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Health selection among metal workers

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KOSKELA R-S, JÄRVINEN E, KORHONEN H, MUTANEN P. Health selection among metal workers. *Scand j work environ health* 9 (1983) 155—161. The objective of the present 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 level (iron foundries), medium level (manufacture of metal products), and light level (manufacture of electrical devices). The population comprised about 15,700 men employed in 1950—1976 in the three branches of the metal industry. The number of person-years of follow-up was about 215,800. During the period 1950—1978, 1,407 deaths occurred. Occupational history, morbidity, and turnover causes were studied by means of a questionnaire sent to 3,500 current and former workers. The survival curves showed no great differences between the three exposure levels. However the heavy level had the highest degree of mortality, and the medium level the lowest. Foundry workers had the highest overall rates of disability. But, in the older age groups, the disability rates of the metal product workers were the highest. Less social selection was suggested for foundry workers than for the two other cohorts. Metal product workers seemed to be selected by both social and health factors. Young electrical workers were occupationally trained. On the other hand older workers with poor health were selected to this light level (negative health selection).

Key terms: cohort study, disability, epidemiologic methods, healthy worker effect, heaviness of work, morbidity, mortality, occupational history, questionnaire study, turnover.

Workers are selected into and out of physically demanding jobs with regard to their health. The study of occupational mortality and morbidity is hampered by this selection. Furthermore, social selection and rapid turnover are involved in health selection (2, 3, 4). Because different stages of disease form only one dimension (dissatisfaction — death) (5, 7), the correct interpretation of the results also requires softer measures than mortality. Earlier studies have concluded that soft and hard measures of health follow one another as explanations of the termination-of-employment rate (5, 6).

The aim of the present study was to determine which age and exposure cate-

gories are the most prone to health selection.

It was initially assumed that low mortality in an occupation may be caused by health selection, whereby workers with health problems change to other occupations; thus health selection causes excess mortality in these occupations (fig 1).

The following hypotheses were formed: (i) if the levels of exposure are defined as heavy, medium, and light, according to the physical demands and exposures connected with the work, the heavy level has the strongest health selection and, consequently, low mortality rates; (ii) the medium level has the highest degree of mortality due to three reasons — first it includes persons who are primarily unfit for heavy work; second it includes persons who could not continue doing heavy work; third the work itself involves considerable exposure; (iii) persons at the light level have a strong occupational and “negative”

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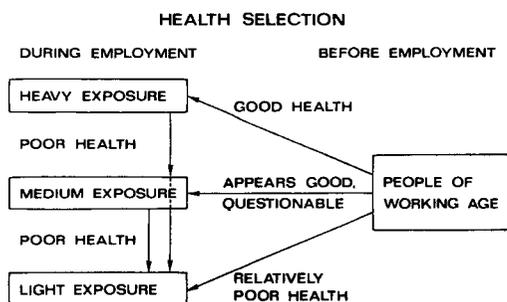


Fig 1. A scheme of health selection before and during employment.

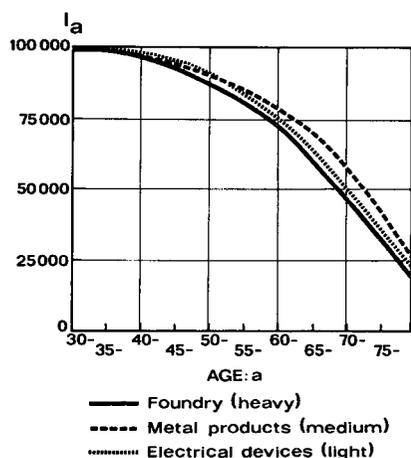


Fig 2. Survivors ≥ 30 a of age according to the three levels of exposure [I_a = survivors at age a, $I_{30} = 100,000$ (radix)].

health preselection — selection during the period of employment is low; (iv) selection mechanisms result in different turnover rates at the three levels, (v) high mortality and morbidity rates are not necessarily concentrated at the same level(s).

The levels of exposure in this study were defined primarily according to the physical demands and exposures connected with the work: heavy level (iron foundries), medium level (manufacture of metal products), and light level (manufacture of electrical devices). The population comprised about 15,700 men employed between 1950 and 1976 in the three branches of the metal industry representing the different levels of exposure (4,000–6,000 workers from each branch). The number of person-years of follow-up was about 215,800. During the period of

1950 to 1978, there were 1,407 deaths. In addition another methodological (cross-sectional) cohort was comprised of employees who had been hired earlier and were still working in 1950. The period of follow-up for disability began in 1969 and ended in 1978. Data for the analyses of mortality and disability were obtained from national death and disability registers. A sample was used to study the occupational histories, morbidity, and the reasons for turnover. A postal questionnaire was sent to 400 current and 600 former workers from each branch. In addition a questionnaire about occupational history was sent to the next of kin of 450 deceased workers.

