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Joan Patricia Lindsay

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OCCUPATIONAL CANCER MORTALITY IN A TEN PERCENT SAMPLE OF MALES IN THE CANADIAN LABOUR FORCE, 1965-1979: THE ESTABLISHMENT OF A MONITORING SYSTEM

by

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ABSTRACT

This study involved the establishment of a system for monitoring occupational cancer mortality in a ten percent sample of males in the Canadian labour force. The system was designed to detect associations between occupations and industries, and specific cancer sites, which merit more detailed study.

Occupational histories of approximately a ten percent sample of the Canadian labour force from 1965 to 1971 were linked to the Canadian mortality data base maintained by Statistics Canada to determine the mortality experience of the cohort between 1965 and 1979, using computerized record linkage. Standardized mortality ratios (SMR) were calculated for each occupation and industry code, for 33 cancer categories, with the total cohort as the reference population. In addition, occupations were grouped into four social classes so that the mortality for individual occupations could be compared to all occupations in the same social class. This provided an indirect method of controlling for confounders, on the theory that people in similar economic circumstances have similar lifestyles. The mortality of the ten percent sample was also compared to that of the Canadian population as a whole.

The file for analysis consisted of 415,316 males, of whom 41,196 had died by the end of 1979. Statistically significant results ($P < 0.05$, 1 sided) with at least five observed deaths

in the ten percent sample were compared with four other analyses of occupational cancer mortality, and five reviews of occupation-cancer associations. The results of the 10 percent sample were assessed according to specific criteria e.g. strength, and consistency. The strongest findings included the associations of plumbers and pipefitters with lung cancer, truck drivers with lung cancer, waiters and bartenders with cancer of the buccal cavity and pharynx, and carpenters with stomach cancer.

It was concluded that the above findings, as well as several others merit more detailed study in order to quantify risks and recommend preventive measures. Further follow-up of the ten percent sample would be valuable because the cohort was still relatively young as of 1979, and longer latent periods may be necessary to detect some occupation-cancer associations.

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CHAPTER 1

INTRODUCTION AND OBJECTIVES

Exposure to carcinogens in the workplace has long been recognized as a major potential cause of cancer in industrialized societies. Estimates of the percentage of cancer attributable to occupational exposure have ranged as high as 38 percent (Bridbord, Decouflé, Fraumeni et al., 1978), although this figure is a matter of some dispute (Higginson, 1979). A more recent detailed analysis of the proportion of cancer deaths due to occupational exposure in the United States by Doll and Peto (1981) suggests an alternative estimate of 4 percent.

Industrial toxicology is a field in which interest has grown over time as the number of established occupational carcinogens and otherwise hazardous substances has increased. Although animal tests are of some value in establishing the carcinogenicity and/or toxicity of chemicals, results of animal studies are not always applicable to man (Lauwerys, 1980). The American Chemical Society has estimated that more than 4 million chemicals are in existence and about 6,000 new ones are identified every week (Calkins et al., 1980). Over 60,000 chemicals are commonly used in industry and approximately 700 new chemicals are introduced every year (Mausner and Kramer, 1985). It is often many years before the effects of chemicals on humans become evident due to the long

latent periods which are characteristic of carcinogens.

Most of the known occupation-cancer associations initially developed from anecdotal observations, and little work has been done in the area of systematic monitoring of large samples of the labour force to detect new possible associations.

There are two major problems in attempting to establish such a monitoring system: 1) the cost of assembling a sufficiently large cohort of individuals with known occupational history and 2) the difficulty and cost in following such a cohort for a sufficient period of time to obtain data on a large enough number of cancer cases or deaths.

One approach to such a system is that of the Registrar General of England and Wales (1978) who issues a publication analysing occupational mortality, using the number of individuals recorded in an occupation as shown on the death certificate as the numerator (for the 3 years surrounding the census), and the estimated number of individuals working in the occupation at the time of the census as the denominator.

In the United States, only one national mortality study has been conducted for the year 1950 (Guralnick, 1963). Occupational mortality studies from 4 states have been published: Washington, 1950-1979 (Milham, 1983), California, 1959-1961 (Peterson and Milham, 1980), Rhode Island, 1968-1972 (Gute, 1981) and Massachusetts, 1971-1973 (Dubrow and Wegman,

1984). Recently, many states have started to code occupation and industry on death registrations as a result of a collaborative effort by the National Center for Health Statistics (NCHS), National Institute for Occupational Safety and Health (NIOSH), and the National Cancer Institute (Dubrow, 1986). As a result, data should soon be available for more than 30 states for the analysis of occupational mortality.

In Canada, only British Columbia has coded occupation and industry on death registrations for several years; these data have recently been analysed and published (Gallagher et al., 1986).

In Canada, between 1965 and 1971, occupational data were collected on 10 percent of the labour force (originally for the purpose of producing employment statistics). The 10 percent sample of the Canadian labour force is the only known collection of data which is feasible for use in a nationwide monitoring system involving computerized record linkage. Other sources of occupational data exist, for example, census data and more recent Labour Force Survey (LFS) data. Although these data contain information on socio-economic factors (census) and smoking (LFS), the data cannot be used for computerized record linkage due to lack of identifying information in machine readable form.

Data and facilities are available in Canada to make possible the establishment of an occupational monitoring system. Computerized record linkage (Howe and Lindsay, 1981)

was used in conjunction with the Canadian mortality data base maintained by Statistics Canada to determine the mortality experience of the cohort from 1965 to 1979.

Objectives:

1. The establishment and use of a system to monitor occupational mortality: The major objective of this study is the establishment of a monitoring system based on individuals (forming approximately a 10 percent sample of the Canadian labour force) for whom occupational histories have been analysed in conjunction with mortality from 1965 to 1979. The 10 percent sample of the Canadian labour force is the only known collection of data which provides a unique opportunity to monitor occupational cancer mortality for the entire country.

In addition, mortality within social class has been analysed as a crude means of controlling for life style factors which were not directly available from the occupation records. The results of the analysis controlling for social class will be assessed.

2. The confirmation of existing and discovery of new associations: The system should provide the basis for continued occupational mortality monitoring, and particularly after additional years of follow-up, should be valuable for both generating and testing hypotheses concerning occupation and risk of cancer. The results of this analysis will be assessed according to criteria which are relevant to their

importance, outlined by A.B. Hill (1965), including strength, consistency, specificity, temporality, biological gradient, and plausibility of the observed associations.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Scope of the review

This chapter includes a brief and not exhaustive summary of the history of occupational epidemiology; a review of the methods used to study associations between occupation and disease; a detailed review of systems for monitoring occupational cancer mortality; a brief review of systems for monitoring occupational cancer incidence; and an overview of the development of record linkage techniques used to monitor occupational mortality of Canadians using a 10 percent sample of the labour force.

The emphasis is placed on systems for monitoring occupational cancer mortality rather than incidence since the 10 percent sample has been followed up only with respect to mortality. Canadian cancer incidence data could potentially be used as an end point in the same manner as mortality data. Systems to monitor cancer incidence in relation to occupation are valuable, particularly for less fatal cancer, e.g. bladder. However, methods for monitoring occupation-cancer incidence associations vary widely and may be less relevant to the methods employed to study the 10 percent sample.

2.2 Review of occupation - cancer associations

Ramazzini was the first to recognize the importance of

occupation as part of a patient's medical history. He completed the first systematic review of occupational hazards noting that the high incidence of breast cancer in nuns was more likely due to celibacy than to their actual occupation (Cole and Goldman, 1975). The first documented occupation-cancer association was that of chimney sweeps and cancer of the scrotum, by Percivall Pott in London, in 1775 (Pott, 1775). In 1879, Härting and Hesse identified pulmonary cancer as an occupational hazard in metal miners in central Europe (Decouflé, 1982). This was followed in 1895 by the observation by Rehn in Germany that bladder cancer was associated with dye workers (Cole and Goldman, 1975).

Initially, the causal agents responsible for these associations were unknown. One hundred years after Pott's publication, it was established that skin cancer, including the scrotum, could be induced by several coal tar products (Decoulflé, 1982). Radiation exposure was relatively recently determined to be the causal agent of lung cancer in the mines in Härting and Hesse's study (Hueper, 1966). After much study, it was discovered that two aromatic amines; benzidine and ß-naphthylamine were responsible for bladder cancer in dye workers.

Currently, several associations between occupations and cancer have been established where the causal agent is known, but many carcinogens remain to be identified in cases where the association between the occupation and cancer site is

clear. Tables 1 to 3 list associations according to the level of certainty with which they have been established (Decouflé, 1982). A review of a more recent evaluation of associations between occupations and exposure substances, and resulting cancer (Alderson, 1987) shows no substantial differences from the following tables.

