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Different stages of disease, changes in heaviness of work and life cycle

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KOSKELA R-S, KORHONEN H, JÄRVINEN E, KOLARI PJ, MUTANEN P. Different stages of disease, changes in heaviness of work and life cycle. *Scand J Work Environ Health* 10 (1984) 451—454. The aim of this study was to determine which age and exposure categories are the most prone to health selection. Mortality and morbidity were studied on three different exposure levels defined primarily according to the physical demands of the work, heavy (iron foundries), medium (manufacture of metal products), and light (manufacture of electrical devices). The population comprised 15 714 men hired in 1950—1976 to work in the three branches of the metal industry. A questionnaire on occupational history, morbidity, and the causes of turnover was sent to 3 450 current and former workers. The occupational histories of current and former workers were compared for changes in heaviness throughout their complete occupational histories. Occupations during a lifetime were also classified into three levels of exposure on the basis of physical demand (heavy, medium, and light). The three levels of exposure showed different patterns of changes in heaviness of the work according to age throughout the workers' complete occupational histories. Selection into and out of jobs within and between different levels of exposure seemed to be some kind of continuous process, a chain of selection. Similarily as changes in the heaviness of the work formed a chain of selection during lifetime, the workers' health also changed to form a chain through their life cycle. Hard and soft measures formed a continuum (dissatisfaction — death), and they followed each other as explanations for termination of employment. The points of inflection in age, where the measures of different stages of disease turned from soft to hard, varied according to the level of exposure. The life-table technique was used to show the turning of the measures.

Key terms: health selection, metal industry, morbidity, mortality, occupational history.

The aim of this study was to determine which age and exposure categories are the most prone to health selection. Mortality and morbidity were studied on three different exposure levels defined primarily according to the physical demands of the work, heavy (iron foundries), medium (manufacture of metal products), and light (manufacture of electrical devices). The population comprised 15 714 men hired in 1950—1976 to work in the three branches of the metal industry. Data for the mortality and disability analyses were obtained from national death and disability registers. A questionnaire on occupational history, morbidity, and the causes of turnover was sent to 400 current and 600 former workers from each branch. In addition, a questionnaire concerning occupational history was sent to the nearest relatives of 450 dead persons.

Workers are selected into and out of physically demanding jobs with regard to their health (1, 2). The study of occupational mortality and morbidity is hampered by this selection. Furthermore, social selection and rapid turnover are involved in health selection. Because different stages of disease form only one continuum (dissatisfaction — death) (figure 1), the correct interpretation of the results also requires measures softer than mortality. Earlier studies (3, 4, 5) have concluded that soft and hard measures of health follow one another as explanations for the termination-of-employment rate (figure 2).

In the present study the occupational histories of current and former workers were compared for changes in heaviness throughout their complete occupational histories. Occupations during a lifetime were also classified into three levels of exposure on

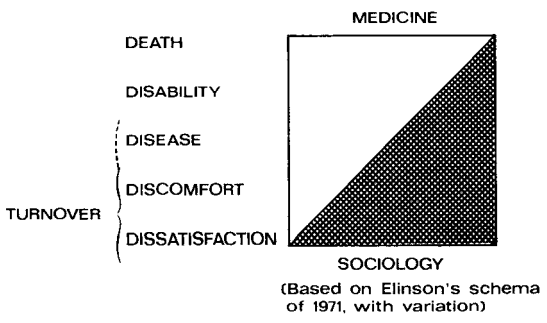

Figure 1. Different stages of disease.

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the basis of physical demands (heavy, medium, and light).

Transitions from one level to another were grouped into transitions to either heavier or lighter levels of exposure. The changes have been expressed as percentage differences (percentages of transitions to heavier levels minus those to lighter levels of exposure) in relation to the total number of workers in the age class.

Among the foundry workers, the current workers had transferred mainly to heavier work until the age of 35 years (figure 3). Former workers with a long duration of exposure had moved to heavier work until the age of 25 years, whereafter they switched to lighter work. Former workers with a short duration of exposure had sought lighter work from the very beginning. Changes in the heaviness of the work were clearly associated with the occupational histories within foundries.

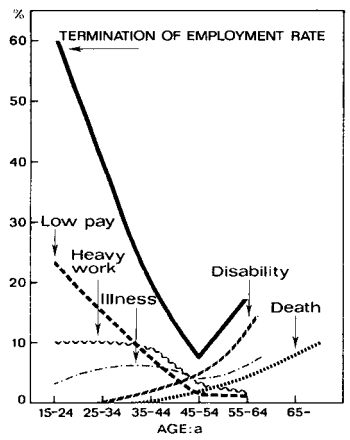

Figure 2. Termination of employment and reasons for termination versus age in a cohort of cotton mill workers (4).

Among the metal product workers (figure 3), workers who had changed the level of heaviness during their lifetime tended to choose a lighter level of exposure. The trend was quite even until the age of 45 years, whereafter most of the changes were to lighter levels of exposure. Also among the metal product workers the changes were associated with the complete occupational histories, but not as clearly as among the foundry workers.

