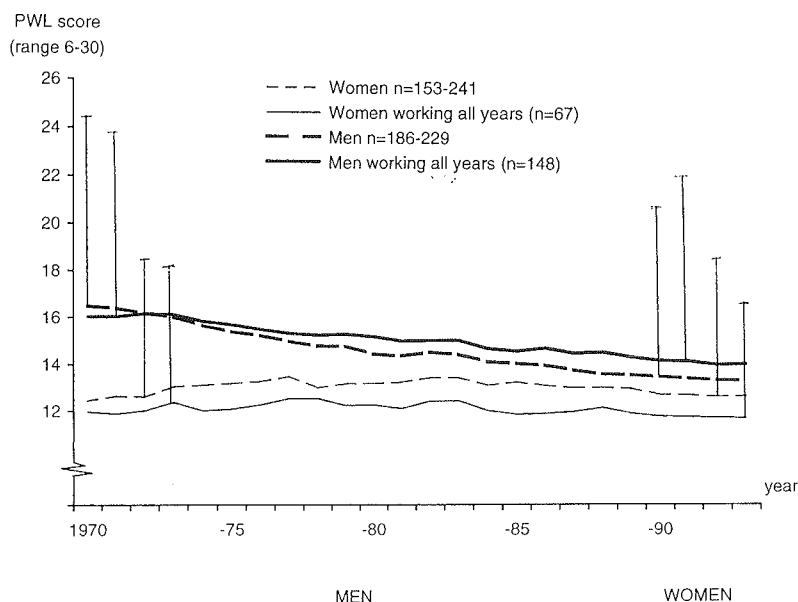


Figure 1. Annual physical work load (PWL) score, based on self-reports, between 1970 and 1993 for the men and women and for those who worked all years. In the groups "men" and "women" each subject was included only in the annual values corresponding to the years during which he or she was employed. Totally there were 232 men and 252 women in the study. The results are presented as means and standard deviations.

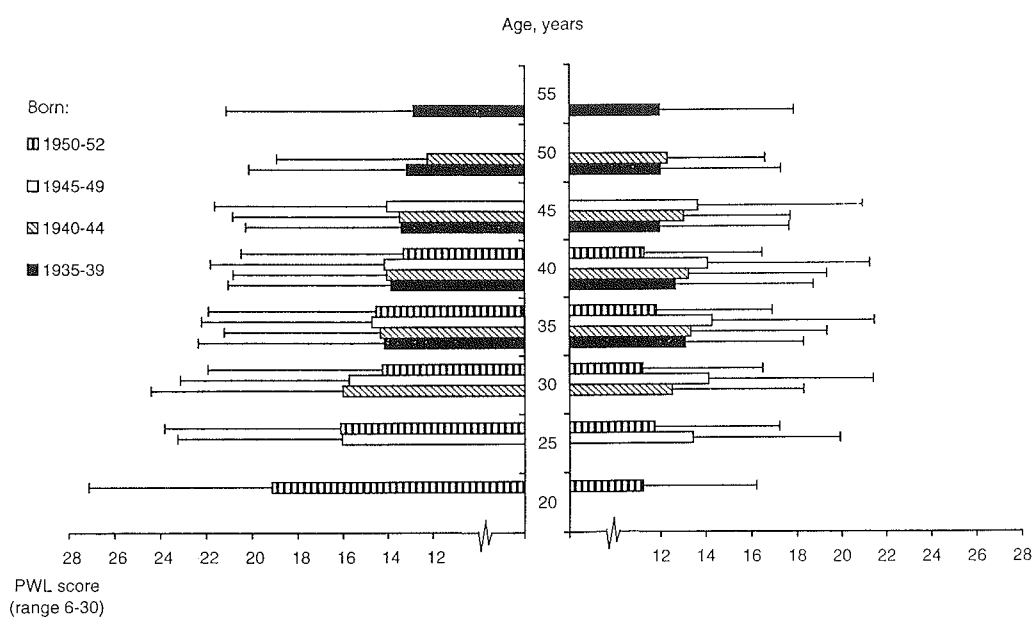


Figure 2. Physical work load (PWL) score among the men and women in relation to birth cohort and age. Each subject is included only in the annual values corresponding to the years during which he or she was employed. Totally there were 232 men and 252 women in the study. The results are presented as means and standard deviations.