Table 1. Well established occupation-cancer relationships (Decouflé, 1982)

Site	Agent, industrial process or occupation
Bladder	Benzidine, ß-naphthylamine, 4-aminobiphenyl (xenylamine); manufacture of certain dyes (auramine, magenta)
Blood (leukemia)	Benzene, x-radiation
Bone	Radium, mesothorium
Larynx	Ethanol (ethyl alcohol) manufacture by strong acid process (diethyl sulfate?); isopropyl alcohol manufacture by strong acid process (diisopropyl sulfate?); mustard gas
Liver (angiosarcoma)	Arsenic (inorganic compounds); vinyl chloride
Lung, bronchus	Arsenic (inorganic compounds); asbestos; bis(chloromethyl)ether; chromium compounds; coal carbonization processes; coal tar pitch volatiles; iron ore (hematite) mining; mustard gas; nickel refining; radiation (radioactive ores)
Nasal cavity, sinuses	Isopropanol (isopropyl alcohol) manufacture by strong acid process (diisopropyl sulfate?); mustard gas; nickel refining
Peritoneum (mesothelioma)	Asbestos
Pharynx	Mustard gas
Pleura (mesothelioma)	Asbestos
Skin (including scrotum) (epitheliomas)	Arsenic (inorganic compounds); coal tar products; coal hydrogenation; mineral oils; x-radiation

Table 2. Industrial materials for which epidemiologic studies suggest carcinogenicity (Decouflé, 1982)

Material	Site(s)
Acrylonitrile	Lung
Asbestos	Colon, rectum, esophagus, larynx, stomach
Beryllium	Lung
Cadmium	Lung, prostate
Coke oven emissions	Kidney, prostate
Cutting oils	Lung, (digestive organs) stomach, large intestine
Ethylene oxide/ethylene dichloride	Blood (leukemia), stomach
Lead	Lung
Polychlorinated biphenyls	Skin (melanoma)
Vinyl Chloride	Brain, lung

Table 3. Occupational groups associated with high risks for cancer, with no specific agent identified (Decouflé, 1982)

Occupational group	Site(s)
Benzoyl chloride manufacture	Lung
Chemists	Brain, lymphatic and hematopoietic tissue
Coal miners	Stomach
Coke by-product plant workers	Colon, pancreas
Foundry workers	Lung
Leather workers	Bladder, larynx, mouth, pharynx
Metal miners	Lung
Oil refinery/petrochemical workers	Brain, leukemia, multiple myeloma, stomach, esophagus, lung
Painters	Leukemia
Printing workers	Lung, mouth, pharynx
Rubber industry work areas	Bladder, leukemia, brain, lung, prostate, stomach
Textile workers	Nasal cavity and sinuses
Woodworkers	Hodgkin's disease

2.3 Review of methods used in occupational studies

The basis for studying an occupation-cancer association is often the observation of a cluster of cases of a specific cancer in a given industry, either by clinicians or by the victims themselves (Mausner and Kramer, 1985). This is more

likely in the case of a rare disease. Epidemiologic study is needed to confirm these observations and distinguish occupational exposures from other causes in more common diseases. Laboratory studies are needed to confirm epidemiologic observations. The major types of epidemiologic study are briefly described in the following sections.

2.3.1 Ecological studies

Ecological studies provide a broad indication of associations between occupation (or environment) and disease. They may be considered as hypothesis generating rather than hypothesis testing (Mausner and Kramer, 1985). Ecological studies involve the comparison of groups of people, usually living in specified geographic areas. Levels of various factors in the environment are compared with levels of mortality from specified diseases. Ecological studies can also consist of examining time trends rather than geographic differences. Such studies are subject to 'ecological fallacy' (Morgenstern, 1983), namely that conclusions concerning individual risk on the basis of group risk must be made cautiously, because there may be factors influencing individuals' risks that have not been taken into consideration. In addition, if the risk for a small segment of the population increased substantially, only a small increase would be detected for the group as a whole.

2.3.2 Cross-sectional studies

Cross-sectional studies are descriptive and measure the presence of both risk factors and disease at a single point in time, for example, in the case of national health surveys. A major limitation is the inability to establish the sequence of events and thus to draw causal inferences.

2.3.3 Case-control studies

Case-control or retrospective studies consist of comparing people with the disease under study with a (control) group of persons who do not have the disease. The two groups are compared with respect to suspected exposures, in order to establish etiologic relationships. It is necessary to have precisely defined hypotheses to be tested. Cases are most often ascertained from hospital records; controls may be selected using a number of different sources, e.g. the general population, residents of the same neighbourhood, or hospital patients with different diseases.

Case-control studies permit the testing of hypotheses on a fairly small number of people and are economical in comparison to cohort studies using conventional methods of follow-up (e.g. mailed questionnaires, telephone interviews etc.). They are particularly efficient for the study of rare diseases. It is generally possible to collect much more detailed data with respect to exposure than would be possible in a retrospective cohort study.

However, there are many potential sources of bias to which case-control studies are susceptible (Sackett, 1979). If a bias applies equally to cases and controls, valid comparisons can still be made between the two groups; but generalization to the population of an increase in risk of a specific magnitude is often not possible.

2.3.4 Cohort studies

Cohort, prospective or historical prospective studies involve the follow-up of a defined group or cohort, some of whom have been exposed to a suspected hazard to determine who subsequently develops the disease(s) under study. A study of an occupational hazard often involves a cohort of all employees of a specific industry or industries, over a given time period for a specified minimum period of time, where some or many of the employees have been exposed to the hazard in question. The cohort is followed up to determine whether the exposed group is more likely to develop the disease(s) in question than those who were not exposed. Traditionally, follow-up has been conducted by means of mailed questionnaires or manual linkage to mortality or morbidity records.

The advantages and disadvantages of the cohort study are, generally speaking, the reverse of the case-control study. Some problems of bias may be solved depending on methods of data collection, detection of elevated risks for rare diseases is much less feasible, and the time required to conduct the

study and hence its cost are much greater. However, the use of computerized record linkage in 'historical prospective' studies reduces time and cost substantially in comparison with other methods of follow-up. A limitation, however, of this particular method is that historical files were not created for the purposes of epidemiologic study, and may therefore lack detailed data on exposure and confounders.

In the current study, a cohort of workers for whom occupational histories were available for the years 1965 to 1971 were followed by means of computerized record linkage to the Canadian mortality data base (in a historical prospective manner) to determine their mortality patterns.

2.4 Systems to monitor occupational cancer mortality

Very little has been done to establish systems to monitor occupational (cancer) mortality on a long term basis. The major long term analyses include the decennial supplement on occupational mortality in the United Kingdom, which dates back to 1851 (Logan, 1982), occupational mortality in Washington State, from 1950 to 1979 (Milham, 1983), and in British Columbia, from 1950 to 1978 (Gallagher et al., 1986). Several shorter term studies of occupational mortality have been reviewed, although it does not seem appropriate to classify such studies as monitoring systems. They are included because they appear to have (had) potential for development into long term monitoring systems.

2.4.1 The United Kingdom

The study of occupational mortality in the United Kingdom (U.K.) as a whole, dates back to 1851 (Logan, 1982) and has been carried out using mortality data for the 3 year period around each census year since that time (1941 is excluded since there was no census). The first 3 decennial analyses (1851 to 1871) examined mortality from all causes combined; in 1881 some causes of death were introduced, but not cancer; in 1891 and 1901 cancer was included as a single cause; and from 1911, different types of cancer were included. Changes in the coding structure of occupation and industry occurred over time as well as modifications to the classification of occupations by social class.

The method used throughout the years was cross-sectional, in which the numerator (age, sex, cause of death and occupation) was related to the denominator (persons of corresponding age, sex and occupation according to the population census). Most recent occupation was reported on death registrations and current occupation was recorded on a 10 percent sample of more detailed census returns. Although the population by occupation was estimated based on the more detailed sample, and was not directly matched with mortality records, it was used as the denominator in the calculation of standardized mortality ratios (SMR). This has been criticized as not corresponding exactly to the deaths as numerator (Mausner and Kramer, 1985), i.e. a record corresponding to a

death may not appear in the denominator. Also, a person could change occupations between the date of the census and date of death. However, the two are certainly much more closely related than in countries such as Canada and the U.S. where 'usual occupation' is reported on the death registration. Three years of mortality data around the census year were included to minimize problems of small numbers.

The methods used are suited to suggesting associations between occupation and mortality, but the data are not adequate for demonstrating complex relationships. There were no measures of exposure; a person may have changed jobs, and past work may have resulted in exposures not reflected in the (most recent) reported occupation. The effects of lifestyle factors may be more apparent than occupational exposures. In addition, self selection may lead healthy workers to certain occupations resulting in low mortality, and conversely, those who are less healthy may be employed in other occupations requiring less physical fitness thereby raising mortality rates.

