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Summary and recommendations of a project involving cross-sectional and follow-up studies on the aging worker in Finnish municipal occupations (1981—1985)

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ILMARINEN J, TUOMI K, ESKELINEN L, NYGÅRD C-H, HUUHTANEN P, KLOCKARS M. Summary and recommendations of a project involving cross-sectional and follow-up studies on the aging worker in Finnish municipal occupations (1981—1985). *Scand J Work Environ Health* 1991;17(suppl):135—41. This report is a summary of the main findings of 15 studies comprising a multidisciplinary research project. Recommendations are also made on the basis of the findings, and they emphasize the following points: (i) work demands should change with age, (ii) work should be designed for unhealthy people, (iii) work ability should be promoted, (iv) work ability should be regularly monitored, (v) special attention to stress reactions is needed, (vi) knowledge of aging is needed, and (vii) action programs are needed.

Key terms: action program, job redesign, knowledge of aging, promotion, stress reactions, work ability, work ability monitoring, work demands.

The project stems from both the dramatic demographic changes in the age structure of the Finnish work force and the need for new concepts for retirement. Since 1964 the municipal branch in Finland had followed a job-dependent retirement system in which workers retired between the ages of 53 and 62 years, old-age retirement becoming effective at 63 years of age. For the Local Governmental Pensions Institution it was unclear whether the job-related pension ages were still relevant. Therefore a multidisciplinary research project was planned to search for new concepts of work and retirement. The general aim of the project was to clarify how the factors of work, health, functional capacity, work ability, and perceived strain influence the aging worker. The project had two phases. The first comprised cross-sectional studies in 1981 to obtain descriptive and base-line data for 6257 municipal employees who had a mean age of 51 years and were employed in different occupations. The second covered the four-year follow-up (1981—1985) of various groups of the same employees. The project included 15 studies, eight of which were questionnaire studies, five were laboratory studies and two were field studies.

Cross-sectional studies

The aims of the field studies were to analyze the jobs of aging workers in municipal occupations and assess the stress and strain involved under actual work conditions.

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Job analyses were carried out with an ergonomic job analysis procedure commonly known as the AET (Arbeitswissenschaftliche Erhebungsverfahren zur Tätigkeitsanalyse) method. The more than 100 job titles designated as municipal occupations were clustered into 13 homogeneous groups according to work content. These cluster groups were used to standardize the work for the other studies of the project. This procedure made it possible to study work-related aspects at three levels, according to job title, according to cluster group, and finally according to work content (physical, mental, or mixed physical and mental types of work). At each level the stress factors of work were systematically defined.

The job analysis indicated that the job title was often misleading with respect to the stress factors of work. On the other hand, several occupations were similar, for example, auxiliary types of jobs.

The assessment of stress and strain during work indicated that, still today, work can be heavy for older workers. On the average, the measured oxygen consumption during work was not high [0.7 (SD 0.3) $l \cdot min^{-1}$]. The strain induced by the aerobic demands was strongly related, however, to the maximal cardiorespiratory capacity of the subjects. The lower the capacity, the higher the individual strain. During peak loads the relative aerobic strain sometimes exceeded 90 %. Thus a high strain level can be a marked health risk for an aging worker; for example, in our study every second subject had at least one diagnosed disease at the age of 51 years. The majority of the subjects doing physical work used some type of medication, for example, beta-blocking agents.

The high level of strain during physical work was primarily due to a low physical work capacity. Espe-

cially older women often had such a low capacity that ordinary physical tasks induced high strain on the cardiorespiratory system. It should be emphasized that it is not only the aerobic demands of work which can become heavy, but also, especially, poor work postures were found to be common in the work of the elderly. Among older men and women 15 and 22 % of the workshift, respectively, induced poor work postures. Thus both cardiovascular and musculoskeletal demands were prevalent among the aging workers. Therefore, physical work demands should decrease with age, especially among women older than 50 years. For everyone, however, maintaining sufficient cardiorespiratory and musculoskeletal capacity during aging is the basic requirement for being able to manage with one's work.

