

to be slightly above expectancy (SPIR 115) (figure 8.4), due mainly to a significant excess risk of 32 cases observed and 20.9 expected for the spinning, weaving and finishing of textiles (SPIR 153). Even though a deficit of cases was observed among the women in trade, restaurants and hotels (figure 8.5), an excess risk was detected in that part of retail trade manufacturing clothing and leather goods (SPIR 135), with 60 intestinal cancers observed and 44.6 expected (95 % CI 105—173).

Finally, figure 8.6 gives the risks among selected subgroups of male employees in financing, insurance and real estate and in community, social and personal services. Most of the employees in these areas of business experienced risks above or close to average expectancy.

Liver

Primary liver cancer (ICD-7 155.0) is a rare malignancy in Denmark (as in the rest of northern Europe, the United Kingdom and North America), accounting for approximately 1 % of all malignant tumors in the country (48). The age-standardized incidence rates are 3.4/100 000 men and 2.2/100 000 women (world standard), with a male:female sex ratio of 1.5:1. Although subject to incomplete tumor ascertainment, a substantial increase in the incidence of primary liver cancer has apparently taken place in Denmark since the start of the Cancer Registry in 1942 — among both men and women (158).

In many parts of the world, especially in Africa and Asia, primary liver cancer is the leading cause of death (111). Hepatitis B virus is thought to be the most important factor in the predominant type of liver cancer, hepatocellular carcinoma (53). Together with aflatoxins, which occur widely in the diet and environment of millions of people in the Third World, the hepatitis B virus may prove to be a factor that can be controlled. In the industrialized world, alcohol consumption is highly correlated with cirrhosis and with risk of liver-cell carcinoma (109, 124), and in a Danish study of brewery workers who were entitled to consume an allotment of beer every workday, both an excess risk of primary liver cancer and an increased risk of dying from liver cirrhosis were observed (88).

Hepatic angiosarcoma, which is a very rare type of primary liver tumor, has been causally associated with occupational exposure to the vinyl chloride monomer (16). This tumor is also caused by thorotrast, a radioactive diagnostic substance (77), and in one study it was associated with exposure to inorganic arsenical insecticides (165). Other reports have described an increased risk of primary liver cancer in association with oral contraceptive use (99) and with treatment with androgenic-anabolic steroids (153).

Findings. Of the patients included in the study, 1 377 had a primary cancer of the liver. For 796 of these (587

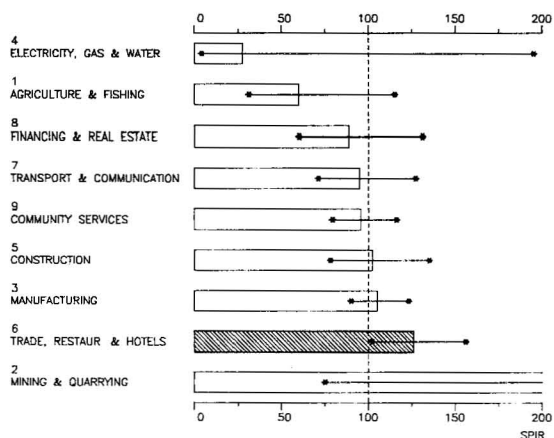


Figure 9.1. Risk of primary liver cancer among the men.

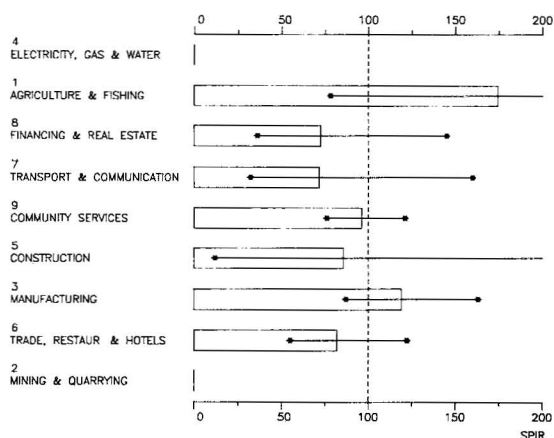


Figure 9.2. Risk of primary liver cancer among the women.

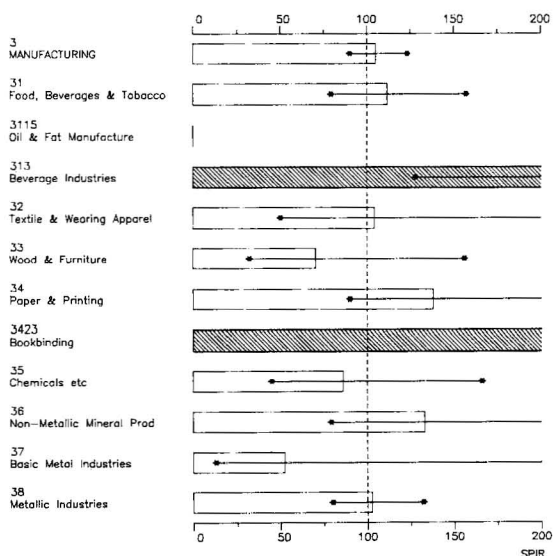


Figure 9.3. Risk of primary liver cancer among the men.

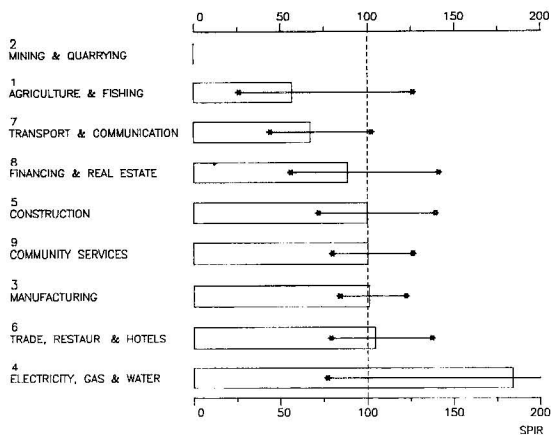


Figure 10.1. Risk of cancers of the biliary tract among the men.

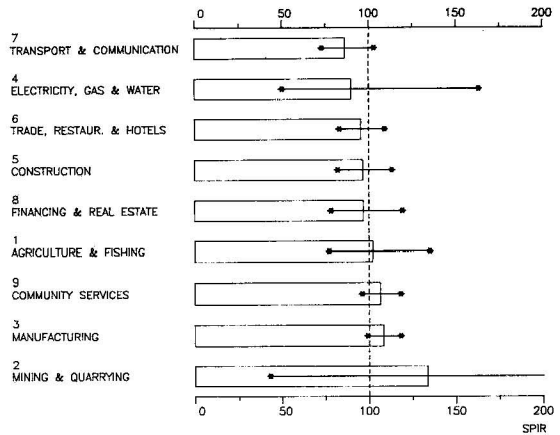


Figure 11.1. Risk of cancer of the pancreas among the men.

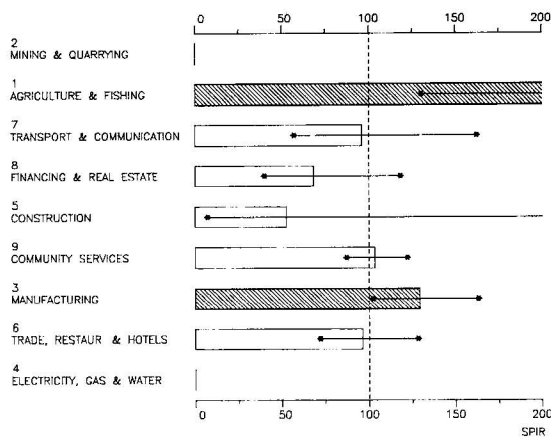


Figure 10.2. Risk of cancers of the biliary tract among the women.