It was noted that there was a tendency to report a person's main occupation rather than the most recent one either because it was more prestigious (death records are public documents in the U.K.) or because it was felt to be more relevant to the death.

The U.K. Decennial Supplement on Occupational Mortality used social class in different ways to control for lifestyle

factors. For example, one method involved a comparison of the mortality of men in a given social class to wives of men in that social class, on the theory that they lead similar lives which differ mainly with respect to the men's occupational risks. However, men and women have different leading causes of death, e.g. the leading cancer cause of death in women, aged 15-64 was breast cancer, and in men, lung cancer; therefore it does not seem that male and female mortality are comparable with the exception of occupational risks. Some lifestyle factors are not the same even within families. Male-female differences in mortality for some more common causes of death are not comparable due to the importance of some sex-specific causes; also female mortality is generally lower. In addition, as more women work, they undoubtedly develop their own occupational risks.

The mortality of men in specific occupations was also compared with the mortality of the social class in which that occupation was classified. This assumed uniformity in lifestyle factors within social classes, and although this may not always be the case, it would seem more valid than the comparison of male and female mortality within a social class.

In the analysis of the 1911 data, mortality was analysed according to the following social classes: I Professional, II Intermediate, III Skilled, IV Semi-skilled and V Unskilled occupations (Logan, 1982). In addition, three occupational groups were examined separately (and considered as additional

classes): VI Textile workers, VII Miners and VIII Agricultural labourers. Since 1921, five social classes have been used, although there have been revisions to the occupations included in each group which were intended to reflect changes in the occupations. In 1971, the third social class was subdivided into IIIN Skilled non-manual and IIIM Skilled manual (Registrar General, 1978).

Socio-economic groups (SEG) were also used since 1951, and were intended to combine occupations of people with similar behaviour and social, cultural and recreational standards (Registrar General, 1978). Social class and SEG are distinct and not directly related to each other.

The mortality data included all deaths registered in, and occurring to residents of England and Wales. Cause of death was coded to the appropriate revision of the International Classification of Diseases (WHO); the 1970-1972 deaths were coded to the eighth revision (WHO, 1965).

Mortality indices included, for each occupation and social class, a comparative mortality figure (CMF), since 1921, and, since 1931, standardized mortality ratios (SMR). From 1951 proportionate mortality ratios (PMR) were also calculated.

The CMF involves direct standardization, whereas the SMR involves indirect standardization. The CMF is calculated by applying the age-sex-specific death rates, for example in social class I to the 'standard' male population, i.e. the

total male population for the census year around which the deaths are centred. Thus the CMF is comparable from one social class to another for the time period in question, but not with other decennial analyses if the age structure of the population has changed.

The SMR is calculated by applying the death rates for the standard population to the population in the specific social class (or occupation) to obtain expected numbers of deaths. The SMR is the ratio of the observed deaths to expected deaths (which, in the U.K. decennial supplement, was multiplied by 100). The PMR is the ratio of the proportion of deaths for a specific cause of death for a social class or occupational group to the proportion of deaths for that cause for the total population.

The 1970-1972 decennial supplement is of most interest since it falls within the time period for which the mortality of the Canadian 10 percent sample has been analysed. In the 1970-1972 decennial supplement (Registrar General, 1978), mortality was examined for each of 27 occupational orders and 223 occupational 'units' which are similar to Canadian individual occupation codes. This was done using the Classification of Occupations for 1970 (Office of Population Censuses and Surveys, 1970). The emphasis was on cancer mortality which was compared to cancer incidence for two time periods; 1966-67 and 1968-70. Mortality by occupational unit was also standardized for social class as a means of

controlling for lifestyle factors such as smoking. Thus, if a high level of mortality was seen for a specific occupation and cause, the association was strengthened if it remained when controlling for social class, and also if it was also observed in the cancer incidence data.

The decennial supplements provide a long term (since 1851) and increasingly comprehensive system of monitoring associations between occupation and cancer incidence and mortality, as well as other causes of death.

2.4.2 The United States

There has been no regular monitoring of occupational mortality in the United States, for the country as a whole. The only nation-wide study of occupational mortality was conducted by Guralnick (1962, 1963) using occupation as recorded on 1950 mortality records in conjunction with the 1950 census. There was no systematic follow-up in more recent census years; thus this study did not actually evolve into a monitoring system.

Although occupation and industry have been routinely recorded on mortality records in the United States, they were not, in the past, coded and put into machine readable format. This situation has changed recently; as of 1985, at least 30 states were capturing this information as the result of a collaborative effort of NIOSH, NCI, NCHS and the individual states (Dubrow, 1986). This should soon produce valuable

data.

In the 1950 study of occupational mortality, usual occupation was recorded on death registrations as opposed to current occupation on census records. In spite of this discrepancy, SMRs were calculated (with mortality as the numerator and census as the denominator). However, PMRs were subsequently calculated and results were considered of interest only if both the PMR and SMR achieved statistical significance.

A number of limitations of the recording of occupation and industry on death registrations were noted as follows:

1. The selection of persons entering the occupation for health related characteristics. For example, both by self-screening and preemployment examinations, all men becoming firemen (firefighters) will be physically fit upon entrance into this occupation.
2. Similarly, selective transfer of persons who have developed an illness or disablility to less strenuous occupations. The fireman who is seriously injured in his work may be reassigned to clerical or other tasks.
3. Variations in retirement practices. Many firemen can retire at ages 50 or 55 years and may then enter a lighter occupation. Most likely, they will be enumerated in their new line of work, but, because the death certificate asks for usual occupation, they will be reported as firemen at death. The death rate for firemen

at ages 60-64 years may thus be overstated because the enumerated population does not include ex-firefighters.

4. Concentrations of selected groups in particular occupations. Through social or historic accidents, the majority of persons in an occupation may be of one national group, or one color group, making it difficult to know whether the rates described by the occupation can be attributed to the work, or to some characteristic of the group entering the occupation.
5. The same type of selection of persons in an occupation may be related to age or marital status. Rates specific for age will solve the one difficulty of interpretation but it is rarely possible to compute rates by occupation and marital status.
6. The physical environment is selected in certain industries. For example, should copper mining exist only in a mountainous area, death rates for copper mine workers would combine the risks of the industry and of living at a high altitude.
7. Education and socioeconomic status are closely associated with an occupation, and may, in fact, be more highly correlated with mortality rates than the occupation itself (Guralnick, 1962).

Point 3 above demonstrates that the calculation of SMRs is really not valid since the numerator and denominator do not correspond. In other studies using death certificates where

'usual' occupation is recorded, it is customary to calculate only PMRs (Milham, 1976; Gallagher et al., 1986).

A detailed study was conducted on the comparability of occupation as reported on vital records and the 1950 census (Kaplan et al., 1961). The comparability of occupation on death records with 1950 census records was examined in detail in relation to several other variables, e.g. age, cause of death, residence, and it was found that there were large gross differences between matched death certificates and census records, i.e. there were fairly large discrepancies between matched records; but there were small net differences, or the proportions of records from the two sources were similar.

Reasons for the discrepancies are offered, such as the likelihood that persons enumerated shortly before death would be less likely to be in their 'usual' occupation at that time. The fact that 1950 census enumeration and 'usual' occupation recorded on the death certificate do not correspond in time was alluded to but not discussed directly. The small 'net' differences were no doubt due to the relative stability of persons' occupations prior to 1950 as compared with more recent years.

2.4.3 Washington State, 1950-1979

Occupational mortality has been monitored in Washington State from 1950 to 1971 (Milham, 1976) and updated to 1979 (Milham, 1983). Usual occupation as reported on death

certificates was analysed in relation to cause of death. Occupation had not been routinely coded and put into machine readable form. Initially, this was done for a few specific studies and then expanded to include all white males. Proportionate mortality ratios (PMR) were standardized for age and year of death, and calculated for 194 occupations and 160 causes of death (Milham, 1976). PMRs were used because there were no available denominator data for the calculation of rates or SMRs. The study included white males aged 20 and over, since the exclusion of non-white males reduced the size of the study population by less than 3 percent. Results were compared with the U.S. 1950 occupational mortality data (Guralnick, 1963) and with the U.K. decennial supplement on occupational mortality (Registrar General, 1978). The Washington data were described as consistent with many previously observed associations, and additional associations were observed which the author felt merited further study.

The Washington State data represent the most comprehensive analysis of occupational mortality over the longest time period in the United States.

2.4.4 British Columbia, 1950-1978

In Canada, most provinces record 'usual occupation' on death registration forms, but only British Columbia has coded occupation and included this information on their machine readable files. These data were recently analysed by

Gallagher et al. (1986), and this monitoring system used methods which were identical to those of Milham in his analysis of the Washington State data (1976).

Cause of death for all years was reconciled with the 7th revision of the International Classification of Diseases (World Health Organization, 1957), and occupation codes were standardized to the 1961 Canadian occupational manual format used for the 1961 census (Dominion Bureau of Statistics, 1961).