The relationship between the self-assessment and clinical assessment of health status and work ability was good. Some divergence was detected at the individual level, but it could usually be explained on the basis of the available data. Thus the results of the psychological tests supplemented the medical results and vice versa.

The correspondence between the clinically determined musculoskeletal capacity and the work ability index was the best in that 61 % of the subjects received the same classification for both. This similarity was probably due to the fact that the measurements of the subjects' performance in various tasks and activities were closer to the work ability index than the other clinical methods were.

In general, the available laboratory tests need to be improved to be more work-related if they are to describe work ability. It is obvious that clinical examinations measure different aspects of work and functional capacity, and they cannot, as such, fully agree with the subjective evaluation of work ability.

Follow-up studies

Questionnaire studies

As indicators of a poor ability to manage at work the following variables were used: granted work disability pension, perceived poor health, poor work ability, and accentuated strain.

The highest mortality and work disability pension rates were found for physically demanding occupations. The highest mortality rate was found for men doing installation work. Of the work stressors, the muscular demands and physical-chemical work environment were the factors most often associated with a poor ability to manage at work. During the four years of follow-up a high proportion of subjects in occupations involving much muscular work and poor work postures or a perceived harmful physical-chemical environment received a work disability pension or died.

Individual factors like perceived poor health and poor work ability, number of diagnosed diseases, and increasing age also explained the poor ability to manage at work. Diseases such as cancer, coronary artery disease, congestive heart failure, rheumatic diseases, chronic bronchitis and asthma, diseases of the back or lower extremities due to an accident, and mental disorders were the major causes of work disability.

Cardiovascular death was common among workers with manifest cardiovascular disease at the beginning of the follow-up period. For those suffering from both cardiovascular and musculoskeletal disease the mortality rate was lower, but the work disability pension rate was nearly double the rate of those having only cardiovascular disease. It is possible that those suffering from both diseases are more willing to retire, and thus the occupational load on the cardiorespiratory system disappears. On the other hand, severe cardiovascular disease may hide musculoskeletal symptoms to the point that they are neglected. In addition, musculoskeletal disease can prevent the cardiorespiratory system from being overloaded in physically demanding occupations, a subsequent decrease occurring in death risk.

Factors of strain also explained the workers' ability to manage at work. Of those who reported cardiorespiratory, musculoskeletal, or mental symptoms before the follow-up period, many were granted a work disability pension during the follow-up. The prognosis was poorest for those reporting multiple symptoms. The mortality rate was accentuated if cardiorespiratory symptoms were not combined with psychological symptoms or if the psychological symptoms were not associated with musculoskeletal symptoms.

During the follow-up period the health and work ability of those who had continued in the same occupation were weakened, and the strain due to work increased. In the physical, mixed, and mental work groups the decline of health and work ability was approximately the same. Thus the differences found between the different occupational groups before the follow-up period remained the same during the four years among those who had not changed jobs.

When the mortality and work disability pension rates were combined with the morbidity rates for cardiovascular and musculoskeletal diseases after the follow-up in 1985, the occupations could be ranked according to their health demands. This analysis indicated that, among the women, a poor ability to manage at work accumulated in the following groups: (i) construction workers, (ii) streetsweepers, (iii) bathers, and (iv) cleaners. The list of men's occupations with poor management was the following: (i) park workers, (ii) carpenters, (iii) painters, (iv) electricians, (v) machine mechanics, and (vi) pipe layers. On the other hand, women in worklife at the mean age of 55 years had a good ability to manage as head nurses, social welfare inspectors, nurses specialized in surgery, nurses specialized in policlinic work, typists, dentists, head ward nurses, vocational school teachers, and practical nurses in hospitals. The list of occupations in which

men managed well included physicians, teachers, psychiatric nurses, and supervisors.

