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by Tuomi K, Eskelinen L, Toikkanen J, Jarvinen E, Ilmarinen J, Klockars M

Affiliation: Institute of Occupational Health, Department of Epidemiology and Biostatistics, Helsinki, Finland.

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Work load and individual factors affecting work ability among aging municipal employees

by Kaija Tuomi, LSocSc, Leena Eskelinen, PhL, Jouni Toikkanen, MSocSc, Erkki Jarvinen, MSc, Juhani Ilmarinen, PhD, Matti Klockars, MD[1]

TUOMI K, ESKELINEN L, TOIKKANEN J, JARVINEN E, ILMARINEN J, KLOCKARS M. Work load and individual factors affecting work ability among aging municipal employees. *Scand J Work Environ Health* 1991;17:128—34. The effects of work stressors, individual characteristics, symptoms, and diseases on work ability were studied among 4255 municipal employees. Work ability was assessed by a work ability index in two cross-sectional inquiries, one in 1981 and the other in 1985. The most impairing for work ability were mental symptoms and musculoskeletal disease. Among the work stressors, high physical demands at work, poor physical work environment, and lack of freedom were associated with impaired work ability. Muscular work, disturbing temperatures at the workplace, and lack of freedom particularly affected employees with disease, whereas poor work postures and role conflicts at work were particularly injurious for healthy employees. The worst situation was observed when a worker with many symptoms and disease was exposed to many different work stressors. Life satisfaction, sitting work posture, a good basic education, and physical exercise during leisure time were associated with good work ability.

Key terms: disease, stress symptoms, work stressors.

The framework of the present study was the stress-strain concept developed by Rutenfranz (1). This model analyzes factors associated with a person's strain at work. The level of individual strain depends both on stress factors of work and on individual characteristics. The stress-strain relationship can be either suitable or injurious to health and work ability.

People have many needs and expectations with regard to their work. If the content and demands of work correspond to these needs, work can be a source of good health. Such positive characteristics include explicit and sensible goals, possibilities to develop, independence, positive feedback, and possibilities for social support and interaction (2, 3). On the other hand, work can become injurious to health due to both its physical and psychological characteristics. The physical demands of work can be constantly over- or underloading, or work can contain high peak loads. Static or repetitive work and poor work postures can be injurious. A poor physical-chemical work environment can increase the injurious effects caused by physical demands. Work in a cold, hot, or noisy environment or the use of chemical substances can impair health (4). Increased physical demands can also cause mental stress, as can the psychological demands of work. High and difficult demands combined with little independence and social support, a high demand for attention, lack of freedom, a high work pace, rushed work, or isolation can be straining (2, 5, 6).

The stress-strain concept emphasizes the role of individual characteristics. The physical capacity of women is only 70—80 % of that of men of the same age (7). Similar work will consequently stress a woman more than a man. In addition age can be a factor. A person 60 years of age has about 60 % of the physical capacity of a person 20 years of age. Thus similar work will load an older worker more than a young one.

The ability to defend oneself against stress or cope with it decreases with age. Impairments occur in respiratory, cardiovascular, musculoskeletal, and endocrine functions and in the sensory organs, but only slight changes take place in the capacity of the nervous system (8). Poor nutritional habits, smoking, heavy drinking, or major life changes can be injurious, whereas, for instance, physical exercise can have a positive effect on health.

The present study was undertaken to determine the effect of health-impairing and health-maintaining stress factors on work ability. Our purpose was to answer the following questions: (i) which occupational stress factors, stress symptoms, and diseases influence work ability in general, and workers with musculoskeletal, cardiovascular or mental disease in particular; (ii) how will different combinations of work stressors, symptoms, and diseases affect work ability; and (iii) which factors interact with physical work ability and which with mental work ability?

Subjects and methods

In the present study we included 4255 subjects who held the same occupation during a four-year follow-up pe-

[1] Institute of Occupational Health, Helsinki, Finland.