PMRs were calculated for male and female deaths of those aged 20 and over. A second set of PMRs was produced for males aged 20 to 65. PMRs were calculated for three time periods: 1950-1959, 1960-1969 and 1970-1978 for male deaths aged 20 and over. Although females were included in the analysis, 151,113 of 165,912 were coded as homemakers.

2.4.5 California 1959-1961

The analysis of California occupational mortality for the years 1959 to 1961 using death certificate information was described as an off-shoot of the Washington State analysis (Peterson and Milham, 1980). It was the first such study of occupational mortality in California since the 1950 data were analysed by Guralnick (1963). Like the 1950 U.S. analysis, this study was short term and did not constitute an ongoing monitoring system. As was the case in the Washington State study, this study included white males and PMRs standardized

for age were calculated.

2.4.6 Rhode Island, 1968-1972

Gute (1981) published an analysis of occupational mortality for the state of Rhode Island for the years 1968 to 1972. The study included 43,311 white males and females aged 16 years or more at the time of death, and all causes of death. However, there was very little breakdown of cancer sites. Occupation and industry were coded to the system used in the 1970 U.S. census, with slight amendments, using 417 occupation and 215 industry codes. These were combined into a smaller number of groups of occupations and industries which varied according to whether the analysis was of males or females, and whether SMRs or PMRs were being calculated, and depended on the availability of census data. SMRs were calculated using the white civilian labour force with work experience in 1970 as the standard population, chosen as the mid-point of the time period analysed. Deaths of those who were institutionalized, students or members of the armed forces were excluded so the numerator was comparable to the denominator in that respect. However, the fact that death certificates contained 'usual occupation' (over a period of many years prior to 1970), and the population were classified by occupation in 1970 poses a problem which has not been dealt with by the author, except for the older age groups. For those who died at age 65 and over, PMRs were calculated. This

was because the declining participation in the labour force of this portion of the population resulted in an artificially low denominator on which to base an SMR. Finally, for 'the sake of age group consistency with the SMR, PMR analysis was carried out on the 16-34, 35-44, 45-54, and 55-64 age groups as well'.

The results of the analysis were generally consistent with the U.S. 1950 study, Washington State data and the U.K. decennial supplement.

2.4.7 Massachusetts 1971-1973

Dubrow and Wegman (1984) published an analysis of occupational cancer mortality for white males in Massachusetts for the years 1971-1973. Usual occupation which was recorded on death registrations, was coded to 321 individual occupation categories.

The study included all adult males aged 20 or older whose underlying cause of death was coded as a malignant neoplasm (plus cirrhosis of liver); and a sample including every fourth adult male death was chosen to serve as a comparison group in the age-standardized mortality odds ratio (sMOR) analysis. The mortality odds ratio (MOR) was intended to overcome the problems in calculating accurate SMRs in death certificate studies (Miettinen and Wang, 1981). The MOR is the ratio of mortality odds between the cancer of interest and other (auxiliary) diseases for the occupation of interest,

compared with a nonexposed comparison group.

This was basically equivalent to a case-control approach, where the cases were all deaths from the cancer of interest, the controls were the auxiliary causes of death, and the exposure of interest was occupation. The exposure odds ratio (the ratio of the exposure odds between the occupation of interest and the nonexposed comparison group for the cancer of interest compared with the auxiliary diseases) is equal to the MOR. The sMOR can be interpreted as the SMR on the assumption that the mortality rate for the auxiliary causes of death is the same in the occupation of interest and the comparison group (Miettinen and Wang, 1981).

Analyses were performed using all other individuals in the population as the comparison group, and also using all individuals within the same social class as the comparison group (in a separate publication - Dubrow and Wegman, 1983b). The finding emphasized in the report was that of an excess of lung cancer associated with several occupations, for which there is support from other epidemiologic studies and/or for which there are reasonable hypotheses regarding possible carcinogenic exposures (including truck drivers, painters, machinists, automobile mechanics, plumbers, cooks, fishermen, heated metal workers, and brickmasons/stone-masons/tile setters).

The methods used in this study were a definite improvement over the PMR calculations used in most analyses

of occupational mortality data. The short study period may have been a limitation: possibly small numbers prevented some associations from emerging with the use of detailed coding of occupation and cancer cause of death.

2.5 Other countries

2.5.1 Australia

Alderson (1986) reported a study by McMichael and Hartshorne (1982) which examined broad causes of mortality for 9 occupational groups for males aged 30-34. Census estimates by occupation were used and directly standardization was performed. In addition, results for a few specific occupations were given for cancer of the lung and mouth/pharynx/esophagus.

2.5.2 Denmark 1970-1975

An analysis of occupation mortality has been published for deaths from 1970 to 1975, which involved the 1970 census to subsequent deaths (Danmarks Statistiks, 1979). Due to the small number of deaths, only broad cause of death groups were included (e.g. all cancer); therefore these data cannot be compared with other more detailed data.

5.2.3 Finland 1970-1975

The 1970 census has been linked to deaths from 1970 to 1975, and an analysis of cause of death and occupation

published (Sauli, 1979). The data presented were restricted due to small numbers of deaths. The file for analysis is being updated and expanded by adding the 1975 census and more recent years of deaths and cancer incidence (Alderson, 1986).

2.5.4 France 1954-1971

A special study was conducted by Desplanques (1976) in which a sample of males aged 30-69 was selected from the index of the population in 1954. Subsequent deaths were identified up to 1971, and age-specific mortality rates calculated, according to occupation in 1954. The analyses presented were for 7 broad causes for 12 socio-economic groups; thus there is no possibility of comparison of these data with more detailed monitoring systems.

2.5.5 Italy 1981-1985

The 1981 census for the population of Turin (about one million) has been linked with deaths. This study is considered too small for analysis by occupation and mortality by cancer site (Alderson, 1986).

2.5.6 New Zealand 1974-1978

Pearce and Howard (1985) described occupational mortality in New Zealand males aged 15 to 64, from 1974 to 1978. They presented age standardized mortaltiy rates for 6 occupational orders and 79 occupational groups for 14 major disease groups.

The data were also standardized for social class (as in the U.K. Decennial Supplement) in order to minimize confounding by other factors such as lifestyle, smoking and diet. The numerator consisted of all deaths registered in New Zealand from 1974 to 1978; the denominator data were derived from a 10 per cent random sample of the 1976 New Zealand census.

Unfortunately, the cause of death categories used were very broad and there was no breakdown of malignant neoplasms by site in the published data, making detailed comparisons with other studies impossible.

2.5.7 Northern Ireland 1960-1962

The Registrar General for Northern Ireland conducted an analysis of occupational mortality from 1960 to 1962, using the 1961 census as denominator; however, no official report has been published (Alderson, 1986).

2.5.8 Norway 1970-1973

The 1970 census was linked to deaths from 1970 to 1973 (Haldorsen and Glattre, 1976). This was extended to include the 1960 census information and to study different combinations of labour force activity in the 2 time periods (Kristofersen, 1979). In spite of this expansion of the study, examination of detailed categories (by sex, occupation and cause of death) resulted in numbers too small for interpretation. A major extension of the study is planned

which will link the 1970 census to all deaths from 1970 to 1980 (Alderson, 1986).

2.5.9 Scotland 1949-1953...1969-73

The Registrar General for Scotland has published data following each decennial census in Scotland, using the same technique as in England and Wales (Alderson, 1986). The same strengths and weaknesses apply, plus the fact that Scotland has a population which is only about one tenth of that of England and Wales, making analysis by detailed occupation and cause of death infeasible.

In addition to the publication of the 1949-1953 data, Morrison (1957) reported on mortality due to coronary heart disease and cancer of the respiratory system, based on data from the Registrar General's report.

SMRs were published for males aged 15-64 and 15 and over for broad categories of causes of death and occupational groups. More specific causes of death and occupational groups could not be used due to problems with small numbers.

In Morrison's discussion of coronary heart disease and respiratory cancer, it is interesting to note that there was no mention of smoking as a possible cause of mortality or as a confounder.

2.5.10 Sweden 1960-1980

The 1960 census was linked to cancer registrations from

1960 to 1973 (National Board of Health and Welfare, 1980), and deaths from 1961-1970 (Statistika Centralbryan, 1981). The 1970 census was then linked to deaths from 1971 to 1980; it is intended to combine this with the earlier data. The system is intended to respond efficiently to ad hoc requests.

2.6 Systems to monitor occupational cancer incidence

The following review of systems for monitoring associations between occupation and cancer incidence is not intended to be exhaustive, but to demonstrate that methods may vary widely from one system to another.