Every second subject who had continued in the same occupation during the follow-up reported that the mental load of their work was increased and that this increase was associated with an increase in work quantity and the knowledge needed to handle their jobs. In general, however, the work was experienced as developing in a positive direction. The changes noted as most positive were observed in the work environment and in the development of work tools. This positive trend was associated with automation and mechanization, which decreased physical work load.

However, more subjects than earlier reported that the work required much muscular work and physical demands. This result is obviously explained by the fact that the morbidity, poor work ability, and symptoms increased remarkably during the follow-up. In addition, the increase in work quantity and the lack of freedom of choice probably together influenced the opinions of the worker. Although the prevalence of poor work postures was not reported to have increased, aging, more work, and also a better understanding of occupational health and safety matters probably both subjectively and objectively increased the physical demands of the work. These rather contradictory results can also be interpreted to mean that, in spite of the positive changes in work, the effects were so weak that the health or work ability of the aging worker was not considered to have improved during the four years.

Laboratory studies

As expected, the maximal cardiorespiratory capacity ($\dot{V}O_2max$) decreased during the four years among the women. Among the men, however, the cardiorespiratory capacity increased 8 %, due to the extra physical training of the men. It should be mentioned that physical training was recommended to all the subjects who had a lower than average age-related capacity before the follow-up. About two-thirds of the men but only one-third of the women improved their capacity although the same recommendations were given.

The most interesting finding was the remarkable individual decrease or increase during the follow-up. In four years, the maximal cardiorespiratory capacity of some individuals between 45 and 62 years of age decreased more than 20 %. This decrease is manifold that usually expected, and it was not always explained by an appearance of disease. The finding indicates that maximal cardiorespiratory capacity is a more sensitive function during aging than the general age curves of $\dot{V}O_2max$ suggest. This contradiction might be explained, for example, by the effect of sampling. A random population includes both active and inactive subjects, and the $\dot{V}O_2max$ of the active part of the population in the respective age group can make the slope of the age curve decrease more gently. However, if the physically inactive subjects are considered alone, their level of $\dot{V}O_2max$ is much lower. The unfit subjects with a low $\dot{V}O_2max$ can be more sensitive and less tolerant to other health-related changes than the fit subjects. A logical explanation for a dramatic decrease in $\dot{V}O_2max$ is a dramatic change in physical activity habits.

Work content was associated with changes in $\dot{V}O_2max$ so that both the decrease among the women and the increase among the men was the most pronounced in the group with mental work demands. This trend suggests that physical work might slow down the age-related decrease of $\dot{V}O_2max$. On the other hand, physical work does not seem to motivate subjects to participate in additional physical training.

Musculoskeletal capacity showed significant changes during the four years. The decrease was especially great in trunk strength, up to 22 % among the men and 10 % among the women. The handgrip strength decreased as expected (up to 8 % among the women). The decrease in muscle strength could partly be explained by the increase in musculoskeletal symptoms and diseases. Back problems especially could have affected trunk strength. The changes were in general similar in all of the work content groups. In some cases the subjects with mixed physical and mental work (eg, nurses) had improved their capacity. This finding possibly indicates that a combination of physical and mental tasks is better than one-sided musculoskeletal over- or underloading during work. The changes in muscular strength were not so great that they affected the overall musculoskeletal disability according to an index constructed from several practical functional tests. Physical types of work do not seem to have any physiological training effects on musculoskeletal capacity because the subjects in the physical work group had only the same or often a lower capacity than those in the mental or mixed physical and mental work groups. The muscle strength of the women averaged only about two-thirds of that of the men, and the difference was often greatest in physical work. These results indicate that it is very important to motivate elderly persons involved with physical work to train their musculoskeletal capacity actively.

The changes in mental capacity were not as systematic as the changes in physical capacity. In general, the four-year period between 51 and 55 years does not seem to be critical. Some results, however, are worth mentioning. Visual speed decreased 17 % among the men doing mixed work, such as bus driving. Thus the function most needed by drivers seems to deteriorate the most. On the other hand, complex short-term memory was weakened the most among the women doing mixed work and among the men doing mental work. In nursing, in which memory capacity is continuously needed, such a capacity seems to weaken the most. These indirect findings suggest that the central nervous system can be as sensitive as the hemodynamic

system when exposed to one-sided, long-term work loads during aging. This suspicion, however, should be further studied with neurophysiological methods.