The results were compared between the levels for the analyses of mortality, disability, and turnover, and within the levels for the analyses of turnover and morbidity.

When the mortality of the three exposure-level cohorts were compared with the mortality of the general male population of Finland (8), the standardized mortality ratios (SMRs) were exceptionally high: 124 for the foundry workers, 92 for the metal product workers, and 107 for the electrical workers. The standardized mortality ratios of occupational cohorts usually remain below 100. The most probable reason for the high ratios was that, for methodological reasons, there were no criteria for the duration of exposure.

No great differences were found for the survival curves of the three exposure-level cohorts. The order of the survival curves implied that the heavy-level cohort had the highest degree of mortality, and the medium level the lowest. The curve of the light level was similar to the medium one until the workers aged, when the curve attained that of the heavy-exposure cohort (fig 2).

Social and health selection are intermingled. Therefore variations in the numbers of unskilled workers may have caused different mortality patterns among the three exposure-level cohorts. Laborers and other unskilled workers had a tendency towards higher mortality than skilled workers. But, when the unskilled workers were excluded from each level, the order of the survival curves remained unchanged between the industries.

Some cause-specific findings supported social and health selection (fig 3). The probability of violent death was highest for the foundry workers (about 1.5 times that of the metal product workers). The foundry workers also had the highest incidence of deaths for which alcohol was a contributing cause (ICD codes 291, 303, 571, E 979 & E 980). The metal product workers had the lowest incidence. The highest incidences of deaths with alcohol as a contributing cause were found for the older age groups of electrical workers. This finding may reflect negative social and health selection. Negative health selection among electrical workers was also compatible with the rather high rate of mortality from tumors within the group of aged workers.

Mortality from coronary heart disease seemed the lowest for the electrical workers, a result which may indicate that health selection is low during employment at the light level. This assumption was confirmed when mortality from cardiovascular diseases was compared with that of the cross-sectional cohorts which included workers who were occupationally active in 1950 but had been hired earlier

and, therefore, were highly selected groups. The cross-sectional cohort of electrical workers had higher rates of coronary heart disease than the main cohort. On the contrary, a comparison of these cohorts revealed health selection during employment in the heavy and medium levels of exposure. The main cohort of foundry workers had a higher rate of mortality from cardiovascular diseases than the cross-sectional one. The difference was mainly due to the mortality from coronary heart disease. A similar difference between the cross-sectional and main cohorts was found for the metal product workers, but it was not explained by coronary heart disease.

When compared to the active male population of Finland (1), foundry workers, metal product workers, and electrical workers had standardized disability ratios of 121, 108, and 97, respectively. The effect of selection can be summarized with a disability index defined in such a way that the observed number equals 100 for each age category (fig 4).

The high disability rates of the young foundry workers were mainly due to mental disorders ($p < 0.001$, Poisson