2.6.1 Montreal case-control study, 1979-1983

Siemiatycki et al. (1981) have undertaken an hypothesis generating case-control study in Montreal, which includes 19 cancer sites. Over 2000 male residents of Montreal, aged 35 to 70 were given interviews designed to collect detailed occupational histories. A team of chemists reviewed the job histories and converted them into histories of occupational exposures. The data have been analysed with respect to 9 organic dusts (Siemiatycki et al. 1986) and 10 types of exhaust and combustion products (Siemiatycki, 1988).

This study has collected very detailed occupational histories, and is enhanced by the calculation, for each job history, of detailed exposure estimates. It is limited slightly by the selection of cancer sites, and by precision

of recall of lengthy job histories.

2.6.2 Third National Cancer Survey (United States), 1969-1971

The U.S. Third National Cancer Survey (Williams et al., 1977) consisted of a 10 percent interview survey of all incident cancer cases for a 3 year period, in 8 study areas, yielding data for 7,518 cases of which 3,539 were male. (There was a 57% response rate.) Data were collected on usual and recent occupation and industry, and other jobs held; use of tobacco and alcohol, by type, amount and duration; family income, and patient education. Odds ratios were calculated, classifying subjects as either having a specific cancer or not and as having either a specific job category or any other known job. The analysis included stratification according to 18 5-year age groups, 3 races, 3 educational levels, nonuse and 3 levels of use for alcohol and cigarettes, and 8 survey areas; more detailed analyses were conducted for associations suggested by an initial screening analysis. Most results were based on main lifetime industry and occupation. Analyses of recent industries were also conducted, using the 1970 U.S. census tabulations as the comparison group. This avoided potential exposure bias, but only the patients who were not retired at the time of diagnosis could be included, and data on confounding variables were not available for the census data. More credence was given to results obtained from both methods of analysis.

2.6.3 England and Wales National Cancer Registry 1966-67 and 1968-70

As discussed in section 2.4.1, the U.K. Decennial Supplement on Occupational Mortality, 1970-72 (Registrar General, 1978) included the comparison of occupation-mortality associations with results from cancer incidence data for the time periods 1966-67 and 1968-70.

2.7 A synthesis of the results of occupational disease surveillance studies

Dubrow and Wegman (1983) published a synthesis of the results of 12 occupational disease surveillance studies, most of which have been reviewed in this chapter. They include:

1. Washington State death certificates, 1950-71;
2. California death certificates, 1959-61;
3. England and Wales death certificates, 1970-72;
4. United States death certificates, 1950;
5. Third national cancer survey,cancer incidence, 1969-71;
6. Los Angeles County cancer surveillance program,1972-77:
7. Roswell Park Memorial Institute hospital registry, 1956-65;
8. Rhode Island death certificates, 1968-72;
9. England and Wales death certificates, 1959-63;
10. England and Wales cancer registry, 1966-67;
11. England and Wales cancer registry, 1968-69; and
12. Massachusetts death certificates, 1971-73.

The studies not reviewed in this chapter are Los Angeles

County, 1972-77; and Roswell Park Memorial Institute, 1956-65. Los Angeles County was excluded since it is a small geographic area, and the data were reported to be unpublished. Roswell Park Memorial Institute was excluded because registry data from one hospital is most unlikely to be population based, and again, this would have covered a small geographic area.

Dubrow and Wegman combined the results from the 12 studies and calculated aggregate observed-to-expected ratios for the strongest and most consistent occupation-cancer associations. They chose this approach because repeated observation in different populations and under different circumstances strengthens the credibility of an association. The strength and consistency of associations were assessed on the basis of the number of studies in which the association was statistically significant, the correspondence of the association across the studies, and the aggregate observed-to-expected ratio obtained by combining the results of the individual studies.

2.8 Development of computerized record linkage

In Canada, there is no unique identifying number in common usage; therefore in order to link records pertaining to the same individual, it is necessary to use other identifying information such as surname, given names, date of birth, etc. Computerized record linkage was first conducted

by H.B. Newcombe (Newcombe and Kennedy (1962); his description of the process was that he simply programmed the computer to function as clerical staff did when they manually decided if two records belonged to the same person. This procedure was expressed in mathematical formulae by Fellegi and Sunter (1969).

In the mid-1970s, Statistics Canada began to use computerized record linkage for health studies. As the volume of requests to conduct such studies increased, the need for a generalized record linkage computer system became evident. A generalized system was developed jointly by Statistics Canada and the Epidemiology Unit of the National Cancer Institute of Canada, and in the process, the methods were further refined (Howe and Lindsay, 1981). The generalized iterative record linkage system (GIRLS) was used for the present study in the linkage of the 10 percent sample to mortality data. (Greater detail is contained in section 3.2.)

CHAPTER 3

MATERIALS AND METHODS

This study is a cohort (or historical prospective) study, in which the cohort is approximately a 10 percent sample of the Canadian labour force between 1965 and 1971. The cohort has been followed up by means of computerized record linkage to the Canadian mortality data base for the years 1965 to 1979.

3.1 Sources of data

3.1.1 Occupational data

Between 1965 and 1968 the Unemployment Insurance Commission (UIC) collected data annually from all employers in Canada for all employees whose Social Insurance Number (SIN) ended in the digit 4, resulting in approximately a 10 percent sample of the labour force (for more detail concerning the sample, see section 3.1.3). The data consisted of the individual's SIN, surname, sex, year of birth, and occupation and industry in which the individual was then employed. For 1969 and 1971, only those persons whose SIN ended in 4, preceded by an odd number were included in the sample. The data for 1970 could not be found.

The occupations were coded using the three digit 1961 Canadian census occupation codes (Dominion Bureau of Statistics, 1961) for the data from 1965 to 1969 (see Appendix

I), and the four digit 1971 Canadian census codes (Dominion Bureau of Statistics, 1971) for the 1971 occupations. Industries were coded using the 1960 (see Appendix II) and 1970 versions of the three digit Canadian census industry codes (Dominion Bureau of Statistics, 1960 and 1970). (Section 3.1.3 explains that the 1971 data were not included in the analysis. Therefore the occupation and industry codes for 1971 are not included as appendices.) The data were converted to machine readable form and were originally used to examine employment patterns in Canada (Newcombe, 1974) and thus were not intended for use in epidemiologic research. The coding of occupation and industry was done by experts in the Labour Division at Statistics Canada (formerly the Dominion Bureau of Statistics).

The file of approximately three million records was sorted by SIN to bring together records referring to the same individual, thereby forming composite occupational histories. Records that had the same SIN but different surname, sex or year of birth were inspected, and as a result, less than 0.1 percent of the records were dropped from the file leaving 700,335 individuals. To obtain further identifying information for the purposes of record linkage, a list of the SINs was given to the UIC, the agency responsible for the issuing of the SINs. The UIC added identifying information for all members of the cohort, so that the items available for linkage were surname; first and second given names; sex;

day, month and year of birth; mother's maiden name; and province in which the individual most recently worked.

3.1.2 Mortality data

Statistics Canada maintains a mortality data base that contains records for all deaths registered in Canada since 1950 (Smith and Newcombe, 1982). These data are supplied to Statistics Canada by the Registrar of Vital Statistics from each province and territory. The data also include the deaths of Canadian residents that occur in the United States. The mortality records contain the same identifying information as the occupation records, plus additional identifiers that could not be used in the present study. In addition place and date of death are included as well as underlying cause of death coded to the appropriate revision of the International Classification of Diseases (ICD) or International Classification of Diseases Adapted for use in the United States (ICDA).

3.1.3 File generated for analysis

The data for analysis consisted of occupation records linked to the mortality data base from 1965 to 1979. A summary file was prepared which contained the occupational history plus the year, province and cause of death where applicable, together with the weight of the link (see section 3.2). Records were omitted from analysis as follows:

Males:

1. Occupation records of males containing invalid birth dates were omitted; specifically men under 9 or over 75 years of age as of 1965. This applied to 683 records.
2. Males who entered the cohort in 1971 (42,135) were excluded due to the major differences in the 1961 and 1971 occupation codes which were not reconcilable.

Thus the file of males for analysis consists of 415,316, of which 41,196 had died by the end of 1979. (No records were omitted from the mortality file prior to linkage.)

Females:

Females were excluded from the analysis because there were too few deaths to produce meaningful analysis, both because there are not as many females as males in the cohort and because they are younger and have longer life expectancy. (However, the females were linked using exactly the same procedures as for the males.) Since the major objective of this study is to establish an occupational monitoring system, it is felt that analysing male mortality only is adequate to demonstrate the utility of the system.

3.1.4 Representativeness of sample

The 10 percent sample was compared to the Canadian population in 1961 since it contained the same coding system as the 10 percent sample, and the 1971 occupation codes were not compatible with those of 1961. Some occupations were

noticeably underrepresented in the 10% sample; this is because some occupational categories did not contribute to the unemployment insurance plan, such as farmers who owned their farm, members of the armed forces and those earning in excess of $7,500 per year. Table 4 shows the comparison of the 10 percent sample with the Canadian population in 1961 for occupation divisions. It can be seen that the 10 percent sample has fewer people in managerial, and professional and technical occupations, and more labourers, n.e.s. than the 1961 Canadian population. However, it is otherwise representative.