The electrical workers (figure 3) for whom the level of heaviness had changed during their lifetime transferred mainly to lighter levels. However, two downward peaks, at the ages of 20—24 and 45—49 years, indicate bimodality in the age distribution at the time of entry (and also negative health selection).

The three levels of exposure showed different patterns of changes in heaviness of the work according to age throughout the workers' complete occupational histories. Selection into and out of jobs within and between different levels of exposure appeared to be some kind of continuous process, a chain of selection (figure 4). This conclusion was ascertained when the complete occupational histories were analyzed according to the levels of heaviness (heavy, medium, light) of the occupations from which the workers came and to which they transferred.

The foundry workers entered the industry from either heavy-level or medium-level occupations, and most of them sought lighter work in medium-level occupations. The metal product workers either began their worklives within the metal product industry or they transferred to it from work of the same level of heaviness. After leaving a job, they generally moved to medium-level (the same level) or light-level occupations. The electrical workers switched from medium-level work, or they began their worklives within that industrial branch. When they left a job, they chose medium-level or light-level work in the metal industry.

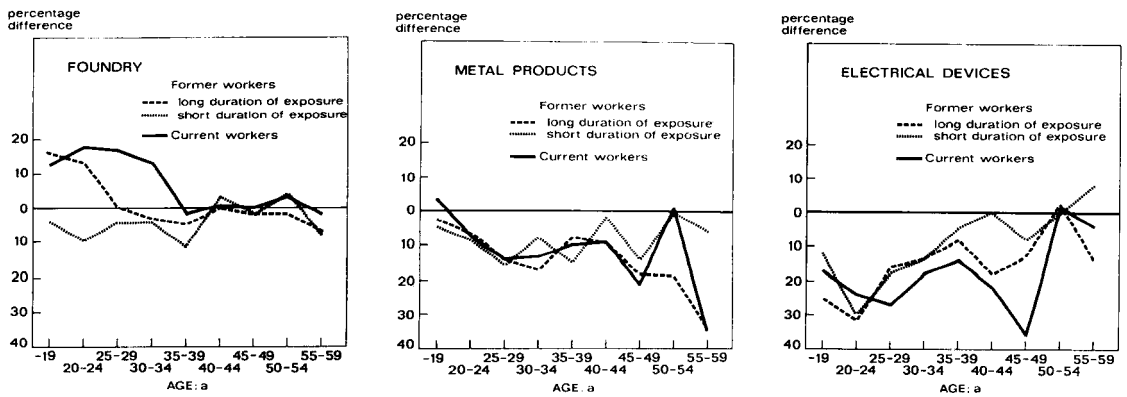

Figure 3. Changes in the heaviness of the work throughout the complete occupational histories of the foundry, metal product, and electrical workers. Transitions from one level to another were grouped into transitions to either heavier or lighter levels of exposure. The changes are expressed as percentage differences (percentages were calculated in five-year age classes for each level of exposure, the total percentage being 300; percentages of transitions to lighter levels were subtracted from those to heavier levels of exposure and divided by three, the total percentage in each age group being 100) in relation to the total number of workers in the age class.

The chain of selection from one exposure level to another also means that the mortality and morbidity rates for a certain level of exposure may be underestimated or overestimated if complete occupational histories are not available.

Just as changes in the heaviness of the work formed a chain of selection during lifetime, the workers' health also changed to form a chain through their life cycle.

The combined results for mortality, disability, and morbidity indicated that different stages of disease decreased the cohorts on the heavy, medium, and light levels of exposure in different ways (figure 5). The cohort of workers on the heavy level decreased because of lessening work capacity, disability, and death. The cohort of workers on the medium level of exposure was reduced mainly through disabling diseases and disability in the older age classes. Workers on the light level of exposure had the smallest decrement attributable to different stages of disease; however, they had an increased decrement due to death in the older age classes, a finding which indicates negative health selection.

The points of inflection in age, where the measures of different stages of disease turned from soft to hard, varied according to the level of exposure. Hard and soft measures formed a continuum (dissatisfaction — death), and they followed each other as explanations for the termination of employment (figure 6). The life-table technique was used to show the turning of the measures.

The occurrences of excellent work capacity and soft measures (dissatisfaction, discomfort, disease) were calculated for the workers still active, whereas hard measures (disability, death) were considered

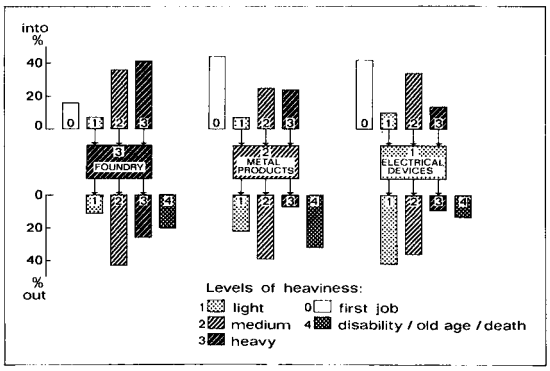

Figure 4. Selection of workers into and out of jobs according to heaviness of the work during the workers' lifetimes.