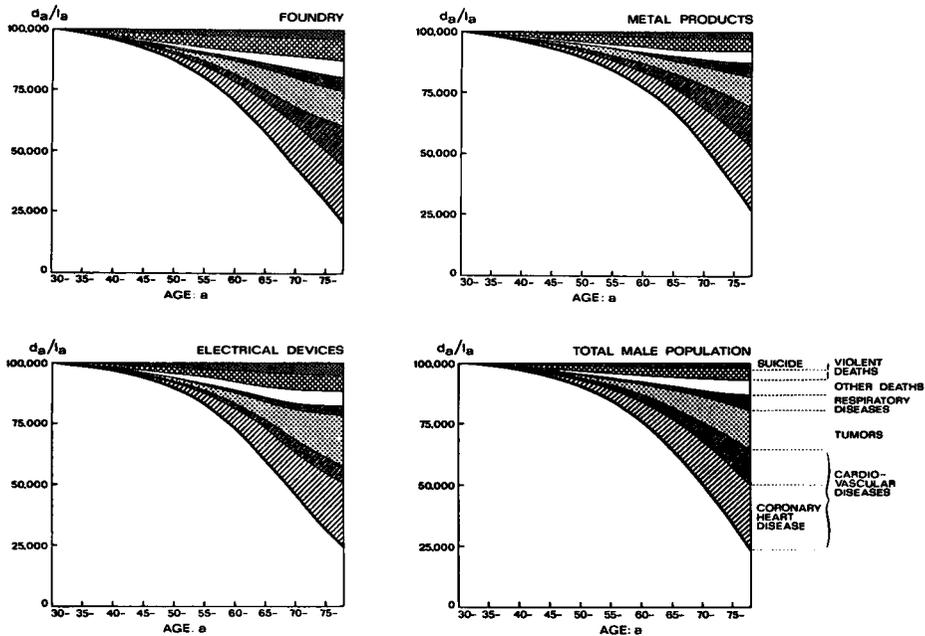


Fig 3. The survivors and the deceased ≥ 30 a of age by cause of death in the three cohorts and in the total male population of Finland. [l_a = survivors at age a , d_a = the deceased at age a , $l_{30} = 100,000$ (radix)].

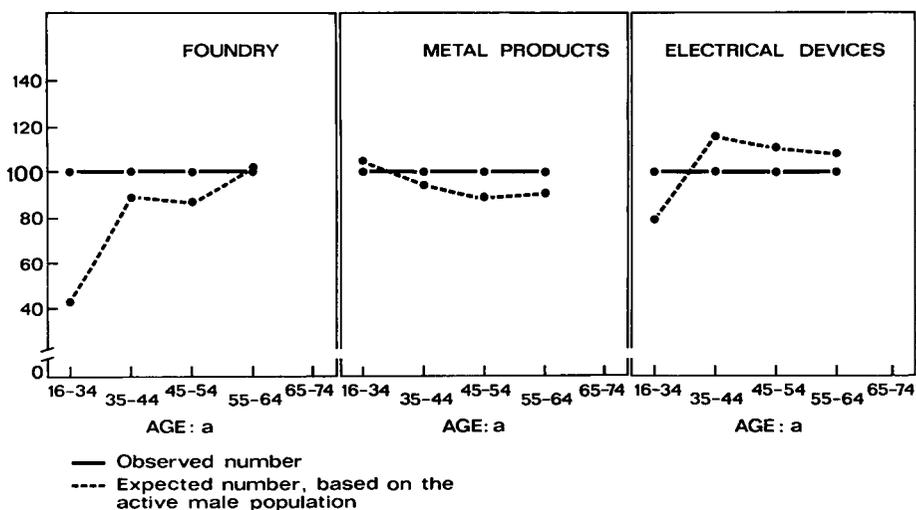


Fig 4. The observed and expected numbers of invalidity pensions due to disability during the period 1969—1978. The numbers are expressed as an index; observed numbers = 100.

Table 1. The cause-specific observed and expected numbers of invalidity pensions due to disability among metal workers hired between 1950 and 1976. The expected values are based on the proportional disability figures of the Finnish active male population. The follow-up period was 1969—1978.

Cause of disability	Foundry		Metal products		Electrical devices	
	Observed	Expected	Observed	Expected	Observed	Expected
Mental disorders	161 ***	109.8	54	42.7	83 ***	54.1
Cardiovascular diseases	172 **	217.2	95	102.0	59 *	76.2
Coronary heart disease	96 *	120.2	46	56.2	34	41.2
Respiratory diseases	50	42.9	27	20.4	10	15.4
Musculoskeletal diseases	187	185.7	80	82.7	49 *	68.9
Others	169	183.4	70	78.2	90	77.4
Total	739	739.0	326	326.0	292	292.0

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (Poisson distribution).

distribution) (table 1). This finding led to the assumption that foundry workers are less preselected by social factors and health reasons than the other two industrial cohorts. The observed numbers of all cardiovascular diseases, and coronary heart disease separately, were significantly lower ($p < 0.01$ and $p < 0.05$) for the foundry workers than for the active Finnish male population. This result can be explained both by health selection during employment and by the effect of mortality from cardiovascular diseases. Health selection during employment was also implicated by the rates for respiratory diseases. The observed numbers were

significantly higher than was expected ($p < 0.05$) for the cross-sectional cohort as a whole, as well as for the oldest age group (55—64 a of age) of the main cohort of foundry workers.

The metal product workers had the highest social and health preselection. The observed numbers of disability for older age groups exceeded the expected values (fig 4). The primary causes of the excess were respiratory diseases and mental disorders. Nevertheless, no specific cause reached statistical significance.

The electrical workers had disability rates below the expected values. The youngest age class, for which mental

disorders caused an excess of disability ($p < 0.001$), was an exception.