Table 4. Comparison of 10 percent sample and 1961 population

Occupation division	10 percent sample		Canadian population	
	Number	%	Number	%
1. Managerial	21860	3.6	453904	11.7
2. Professional and technical	22782	3.7	326705	8.4
3. Clerical	56128	9.2	315539	8.1
4. Sales	37311	6.1	255866	6.6
5. Service and recreation	41790	6.8	377064	9.7
6. Transport and communication	49803	8.1	332263	8.6
7. Farmers and farm workers	7342	1.2	58944	1.5
8. Loggers and related workers	12073	2.0	56062	1.4
9. Fishermen, trappers and hunters	4257	0.7	28966	0.7
10. Miners and quarrymen and related	11972	2.0	55744	1.4
11. Craftsmen, production process etc.	201956	33.0	1274705	32.9
12. Labourers, n.e.s.	120947	19.8	258570	6.7
13. Occupation not stated	23126	3.8	59867	1.5
Total	611347	100.0	3880056	100.0

3.2 Methods - Record linkage

Computerized record linkage was first developed in Canada by H.B. Newcombe (1969), initially primarily for use in genetic studies. His methods were formalized by Fellegi and Sunter (1969) using likelihood theory, and by Howe and Lindsay (1981). The methodology was extended and generalized and a generalized computer linkage system was developed by Howe and Lindsay (1981).

Theoretically, record linkage involves the comparison of all records on one file (the 10 percent sample) with all records on another file (the mortality data base) and the calculation of a score (weight) that is a measure of the probability that two records, one from each file, refer to the same person.

In practice, it would not be economically feasible to compare all records on one file with all records on another file. It is necessary to block the files using a combination of identifying items or derivatives of identifying items to define the blocks. Comparisons are then carried out only between records in corresponding blocks on the two files. The block identifiers used in the linkage of the occupation file to the mortality file were sex and the NYSIIS code of surname (Lynch and Arends, 1977). The NYSIIS (New York State Identification and Intelligence System) code is an alphabetic code designed so that surnames of similar sound have the same code, and frequently encountered errors of misreporting do not

result in change in the NYSIIS code.

The record linkage system is modular so that the comparison of records, which is the most expensive step, need only be carried out once. This eliminates obvious non-links and produces a file of potential links which then have subsequent procedures applied with refinements where necessary.

For linkage of the 10 percent sample file with the mortality data base file, the identifiers consisted of surname; first and second given names; day, month and year of birth; sex and mother's maiden name. The 10 percent sample and the mortality data were both split by sex, so that only males on one file were compared with males on the other; the same thing applied to females. Also, as mentioned, records were compared between the 2 files only if they contained the same NYSIIS code.

The comparison rules used for the linkage were as follows:

1. Surname: agreement on the first 7 characters constituted full agreement; the first level of partial agreement was on the first 4 characters; and the second level of partial agreement, on NYSIIS code only. Full agreement was limited to 7 characters of the surname because it has been found that errors in spelling tend to increase toward the end of longer names.
2. Given names were compared on the first 4 characters for

full agreement and on initial only for partial agreement. If this resulted in disagreements, given names were cross compared, and a less positive weight assigned where cross agreements occurred. Only 4 characters were compared to minimize disagreements due to different spellings of the same name.

3. Birth date: day, month and year were compared individually; exact agreement was required except for year of birth. For birth year, full agreement was considered to exist if the values did not differ by more than 1. A first level of partial agreement on birth year was defined as a difference of 5 or less, and a second level of partial agreement, as a difference between 6 and 10.

4. Mother's maiden name was considered to agree if the NYSIIS codes were identical. This was used rather than the actual name since test runs demonstrated that this was not as well reported as other identifying information.

The weights were calculated by comparison of the individual identifying items as specified above, and assignment of a positive or negative component to the total weight depending on whether the items in question agreed, partially agreed or disagreed.

Weights for agreement and partial agreement were calculated according to the number of times a value (e.g.

Smith or 1910) was present in a specific field (e.g. surname or birth year) on the file in relation to the total number of records for which the field was not blank. The more frequently a value occurred on a file, the lower the agreement weight is; and the rarer the value, the higher the weight is (Howe and Lindsay, 1981). For example, a common surname such as 'Smith' resulted in a low agreement weight. Due to the frequent occurrence of Smith on both files, an agreement resulted in less confidence that a pair of records pertained to the same person than a rare surname would.

Where the comparison rules allowed for partial agreement, weights were calculated specifically for the different levels of partial agreement; for example, surname was compared on 7 characters as full agreement, 4 characters as the first level of partial agreement and on NYSIIS only as the second level of partial agreement. A weight for partial agreement can be arrived at either by performing the same calculation as for full agreement, or by arbitrarily assigning a weight that is lower than an average weight for full agreement (or the previous level of partial agreement). For this study, partial agreement weights were assigned arbitrarily and tested extensively prior to linking the complete files.

Disagreement weights were calculated according to the accuracy of reporting and the likelihood of a genuine change occurring. An inaccurately reported item or one that often changed, such as place of residence, received a less negative

disagreement weight than one that was well reported and stable. Disagreement weights were calculated based on the number of disagreements occurring in a sample of linked records in relation to the number of times the item was present in the linked pairs of records.

As a result of inspecting a number of links, a threshold was determined above which all links were considered to be 'definite', and below which all links were rejected.

The generalized computer record linkage system was applied as described above in order to identify those who died between 1974 and 1979. The deaths occurring between 1965 and 1973 were determined using the same techniques (Howe and Lindsay, 1983), prior to the development of the generalized linkage system.

3.3 Preparation of data, definitions and statistical analysis

3.3.1 Definition of exposure

An individual was categorized as exposed to a particular occupation or industry if he was recorded as employed in that occupation or industry for at least one year between 1965 and 1969; thus he may have been included in more than one exposure group. The data were also analysed specifying that the individual was coded to the same occupation or industry for at least 2, 3, 4 and 5 years.

3.3.2 Stratification by age and calendar year

SMRs were standardized for age (0-19, 20-24,...80-84, 85+) and 3 calendar periods of death (1965-69, 1970-74, 1975-79) due to the obvious change in mortality rates with increasing age and the fact that the rates for some causes of death under study changed during the 15 year period studied, for example, lung cancer. In addition, exposure may be expected to vary by age and calendar year.

3.3.3 Calculation of person years

Person years of observation were computed for each exposure group classified by calendar period of observation and age group as specified in the previous section. A member of the cohort was defined as entering the study, and thereby contributing person-years of observation, at the midpoint of the year in which occupational information was first recorded, and as exiting the study either at the midpoint of the year of death or at the end of 1979 if still alive.

3.3.4 Reference groups

SMRs were computed with respect both to Canadian population death rates (Statistics Canada, 1965-1979) and to death rates for the male portion of the 10 percent sample as a whole. The mortality of the entire 10 percent sample was compared to the Canadian population to examine the 'healthy worker effect'. However, unless otherwise specified, the

reference group was the entire 10 percent sample. This is because it is preferable that both the group of interest and the referent group have their mortality determined by record linkage since certain limitations of the methodology need to be considered. For any linkage, a threshold weight is chosen so that all links having a weight greater than that value are considered to be true matches, and those below, non-matches. If the threshold is too high, the apparent mortality rate will be lower than the true rate; but if the threshold is too low, rates will be determined which are higher than the true value. In the latter case, the resulting misclassification will bring the rates for any two groups being compared (exposed vs. non-exposed) towards the common population rate and thus introduce a bias toward the null. If the two groups being compared have linked with the same efficiency and the threshold value selected is reasonably high, the relative estimate for the two groups should be unbiased, though the absolute rates may be low (Howe et al., 1979).

An alternative type of reference group used in the analysis of the 10 percent sample was formed by grouping all occupations of similar socio-economic status. The classification of occupation by social class used was derived from the system used by the Registrar General of England and Wales in the U.K. Decennial Supplement on Occupational Mortality, 1970-1972.

3.3.5 Calculation of standardised mortality ratios (SMR)

Standardized mortality ratios (SMR) were computed for various subgroups of the cohort for all causes of death combined, for all cancer deaths and for deaths according to 33 cancer categories (table 7). Expected numbers of deaths were calculated by application of the age-specific rates for the particular cause of death for the reference group to the person-years of observation of the exposed group for 15 age categories (0-19, 20-24,...80-84, 85+) and for 3 calendar periods of observation (1965-69...1974-79). The SMR for a particular exposure group was then calculated as the ratio of the sum of the observed number of deaths in the group to the sum of the expected number of deaths according to the following formula (Monson, 1980):

$$SMR = \Sigma a_i / \Sigma E(a_i)$$

where a_i is the number of persons with a specific cause of death in the ith age group and calendar period and $E(a_i)$ is the number expected based on the age and time specific mortality rates in the reference population (see section 3.3.3). (The SMR was not multiplied by 100.)