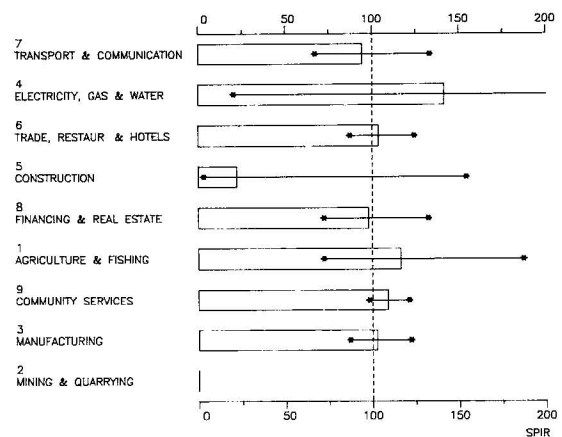


Figure 11.2. Risk of cancer of the pancreas among the women.

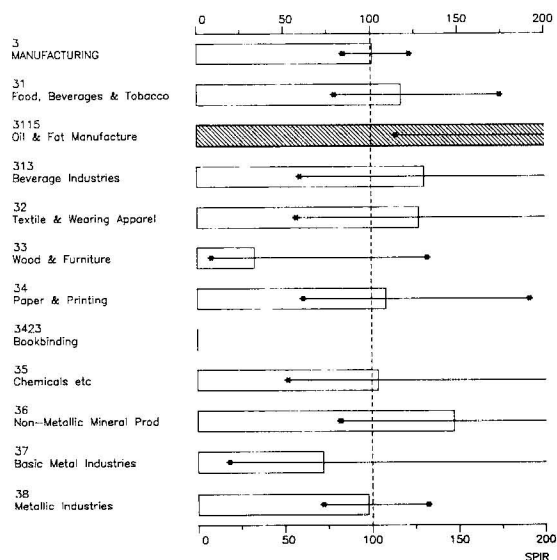


Figure 10.3. Risk of cancers of the biliary tract among the men.

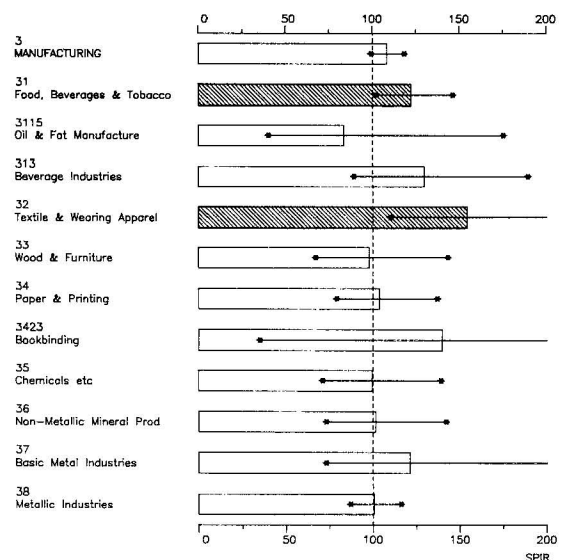


Figure 11.3. Risk of cancer of the pancreas among the men.

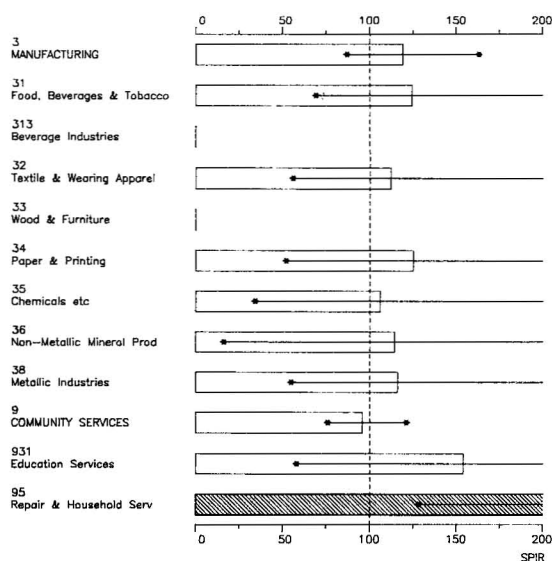


Figure 9.4. Risk of primary liver cancer among the women.

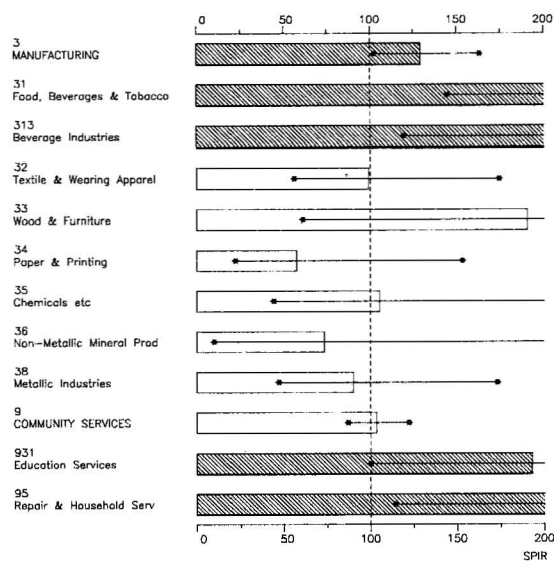


Figure 10.4. Risk of cancers of the biliary tract among the women.

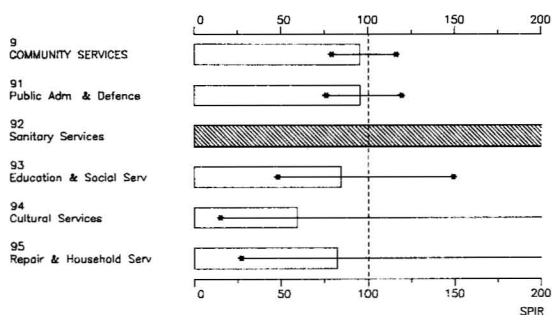


Figure 9.5. Risk of primary liver cancer among the men.

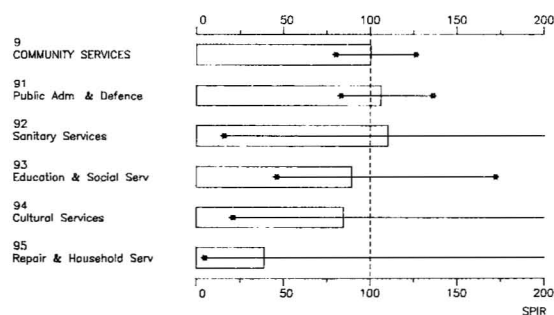


Figure 10.5. Risk of cancers of the biliary tract among the men.

men and 209 women), an occupational history was available in the Supplementary Pension Fund (table 4).

Male employees in the main industrial branches of construction (SPIR 102), manufacturing (SPIR 105), and trade, restaurants and hotels (SPIR 126) showed slight to moderate excess risks of liver cancer (figure 9.1). Among the men in the last-mentioned industry, a significantly elevated SPIR was detected, with 86 liver cancers observed and 68.2 expected (95 % CI 102–156). Deficit numbers of cases were seen in the other main branches, but none was significantly below expectancy.

Figure 9.2 gives the corresponding risk estimates for the women. Except for the employees in community, social and personal services (SPIR 96), manufacturing (SPIR 119), and trade, restaurants and hotels (SPIR 82), the numbers were small, and no significant deviation from unity was seen.

In the subgroup of male employees in manufacturing (figure 9.3) two occupations were distinctly different from the rest. Employment in the beverage industries,

which are mainly breweries, and in bookbinding entailed an SPIR of 216 (14 cases observed and 6.5 expected) and 834 (4 cases of primary liver cancer and 0.5 expected), respectively. Among the women in manufacturing (figure 9.4) no outstanding deviation was seen in any subgroup.