Physical work load in relation to occupational class and education

Among the men in occupational classes with at least 10 subjects both in 1970 and 1993, the highest PWL score was found for "production work", and the lowest score for "administrative work". Among the corresponding women, the highest PWL score was seen for "service work", and the lowest score for "administrative work".

About 30% of the women working in 1970 were in the same occupation in 1993, compared with 42% of the men. No obvious difference in perceived general exertion and PWL score was found between the subjects (men and women) with the same occupation in both 1970 and 1993 and all men and women, except for a somewhat

higher PWL score in 1993 for the men remaining in the same job.

The level of education in 1993 covaried with the PWL score level for the men [ie, there were higher PWL scores for those with a low level of education (not more than 9 years of compulsory school) and low PWL scores for men with a university or college education]. This pattern was not found for the women, for whom the PWL scores were similar for those with a low and a high level of education.

Representativeness of the study group

The distributions of socioeconomic and occupational classes among the study subjects were similar to those

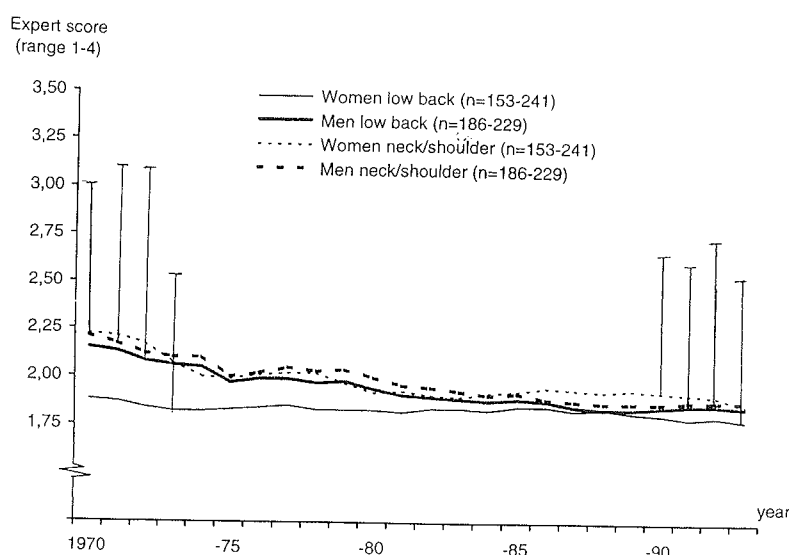


Figure 3. Annual low-back load score and neck or shoulder load score, based on job titles, between 1970 and 1993 for the men and women. Each subject was included only in the annual values corresponding to the years during which he or she was employed. Totally there were 232 men and 252 women in the study. The results are presented as means and standard deviations.

Table 2. Variation in physical work load from 1970 to 1993, expressed as the coefficient of variance (CV%),^a and the proportion of subjects with the same value for all years (zero range). The results are presented in relation to gender and birth cohort as the mean value and standard deviation of the CV%, and the percentage of the zero range, for 3 measures of physical work load (based on self-reports^b and expert matrix scores on low-back and neck or shoulder loads based on occupational codes). Years of employment in different subgroups are also presented.

Gender	Years of employment between 1970 and 1993		Physical work load ^b			Low-back load			Neck or shoulder load		
			CV%		Zero range (%)	CV%		Zero range (%)	CV%		Zero range (%)
	Mean	SD	Mean	SD		Mean	SD		Mean	SD	
Women all (N=252)	19.8	4.5	15.7	16.1	27	11.6	13.4	41	12.5	14.8	41
Born 1935–1939 (N=36)	20.5	4.6	14.3	17.8	39	8.7	11.6	53	7.9	13.0	56
Born 1940–1944 (N=70)	19.2	5.1	14.9	15.3	31	12.1	15.0	40	12.1	15.2	46
Born 1945–1949 (N=106)	20.1	4.0	15.8	16.5	23	11.3	13.3	43	12.5	14.1	40
Born 1950–1952 (N=40)	19.5	4.6	18.3	15.2	23	14.1	11.9	28	17.5	16.4	26
Men all (N=232)	22.6	2.3	15.9	16.8	25	12.3	16.4	46	11.6	14.2	44
Born 1935–1939 (N=36)	23.1	1.8	7.1	9.5	44	4.8	9.5	67	5.6	9.0	58
Born 1940–1944 (N=69)	23.2	1.7	17.8	18.9	25	12.2	16.8	48	11.3	14.7	45
Born 1945–1949 (N=96)	22.7	2.6	16.7	16.0	19	14.2	17.3	40	13.4	14.6	38
Born 1950–1952 (N=31)	20.2	5.0	19.4	18.4	20	15.2	17.1	40	13.4	15.2	43

^a CV% = standard deviation/mean value × 100.