Reprint requests to: Ms K Tuomi, Institute of Occupational Health, Department of Epidemiology and Biostatistics, Topeliuksenkatu 41 a A, SF-00250 Helsinki, Finland.

riod (in 1981—1985). These municipal employees answered a questionnaire both in 1981 and 1985, when their mean ages were 50 and 55 years, respectively (9). We measured work ability using the same work ability index in both cross-sectional studies (10). The change in work ability over the follow-up was defined as the sum of the two indices. If the change is assumed to be steady over time, a sum or an average of the index will best describe the change. The sum described both the basic level of work ability and the changes over the four-year period. Because some of the workers had a poor recollection of their absence from work because of disease during the previous year, the sum of the work ability index was calculated for only 3312 subjects. Sum variables were formed separately also for physical and mental work ability.

Table 1. Factors and scales of the dependent and independent variables used in the general and special analyses.

Variable group	Scale
Dependent	
Work ability index (1981 + 1985)	14—98
Physical work ability (1981 + 1985)	2—10
Mental work ability (1981 + 1985)	2—10
Independent	
Work stressors	
Physical demands[a]	0—10
Muscular work[b]	0—10
Work posture[b]	0—10
Sitting work[b]	0—10
Change of work load in last two years[b, c]	1—3
Mental demands[a]	0—10
Use of knowledge[b]	0—10
Responsibility for people[b]	0—10
Possibilities to develop[a, b]	0—10
Tools and rooms[a, b]	0—10
Physical environment[a]	0—10
Dirtiness and risk of accident[b]	0—10
Machine effects[b]	0—10
Physical climate[b]	0—10
Restlessness[b]	0—10
Work organization[a]	0—10
Management[b]	0—10
Role conflict[b]	0—10
Lack of freedom[b]	0—10
Uninspiring work[b]	0—10
Work schedule[a, b]	0—10
Work content/AET[a, b, d]	1—3
Individual factors	
Musculoskeletal disease[a]	0—1
Cardiovascular disease[a]	0—1
Mental disease[a]	0—1
Age[a, b]	44—58
Overweight (weight/height)[a,	14—45
Cigarette smoking[a, b]	0—2
Physical exercise[a, b]	1—5
Alcohol consumption[b]	0—3
Marital status (no/yes)[b]	1—2
Basic education[b]	0—3
Life satisfaction[b]	1—5
Gender (male/female)[a, b]	1—2
Stress symptoms	
Immediate physical stress at work[a]	0—10
Musculoskeletal symptoms[a]	0—10
Cardiorespiratory symptoms[a]	0—10
Mental symptoms[a]	0—10
Work satisfaction[a]	0—10

[a] General analyses.
[b] Special analyses.
[c] Not included in physical demands.
[d] Work content assessed by the AET (Das Arbeitswissenschaftliche Erhebungsverfahren zur Tätigkeitsanalyse) method and grouped according to dominating work demands into physical, mental and mixed (physical and mental) work (11).

The variables measuring work stressors, reported diseases, and other individual factors, as well as stress symptoms, in 1981 were used as independent variables (table 1). The formation of these variables has been described in detail elsewhere (9, 10, 12). These general independent variables, and also more specific ones, were used in the linear regression analyses, and also separately in analyses for the different disease groups and for different work content groups. The analyses of the independent variables were performed in three stages. First we selected the model with the lowest cp-indicator of Mallows (13). This indicator resembles the rate of correct explanation, but suggests a more economical model. The rate of the indicator depends on the residual sum of the squares, on the estimate of variance, and on several parameters and observations. It examines the biasedness of the model. Second, we fitted the model to an initial model of backward eliminative regression analysis. In this procedure some variables can be removed. Finally the regression coefficients were standardized to facilitate comparison.

Three models were also formed from the combination of three independent variables. These variables were selected on the basis of the aforementioned regression analysis and the results of chi-square tests. We explored the use of different models by combining one work stressor variable, one individual characteristic variable, and one stress symptom variable. These combinations were compiled in a cross-tabulation of two-class variables. The independent variables were scaled into two classes ($<$ median, $\geq$ median) or from comparable points. The combinations of variables are presented in table 2. Using this model, we explained the prevalence of poor work ability, defined as subjects obtaining 14—54 points for the sum of the two work ability indices (10).