Although the overall risk of liver cancer in community, social and personal services was slightly below average for both sexes, two occupational subgroups attracted special attention. Substantial excess risk was detected for the female employees in repair and household services (SPIR 257), with 8 liver cancer cases observed and 3.1 expected (figure 9.4) and for the men in sanitary services (SPIR 472), with 6 cases observed and 1.3 expected (figure 9.5).

Biliary tract

Cancers of the biliary tract (ICD-7 155.1), including the gall bladder and extrahepatic bile ducts, account for 1.1 % of all cancers in Denmark (48). The age-

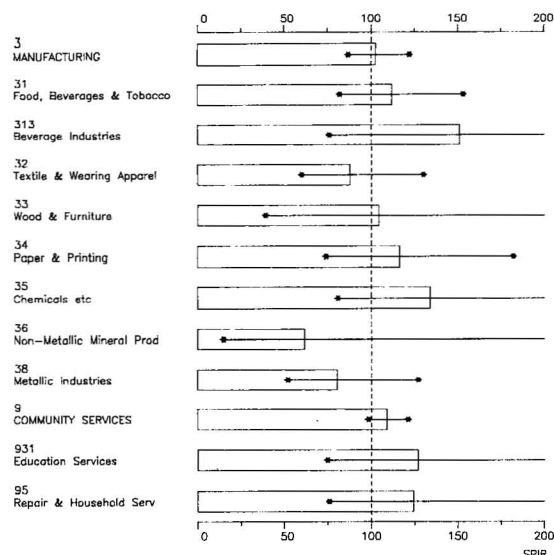


Figure 11.4. Risk of cancer of the pancreas among the women.

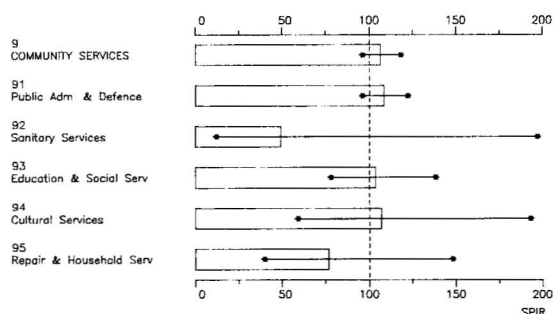


Figure 11.5. Risk of cancer of the pancreas among the men.

standardized incidence rates are 1.9/100 000 men and 2.9/100 000 women (world standard), yielding a male:female sex ratio of 0.6:1. In the 1940s, 1950s, and 1960s an annual increase in incidence of about 5 % among men and 3 % among women has taken place. However, since the mid-1970s, a decrease in incidence has been observed among both sexes (158).

For a significant number of cases of gallbladder cancer, there is a positive medical history of gallstones, indicating either a causal relationship or common risk factors (57). No clear-cut socioeconomic gradient in the occurrence of cancers of the biliary tract has been described.

Only limited evidence is available for a role of occupational exposures. At least two studies have reported excess risks of gallbladder and bile-duct cancers among rubber workers (101, 122). Elevated risks of these tumors among textile and metal workers, and in the aircraft, chemical and wood-finishing industries, have also been suggested (101).

Findings. Of the patients included in the study, 1 830 had a cancer of the biliary tract. For 789 (422 men and 367 women) an occupational history was available in the Supplementary Pension Fund (table 4).

Figure 10.1 shows the risks of cancers of the biliary tract among the men employed in the nine main branches of industry. Nonsignificant deficits were observed in agriculture, forestry and fishing (SPIR 57), transport, storage and communication (SPIR 68), and financing, insurance and real estate (SPIR 89). Except for employees in electricity, gas and water supply, for whom a nonsignificant excess risk (SPIR 184) was seen, the risks of cancer of the biliary tract in the other main industrial groups were close to expectancy.

For the women (figure 10.2) excess risks for these tumors were detected in the main trades of agriculture, forestry and fishing (SPIR 219), with 14 cases observed and 6.4 expected (95 % CI 130–370), and in manufacturing (SPIR 129), with 70 cases observed and 54.1 expected (95 % CI 102–163). A nonsignificant deficit was observed among the women employed in financing, insurance and real estate (SPIR 69).

Figure 10.3 gives the risk of cancers of the biliary tract among selected subgroups of male employees in manufacturing. For those engaged in the manufacture of vegetable and animal oils and fats, a significant excess of 5 cancers of the biliary tract was discovered as compared to 1.8 expected (SPIR 274, 95 % CI 114–658). For the women in manufacturing (figure 10.4) an elevated risk was observed in relation to food manufacturing (31 cases observed and 15.1 expected, SPIR 205), due mainly to significant excess risks in the beverage industries (SPIR 264, 6 cases observed) and in the manufacture of bakery products (SPIR 247, 6 cases observed). (See the appendix.)

No excess was detected in the metal or textile industries, among either the women or the men (figures 10.3 and 10.4). There were too few cases to yield reasonable confident risk estimates among the employees in the manufacture of wood and wood products.

A marginally significant excess of 9 cancers of the biliary tract was detected for the female employees in educational services, as compared to 4.7 expected (SPIR 193), and a significant excess of 11 cases was observed for the women in repair and household services, with 5.4 expected (SPIR 205) (figure 10.4). No significant deviation from expectancy was detected in the subgroup of male employees in community, social and personal services (figure 10.5).

Pancreas

Pancreatic cancer (ICD-7 157) is a relatively common malignancy in northern Europe and the United Kingdom, accounting for a little more than 3 % of all malignancies in Denmark (48). The age-standardized incidence rates are 9.0/100 000 men and 6.9/100 000 women (world standard), yielding a male:female sex

ratio of 1.3:1, which is below the 50 % higher excess risk observed for men in most parts of the world (199). Although changes in diagnostic criteria for this category of cancer may obscure the true incidence trend, a dramatic increase in incidence was observed in the calendar period 1943—1970, followed by a stagnation or even a decrease among men, but no decrease among women (158). The rates of pancreatic cancer in urban areas of Denmark are consistently higher than those in rural areas, among both men and women (47).

Studies on the etiology of pancreatic cancer are severely hampered by the generally poor histological ascertainment of the disease. However, in descriptive studies of pancreatic cancer, increased risks have been suggested for workers in a number of industries and occupations (119). Only a few such excesses were reported more than once, including those for managers and administrators, paper workers, metal workers, produce workers, timber workers, stationary engineers, dentists, chemists, and electrical workers (119). No common work conditions were obvious for these occupational groups.

Radiation received at the workplace or as medical treatment may play a minor role in the etiology of pancreatic cancer (41, 123, 129). Smoking is the factor most consistently associated with this cancer (31, 95). Alcohol, diet, and coffee drinking have been less well investigated, but studies have suggested that a high intake of animal fat and of coffee are positively connected with the risk of pancreatic cancer (58, 120).

Findings. A total of 5 006 patients eligible for investigation had cancer of the pancreas. Of these 2 759 (1 905 men and 854 women) had been members of the Supplementary Pension Fund (table 4).

Figure 11.1 indicates the small variations in risk of pancreatic cancer determined for the male employees in the main branches of industry. None of the risk estimates deviated significantly from unity. No noticeable deviation from expectancy was observed among the women in any of the main branches of industry (figure 11.2).

The slight (8 %) excess risk seen for the men in manufacturing (figure 11.3) was due mainly to excesses in the manufacture of food, beverages and tobacco (SPIR 122), with 117 cancers of the pancreas observed and 96.0 expected (95 % CI 102—146), and in the textile, wearing apparel and leather industries (SPIR 154), with 33 cases observed and 21.3 expected (95 % CI 110—217). Male employees in the manufacture of grain-mill (SPIR 165) and bakery products (SPIR 159) and in most subgroups of the textile industries were the most prone to this malignancy. (See the appendix.) No significant deviation from unity was observed for the men employed in the remaining subgroups of manufacturing (figure 11.3).