3.3.6 Testing for significance

Tests of significance and interval estimation were performed by treatment of the observed number of deaths as a Poisson variable and with the use of standard techniques based on the Poisson distribution. One sided P values are presented

because the hypothesis being tested is that occupational exposure results only in increased risks, and not in decreased risks. The research question being addressed is whether the level of mortality from each of 33 cancer sites, for any occupation, is higher than the mortality for the cohort as a whole for the same type of cancer.

3.4 Social class

An attempt was made to control for lifestyle factors by allocating individuals to 'social classes' according to their occupation. The assumption was made that people in similar economic and occupational circumstances tend to be similar in other ways such as smoking, diet, etc. That such factors differ by social class is supported by data on smoking habits of Canadians, which show an inverse correlation between smoking and level of education (Health and Welfare Canada, 1980). Thus if an association were due to lifestyle factors rather than occupation, the SMR calculated with the social class as the reference group would be expected to be weaker than with the entire cohort as the reference group.

To examine this theory, all occupations were coded to a social class in the same manner as in the U.K. decennial supplement as follows: 1) professional, etc. occupations plus intermediate occupations; 2) skilled occupations - non-manual; 3) skilled occupations - manual; and 4) partly skilled and unskilled occupations. The first category

combined classes 1 and 2 of the U.K. system; this was done because both contained small numbers of individuals and their mortality was similar. The U.K. partly skilled and unskilled classes (4 and 5) were combined because there were very few different occupation codes in the 'unskilled' group in the Canadian data. (See table 5.)

An individual was defined as a member of a social class only if all his occupations fell in the same social class; this resulted in the exclusion of about 24 percent of the cohort. SMRs were calculated for each social class as a whole, with the entire male cohort as the reference group.

Consideration was given to using a scale which was developed by Blishen (1967) using 1961 census data. This scale ranked occupation according to level of income and education reported on 1961 census returns. It was decided to follow the methods used in the U.K. decennial supplement since this enables comparison between the two studies.

Table 5. Comparison of social classes in the U.K. decennial supplement and the 10 percent sample

U.K. decennial supplement		10 percent sample
I Professional etc. occupations	\	
	>	Social class 1
II Intermediate occupations	/	
IIIN Non-manual skilled occupations		Social class 2
IIIM Manual skilled occupations		Social class 3
IV Partly skilled occupations	\	
	>	Social class 4
V Unskilled	/	

3.5 Causes of death

Table 6 shows the cancer categories examined and provides the ICD codes for the 7th (1957), 8th (1967) and 9th (1977) revisions, as well as the number of deaths for each category.

Table 6. Cancer cause of death showing codes from the 7th, 8th and 9th revisions of the International Classification of Diseases

Cancer cause of death	ICD-7 code	ICD-8 code	ICD-9 code
Lip	140	140	140
Buccal cavity and pharynx	141-148	141-149	141-149
Esophagus	150	150	150
Stomach	151	151	151
Colon (intestine except rectum)	152-153	152-153	152-153
Rectum (and rectosigmoid junction)	154	154	154
Liver (and biliary system)	155	155-156	155-156
Pancreas	157	157	157
Larynx	161	161	161
Lung (& trachea, bronchus)	162-163	162	162
Bone	196	170	170
Breast	170	174	174-175
Prostate	177	185	185
Bladder	181.0	188	188
Kidney	180	189.0-189.1	189.0-189.1
Other and unspecified urinary organs	181.7-181.9	189.2-189.9	189.2-189.9
Skin	190-191	172-173	172-173
Brain	193.0	191	191
Other parts of nervous system	193.1-193.9	192	192
Hodgkin's disease	201	201	201
Non-Hodgkin's lymphoma	200, 202	200, 202	200, 202
Myeloma	203	203	203
Lymphatic leukemia - acute (& chronic & other to 1968)	204.0	204.0	204.0
Lymphatic leukemia - chronic	..	204.1	204.1
Lymphatic leukemia - other	..	204.9	204.2-204.9
Myeloid leukemia - acute (& chronic & other to 1968)	204.1	205.0	205.0
Myeloid leukemia - chronic	..	205.1	205.1
Myeloid leukemia - other	..	205.9	205.2-205.9
Monocytic leukemia - acute (& chronic & other to 1968)	204.2	206.0	206.0
Monocytic leukemia - chronic	..	206.1	206.1
Monocytic leukemia - other	..	206.9	206.2-206.9
Other and unspecified leukemia	204.3-204.4	207	207-208
All other cancer	- remaining codes within ranges specified as total		
Total	140-205	140-207	140-208

CHAPTER 4

RESULTS

4.1 Introduction

In this chapter, results are presented which correspond with the other monitoring systems to which the 10 percent sample has been compared, or with selected reviews of occupational-cancer associations (specified in section 4.1.3). The complete results for all associations with at least five observed deaths, and p (one-sided) less than 0.05 are presented in Appendix IV, by cancer site, by occupation and industry.

4.1.1 Data for analysis

SMRs were calculated for each individual occupation and industry, for each cause of death. Initially, SMRs were calculated based on all individuals who were recorded as working in the specific occupation or industry for one year; this was repeated for those in the same occupation or industry for 2, 3, 4 and 5 years (from 1965 to 1969). The comparison group was the entire cohort unless otherwise specified.

The number of individuals, person years and deaths for each occupation and industry is included in Appendices I and II, respectively. A summary table of deaths by cancer site and calendar period follows.

Table 7. Deaths by cause and calendar period

Cancer cause of death	Calendar period 1965-69	1970-74	1975-79	Total
Lip	3	6	7	16
Buccal cavity and pharynx	50	108	143	301
Esophagus	33	75	103	211
Stomach	183	289	353	825
Colon (intestine except rectum)	139	288	390	817
Rectum (and rectosigmoid junction	73	114	172	359
Liver (and biliary system)	33	65	90	188
Pancreas	109	211	254	574
Larynx	20	44	85	149
Lung (& trachea, bronchus)	505	1093	1656	3254
Bone	12	22	18	52
Breast	1	3	3	7
Prostate	64	182	308	554
Bladder	58	90	146	294
Kidney	37	89	101	227
Other and unspecified urinary organs	3	-	9	12
Skin	17	45	60	122
Brain	64	84	122	270
Other parts of nervous system	4	13	17	34
Hodgkin's disease	32	47	33	112
Non-Hodgkin's lymphoma	47	105	128	280
Myeloma	21	51	46	118
Lymphatic leukemia - acute (& chronic & other to 1968)	14	9	7	30
Lymphatic leukemia - chronic	3	17	31	51
Lymphatic leukemia - other	1	3	4	8
Myeloid leukemia - acute (& chronic & other to 1968)	13	38	40	91
Myeloid leukemia - chronic	3	11	17	31
Myeloid leukemia - other	-	6	4	10
Monocytic leukemia - acute (& chronic & other to 1968)	1	3	4	8
Monocytic leukemia - chronic	-	1	1	2
Monocytic leukemia - other	-	1	-	1
Other and unspecified leukemias	26	37	53	116
Other cancer	100	188	327	615
All leukemia	61	126	161	348
All cancer	1669	3338	4732	9739
All causes	7766	14573	18857	41196

4.1.2 Interpretation of results

The following factors are relevant to the credibility of the results: strength of the SMR, the p value, consistency from 1 to 5 years if there are enough deaths (see Appendices I and II), consistency with other monitoring systems and studies, and with established causes of cancer.

4.1.3 Comparison with other monitoring systems

The results of the 10 percent sample were compared only with data from systems for monitoring occupational cancer mortality, which at least partially overlapped the time period of the 10 percent sample follow-up (1965-79), and which covered a broad geographic area (at least one province or state). These criteria allowed comparison of the 10 percent sample with British Columbia occupational mortality, 1950-78 (Gallagher et al., 1986), Washington State mortality, 1950-79 (Milham, 1983), the United Kingdom decennial supplement on occupational mortality, 1970-72 (Registrar General, 1978), and Massachusetts occupational mortality, 1971-73 (Dubrow and Wegman, 1984). A study of occupational mortality in Rhode Island (Gute, 1981) was examined but excluded because there was very little analysis by cancer site. One exception to the decision to include mortality only was made in the case of the U.K. decennial supplement; since it combined a comparison of mortality with cancer incidence; the incidence data were specified under 'other ' in tables 9 to 25.