Table 2. Combination of variables used in the model.

Work stressor level	Stress symptom level	Presence of disease
Low	Low	No
High	Low	No
High	High	No
High	High	Yes

Results

Regression analysis of general characteristics and work ability

The regression analysis of the work stressors, individual factors, and stress symptoms on work ability is shown for the cohort in table 3. Among the work stressors, high physical demands, poor physical work environment, and poor work schedules had the most negative effect on work ability. Good possibilities to develop at work had a positive effect. Particularly the presence of musculoskeletal disease had a negative effect on work ability. Among other individual factors aging, overweight, and cigarette smoking were associated with a low work ability. Stress symptoms, particularly mental and musculoskeletal symptoms, had the greatest negative effect on work ability. Satisfaction at work had a positive effect.

Among the work stressors, psychological demands, the quality of work tools and rooms, and work organization were eliminated from the most economical model. For the individual characteristics the same occurred for physical exercise.

Table 3. Regression analysis of general characteristics indicating work ability (correlation coefficient for the model: $r^2 = 0.63$, N = 3312, P<0.0001).

	Standardized regression coefficient
Work stressors	
Physical demands	−0.06***
Possibilities to develop	0.03**
Physical environment	−0.05***
Work schedule	−0.03*
Individual factors	
Musculoskeletal disease	−0.25***
Cardiovascular disease	−0.11***
Mental disease	−0.03**
Age	−0.10***
Overweight	−0.05***
Cigarette smoking	−0.04***
Stress symptoms	
Immediate physical stress at work	−0.08***
Musculoskeletal symptoms	−0.20***
Cardiorespiratory symptoms	−0.09***
Mental symptoms	−0.30***
Work satisfaction	0.03***

* P<0.05, ** P<0.01, *** P<0.001.

Poor work ability according to combinations of a work stressor, a stress symptom and the occurrence of disease

The prevalence of poor work ability (according to the work ability index) during the follow-up period was assessed for various combinations of a stressor, a symptom, and a disease (tables 4—6). All of the combination variables were good predictors of poor work ability. This trend was common regardless of the disease included in the analysis. A combination using physical, mental, and social (organization) variables was the most effective. The proportion of poor work ability increased systematically when work load, stress symptoms, and disease were included in the various combinations. The risk rates of certain combinations reached levels of about 20—30 % and higher.

Prediction of work ability from the occurrence of different diseases

We also studied the prediction of work ability in different disease groups separately. As the dependent variable we used the sum of the work ability index during the follow-up period. We compared subjects with the

Table 4. Prevalence of poor work ability among the men and women in the three work content groups in 1981—1985 according to combinations of various levels of work organizational stress, cardiorespiratory symptom level, and the presence of musculoskeletal disease in 1981.

Work content group	Poor work ability							
	Low work organizational stress,[a] low symptom level,[a] no disease		High work organizational stress,[b] low symptom level,[a] no disease		High work organizational stress,[b] high symptom level,[b] no disease		High work organizational stress,[b] high symptom level,[b] disease	
	N	%	N	%	N	%	N	%
Physical								
Men	78	0	49	4	135	12	97	30
Women	68	1	56	0	128	7	109	35
Mixed mental and physical								
Men	36	0	47	2	87	10	59	34
Women	105	0	100	0	137	4	107	20
Mental								
Men	110	0	81	1	101	6	47	26
Women	153	1	88	0	126	5	81	20

[a] Low = <median.
[b] High = ≥median.

presence or absence of musculoskeletal, cardiovascular, or mental disease. As independent variables we used work stressors and individual characteristics.

Regardless of disease, the work stressors and stress symptoms correlated with work ability. According to the correlations the most impairing work stressors were muscular work and poor work posture, temperature at the workplace, dirtiness, risk of accident, and lack of freedom. Among the individual factors, life satisfaction and a good basic education predicted good work ability. These factors correlated with the sum of the work ability index at a level of about 0.20 to 0.30.