No clear-cut risk pattern was detected for the women in manufacturing (figure 11.4). The slight, nonsignifi-

cant increase in risk of pancreatic cancer for the women in community, social and personal services was due to slight to moderate excesses in most subgroups, of which those in social and related community services reached marginal significance (SPIR 125, 95 % CI 100—156). (See the appendix.)

Although a similar excess risk of pancreatic cancer was recognized for the male employees in community, social and personal services (figure 11.5), no excess in educational and medical services was discernible.

Comments

Esophageal and gastric cancer. The risk distribution of esophageal and gastric cancer in the main branches of industry (figures 6.1 and 7.1) indicates an inverse association with socioeconomic class. Except for esophageal cancer among women, of which there were few cases (figure 6.2), only significant differences were seen between the two sexes in the main branches of industry.

Differences in risk pattern appeared, however, among subgroups of employees. Except for a significantly elevated risk in the beverage industries, most male subgroups within the branch of manufacturing showed risks of esophageal cancer below unity (figure 6.3). Conversely, excesses of gastric cancer were observed in most subgroups of manufacturing, except for a noticeable deficit among the men in the beverage and the paper and printing industries (figure 7.3). These observations indicate that the carcinogenic action of alcohol — perhaps in combination with tobacco — is restricted to the esophagus, and the findings are similar to the results of a large cohort study of male workers in Danish breweries (88). Increased risks of gastric cancer were also observed among the men engaged in the manufacture of vegetable and animal oils and fats (figure 7.3) and among the women in slaughtering and preparing and preserving meat (figure 7.4). Although the number of cases is modest, a common carcinogen, such as animal fats, might be present, as slaughtering also includes the rendering and refining of lard and other edible animal fats.

Other outstanding findings are those among employees in the manufacture of wood and wood products, including furniture. An excess risk for gastric cancer risk was observed among the men, especially in the processing of lumber and wooden building materials (figure 7.3), and among the women, predominantly in the furniture industry (figure 7.4), for which a significant excess risk of esophageal cancer was also observed (figure 6.4).

The fact that employees in trade, restaurants and hotels appear to have an increased risk of esophageal cancer and a decreased risk of gastric cancer is explained by the excessive risk of esophageal cancer among employees in restaurants and hotels, especially among the women (figure 6.5 and the appendix), while employees in wholesale and retail trades expe-

rienced decreased risks of both esophageal and gastric cancer. Again, above-average alcohol consumption and tobacco smoking are the most likely explanations for the raised risk of esophageal cancer among the staff of hotels and restaurants. No excess risk was detected among the employees in tobacco manufacturing.

The deficit of cases of cancers of both sites among the men in financing, insurance and real estate and in community, social and personal services may well be ascribed to the preponderance of people of higher socioeconomic classes in these branches.

Intestinal cancer. In line with earlier reports (5, 6), colorectal cancer in Denmark seems to be associated with higher socioeconomic classes, the excesses occurring in most subgroups of white-collar workers (figures 8.1, 8.2 and 8.6). In addition, however, women engaged in the spinning, weaving and finishing of textiles (figure 8.4) and in the retail trade of clothing and leather goods also showed excess cases of intestinal cancer. Thus this analysis confirms earlier findings of excessive mortality due to colorectal cancer in occupations associated with yarn, textiles and leather goods (173). Interestingly, an excess risk of esophageal cancer was also observed among women employed in the clothing and leather goods trade (figure 6.5).

On the whole, intestinal cancer rates do not appear to be influenced greatly by occupational exposures (figures 8.3 and 8.4).

Cancers of the liver, biliary tract and pancreas. The observed distribution of cases among the men in the main branches of industry were fairly similar for liver cancer and cancers of the biliary tract (figures 9.1 and 10.1), but different from the distribution of pancreatic cancer (figure 11.1). The risk patterns for the women (figures 9.2, 10.2, and 11.2) were different from those of the men, especially in agriculture, forestry and fishing, for which deficits of cancers of the liver and biliary tract were observed among the men and excesses appeared among the women.

An earlier Danish study indicated a 50 % excess risk of liver cancer for male members of the Danish Brewery Workers Union (88). The present study confirms this observation, indicating an SPIR value of 216 among the male employees of the beverage industries (figure 9.3). Nonsignificant excesses of cancers of the biliary tract and pancreas were also observed (figures 10.3 and 11.3). No case of liver cancer was detected among the women in this industrial branch, although the analysis revealed a significantly elevated risk of cancer of the biliary tract and a nonsignificant excess of pancreatic cancer (figures 10.4 and 11.4).

Figures 10.3, 11.3, 10.4, 11.4, and the appendix also indicate elevated risks of cancers of the biliary tract and pancreas among the male employees in food manufacturing, most remarkably among the men involved in oil and fat manufacturing, with an excess

risk of cancer of the biliary tract (figure 10.3). This group also had an excess risk of gastric cancer (figure 7.3).

An increased risk of liver cancer was seen among male bookbinders (figure 9.3), for whom the handling of glue, solvents and similar chemicals may be of etiological importance.

The use of chemicals for cleaning might also be involved in the excess risks of cancers of the liver and biliary tract seen among the employees in repair and household services (figures 9.4 and 10.4). Similar considerations may apply to the observed excess of liver cancer among the male employees in sanitary services (figure 9.5).

Respiratory system

Nasal cavities and sinuses

Cancers of the nasal cavity and paranasal sinuses (ICD-7 160) account for only about 0.2 % of all cancers in Denmark (48). The age-standardized incidence rates are 0.8 and 0.5/100 000 for men and women, respectively (world standard) (146). During 1943–1980 the increase in the incidence of these tumors has been 6–7 % per year, but only among men (148).

Several occupations and industrial exposures have been associated with increased risks of cancers of the nasal cavity and paranasal sinuses. Due to the rarity of these tumors in the population at large, the identification of high-risk groups has frequently been based upon the recognition of a few cases with an attendant high incidence rate in an exposed group (162).

A firm association has been established between employment in the furniture-making industry in Europe and North America and the occurrence of nasal adenocarcinomas (2, 118, 160). The excess risk occurs (mainly) among those exposed to wood dust (86). Woodworkers operating outside the furniture-making industry also seem to be at risk, even when exposed exclusively to soft wood (72).

Numerous epidemiologic studies of populations of workers involved in nickel refining clearly show excess incidences of cancer of the respiratory system, including cancer of the nasal cavity and paranasal sinuses (86). Only limited data are available on the effect of long-term exposures to nickel dusts and aerosols in manufacturing processes, such as the production of stainless steel and high nickel-steel alloys (162). According to an IARC working group evaluating the carcinogenic risk of chemicals to humans, it is not possible to state with certainty which specific nickel compounds are human carcinogens, although metallic nickel seems less likely to be so than nickel subsulfide or nickel oxides (86).

Relative risks well in excess of 10-fold have been reported in the boot and shoe manufacturing industries in the United Kingdom and Italy (1, 30, 85). The distribution of the cases within these industries strongly

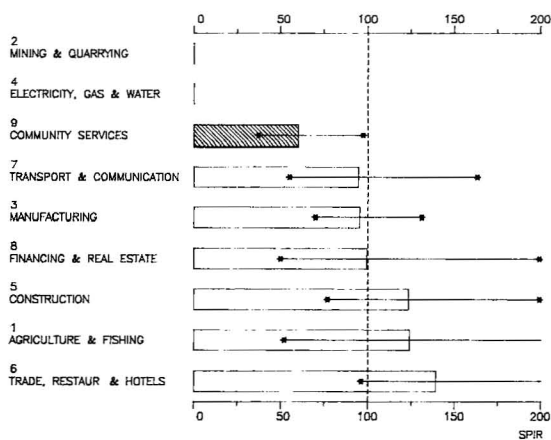


Figure 12.1. Risk of sinonasal cancer among the men.

