

Occupational mortality and morbidity in relation to selective turnover

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KOSKELA R-S. Occupational mortality and morbidity in relation to selective turnover. *Scand j work environ health* 8 (1982): suppl 1, 34-39. Because of the "healthy worker effect" most occupational cohorts, especially those of persons doing physically heavy work, are selected groups with regard to life expectancy. Health selection is also involved in turnover. Mortality and morbidity were studied on three different exposure levels, defined primarily according to physical demands: heavy level (iron foundries), medium level (manufacture of metal products), and light level (manufacture of electrical devices). The population comprised about 15,700 men who were employed in 1950-1976 in the three branches of the metal industry representing the different levels. The number of person-years of follow-up became about 215,800. During the period 1950-1978, there had occurred 1,407 deaths. Data for the mortality and disability analyses were obtained from the national death and disability registers. Occupational history, morbidity, and reasons for turnover were studied in a sample by means of a questionnaire sent to 400 current and 600 former workers from each branch. In addition, a questionnaire concerning occupational history was sent to the next of kin of 450 dead persons. When the three cohorts were compared to the general male population of Finland, the standardized mortality ratio was 124 for the foundry workers, 92 for the metal product workers, and 107 for the electrical 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 showed less social selection than the two other cohorts. Metal product workers seemed to be socially and health selected. Economic fluctuations clearly regulated entries of new employees into the industries and thus introduced additional selective features.

Key terms: cohort study, economic fluctuation, electrical devices, epidemiologic methods, foundry, health selection, healthy worker effect, metal products, questionnaire study.

Because of the "healthy worker effect" (selection of healthy people for employment and the remaining of healthier workers in industry), most occupational cohorts, especially those of workers who do physically heavy work, are selected groups with regard to life expectancy (7, 9, 17, 19, 22). Since occupational cohorts usually show standardized mortality ratios (SMRs) below 100, unemployed populations (those in institutions, those who are somewhat ill, those without work, and asocial groups) have higher mortality (6, 10, 18, 20, 21). In

addition, rapid turnover, which also involves health selection, hampers the study of occupational health risks (11, 12, 13, 14). Some methodological factors also modify the results of a cohort study (eg, the definition of the cohort, the length of follow-up, and minimum exposure time criteria) (5, 8, 15, 16, 27).

The aim of this study was to determine which age and exposure categories are the most prone to health selection. Both hard (mortality and disability) and smooth (morbidity and reasons for turnover) measures were used.

It was initially assumed that low mortality in an occupation may be caused by health selection, which transfers workers with health problems to other occupations and thus causes excess mortality elsewhere

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(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 the following three reasons: it includes persons who are primarily unfit for heavy work, it includes persons who could not continue doing heavy work, and the work itself involves considerable exposure; (iii) persons at the light level have strong occupational and "negative" health preselection, and selection at the time of employment is low; (iv) selection mechanisms result in different turnover rates at the three levels; and (v) high mortality and morbidity rates are not necessarily concentrated in the same level(s).

The levels of exposure were defined in the study 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 who were employed in 1950–1976 in the three branches of the metal industry representing the different levels (4,000–6,000 from each branch). Ninety-nine percent of the total population could be traced. The number of

person-years of follow-up was about 215,800. During the period 1950–1978, 1,407 deaths occurred. In addition, employees who were hired earlier and were still working in 1950, the first follow-up year, formed another methodological cohort.

When the three cohorts were compared to the general male population of Finland, the SMRs were exceptionally high: 124 for the foundry workers, 92 for the metal product workers, and 107 for the electrical workers (28) (fig 2). The SMRs are not mutually comparable. The most probable reason for the high SMRs was that, for methodological reasons, there were no minimum exposure time criteria; therefore, the portion of unskilled workers was appreciable.