^b The physical work load score was based on items on standing or walking, hands high, forward bending, twisted trunk postures, and manual handling of loads.

of the Stockholm area population (born between 1935 and 1952), for example, 61% white-collar workers and 25% blue-collar workers among the REBUS women and 57% white-collar and 26% blue-collar workers in the Stockholm area population. The corresponding figures for the men were 56% white-collar workers and 25% blue-collar workers among the REBUS men and 49% white-collar and 27% blue-collar workers in the Stockholm area population. In the total Swedish population of similar age the distribution of white- and blue-collar workers was 46% and 35% for the women and 41% and 38% for the men, respectively. Besides the main 2 socioeconomic groups, there were self-employed (3% women and 7% men), unemployed (12% women and 9% men), and a group with no information in the national data base (4% women and 5% men), calculated from the Swedish population sample.

The women in the REBUS-93 study group showed higher percentages of professional or technical and administrative work (19% and 28%, respectively) than in the Swedish population (14% and 20%, respectively). The men in the REBUS-93 study group showed higher percentages of professional or technical and sales work and lower percentages of production work (28%, 13%, 21%, respectively) than in the Swedish population (18%, 8%, 29%, respectively).

Discussion

The main findings in this study of a sample from the general middle-aged population were an increasing fraction of white-collar work and decreasing physical loads among men over a 24-year period. However, among the women the loads were unchanged or increased and the fraction of blue-collar work increased, especially among the women born in the early 1940s.

Physical work load, measured in the form of PWL scores, had decreased during the last 2 decades, especially among younger men, mainly on account of a reduction in manual handling. This finding was partly due to transition into white-collar occupations among the men but also probably to changes in work methods and workplace reorganization in the direction of less physically demanding work tasks during the study period. No similar reduction in physical work load during this period seemed to have taken place in occupations dominated by female workers (eg, service and health or social work). Many of the women in the study entered the labor market during the late 1970s during the expansion of the public sector in Sweden, and they started to work in these branches. Subsequently they often stayed in the same occupations. These traditionally female occupations are dominated by direct manual and individual contacts with

other people (ie, work tasks that have not been mechanized in the same way as tasks in administrative and industrial occupations), and this is probably the main reason for the unchanged physical work loads among the women during the follow-up period.

The physical work load "career" was found to be related not only to gender, but also to birth cohort, although differently among the men and women. This finding was especially apparent in the youngest birth cohort (born in the early 1950s), with decreasing physical work loads among the men but constantly low loads among the women. Concerning the women, this finding may be explained by the fluctuating need for new employees in the public sector. That is, in times of public sector expansion women will enter jobs with high physical work loads and usually few natural career possibilities. This possibility is in agreement with reports of today of a generation gap in the health and service sector, with mainly older women (born in the 1940s). An unchanged and high physical work load was also found for the men who had stayed in physically demanding jobs (production work), but transfer to less demanding jobs was common.

In a health perspective, equal or increasing work loads among women at the age of 50 years compared with the work loads 25 years earlier in physically demanding jobs give reason for concern, in light of the expected decrease in physical capacity with age (11, 12). The suitability of high physical work loads among older workers has been questioned, especially after the age of 50 years (13, 14). The findings of equal physical work loads (PWL scores) among the women in our study in 1993 compared with 1970 was partly due to a decreased fraction of the workday spent sitting. This finding was especially noted for women in professional and administrative work, and it hopefully also indicates more stimulating and varied work tasks in these occupations. However, prolonged standing has been identified as a risk factor for reduced work ability in a 10-year longitudinal study of Finnish municipal employees (15), and it has been related to sensations of fatigue and foot discomfort (Messing K and Kilbom Å, in manuscript). For men, an increasing fraction of the workday sitting during the follow-up period was reported especially in connection with sales work and transport and communication work; this finding was possibly related to an increase in both vehicle driving and office work in these occupations.