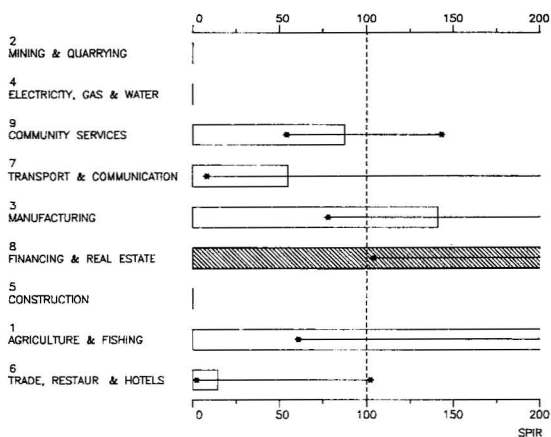


Figure 12.2. Risk of sinonasal cancer among the women.

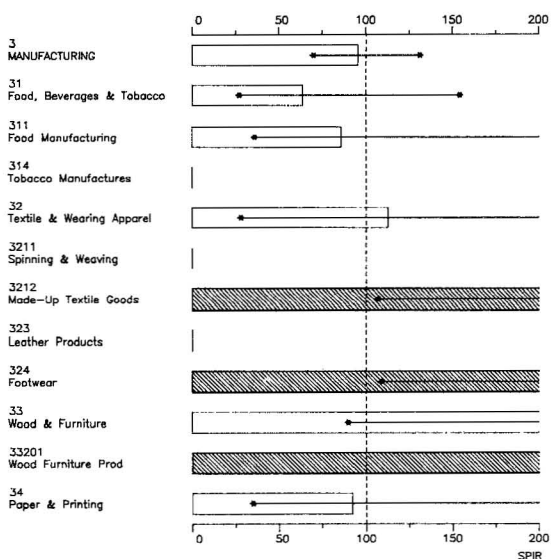


Figure 12.3. Risk of sinonasal cancer among the men.

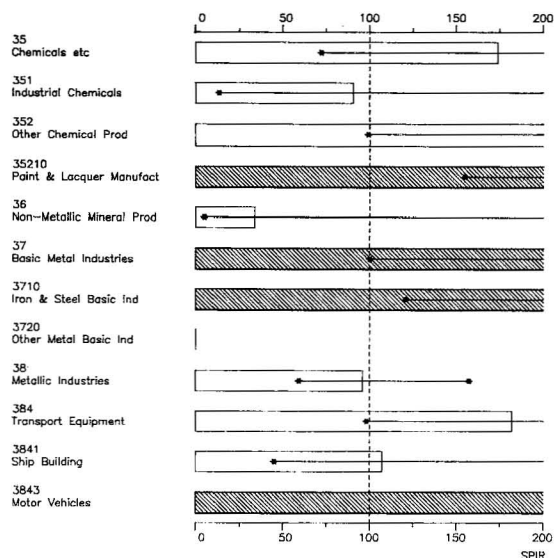


Figure 12.4. Risk of sinonasal cancer among the men.

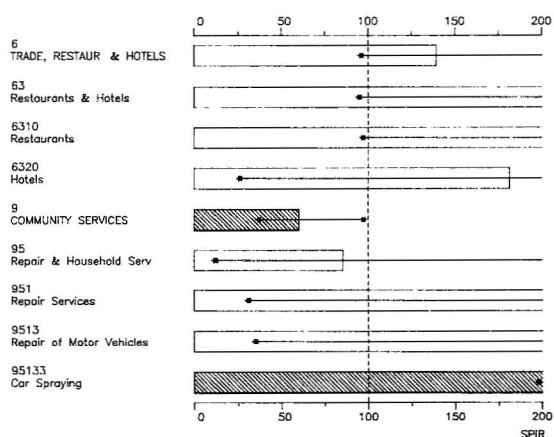


Figure 12.5. Risk of sinonasal cancer among the men.

suggests that exposure to leather dust plays a role in the association (86).

The manufacture of isopropyl alcohol by the strong-acid process is associated with an increased incidence of cancer of the paranasal sinuses (79, 114). Several studies have shown excess mortality from respiratory cancer among people exposed to mustard gas, particularly in the production process (193). Although metallic chromium is biologically inert, several chromium compounds are corrosive to human tissues. Their effects include ulceration of the skin and ulceration and perforation of the nasal septum. An increased incidence of lung cancer has been observed in the chromate-producing industry, and a few studies suggest an excess risk of cancers of the nasal cavity and paranasal sinuses among workers involved in the manufacturing of chromate pigments (79, 107).

Exposures in the textile industry, to radium, and in chemical and petroleum manufacturing have also been implicated in the etiology of nasal cancer (3, 20, 155). Recently, it was suggested that both formaldehyde exposure and cigarette smoking might increase the risk of cancer of these sites (22, 151).

Findings. Only 300 persons included in the study had had a cancer of the nasal cavity or paranasal sinuses, of which 211 (161 men and 50 women) were listed in the files of the Supplementary Pension Fund (table 4).

Figure 12.1 shows that the risk of sinonasal cancer among the men was below expectancy within the main branches of community, social and personal services (SPIR 60), transport, storage and communication (SPIR 94), and manufacturing (SPIR 95). The deficit was significant only among the employees in the first branch, with 17 observed cancer cases compared to 28.2 expected (95 % CI 37–97). Nonsignificant excesses were seen in the main branches of construction (SPIR 123), agriculture, forestry and fishing (SPIR 121), and trade, restaurants and hotels (SPIR 139). Even in the main branches of industry, the numbers of female cases of sinonasal cancer (figure 12.2) were too small to yield reasonably accurate risk estimates. In the branch of financing and real estate, 6 cases were observed among the female employees and 2.3 were expected.

Despite the slight deficit of cases among the men in manufacturing, several subgroups had excess risks of cancer of the nasal cavity and paranasal sinuses (figure 12.3 and 12.4). Thus, 5 cases were detected in wooden furniture production compared to 0.8 expected (SPIR 588, 95 % CI 245–1 414). One case was observed in the manufacture of footwear and one in made-up textile goods compared to 0.1 expected in each subgroup. Two cases were observed among employees engaged in the manufacture of paints and lacquers compared to 0.3 expected (SPIR 620, 95 % CI 155–2 480), and an increased risk was seen in the basic iron and steel industries (SPIR 376), with 3 cases observed and 0.8 expected (95 % CI 121–1 161), and, most notably, in the manufacture of motor vehicles (SPIR 745), with 5 cases of sinonasal cancer observed and only 0.7 expected (95 % CI 310–1 790). No case was discovered in the manufacture of wood and wood products other than furniture. (See the appendix.)

Even though a significant deficit of cancer of the nasal cavity and paranasal sinuses was detected among the men in the main branch of community, social and personal services (figure 12.5), 1 case was observed in car paint-spraying compared to 0.07 expected (SPIR 1 403).

Larynx

Laryngeal cancer (ICD-7 161) accounts for 1.0 % of all cancer cases in Denmark (48). The age-standardized

incidence rates are 5.4/100 000 for men and 0.8/100 000 for women (world standard), with a male:female sex ratio of 7.0:1 (48). During the period 1943–1982, a 350 % increase in incidence was observed among men and a doubling of incidence occurred among women (146).

Epidemiologic studies have clearly shown that tobacco use and excessive alcohol consumption, in particular of strong beverages, increase the risk of laryngeal cancer (10) and that tobacco and alcohol may interact in a multiplicative fashion (171, 205).

Increased risks of cancer of the larynx have been observed in occupations in which asbestos is handled deliberately (86). The process of nickel refining has been linked with cancer of the respiratory tract, including the larynx (154), although it is still not possible to state with certainty which specific nickel compounds are human carcinogens. The manufacture of isopropyl alcohol by the strong-acid process has also been associated with an elevated risk of laryngeal cancer (82). Several studies have revealed increased mortality from respiratory cancer among people exposed to mustard gas (86) and after occupational exposures to soot and tars (83). Men with scrotal cancer, probably induced by cutting oil, subsequently had higher than expected rates of malignancies of the lung and larynx (75, 197).