The survival curves (fig 3) showed no great differences between the three expo-

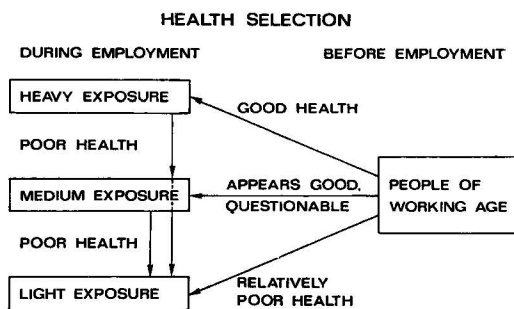


Fig 1. A scheme of health selection before and during employment.

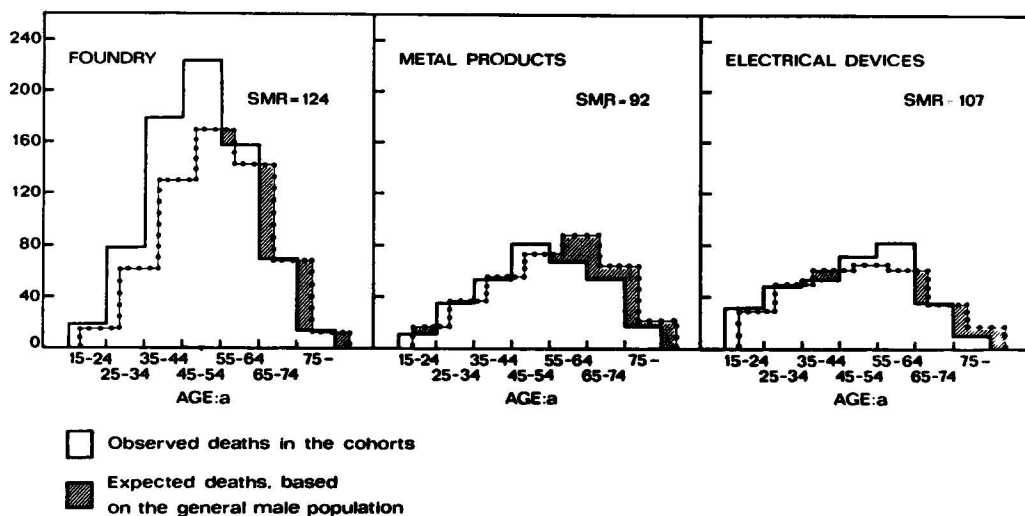


Fig 2. Observed and expected number of deaths in the cohorts by age. (SMR = standardized mortality ratio)

sure levels. However, every level had typical features of its own. The heavy level 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; then it showed the same mortality as that of the workers of the heavy exposure level. If

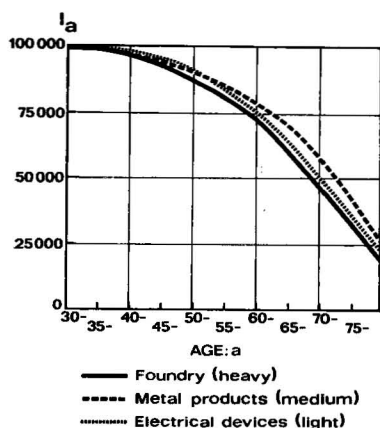


Fig 3. Survivors ≥ 30 a of age according to the three levels of exposure. [I_a = survivors at age a, $I_{30} = 100,000$ (radix)]