It is obvious that special attention should be given to promoting the functional capacities of the aging worker. This promotion is especially important because the work itself does not give any guarantee of maintaining the basic functions automatically at a sufficient level during aging. It is probably much easier to maintain muscle training, perhaps also mental training in the future, to keep functions fit for work than to change the work so that the training needed can be received through the daily work tasks. This training concept does not exclude the possibility that the training needed can be carried out as a part of work, for example, using worktime for maintaining or promoting the work ability of the aged.

Work ability index

One of the general objectives of this study was to develop methods for identifying subjects under the risk of early retirement. Such a method was the work ability index. This index was based on questionnaire data and was constructed from seven different topics. (See reference 1.)

Table 1. Work ability index of 51-year-old municipal workers and the work disability pension rate during the follow-up period from 51 to 55 years of age by gender.

Work ability index at the age of 51 years	Work disability pension between 51—55 years of age			
	Men		Women	
	Number	Percent	Number	Percent
Poor	119	37.8	109	33.3
Average	120	8.4	85	4.4
Good	39	0.8	7	1.5
Poor, average and good combined	242	11.5	201	7.5
Information lacking	56	12.4	45	9.9

The results of the work ability index at the age of 51 years predicted well the outcome during the four-year follow-up. Of those women and men who, at the age of 51 years, had a poor work ability, about one-third became disabled to work during the follow-up period (table 1). Of those with a good work ability at the age of 51 years only a few became disabled to work during the four years of follow-up.

The work ability index predicted well the later disability to work in a relatively short period. Large differences in the work ability of the subjects in different occupations at the age of 51 years resulted in large differences in the dropout rates from worklife four years later. According to the work ability index of the 55-year-old persons still working, about 15—25 % had a poor work ability. Thus, if the dropout rate is the same before and after the age of 55 years, the normal old age pension at the age of 63 years is attainable only for a minor portion of people involved in physically demanding work.

The work ability index is obviously a suitable method with which to identify early signs of decreasing work ability. It can be used as a tool for preventive measures. Occupational health services could select subjects for early rehabilitation by using this index; they could also follow the effectiveness of rehabilitation programs with its use.

Risk factors of work: a list for job redesign

Several of the analyses of this study identified different factors of work which add to the deterioration of the work ability of aging workers. These factors, listed in figure 1, include items of work which decrease the ability to manage at work. This is also the list of factors which push aging people out of worklife.

Each factor in figure 1 can be equally important. The more risk factors the aging worker meets daily, the higher is his or her risk of a decrease in work ability after the age of 50 years. A combination of several factors (eg, lifting + heat + time pressure) suggests that the risk of poor work ability increases fairly linearly already in four years. The list of risk factors is the same for men and women. The most harmful combi-

Physical demands that are too high

* static muscular work
* use of muscular strength
* lifting and carrying
* sudden peak loads
* repetitive movements
* simultaneously bent and twisted work postures

Stressful and dangerous work environment

* dirty and wet workplace
* risk of work accidents
* hot workplaces
* cold workplaces
* changes in temperature during workday

Poorly organized work

* role conflicts
* supervision and tackling of work
* fear of failure and mistake
* lack of freedom of choice
* time pressure
* lack of influence on own work
* lack of professional development
* lack of acknowledgment and appreciation

Figure 1. Factors of work which add to the deterioration of the work ability of aging workers.

nation of risk factors depends on the health of the subjects. Thus those suffering from cardiovascular disease, from musculoskeletal disease, or from mental disorders have a different combination of risk factors which leads to poor work ability. However, a combination of one disease, one symptom, and one factor illustrating that work has been poorly organized was an indicator so strong that a linear model could be established for predicting poor work ability among both the men and women in physical, mixed, and mental work.