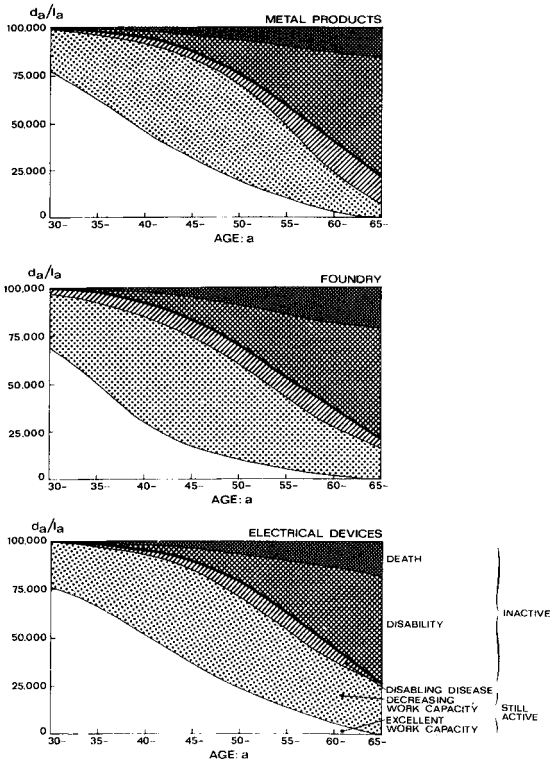

Figure 5. Decrement of the cohorts ≥ 30 a of age through death, disability, disabling disease, or decreasing work capacity [l_a = still active at age a, d_a = the deceased or disabled at age a (l_{30} = 100 000 = radix), still active with disabling disease or decreasing work capacity, and still active with excellent work capacity].

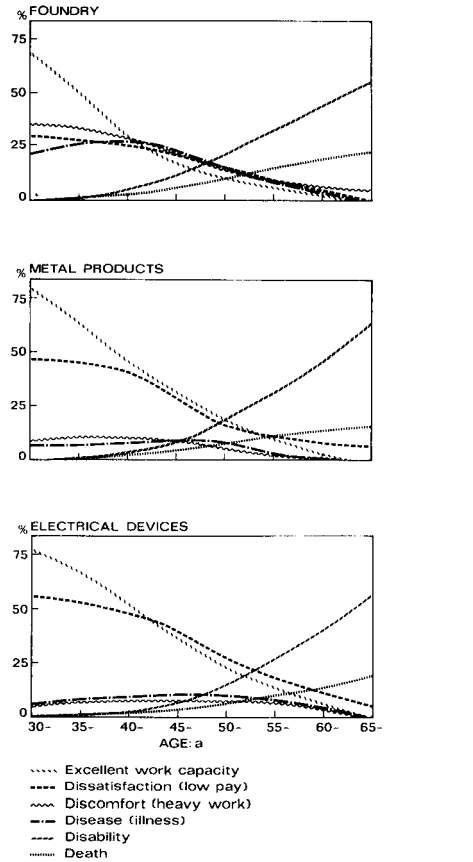

Figure 6. Occurrences of different stages of disease and excellent work capacity according to age.

complementary. The number of persons with excellent work capacity in the cohorts was estimated from the corresponding age-specific figures of the current workers. Excellent present work capacity was defined as a subjective assessment of 9 to 10 points on a 10-point scale. The three most important reasons reported by the former workers with the longest duration of employment were used to represent soft measures of disease, ie, low pay was chosen to represent dissatisfaction, heavy work to represent discomfort, and illness to represent disease.

The proportion of foundry workers with excellent work capacity decreased the most rapidly with age when compared with that of the workers of the other two branches. The highest point of dissatisfaction (low pay) occurred before the age of 30 years (not shown in figure 6) and turned to discomfort (heavy work) at the age of 30—34 years. Discomfort again changed to disease at about the age of 40 years. Different symptoms occurred, and their occurrences were clearly higher than in the other two branches. Since heavy work and different symptoms led to selection out of heavy-level jobs, disease did not change to disability until near the age of 50 years. Thereafter hard measures were the most prominent.

Among the metal product workers, low pay had a more important meaning through the age classes than among the foundry workers. Correspondingly, the proportion of workers who experienced the work as heavy was clearly smaller than among the foundry workers, and the measure turned to disease later (at about the age of 44 years). Nevertheless, disease changed to disability early in the next age class (45—49 years).

The electrical workers retained their excellent work capacity until older ages than the foundry workers and the metal product workers. The electrical workers also had the highest occurrences of low pay (dissatisfaction) through all age classes. The proportions of heavy work and illness were low. Because light-level work is not physically demanding and because there was negative health selection, disease had slightly higher occurrences than discomfort. Discomfort and disease turned to disability in the age class of 50—54 years.

Thus a chain of selection during lifetime was formed not only by changes in the heaviness of the work, but also by health changes during the life cycle. The quality of the study design, cohort formation, follow-up, and the use of the complete occupational history determine what kind of results will be obtained from the complex whole.

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