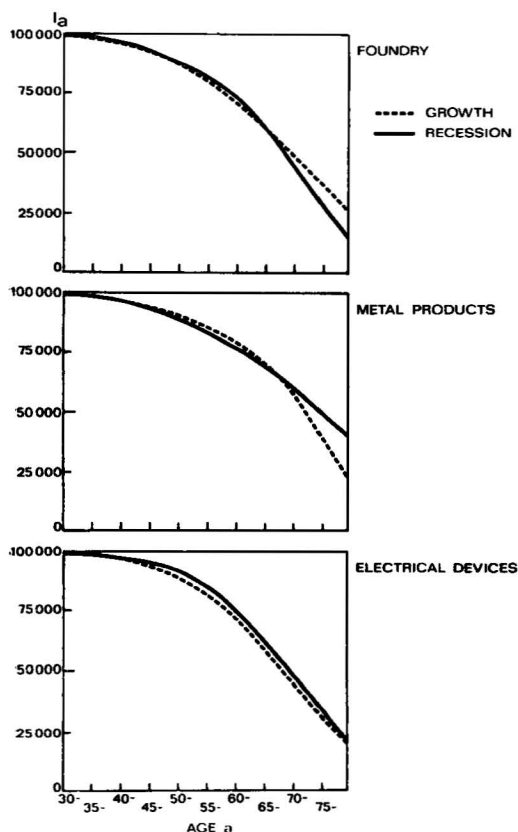


Fig 5. Survivors ≥ 30 a of age according to economic fluctuations. [I_a = survivors at age a, $I_{30} = 100,000$ (radix)]

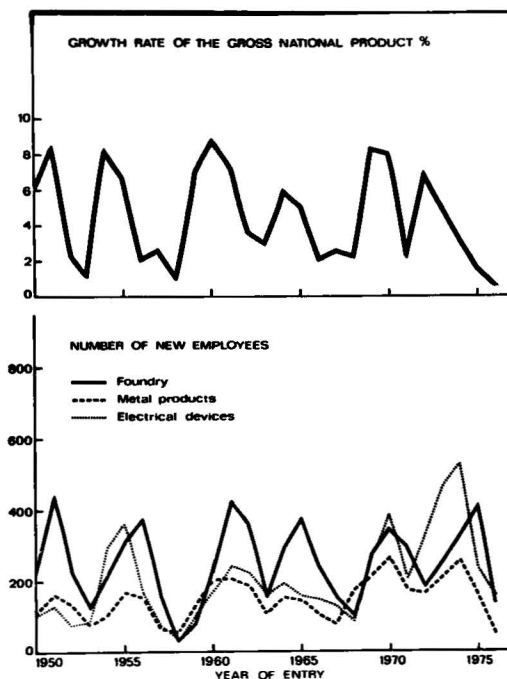


Fig 4. Number of new employees versus growth rate of the gross national product.

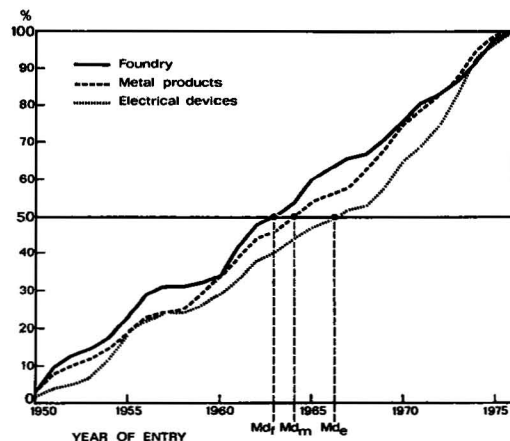


Fig 6. Annual cohort entries expressed as cumulative percentages.

common laborers are excluded from each level because of their high mortality rates, the mortality patterns between the industries do not essentially change.

Since the three levels have different percentages of skilled workers (foundry 45 %, metal products 83 % and electrical devices 76 %), social selection was expected to vary.

Economic fluctuations variously regulate entries of new employees into industries (25, 26). The number of new foundry workers varied the most clearly according to the economic cycle. The number of new metal workers showed the least variation (fig 4).

It was supposed that employees who enter industry during economic recessions are socially selected and vice versa (fig 5). The survival of foundry workers before the age of 65 was better for those who started this work during economic recessions than for those who started during periods of economic growth. The reversed mortality pattern at older ages originated in typical foundry occupations. Besides social selection, the result also reflects health selection among the skilled workers in foundries. The growth and recession curves of the metal product workers were opposite the survival curves of the foundry workers, and they intercrossed correspondingly at the age of 65. The higher mortality in the older age groups among workers who started a specific type of work during periods of economic growth originated from laborers and nontypical metal product workers. However, laborers in the metal product industry had lower mortality rates than laborers in foundries. Metal product workers seemed to be a socially and, also to some extent, a health selected group. Electrical workers who entered the industry during economic recessions had a slightly but systematically lower mortality than those who entered during periods of growth. The result may be due to negative health selection.