A comparison of the turnover of employees in the three industries showed that the foundry workers had the highest termination-of-employment rate until the age of 40–44 a, whereafter the rate seemed to be the highest among the electrical workers. In all age categories the metal product workers had considerably lower rates than the two other groups. The termination-of-employment rates were the highest for young workers regardless of the level of heaviness (fig 5).

In addition to the individual factors (workers' health and social factors) turnover also depends on job market, ie, on the opportunity of securing other employment. The termination-of-employment rates were influenced by the fact that these three industries had different amounts of new employees. Thus economic factors introduced additional selective features.

Selection into and out of industries was analyzed on the basis of the complete occupational histories collected by a questionnaire. The occupations of each worker throughout his lifetime were classified according to three levels of heaviness: heavy, medium and light. Most

of the foundry workers had entered either from heavy-level occupations (such as agriculture, forestry, and construction work) or from medium-level occupations (chiefly the manufacture of metal products). Although 26 % of the foundrymen transferred to heavy work after leaving the foundries, most of the workers sought lighter work (mostly in the metal industry). One of every three foundry workers whose new job involved heavy work transferred to another foundry (fig 6).

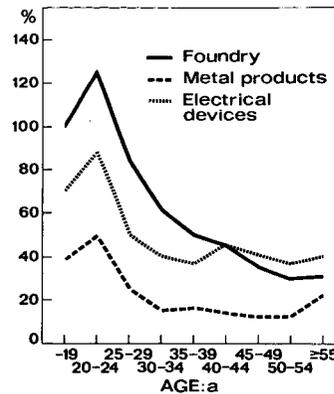


Fig 5. Termination of employment in the three metal industries.

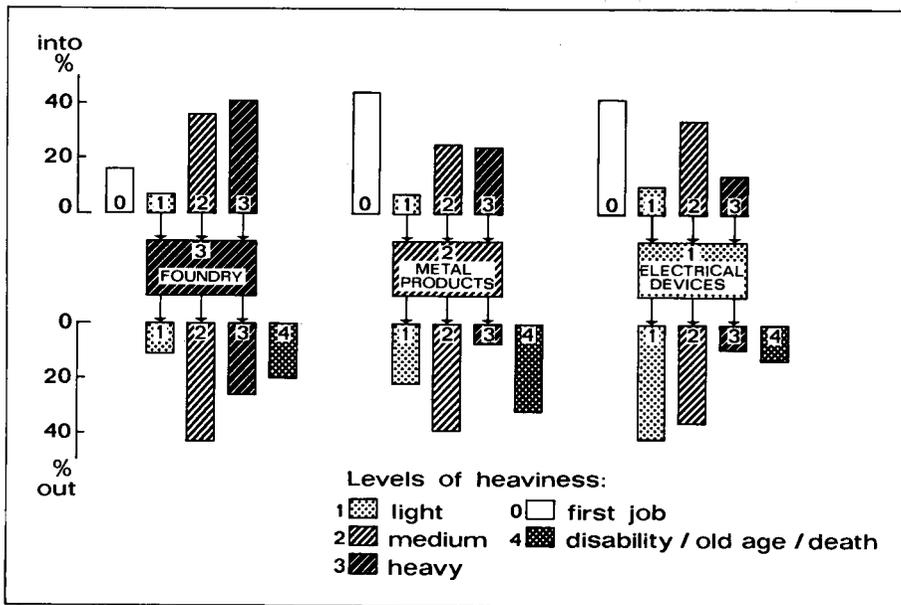


Fig 6. Selection of employees into and out of jobs according to heaviness of work during their lifetime.

The metal product workers either began their work lives within the metal product industry or they transferred to it from work of the same level of heaviness. When the metal product workers left a job, they generally transferred to medium-level occupations. They either continued doing the same task, or they chose a lighter form of work in the metal industry.

The electrical workers had seldom transferred from the same level. They generally switched from medium-level

work, mainly within the metal industry; several electrical workers had begun their work lives within that industrial branch. After leaving the work, they sought either medium-level or light-level work in the metal industry.

The metal product workers and the electrical workers were occupationally preselected because more of the workers had begun their work lives in those branches. Health selection during employment was revealed in the foundry workers' tendency to move to lighter work. To some extent a similar tendency was also found among metal product workers.