Recommendations

The list of occupational risk factors that deteriorate work ability indicates that work content should still be remarkably improved, both for the worker in general and for the aging worker especially. There are several factors that have been neglected in everyday worklife.

New concept: work demands should change with age

At present, the main problem is that work demands do not change with age. In spite of the fact that the functional capacity for physical work decreases with age, the physical demands of work do not. This problem is illustrated in figure 2. Functional reserves decline with age, and after the age of 50 years the reserves are not sufficient for recovery before the next workday (figure 2). Therefore a new concept has to be introduced and should be tested in real-life situations. The new concept is described in figure 3. The concept has been created particularly for aging workers involved in physically demanding jobs. Figure 3 suggests that the physical demands of work should decrease in parallel with the decrease in physical work capacity with age. Then, the reserves for older people can be as large as those for younger people. The lowered physical demands can be met by nonphysical tasks. Thus the total work output of the aging worker is a combination of physical and nonphysical tasks. This model emphasizes that the experiences of the aging worker should be increasingly taken into consideration (figure 3).

Work should be designed for unhealthy people

Another major problem is that work is normally designed for young and healthy men and women. Aging means, however, that half of the 45-year-old workers and two-thirds of the 55-year-old workers have at least one diagnosed disease. In addition, most older workers have cardiorespiratory, musculoskeletal, or mental symptoms which daily increase the perceived strain of work. Healthy and nonsymptomatic persons over 50 years of age are a small minority of the work force. Consequently, work should be designed so that also unhealthy people are able to work without excess strain. A new work-rest schedule should also be developed, as well as recommendations for an acceptable work load with age.

Work ability should be promoted

Work ability is based on individual physical, mental, and social capacities. In figure 3 the curve of physical work capacity does not decrease as fast as in figure 2. Therefore, to guarantee that real reserves are available, actions are needed to prevent an excess drop in physical work capacity. Physical exercise is the only solution. Exercise for the cardiorespiratory and musculoskeletal systems is effective at any age, and remarkable improvements can be achieved by regular walking with moderate intensity. Improvement in functional capacity means improvement in work ability. Because physical capacity decreases remarkably earlier than mental and social capacities, the preventive actions should start with physical exercise, and not later

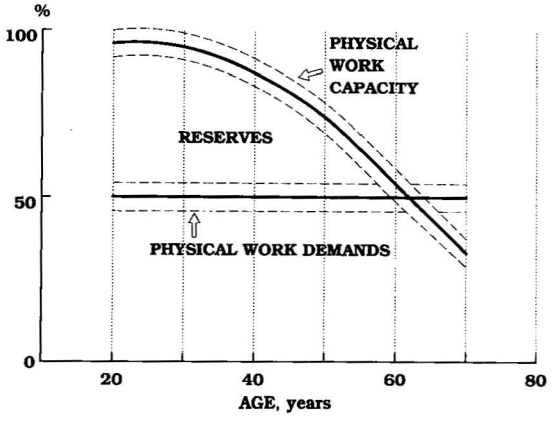

Figure 2. Relation between physical work capacity and physical work demands during aging.

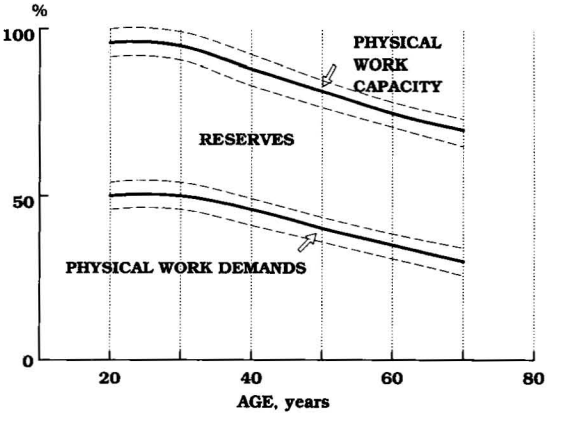

Figure 3. New concept for helping aging workers in physically demanding jobs — physical work demands should decrease with age and the experience of the older worker should be better taken into consideration. (See the text.)

than at the age of 40 years. An optimal situation is that exercise can be taken any time it is suitable. Therefore exercise and work ability promotion should be a part of work, and it should be supported strongly by the employer.