For the subjects with musculoskeletal disease the regression coefficients are shown in table 7. Work stressor factors of special importance to the work ability of the subjects with musculoskeletal disease were disturbing temperatures at the workplace, lack of freedom, and work schedules. Of the individual factors, only marital status had special importance. Among the workers with musculoskeletal disorders, those that were married had a poor work ability.

For subjects with cardiovascular diseases (table 8) factors of special importance were muscular work, sitting posture, responsibility for people, and work

Table 5. Prevalence of poor work ability among the men and women in the three work content groups in 1981—1985 according to combinations of various levels of work organizational stress, mental symptom level, and the presence of cardiovascular disease in 1981.

Work content group	Poor work ability							
	Low work organizational stress,[a] low symptom level,[a] no disease		High work organizational stress,[b] low symptom level,[a] no disease		High work organizational stress,[b] high symptom level,[b] no disease		High work organizational stress,[b] high symptom level,[b] disease	
	N	%	N	%	N	%	N	%
Physical								
Men	168	1	110	7	121	21	46	33
Women	137	3	86	7	180	17	40	43
Mixed mental and physical								
Men	68	4	82	2	79	22	34	32
Women	192	1	144	1	185	10	39	26
Mental								
Men	176	1	106	0	91	12	26	31
Women	210	0	117	2	153	10	31	23

[a] Low = <median.
[b] High = ≥median.

Table 6. Prevalence of poor work ability among the men and women in the three work content groups in 1981—1985 according to combinations of various levels of stressor in the physical work environment, mental symptom level, and the presence of mental disease in 1981.

Work content group	Poor work ability							
	Low stress in physical work environment,[a] low symptom level,[a] no disease		High stress in physical work environment,[b] low symptom level,[a] no disease		High stress in physical work environment,[a] high symptom level,[b] no disease		High stress in physical work environment,[b] high symptom level,[b] disease	
	N	%	N	%	N	%	N	%
Physical								
Men	70	1	243	5	216	21	15	40
Women	110	1	153	8	204	22	13	31
Mixed mental and physical								
Men	39	0	127	6	120	20	9	67
Women	267	1	98	1	146	14	14	43
Mental								
Men	251	0	63	0	72	14	8	63
Women	311	1	56	0	85	16	10	40

[a] Low = <median.
[b] High = ≥median.

Table 7. Regression analysis of work stressors and individual factors for subjects with musculoskeletal disease (correlation coefficient of the model: $r^2 = 0.25$, N = 1064, P < 0.001). (Factors of particular importance are in italics.)

	Standardized regression coefficient
Work stressors	
Muscular work	−0.09**
Work posture	−0.10**
Change of load	−0.07*
Physical climate	*−0.16****
Management	−0.10**
Lack of freedom	*−0.07**
Work schedule	*−0.08**
Individual factors	
Marital status	*−0.06**
Basic education	0.15***
Life satisfaction	0.11***
Physical exercise	0.08**
Age	−0.13***

* P<0.05, ** P<0.01, *** P<0.001.

Table 8. Regression analysis of work stressors and individual factors for subjects with cardiovascular disease (correlation coefficient of the model: $r^2 = 0.25$, N = 522, P < 0.001). (Factors of particular importance are in italics.)

	Standardized regression coefficient
Work stressors	
Muscular work	*−0.27****
Sitting posture	*−0.15***
Responsibility for people	*0.10**
Tools and rooms	−0.08*
Physical climate	−0.10*
Restlessness	−0.09*
Work schedule	*−0.07*
Individual factors	
Basic education	0.16***
Life satisfaction	0.19***
Physical exercise	0.10*
Age	−0.09*

* P<0.05, ** P<0.01, *** P<0.001.

schedules. Responsibility for people positively affected the work ability of the subjects with cardiovascular disease.

For the subjects with mental disease (table 9) lack of freedom (ie, paced and hurried work) was an important harmful factor for work ability. Life satisfaction was important as a positive factor for work ability. Basic education and age also predicted work ability for the mentally healthy subjects.