The foundry workers can be taken as an example of health selection within industries. The occupational histories of current and former foundry workers (as classified when the original cohorts were formed in 1976) were compared for changes in the heaviness throughout their complete occupational histories (fig 7). The occupations were again classified into three levels of exposure on the basis of physical demand (heavy, medium, and light). Transitions from one level to another were grouped into transitions to heavier levels of exposure and to lighter levels. The changes are 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 an age group. Current workers had transferred mainly to heavier work until the age of 35. Former workers with a long duration of exposure had moved to heavier work until the age of 25, whereafter they switched to lighter work. Former workers with a short duration of exposure had sought lighter work from the very beginning.

The timing of the foundry work within the workers' complete occupational histories was examined (fig 8) in the same way as the changes in job level (light, medium, heavy). Changes in the heaviness of the work were clearly associated with occupational histories within foundries (fig 7).

The workers' health was also associated with changes in the heaviness of the work. Both the current and the former workers' own assessments of their present health showed the same pattern of change, from

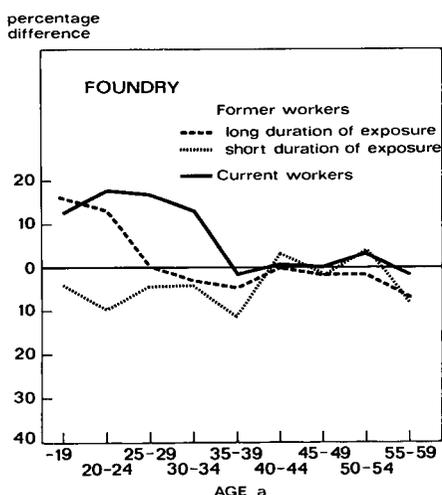


Fig 7. Changes in heaviness of work throughout complete occupational histories of foundrymen expressed as the percentage difference.

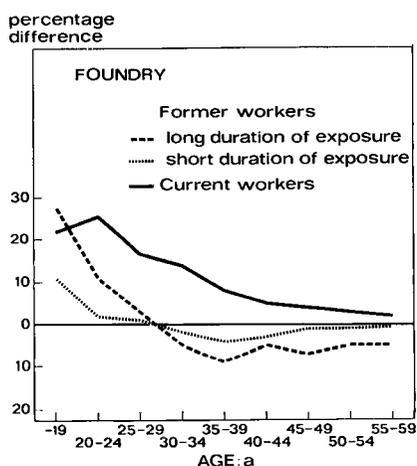


Fig 8. The beginning and termination of foundry work according to age, expressed as the percentage difference. The timing of the foundry work was based on complete occupational histories.

a good to a poor health state, according to age and changes in the heaviness of their work. Health selection between current and former workers was also revealed by the higher prevalences of angina pectoris, chronic bronchitis, and musculoskeletal diseases found among the groups of former workers.

In summary, contrary to the initial hypotheses, mortality was the highest at the heavy level of exposure and the lowest at the medium one. The preliminary results indicate that the two most probable explanations are the high level of exposure and the low social preselection. Although turnover is rapid and workers transfer to the medium level of exposure, the medium-level workers with health problems correspondingly transfer to the light level of exposure. Thus mortality in the older age groups of workers at the light level of exposure was rather high (ie, negative health selection). On the other hand, low mortality at the medium level may be caused by high health preselection and high social preselection. Future analyses of the softer measures of health should provide more-detailed information regard-

ing the differences between and within the levels of exposure.

References

1. Eläketurvakeskus. Tilastotietoja työeläkkeen saajista vuodelta 1976 [Statistics about persons receiving employment pensions 1976]. Helsinki 1977.
2. Fox AJ, Adelstein AM. Occupational mortality: Work or way of life. *J epidemiol community health* 32 (1978) 73—78.
3. Fox AJ, Collier PF. Low mortality rates in industrial cohort studies due to selection for work and survival in the industry. *Br j prev soc med* 3 (1976) 225—230.
4. Kitagawa GM, Hauser PM. *Differential mortality in the United States*. Harvard University Press, Cambridge, MA 1973.
5. Koskela R-S. Occupational mortality and morbidity in relation to selective turnover. *Scand j work environ health* 8 (1982): suppl 1, 34—39.
6. Koskela R-S, Luoma K, Hernberg S. Turnover and health selection among foundry workers. *Scand j work environ health* 2 (1976): suppl 1, 90—105.
7. Smedby B. The role of sociologist in medical care research. *Acta socio-medica scand* 3 (1971) 187—196.
8. World Health Organization. *World health statistics annual 1970: Vital statistics and causes of death*. Geneva 1973.