Some other findings support the conclusions concerning social and health selection. For foundry workers, the probability of dying a violent death was 1.5 times that of metal product workers. Foundry workers also had the highest incidence of deaths for which alcohol was mentioned as a contributing cause, where-

as metal product workers had the lowest rate. Electrical workers again showed a different pattern. For the younger age groups the incidence was nearly the same as that of the metal product workers, but for the older groups the incidence was even higher than that of the foundry workers.

The total mortality rates and some cause-specific results (eg, tumors) suggest that the older electrical workers probably had an occupational history which differed from that of the younger electrical workers. When the annual cohort entries were compared between the three branches of the metal industry, the cohort comprised of workers who manufacture electrical devices was shown to be younger than the other two cohorts (fig 6). The difference from foundry workers was 3.3

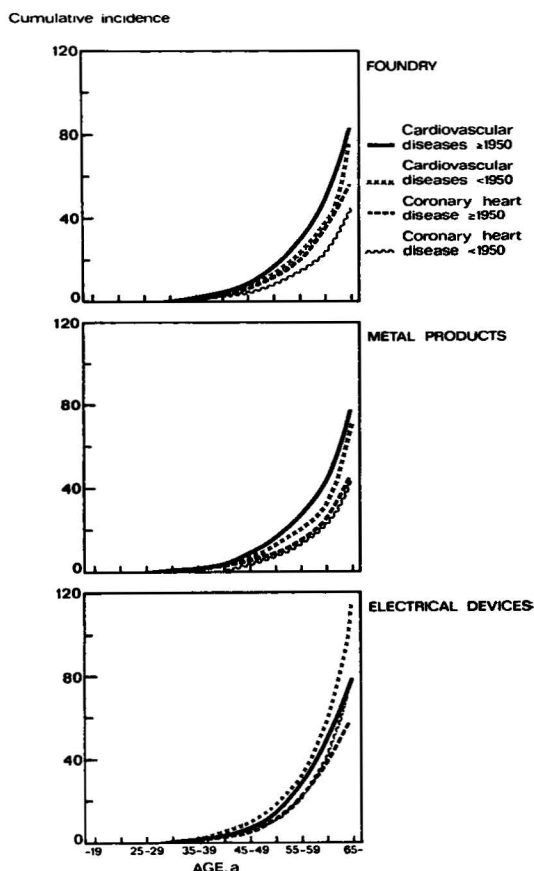


Fig 7. Mortality from all cardiovascular diseases and coronary heart disease. Comparison of the workers who entered the industries in 1950—1976 and those who entered earlier but were still at work in 1950.

a at the medium point. Evidently, the older electrical workers had quite different occupations in their histories, and these

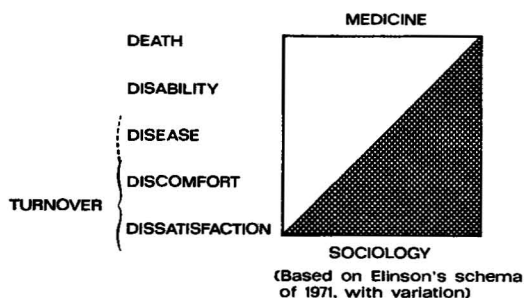


Fig 8. Different stages of disease.