Work stressors and individual factors explaining physical and mental work ability

Muscular work, poor work postures, poor quality of tools and the work environment, and disturbing temperature at work were the factors that predominantly impaired physical work ability (table 10). Correspondingly, role conflicts and restlessness mostly impaired mental work ability, whereas use of knowledge main-

Table 9. Regression analysis of work stressors and individual factors among subjects with mental disease (correlation coefficient of the model: $r^2 = 0.25$, N = 118, P < 0.001). (Factors of particular importance are in italics.)

	Standardized regression coefficient
Work stressors	
Lack of freedom	*−0.27****
Individual factors	
Basic education	0.19*
Life satisfaction	*0.23***
Age	−0.16*

* P<0.05, ** P<0.01, *** P<0.001.

Table 10. Regression analysis of work stressors and individual factors explaining physical work ability (correlation coefficient of the model: $r^2 = 0.29$, N = 3312, P < 0.0001). (Factors of particular importance are in italics.)

	Standardized regression coefficient
Work stressors	
Muscular work	*−0.11****
Work posture	*−0.12****
Change of load	−0.04**
Possibilities to develop	0.03
Tools and rooms	*−0.05***
Machine effects	−0.04*
Physical climate	*−0.09****
Management	−0.07***
Role conflict	−0.05**
Work schedule	−0.04*
Individual factors	
Basic education	0.16***
Life satisfaction	0.13***
Cigarette smoking	−0.04**
Physical exercise	*−0.12****
Age	−0.12***

* P<0.05, ** P<0.01, *** P<0.001.

Table 11. Regression analysis of work stressors and individual factors explaining mental work ability (correlation coefficient of the model: $r^2 = 0.22$, N = 3312, P < 0.0001). (Factors of particular importance are in italics.)

	Standardized regression coefficient
Work stressors	
Muscular work	−0.04*
Change of load	−0.06***
Use of knowledge	*0.05**
Possibilities to develop	0.06**
Dirtiness and risk of accident	−0.04*
Restlessness	*−0.09***
Management	−0.04*
Role conflict	*−0.18****
Uninspiring work	−0.04*
Individual factors	
Marital status	0.03*
Basic education	0.11***
Life satisfaction	*0.19****
Physical exercise	0.07***
Gender	*0.07****
Age	−0.10***

* P<0.05, ** P<0.01, *** P<0.001.

tained it (table 11). Physical exercise primarily maintained physical work ability, and life satisfaction supported mental work ability.

Discussion

A regression analysis of the work stressors, individual factors, and stress symptoms revealed several factors impairing the work ability of 50- to 54-year-old employees. Musculoskeletal disease and musculoskeletal and mental symptoms had the highest regression coefficients (table 3). Due to the relatively high number of subjects in each category, the effects of many work ability factors reached statistical significance. The high intercorrelations between work stressors and stress symptoms created difficulties in interpreting the regression analysis of general characteristics. Separate variables indicated a higher interdependency than that provided by the model. Work organization was eliminated because of its high correlation with physical demands and physical environment, and physical exercise because of its high correlation with overweight. When subjects in physical, mental, and mixed physical and mental work were compared, the results were similar to those of the entire cohort.

The prevalence rate of poor work ability was strongly dependent on the combination of a high work load, a high level of stress symptoms, and the presence of a disease (tables 4—6). The results were similar for all three work content groups (physical, mixed physical and mental, and mental work) and for the men and women. These results suggest that the presence of one disease, be it musculoskeletal, cardiovascular or mental, increases the occurrence of poor work ability manifold when the work load is high and there are many stress symptoms. Therefore, it seems important to redesign the work of older persons who have musculoskeletal, cardiovascular, or mental disease. The work load should be lowered and the causes of stress symptoms should be evaluated and reduced.