Findings. A total of 1 632 cases of laryngeal cancer were included in the study, of which 1 212 (in 1 071 men and in 141 women) were covered by the Supplementary Pension Fund (table 4).

Figure 13.1 shows the risk of cancer of the larynx among the men in the nine main branches of industry. Nonsignificant excess risks were detected in manufacturing (SPIR 106) and among the employees in trade, restaurants and hotels (SPIR 116). Except for the male employees in transport, storage and communication, who had a risk close to unity, fewer cases than expected were observed in all the other main branches of industry. In community, social and personal services, the deficit was found to be marginally significant (SPIR 86, 95 % CI 73–100).

The risk pattern for the women in the main branches of industry (figure 13.2) was quite unlike that for the men. However, the number of cases was small due to the relative rarity of this malignancy among women. The risk appeared to be below expectancy in community, social and personal services (SPIR 88) and among the female employees in trade, restaurants and hotels (SPIR 77), and it was above expectancy in manufacturing (SPIR 119).

From figures 13.3 and 13.4 it appears that most of the excess risk observed for the male employees in manufacturing is due to significant excesses in slaughtering (SPIR 173), with 21 cases observed compared to 12.1 expected, in the beverage industries (SPIR 256), with 28 cases observed and 10.9 expected, and in the processing of industrial chemicals (SPIR 181), with 14

cases observed and 7.7 expected. A slight, nonsignificant increase in the risk of laryngeal cancer was detected in the shipbuilding industry (SPIR 116), where exposure to asbestos has been common.

Among the women in manufacturing (figure 13.5), 4 laryngeal cancers were observed in tobacco manufacturing, whereas 0.7 were expected (SPIR 557, 95 % CI 209–1 484). In the manufacture of made-up textile goods, 2 cases were observed and 0.4 expected (SPIR 570).

Figure 13.8 gives the risk of cancer of the larynx among subgroups of male employees in community, social and personal services. Except for the men in sanitary services (SPIR 191), all subgroups were characterized by below-average risk estimates, most strikingly so among the employees in educational, social and medical services (SPIR 54, 14 observed cases, 95 % CI 32–91). A similar risk pattern for cancer of the larynx was seen for the female employees in these branches of industry. (See the appendix.)

Lung and trachea

Cancer of the lung (ICD-7 162) is the most common malignancy in Denmark, accounting for 12.3 % of all cancer cases (18.8 % among men and 5.8 % among women) (48). The age-standardized incidence rates are 56.3/100 000 and 15.8/100 000 for men and women, respectively (world standard) with a male:female sex ratio of 3.6:1 (48). During 1943–1982, the incidence in Denmark increased five times among the men and six times among the women (146).

Cigarette smoking is the major single cause of lung cancer in Denmark, as in most parts of the world. However, several respiratory carcinogens have also been identified in the work environment (56, 83). Thus lung cancer is assumed to be numerically the most important asbestos-related disease, resulting in about 20 % of all deaths in some exposed cohorts (142, 178). Figure 16 shows industrial asbestos consumption in Denmark, 1910–1985 (5). Most of the substance was used in the shipbuilding industry, the construction industry, the production of asbestos cement, and the manufacture of friction materials for brakes in cars and machinery.

An increased risk of lung cancer has been detected among chromate workers and workers in the chrome pigment industry (17, 104); excess risks have also been suggested for chromium platers (166), workers producing ferrochromium alloys (103), and spray painters using chromium pigments (45). The chromium compound(s) responsible has(have) not been specified (83). Workers in nickel refineries, lead smelteries, and battery plants have excess risks of lung cancer, nickel and, possibly, lead being implicated as lung carcinogens (40, 154).

Despite negative results from experimental studies, epidemiologic evidence from several occupational settings indicates that inhaled arsenicals are carcino-

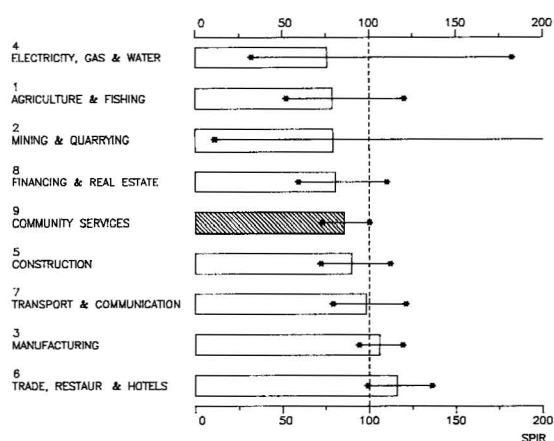


Figure 13.1. Risk of laryngeal cancer among the men.

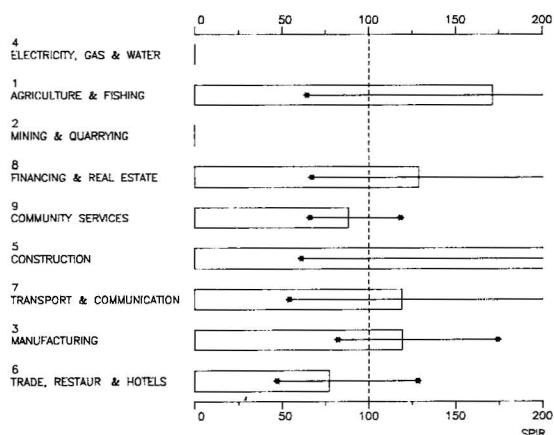


Figure 13.2. Risk of laryngeal cancer among the women.

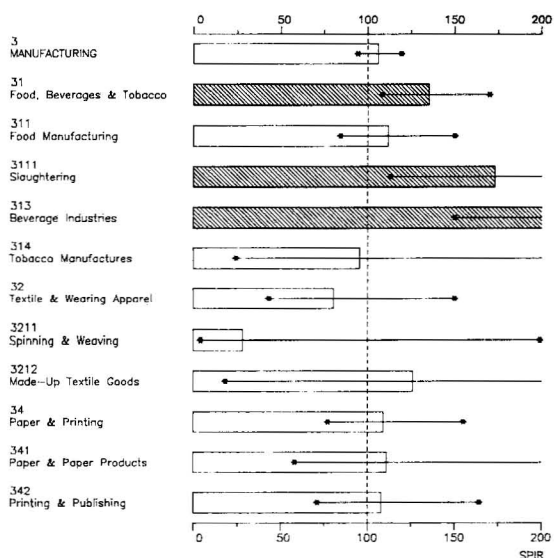


Figure 13.3. Risk of laryngeal cancer among the men.

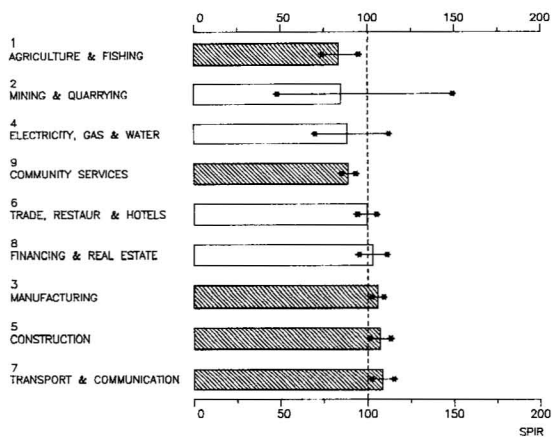


Figure 14.1. Risk of lung cancer among the men.