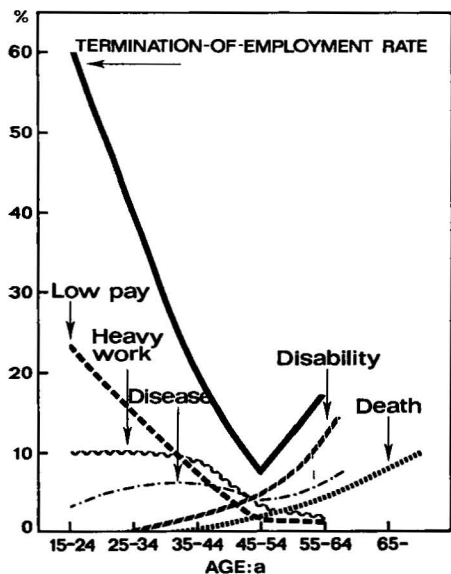


Fig 9. Termination of employment and reasons for termination versus age.

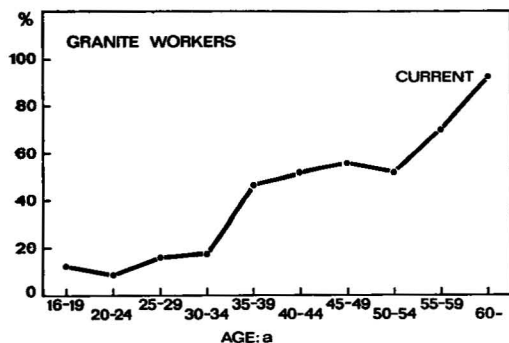


Fig 10. Percentage of current granite workers who were remitted to further examination in another study.

occupations were closer to the heavy than to the medium level.

Health selection during employment was indicated by the results concerning mortality from all cardiovascular diseases combined and coronary heart disease separately (fig 7). The cumulative incidences were compared to those of the cross-sectional cohorts which included workers who were occupationally active in 1950 but who had been hired earlier, ie, highly selected groups. The younger cohort of foundry workers showed a higher mortality from cardiovascular diseases than the older cohort. The difference occurred mainly in the mortality from coronary heart disease. The metal product workers showed a similar difference between the cohorts, but coronary heart disease did not explain the difference. Electrical workers again showed an opposite model. The older cohort had higher cumulative incidences than the younger one. This result suggests that health selection during employment was low.

The results presented in this report are preliminary, and they will be adjusted according to the total occupational histories gathered in questionnaire studies. Furthermore, the results cannot be correctly interpreted without smoother measures than mortality, because different stages of disease form only one dimension (dissatisfaction — death) (fig 8) (23). Smooth and hard measures follow each

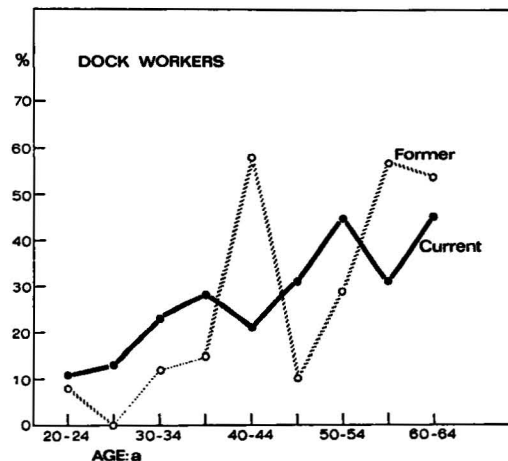


Fig 11. Percentage of current and former dock workers who were remitted to further examination in another study.

other as explanations of the termination-of-employment rate (fig 9) (14).

In the same way that low mortality rates in some occupations are compensated for by higher rates in other populations, the prevalence rates of diseases depend on the termination of employment. If the possibility of turnover is small, the prevalence of findings rises almost linearly with age in a group of current workers; one example of such occurrence is the group of granite workers presented in fig 10 (1, 3). But if the possibility of turnover is high, the prevalence rate shows a decline at a certain age (40–44 a of age in the case of the dock workers in fig 11). This decline is compensated for by a corresponding increase in the group of former workers of the same age. Presumably, this culmination age point is different for the three levels of exposure (4, 24).

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