

Overview of Finnish epidemiologic studies on occupational cancer

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Finland has a population of 4.7 million, of which 2.2 million are economically active. During the past three decades the economic structure of the country has been rapidly changing. The proportion of workers in primary production has steadily decreased, while that of service and industrial workers has increased. In 1975 the majority of the occupationally active population received their income from manufacturing (26 %), community, social and personal services (22 %), trade, restaurants and hotels (16 %), agriculture and forestry (14 %), construction (8 %), transport, storage and communication (7 %), and financing and other business services (5 %). The registration of the population of Finland is maintained by the Population Register Center and is complete for all practical purposes.

The Finnish Cancer Register was founded in 1952 (25), and its coverage is good because the reporting of cancer cases to the Register is obligatory. Consequently, Finland has good conditions for epidemiologic cancer research, and researchers have been active in this field (25). Nevertheless, the study of the relationship between occupational exposures and cancer occurrence was not begun until the 1970s. During the last 10 a interest has been focused on

several exposures and cancer types in both cohort and case-referent studies, as well as in some register-based approaches.

Asbestos

Two independent cohort studies (18, 20) on the same population of about 1,000 workers in an anthophyllite asbestos mine showed an excess mortality of about two-fold for lung cancer among exposed workers. One of the studies (20) used national mortality figures as the basis for expected values, and the other (18), in addition to the national values, used a reference group matched for age and sex and drawn from a township 60 km from the mines. This study also considered the smoking habits of the cohorts (19) and showed that smokers had a much higher risk than nonsmokers (risk ratio 1 for nonsmoking nonexposed referents, 1.6 for nonsmoking asbestos workers, 12 for smoking nonexposed referents and 19 for smoking asbestos workers). The most interesting aspect of these studies was that they showed that anthophyllite asbestos is also carcinogenic in man.

Huuskonen (14, 15) studied the mortality of 174 patients with clinically diagnosed asbestosis who had been exposed to various types of asbestos and found both the total mortality (56 observed, 23.4 expected) and the lung cancer mortality (19 observed, 2.1 expected) increased. Only one of the lung cancer cases was a nonsmoker.

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No cases of mesothelioma were found in the cohort studies. A study of 85 mesothelioma cases reported to the Finnish Cancer Register during 1953–1960 (21) revealed asbestos exposure to be present or probable for 9 cases (11 %) and possible for 28 cases (34 %). No exposure was known for 33 cases (40 %), and the occupation was unknown for 12 (15 %). This classification was based on the occupations recorded on death certificates. In addition an interview of the relatives of ten cases revealed asbestos exposure for five of the ten. The author considered it likely that some association between the mesothelioma cases and asbestos existed.

The internationally recognized association between asbestos exposure and cancer, together with national studies showing a similar association, has resulted in strict legislative measures of control with regard to the use of asbestos in Finland.

Foundry work

Foundry work has been suspected of causing cancer for many decades (27). This suspicion was aroused by case reports, clinicopathological series, case-referent studies, and occupational mortality statistics.

The first cohort study confirming this risk was Finnish (16). In this study the mortality of 3,876 foundry workers in steel, iron, and nonferrous foundries with an exposure period of at least three months between 1950 and 1972 was studied. The standardized mortality ratio (SMR) for all causes of death was 90, but for lung cancer it was 150. A closer analysis of the material revealed that the excess was confined to iron foundries in which workers with at least 5 a of exposure had an SMR of 270 for lung cancer.

A second study (30) comprising 3,425 iron foundry workers with at least 1 a of exposure confirmed the increased risk (51 observed vs 35.3 expected cases, $p < 0.05$), and a case-referent approach within this cohort indicated that the occupational groups most at risk were molders and casters. Evidence suggesting that exposure to polycyclic aromatic hydrocarbons might be the cause of the excess lung cancer risk was also found. This conclusion was based

on the observation that heavy exposure to benzo(a)pyrene was more common (risk ratio 1.7, not significant) among the lung cancer cases than among referents drawn from the cohort. Excess lung cancer risk of iron foundry (5, 6) and steel foundry (8) workers has been shown in other studies in the United States and Canada as well.