The present results contrast somewhat with the reports of increased perceived physical work loads over time (1981–1992) by both men and women in a longitudinal study of Finnish municipal workers (16). An increasing prevalence of health symptoms and a decreasing work capacity with age were suggested as reasons for the higher self-reported work loads in comparison with objectively assessed loads in the Finnish study (17). The subjects in our study started with their work

situation in 1993 and were then asked about their earlier jobs, which perhaps meant that they were less influenced by their own age-related changes in health and capacity during the follow-up period. The difference in the development of self-reported loads between studies could also be due to other factors, like differential changes in work loads over time in different sectors of the labor market, and to higher ages and a higher prevalence of blue-collar occupations in the Finnish study.

The recall of work loads in the past is a problem in retrospective studies, but all the subjects in the REBUS study faced this problem to the same extent, and the observed differences between the groups could not therefore be explained by memory difficulties. Moreover, the validity of these items has been found acceptable for use in epidemiologic studies (4, 5).

The expert scores for low-back load (LBL scores) during the follow-up period among both the men and the women showed a pattern similar to that of self-reported physical loads (PWL scores), which may be regarded as a sign of validity of the self-reported work loads. However, the expert scores for neck or shoulder load (NSL scores) showed a different pattern among the women than the PWL scores did, probably because static loads in female occupations may not be captured by the PWL score items. As expected, less variance of exposure was found with the use of expert scores based on job titles when compared with self-reports, as a result of a loss of variance among those who remained in the same job for many years. This loss seemed to be the most marked in the oldest birth cohort, and this finding is in agreement with results from other studies (18).

The present study group is considered to be a representative sample from the general middle-aged urban population in Sweden and is thereby also probably representative of physical work load development (work career) among the birth cohorts in question during the last 2.5 decades. The REBUS subjects were recruited from the Stockholm county population in 1970, and especially immigrants are therefore underrepresented in relation to the present middle-aged Swedish population. However, it is difficult to assess the extent to which the different aspects of longitudinal work development found in our study would have changed if the subjects had been recruited from the present Swedish or Stockholm county population.

In conclusion, this study has shown a difference in workload development between men and women during a 24-year follow-up period and increasing physical work loads among women in health or social and service work independent of birth cohort. This development is believed to be closely related to the frequently observed decline in musculoskeletal health among middle-aged and elderly women in these occupations. Attention should therefore be focused on the development of physical work

loads in these occupations in the future, and further attempts should be made to reduce loads.

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Appendix

Condensed version of the questionnaire

Work activities	Scale
1 Perceived general exertion	semi-continuous (6—20)
2 Proportion of the day spent sitting	continuous (0—100 %)
3 Proportion of the day using visual display terminal	continuous (0—100 %)
4 Proportion of the day with whole-body vibration	continuous (0—100 %)
5 Proportion of the day with hand-held vibrating tools	continuous (0—100 %)
6 Precision work exceeding 2 hours per day	ordinal (1—5)
7 Hands above shoulder level exceeding 30 minutes per day	ordinal (1—5)
8 Hands below knee level exceeding 30 minutes per day	ordinal (1—5)
9 Bent or twisted body postures several times per hour	ordinal (1—5)
10 Repetitive hand or finger movements several times per minute exceeding 2 hours per day	ordinal (1—5)
11 Occurrence of lifting or carrying loads between 5 and 15 kg	ordinal (1—5)
12 Occurrence of lifting or carrying loads exceeding 15 kg	ordinal (1—5)

Response scales used

Semi-continuous

- 6
- 7 Very, very light
- 8
- 9 Very light
- 10
- 11 Fairly light
- 12
- 13 Somewhat hard
- 14
- 15 Hard
- 16
- 17 Very hard
- 18
- 19 Very, very hard
- 20

Continuous

Not at all _____ All the time

Ordinal

Almost never/ not at all □ (1)	1-3 days per month □ (2)	One day per week □ (3)	2-4 days per week □ (4)	Every workday □ (5)
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