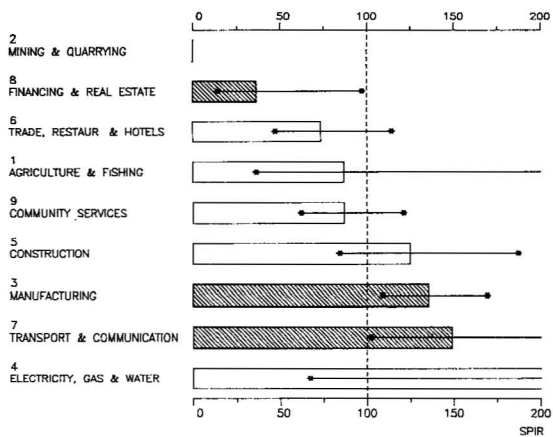


Figure 15.1. Risk of mesothelioma among the men.

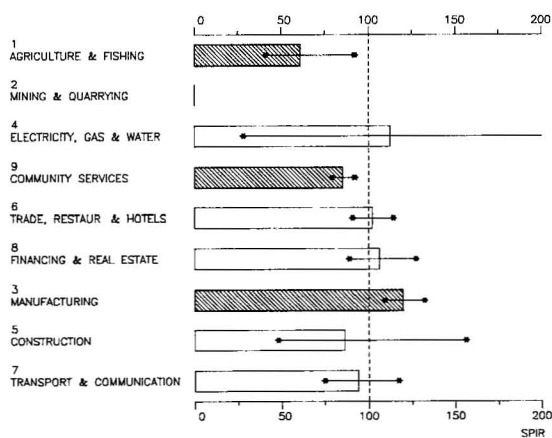


Figure 14.2. Risk of lung cancer among the women.

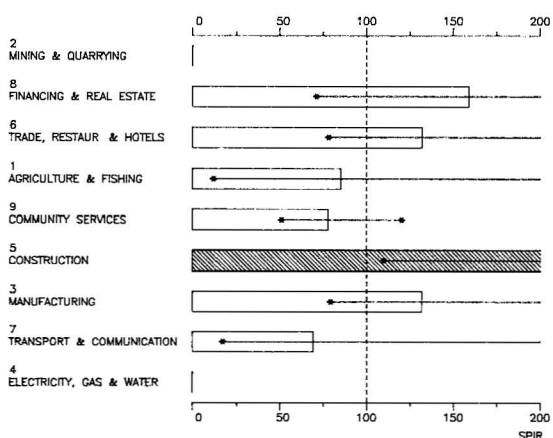


Figure 15.2. Risk of mesothelioma among the women.

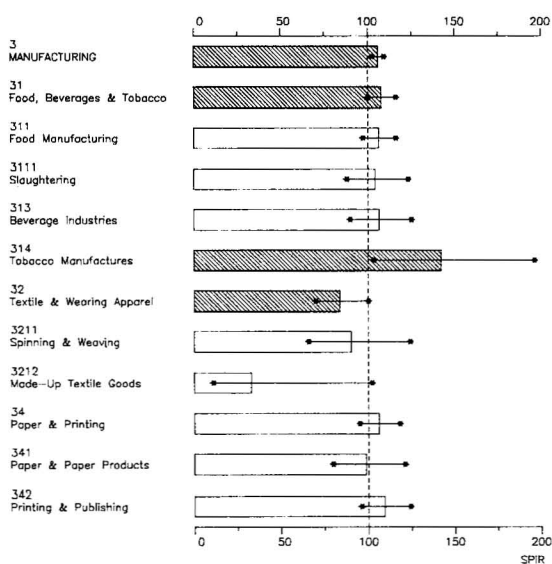


Figure 14.3. Risk of lung cancer among the men.

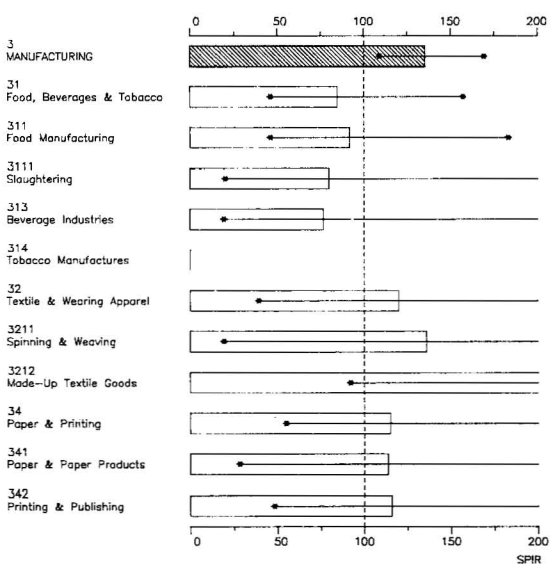


Figure 15.3. Risk of mesothelioma among the men.

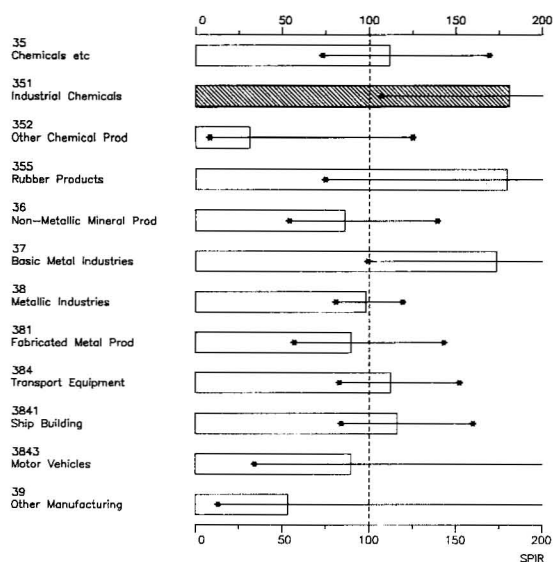


Figure 13.4. Risk of laryngeal cancer among the men.

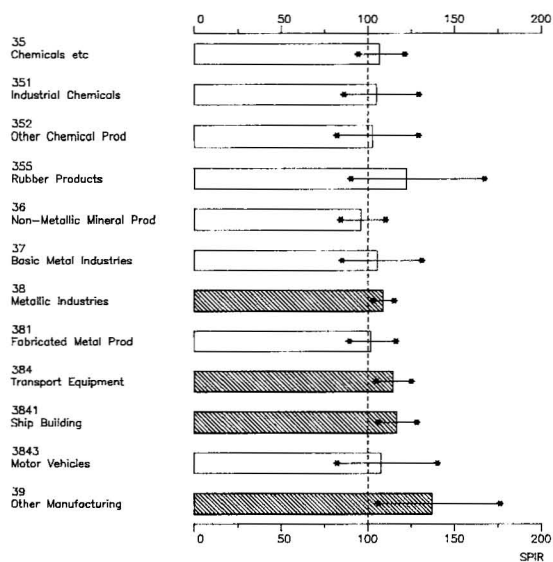


Figure 14.4. Risk of lung cancer among the men.

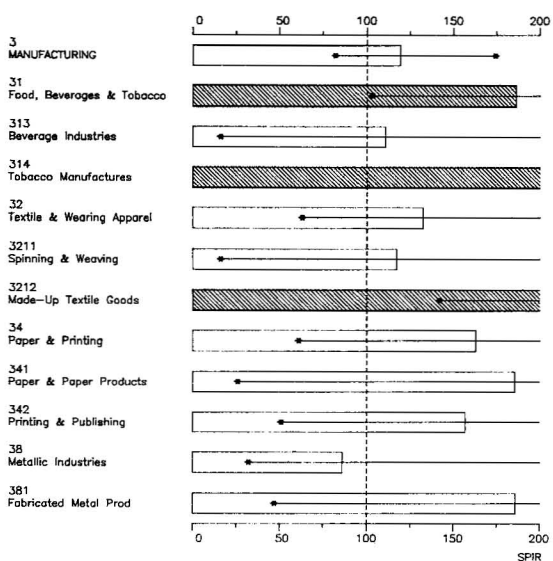


Figure 13.5. Risk of laryngeal cancer among the women.