Rubber work

A cancer incidence and mortality study of workers in the biggest rubber plant of Finland, which employs about 80 % of the rubber workers in Finland, was recently completed (Kilpikari & Kilpikari et al, to be published). The cohort of 1,331 workers exposed after 1945 was followed for cancer incidence in the Finnish Cancer Register during 1953–1976. The observed number of 21 cases did not differ statistically significantly from the expected figure (18.9). The site-specific cancers were not statistically significantly increased either, but the highest difference for the observed and expected values was for urinary bladder cancer cases (2 vs 0.3). Although the total material did not yield statistically significant differences, analysis by department revealed a cluster of five cases among operators of a mixing machine (risk ratio 16.7, $p < 0.01$). The risk of cancer increased with the length of the follow-up but did not reach statistical significance. The results of the mortality study on male workers (Kilpikari, to be published) were similar with regard to cancer risk, ie, no statistically significantly increased risk could be demonstrated. The SMR for all causes of death was 70. In spite of the lack of statistical significance of the differences, the results were interpreted as indicating that cancer risk was increased among Finnish rubber workers. This conclusion was mainly based on the analysis of the literature and the congruence of the results of the study with previous reports. In addition, in an independent case-referent study on bladder cancer, there had been more rubber workers among the cases than among the referents (rubber and leather, 12 vs 5, respectively), although this difference was not statistically significant either (31).

Trichloroethylene

From the files of a biochemical laboratory performing trichloroacetic acid determinations on urine and from some other sources, a cohort of 2,117 workers exposed to trichloroethylene at some time between 1963 and 1976 was identified and followed for mortality (32). Both the total mortality (SMR 69) and the cancer mortality (SMR 77) were lower than expected. Because of the young age structure of the subjects and the brief follow-up time, the results cannot be interpreted as evidence against the carcinogenicity of trichloroethylene, except for a short latency period and high risk. This material will be followed and analyzed again after 5 a.

Mortality studies on occupational cohorts

In addition to the studies specifically aimed at revealing suspected cancer risk in some industries, several mortality studies on different occupational groups have not found excess cancer risk. Such occupational groups include cotton workers (17), dock workers (2), forestry workers (22), granite workers (1), locomotive engineers (10), physicians (3), and viscose rayon manufacturers (12).

Childhood cancer

The observation of Fabia & Thuy (7) that a "hydrocarbon-related" occupation of the father could be a risk indicator for malignant neoplasms in offspring prompted a case-referent study on the topic also in Finland (9). This study included 852 cancer cases from the Finnish Cancer Register and 852 referents matched for date of birth and domicile. The father's occupation was ascertained from the records of maternity clinics. This study revealed no statistically significant association between the most common types of childhood cancer and the occupation of the father. Similar results from the United States have recently been published as well (33).

The association between parental occupation and childhood cancer has also been studied in another case-referent study. This study was based on cancer incidence

data for cancers diagnosed at ages 13 and less and reported to the Finnish Cancer Register between 1959 and 1975 (11). The total number of patients was 948, of which 319 were leukemia cases and 282 brain tumor cases. Information on the parents' occupations was collected from the records of the maternity clinics attended by the mothers during pregnancy. The reference group comprised the children born directly after the cases (or, for part of the material, the children born directly before and directly after the cases) within the same maternity clinic districts. When the occupational distributions were compared in terms of industrial branch for the mothers of the cases and referents, only one maternal occupational group, that of farmer's wife, was statistically significantly more common among the cases ($p < 0.05$). For smaller occupational subcategories of mothers, the food industry was also statistically significantly over-represented among the cases. Other occupations more common among the mothers of the cases were commercial and sales work, and also agricultural, gardening and forestry work. In addition an analysis employing a more-detailed job description revealed a significant excess of pharmacists (odds ratio 3.2) among the mothers of cases. Statistically significantly decreased odds ratio estimates were noted for housewives. For paternal occupations, increased odds ratios were revealed for the children of agricultural, gardening and forestry workers and for children of men listing only their academic degree in place of occupation. Statistically significantly decreased odds ratios were found for children of miners, students, industrial workers, and construction workers. In a more-detailed occupational analysis, the children of farmers and painters were under a significantly increased risk of cancer.