It was evident that different work stressors and individual factors affect healthy workers and subjects with disease differently. For healthy aging workers, poor work postures and role conflicts at work seem to be more important than high muscular demands, a poor work environment, and lack of freedom. These latter features of work particularly impaired the work ability of unhealthy subjects. Marked differences were also demonstrated when workers with different diseases (tables 7—9) were studied. The role of poor physical climate at the workplace was emphasized for subjects with musculoskeletal disease. This finding can be explained by the high number of outdoor workers with musculoskeletal disease. The highest prevalence rates of musculoskeletal disease was determined for auxiliary jobs, and such jobs take place in a cold environment during most of the year. Older outdoor workers should be effectively protected against cold by appropriate work clothing and warm rest facilities.

Subjects with cardiovascular disease are still involved in work requiring muscular work. However, it also appears that sitting work is not optimal for them. On the contrary, work involving responsibility for people had a positive effect on the work ability of the subjects with cardiovascular disease. Lack of freedom was the most impairing for the subjects with mental disorders. Thus a greater degree of freedom at work should be aimed at for people with psychological problems.

The general variables (table 1) of the work stressors, individual characteristics, and experienced symptoms explained 63 % of the variation in work ability. In the regression model an effective variable can obtain a relatively greater proportion of power than a correlated ineffective variable. The work stressors and individual factors explained about a quarter of the variation in the work ability of the subjects with disease. In these models work stressors were more important than in the model including stress symptoms and diseases.

Muscular work explained work ability to the same extent as sitting posture among the subjects with cardiovascular disease. For this reason we studied the distribution of different cardiovascular diagnoses in relation to muscular work and sitting work in more detail (14). There was no selection of diagnoses, but ischemic heart disease and congestive heart failure were distributed evenly among those doing muscular or sitting work. A regression model of subjects with ischemic heart disease resembled the model of workers with cardiovascular disease in general, both muscular and sitting work being impairers of the work ability of workers with cardiovascular disease and responsibility for people being a maintenance factor.

The combination of poor work postures and a lack of freedom explained the increase in poor physical work ability. A risk ratio between the poorest and the best combination was 2.5. On the other hand, mental work ability was mostly impaired by the combination of role conflicts and restlessness, the risk ratio being 3.3 (14). These results clearly suggest the need to redesign the work of the elderly.

The present results support the observations of laboratory studies (7, 15). The decline in physical work capacity during aging explained why poor work postures and a lack of freedom become critical with advancing age. A marked decline in cardiorespiratory capacity (7) and musculoskeletal capacity (15) made the same poor postures more strenuous and harmful than earlier in life, when physical capacity was sufficient. Decreased physical capacity at work can be compensated, for example, by sufficient work-rest schedules. Lack of freedom rarely includes a sufficient number of rest periods or enough flexibility in the worktime. Work schedules often appeared in our regression analysis as a significant factor impairing work ability.

The work performance and work capacity of persons suffering from stress can decrease because of im-

pairment in attention and concentration and the occurrence of fatigue (2). Although our laboratory studies of mental performance indicated that the critical period is perhaps not at the ages of 51 to 55 years, several changes suggested that attention should be given to short-term memory and visual speed (16). Stress due to work in general increased with age (17), which also increased the proportion of subjects experiencing stress. Role conflicts as one of the dominant work stressors that impair mental work ability should by taken into consideration when jobs for the elderly are redesigned.

The regression analysis also indicated factors associated with good work ability. Life satisfaction and a good basic education were expected to be related to good work ability, but the beneficial effect of physical exercise suggested new possibilities for the aging worker. It is clear that physical exercise is important for physical work capacity, but it was surprising that it is significantly linked with work ability independently of type of work. Thus physical exercise improves the work ability of persons in either physical or mental occupations. Improvements in physical work capacity can be obtained independently of age and level of fitness (7). It would be interesting to study to what extent the work ability index increases for individuals who are physically active as they grow older.

The results of the present study suggest that work stressors, individual stress symptoms, and diseases have a strong effect on work ability during aging. Physical work demands, a poor physical work environment, and lack of freedom were the most common work stressors impairing work ability. The mental and musculoskeletal symptoms were the most important stress reactions influencing work ability. Marked differences were found among subjects with different diseases. However, a combination of a work stressor, individual symptoms, and disease impaired work ability the most. The results identified several factors important for the redesign of work for the elderly.

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