Work ability promotion also includes actions for health promotion, like smoking cessation and healthy eating habits. The role of occupational health services is central in advising, motivating, and following the actions. In the future a need for training for mental and social capacities can become as necessary as physical training for physical capacity is already today.

Work ability should be regularly monitored

Instead of the present regular health check-ups, occupational health services should be oriented towards regular work ability examinations. Such examinations should include an assessment of health and functional capacity, with special emphasis on the identification of sufficient or insufficient work ability for daily work tasks. Starting such work ability assessments early enough (eg, at the age of 35—40 years) makes it possible to identify the first signs and symptoms of decreasing work ability. Early rehabilitation and the promotion of functional capacities should follow the identification of an increased risk of declining work ability. Simultaneously, however, actions for job redesign should be started. After rehabilitation the worker should not return to his or her previous work situation, in order to avoid the physical, mental, or social risks that have caused the decrease in work ability.

The frequency of regular work ability assessments should be work- and age-related. In physically loading occupations the assessments should start not later than at the age of 40 years, and the interval between assessments should be two to three years. After the age of 50 years, assessments are recommended once a year.

Work ability assessments should include an interview using the work ability index, measurements of physical work capacity (cardiorespiratory and musculoskeletal capacity), assessments of mental and so-

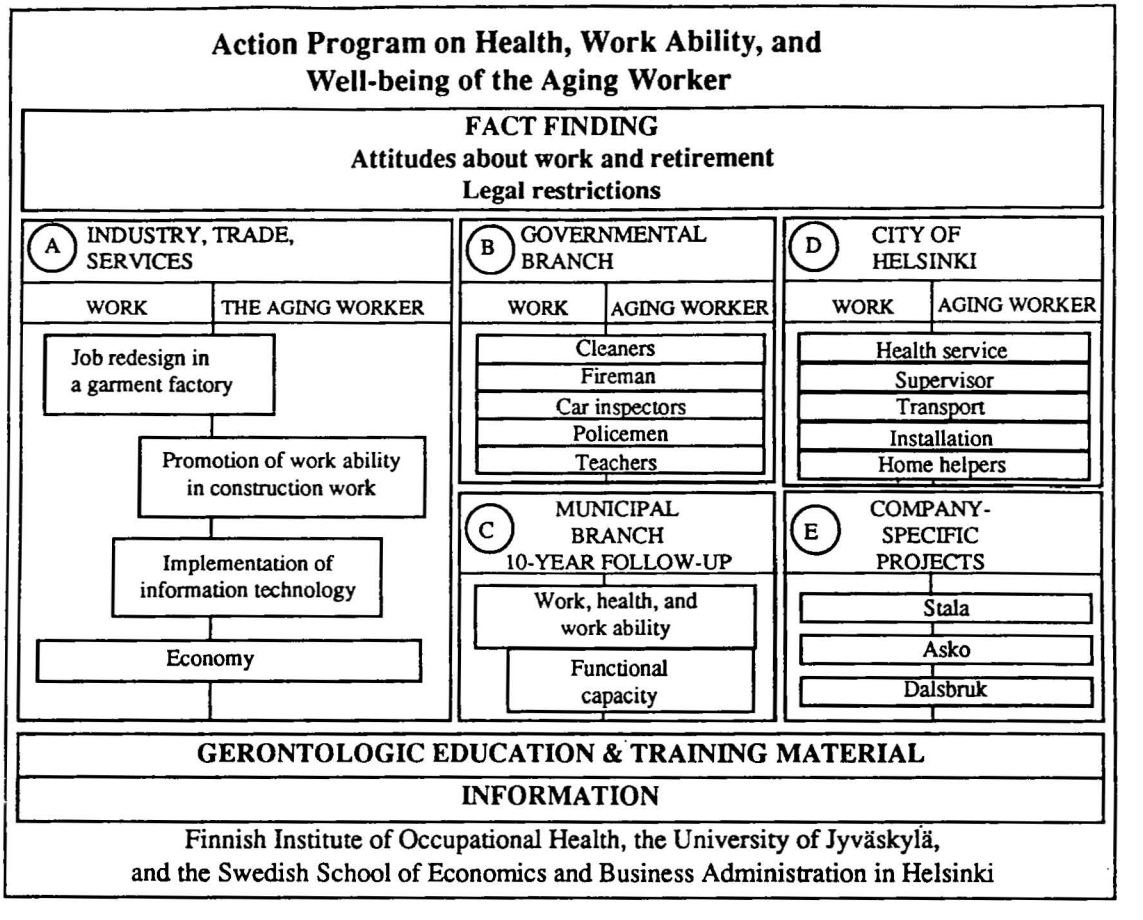

Figure 4. "Respect for the Ageing," an action program on the health, work ability and well-being of the aging worker. (See the text.)

cial capacity, and traditional health examinations, if necessary. The subjects should be given a graphic summary of their work ability profile with reference values. The graph should illustrate the trend of work ability over the previous years. In the case of a subject under risk of decreased work ability, an interview on the loading factors at work should be carried out.

Special attention to stress reactions is needed

In our study the results of workers at the age of 51—55 years indicated that remarkable differences in stress reactions existed between occupations. Chronic work-related symptoms of strain were emphasized in the following occupational groups: men: auxiliary jobs, installation, transport, dump work, teaching, and dental work; women: auxiliary jobs, home care, kitchen supervision, nursing, teaching, and dental work.