This study not only noted maternal and paternal occupations with possible chemical exposure but also many associations with no plausible explanation. The large number of comparisons makes the probability of chance correlations quite high, and thus interpreting the results is difficult. Occupation is also a rather poor indicator of specific exposure. Since the association of antenatal occupational expo-

sure and childhood cancer is theoretically possible and has not been the subject of much research, such studies from other countries are needed. If performed, they should seek more-detailed chemical exposures.

Bladder cancer

The occupational histories of 180 cases of cancer of the urinary bladder were compared in a questionnaire study with those of a reference group matched for age and sex (31). The cases were drawn from the Finnish Cancer Register for 1975–1976, and they represented the most industrialized areas of Finland. The referents were noncancer patients from the same hospitals. Smoking was statistically significantly more common among the cases than among the referents. There were also more concrete and cement-exposed workers among the cases than among the referents (9 vs 1), but this difference was not statistically significant. Nor were there any other statistically significant differences in occupational exposure between the cases and the referents. Nevertheless, exposure to textiles, paints, and pigments was more common among the cases than among the referents (20 vs 16), as was exposure to leather and rubber (12 cases vs 5 referents). Occupations without chemical exposure were evenly distributed between the cases and the referents. This finding indicates that occupational exposure has probably not been a major factor in the etiology of bladder cancer in Finland. Nevertheless, the small size of the sample and the insensitivity of the postal questionnaire, as well as possible information bias with the questionnaire approach, may explain the seemingly negative results of this study.

Nasal cancer

The occupational histories of all cases of cancer of the nose and paranasal sinuses reported in central and southern Finland (to the Finnish Cancer Register) between 1970 and 1973 were studied with the aid of postal questionnaires (29). The reason for this geographic choice was that most of the Finnish wood industry, including

the furniture industry, is situated in this area. Information was available for 45 cases, which were compared with referents matched for age and sex and selected from patients whose cancer was not respiratory in the Finnish Cancer Register. There were no cases with a history of exposure to nickel or chromium, and no occupational group was statistically significantly overrepresented among the cases. Among the histologically verified cases, there were two adenocarcinomas, one in a joiner who had been exposed to oak dust for several years. Knitting during leisure time was statistically significantly more common among the female cases. Nasal trauma and infections were also statistically significantly overrepresented among the cases, but it is difficult to exclude the possibility of the infections being a sign rather than an etiologic factor of nasal cancer. This pilot study is now being followed by two more specific studies. One is an inter-Scandinavian prospective case-referent study on the etiology of nasal cancer using the interview technique, and the other is a study of the occupations of all histologically verified cases of nasal adenocarcinoma reported to the Finnish Cancer Register during 1952–1976. The results of both studies will be reported in 1982.

Occupational mortality and cancer incidence statistics

In addition to specifically designed analytical epidemiologic studies on occupational cancer, two sets of national statistics have recently been published which may be of interest to those studying the relationship between occupational exposures and cancer occurrence. The occupational mortality statistics in 1971–1975 (24), comprising 8,515 men and 6,154 women between the ages of 35 and 64 a, revealed an excess cancer mortality among males for miners and quarry men and workers in industry. Among women excess cancer mortality was found in administrative, managerial, and clerical workers.

When male cancer cases were considered according to cancer type, lung cancer mortality differed statistically significantly between different occupational groups. The highest SMRs were 225 for mining

and quarrying; 190 for construction work; 188 for unskilled work; 170 for food production; 153 for forestry work; 146 for chemical processing; 145 for sheet metal work, welding, plumbing, and construction metal work; 143 for the use and service of work machines and stationary engines; 136 for fitting-assembling and machine and motor mechanic work; 135 for construction carpentry; and 122 for unskilled construction work. The lowest SMRs were for public administration (SMR 45), technical work (SMR 56), and farming (SMR 69). A similar occupational distribution of lung cancer incidence has also been published recently (23).