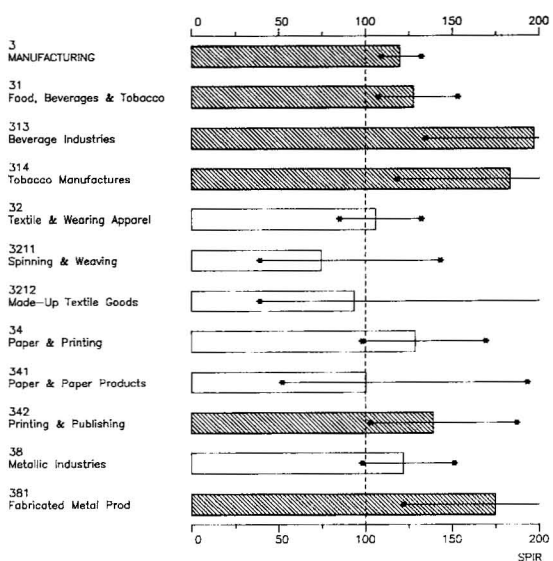


Figure 14.5. Risk of lung cancer among the women.

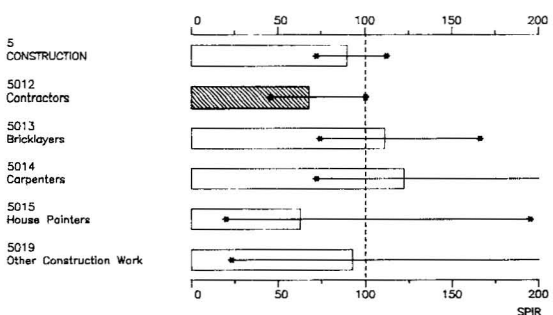


Figure 13.6. Risk of laryngeal cancer among the men.

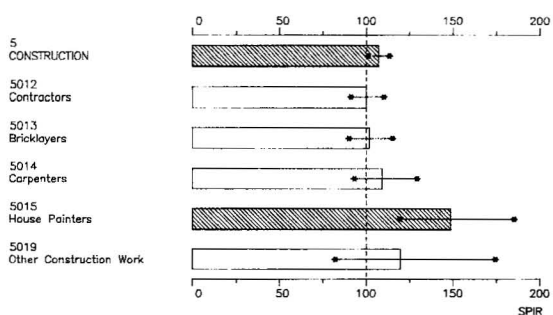


Figure 14.6. Risk of lung cancer among the men.

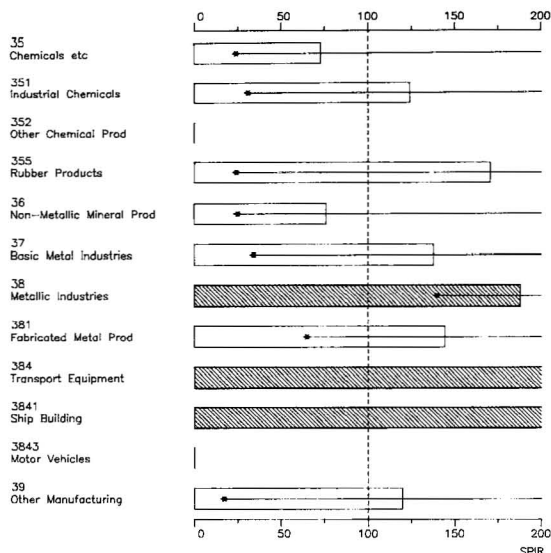


Figure 15.4. Risk of mesothelioma among the men.

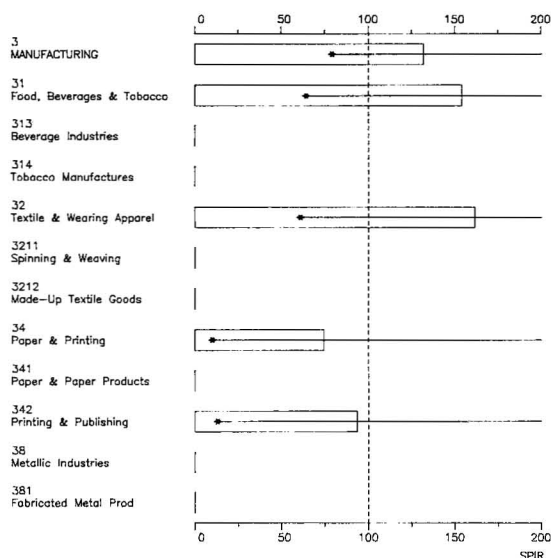


Figure 15.5. Risk of mesothelioma among the women.

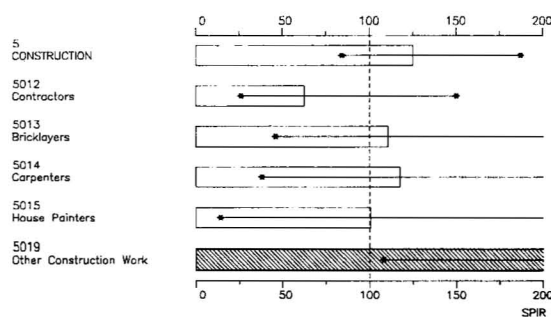


Figure 15.6. Risk of mesothelioma among the men.

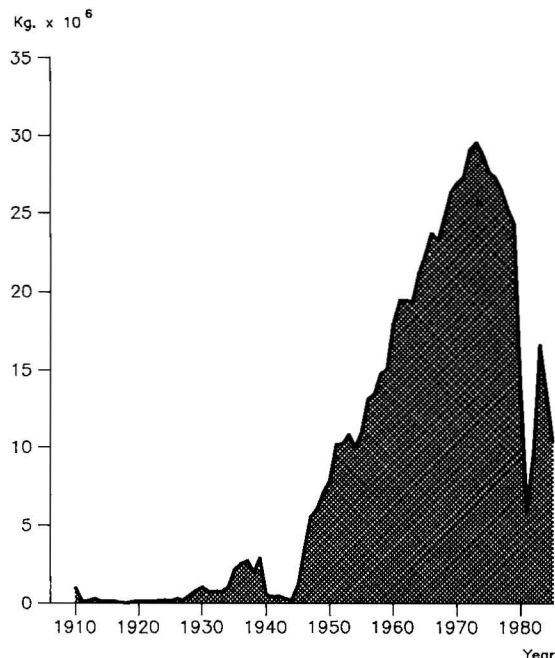


Figure 16. Annual import of raw asbestos to Denmark, 1910–1985.

genic to the lung (56). The risk of lung cancer is elevated among copper smeltery workers (exposed to arsenic trioxide), among vineyard workers exposed to arsenical insecticides, and among workers who have handled arsenic in the manufacture of pesticides and herbicides (56, 105, 117).

An excess risk of lung cancer has been reported in several occupational groups heavily exposed to soot, tars and mineral oils, polycyclic hydrocarbons having been implicated as the carcinogenic substances. Excess risks have been described for gas workers, roofers exposed to asphalt and pitch, workers exposed to tars in the aluminum smelting industry, and chimney sweeps. The lung cancer risk is increased among men with scrotal tumors associated with exposure to mineral oils (52, 68, 69, 98).

Uranium mining, mustard gas production, and vinyl chloride production are also associated with increased lung cancer risks (7, 25, 193). In some studies, an increased risk was observed among rubber workers, workers exposed to beryllium and ferric oxide dust, and workers in lead and cadmium smelteries (12, 39, 134, 195); however, these associations have not been confirmed.

Findings. A total of 21 039 cases of cancer of the lung and trachea was included in the study, of which 14 376 (in 12 166 men and in 2 210 women) had been included in the Supplementary Pension Fund (table 4).

Figure 14.1 shows the risk of lung cancer among the male employees in the nine main branches of indus-