After the age of 50 years, workers in these occupational groups have the highest risk for poor work ability. The analysis of individual symptoms is essential. Occupational health services should use interview methods for early diagnoses of work-related symptoms. This action can be combined with the assessment according to the work ability index.

Knowledge of aging is needed

It is obvious that more information on normal aging is needed. More myths than facts command public opinion. For worklife, facts are needed about changes in physical, mental, and social capacity with age. For new skills due to new technology, continuous learning is an ability widely needed. How does learning change with age, and what are the optimal conditions for learning new skills at an older age? Supervisors need education and training about how the older worker should be supported and managed. The risk factors of work for older persons can be effectively reduced by supervisors. However, the precondition for correct actions is that supervisors understand what characteristics of their staff have changed with age. Facts are also needed to improve the understanding between different age groups within the company. Not of minor importance is a personal understanding about which age-related changes are normal and which are due to other reasons. Training and education material is urgently needed for occupational health service personnel, work and safety professionals, supervisors, and workers of companies.

Action programs are needed

In the near future most OECD (Organization for Economic and Cooperation and Development) countries will have to deal with a work force that is older than ever before. Actions are needed to fit the work to the aging work force. Otherwise the loss of experienced 50- to 60-year-old men and women will be remarkable through different retirement phases. Action programs should establish models which are effective and practical in different companies. The aim of the action programs should be branch- and company-dependent, but a common objective must be both a redesign of work and the promotion of work ability for the aging worker.

Such a program, essentially based on the results and experiences gained in our project, will be started at the Institute of Occupational Health in Helsinki, Finland, in 1991. It is called "Respect for the Ageing" and is an action program on the health, work ability and well-being of the aging worker. The general aims of the program are: (i) a redesigning of jobs for the aging worker and (ii) promotion of work ability for the aging worker.

The objectives will be achieved through research, education, training, and information projects. The research will include several intervention projects at worksites in private, governmental, and municipal work. Comprehensive training and education material will be produced about aging, and it will be tailored for different target groups. Attitudes of the general population towards work and retirement will be studied at intervals during 1990—1995. The planned program is illustrated in figure 4.

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