Although smoking may explain many of the differences, it is improbable that all the differences, especially the largest ones, between occupational groups would be explained only by smoking, since smoking is relatively evenly distributed between different occupational groups (4, 28). Other causes should be sought in more specific epidemiologic studies. For some occupational groups with high SMRs, occupational causes for excess cancer risk are already known on the basis of existing epidemiologic data from other countries. Examples are ionizing radiation in mining and asbestos in plumbing. For women the most common tumors, uterus and breast cancer, were more frequent among women in clerical occupations and less frequent for women in agricultural occupations than in other groups. There was an excess mortality for the group "other malignant neoplasms" among those working with hygiene and cosmetics, those in clerical work, and those employed in sectors of the communications industry.

There is still another recently published approach which may be of some relevance in connection with studies on occupational cancers, namely, the municipality-based ecological analysis of the relationship between different indicators of the way of life and cancer incidence (26). In this study, several characteristics referring to geography and urbanization, population, standard of living, and occupation were derived from the 1950 and 1970 censuses, as well as from some other sources, and these were correlated with the cancer incidence data on the municipality level.

The results with regard to occupation were generally rather nonspecific. Farming and forestry had a negative association with cancer in most instances and the reverse was true for industrial occupations as a group. Nevertheless, both of these occupational groups were also strongly associated with urbanization, and, therefore, their associations with cancer incidence need not reflect true occupational differences in this study.

The analyses for individual industries gave inconsistent values. The lack of specific industrial correlations in this study is of limited value since the individuals with possible carcinogenic occupational exposures constitute only a small section of the population. Even if there were excess cancer risk among some industrial worker groups, it probably would not have any noticeable effect on the incidence of the aggregate populations considered in this review.

A new attempt for the monitoring of occupational cancer risk by exposure is the Register of Workers Occupationally Exposed to Substances and Processes Possibly Causing Increased Cancer Risk (13, Herva & Partanen, unpublished results). This is a central register based on legislative measures which are consistent with the International Labor Organization's convention no 139 and adjoining recommendation no 147, both of 1974. Based on the Finnish Law on Occupational Safety, the Act on the Prevention of Occupationally Induced Cancer was passed in 1975, and a list of substances considered to be sources of carcinogenic risk was promulgated by the Ministry of Social Affairs and Health in 1978 and 1979. Beginning in 1980, employers must send lists of carcinogenic substances, or products containing these substances, and workers exposed to them to the National Board of Labor Protection. In practice, the Register is kept by the Institute of Occupational Health. It has been estimated that the Register will contain the names of more than 20,000 workers and will perhaps provide material for epidemiologic research. The major purposes of the Register are administrative, and it is too early to know if it will really be as useful for research purposes as anticipated.

Concluding remarks

Firm evidence of the association between occupational exposure and cancer occurrence has been shown in Finland for asbestos and iron foundry work. The results with regard to the rubber industry are consistent with the increased risk shown elsewhere, but the material has been small and the differences have not reached statistical significance. The association in Finland between nasal adenocarcinoma and exposure to wood in the furniture industry is under study, but the small number of cases makes the presentation of conclusive evidence difficult. In several industries no excess cancer risk has been demonstrated in mortality studies, but these results should not be interpreted as evidence of the absence of risk since large occupational cohorts may well hide the increased risk experienced by some special worker groups.

Finnish registers of people and cancer incidence are of high quality and have excellent coverage, and consequently they provide a good starting point for epidemiologic research. Nevertheless, there are also some major impediments for the etiologic study of occupationally induced cancer in Finland. These are (i) the small number of exposed workers and the quite rapid turnover, in several occupations, that results in relatively short periods of exposure and (ii) the relatively recent establishment of many industries, in particular the chemical industry, and the rapid changing of the economic structure of the country. Therefore, new epidemiologic projects on occupationally induced cancers presuppose critical planning in order to be scientifically effective.

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