4.1.4 Comparison with reviews of occupation-cancer associations

The results were also compared with a 'synthesis of the results of occupational disease surveillance studies' (Dubrow and Wegman, 1983), and with five comprehensive reviews of occupational cancer mortality: Cole and Goldman in Persons at High Risk of Cancer (1975), Doll and Peto, in 'Avoidable risks of cancer in the U.S.' (1981), Decouflé in Cancer Epidemiology and Prevention (1982), Alderson, Occupational Cancer (1986), and Alderson, in Hunter's Diseases of Occupations (1987).

Exclusion of industry associations: It was not possible to include comparisons of most industry-cancer associations with the results of the other monitoring systems and reviews, because only occupations were included in the other systems. Also, most industries include a wide variety of jobs, which makes associations difficult to interpret. However, in some cases, job titles used in other systems bore more resemblance to industry titles than occupation titles in the 10 percent sample. In these cases industries were included in the analysis. Fortunately, these industries appeared to represent more homogeneous groups of individuals, e.g. specific types of mining, making the comparisons valid.

4.1.5 Presentation of the results

First, results are presented by cancer site, with the Canadian population as the comparison group. The occupation/industry-cancer associations are presented by cancer site, in the order they appear in the International Classification of Diseases, 9th revision (1977), and in order of occupation (and where possible, industry) code number. Lastly, the results are compared to those obtained by using the social class in which the occupation falls as the comparison group.

4.2 Comparison of the 10 percent sample with the Canadian population

Table 8 gives results of comparison of the mortality experience of the entire cohort with that expected from the Canadian population rates (Statistics Canada, 1965-1979). For the 15 year study period, mortality of the cohort for most cancer sites was similar to the Canadian population. However, for the first 5 years, most SMRs were well below 1; the overall mortality of the cohort was only about 74 percent of the Canadian population. The mortality ratios increased for each calendar period and were generally close to 1 in 1975-79.

Table 8. SMRs (and observed deaths) by cancer site, Canadian population as comparison group, by calendar period

Cancer cause of death	SMR (and observed deaths) 1965-69	1970-74	1975-79	1965-79
Buccal cavity and pharynx	0.91 (50)	1.08 (108)	1.27 (143)	1.11 (301)
Esophagus	0.71 (33)	0.88 (75)	1.05 (103)	0.91 (211)
Stomach	0.85 (183)	0.89 (289)	1.17 (353)	0.95 (825)
Colon	0.75 (139)	0.85 (288)	1.04 (390)	0.90 (817)
Rectum	0.78 (73)	0.75 (114)	1.08 (172)	0.87 (359)
Larynx	0.65 (20)	0.77 (44)	1.32 (85)	0.98 (149)
Lung	0.87 (505)	0.95 (1093)	1.21 (1656)	1.07 (3254)
Bone	0.83 (12)	1.05 (22)	1.13 (18)	1.01 (52)
Skin	0.58 (17)	1.05 (45)	1.26 (60)	1.00 (122)
Breast	0.50 (1)	0.61 (3)	0.54 (3)	0.57 (7)
Prostate	0.65 (64)	0.81 (182)	1.00 (308)	0.86 (554)
Kidney	0.64 (37)	0.97 (89)	1.06 (101)	0.92 (227)
Bladder	1.01 (58)	0.83 (90)	1.20 (146)	1.01 (294)
Other and unspecified urinary organs	2.49 (3)	- -	1.80 (9)	1.27 (12)
Brain	0.83 (64)	0.74 (84)	1.17 (122)	0.92 (270)

Table 8. SMRs (and observed deaths) by cancer site, Canadian population as comparison group, by calendar period

Cancer cause of death	SMR (and observed deaths) 1965-69	1970-74	1975-79	1965-79
Other parts of nervous system	0.42 (4)	0.78 (13)	1.06 (17)	0.82 (34)
Liver	0.81 (33)	0.96 (65)	1.16 (90)	1.00 (188)
Pancreas	0.89 (109)	0.94 (211)	1.07 (254)	0.98 (574)
Lip	0.98 (3)	1.09 (6)	1.33 (7)	1.12 (16)
Leukemia	0.69 (61)	0.92 (126)	1.08 (161)	0.93 (348)
Non-Hodgkin's lymphoma	0.69 (47)	0.99 (105)	1.14 (128)	0.98 (280)
Myeloma	0.81 (21)	1.05 (51)	0.80 (46)	0.91 (118)
Other cancer	0.58 (100)	0.68 (188)	1.08 (327)	0.83 (615)
All cancer	0.80 (1669)	0.90 (3338)	1.14 (4732)	0.98 (9739)
All causes	0.74 (7765)	0.85 (14573)	1.08 (18856)	0.91 (41194)

4.3 Mortality by cancer site and occupation or industry

The following sections present the 10 percent sample results in comparison with other monitoring systems and other sources. 'Other' sources include the cancer incidence data from the U.K. decennial supplement, the reviews by Cole and Goldman (1975), Doll and Peto (1981), Decouflé (1982),

Alderson (1986, 1987), and occasionally other papers in the literature. Results are presented for which at least one source corresponded with the 10 percent sample. The ratios from the other monitoring systems were divided by 100 for consistency with the 10 percent sample calculations. The level of significance is indicated by '*' for $p < 0.05$ and '**' for $p < 0.01$. For the 10 percent sample only, the observed number of deaths is shown. Results from all monitoring systems are shown only if there were at least 5 observed deaths and they were statistically significant at the 0.05 level.

For some cancer sites, there were no significant results in the 10 percent sample, due to very few deaths occurring; these included cancer of the lip, breast, other and unspecified urinary organs, and other parts of the nervous system.

4.3.1 Cancer of buccal cavity and pharynx (except lip)

Occupation

Cancer of the buccal cavity and pharynx was high for clerical occupations, n.e.s. in both the 10 percent sample and Washington State (see table 9). For guards and watchmen, n.e.s., the 10 percent sample and British Columbia data were in agreement. Bartenders had high mortality from this site in B.C., Washington State, and Massachusetts, as well as the 10 percent sample; for waiters, there was agreement with

B.C. and Massachusetts. Butchers' mortality from this site was consistent with meat processing workers in 2 of the studies synthesized by Dubrow and Wegman (1983).

Industry

Elevated mortality in breweries was consistent with Alderson's review (1986).

Table 9. Cancer of buccal cavity and pharynx mortality by occupation and industry

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C.[2] (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
249 Clerical occupations, n.e.s.	1.56** (34)	-	2.58**	-	-	
405 Guards, watchmen, n.e.s.	2.06* (12)	1.74*	-	-	-	
414 Bartenders	5.05** (10)	2.41**[3]	2.07**	-	3.04**	
415 Waiters	15.02** (5)	2.41**[3]	-	-	1.61*	
703 Butchers	3.59* (5)	-	-	-	-	+
Industry:						
145 Breweries	6.76** (6)	-	-	-	-	+
875 Hotels, restaurants and taverns	3.31** (9)	-	-	3.49**	-	

* P < 0.05.
** P < 0.01.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.
2. Cancer of mouth only.
3. Bartenders and waiters were combined in the B.C. analysis.

4.3.2 Cancer of esophagus

Occupation

Cancer of the esophagus (Table 10) was high in guards, watchmen, n.e.s. and in the U.K. cancer incidence data. Mechanics and repairmen, motor vehicle had high mortality from cancer of the esophagus in the 10 percent sample and in the Washington State data.

Industry

The SMR for employees of urban transit systems was elevated in the 10 percent sample, and for U.K. esophageal cancer incidence was high for bus conductors.

Table 10. Cancer of esophagus mortality by occupation and industry

Occupation/industry	Monitoring systems[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
405 Guards, watchmen, n.e.s.	1.74* (10)	-	-	-	-	+
822 Mechanics and repairmen, motor vehicle	2.34** (12)	-	1.63*	-	-	
Industry:						
509 Urban transit systems	2.82* (5)	-	-	-	-	+

* $P < 0.05$.
** $P < 0.01$.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

4.3.3 Cancer of stomach

Occupation

The elevated mortality observed for lumbermen, including labourers in logging, in the 10 percent sample was also seen in the Washington State data (see Table 11). Miners had high SMRs for 2, 3 and 4 years in this occupation. The Dubrow and Wegman (1983) review found 3 significantly high results among miners in 7 studies. Carpenters in both the 10 percent sample and B.C. had high mortality from stomach cancer. Metalworking occupations, n.e.s. showed high mortality which corresponded with results of the U.K. decennial supplement. In both the 10 percent sample and B.C., there was high mortality for sectionmen and trackmen.

Industry

The association between coal mining and elevated stomach cancer mortality was consistent over 4 years of observation; the U.K. data were consistent for deaths and cancer incidence. There are several reports of an association of coal mining and stomach cancer in the literature (Alderson, 1986, Rockette, 1977; Ashley, 1969; Creagan et al., 1974), although Decouflé (1982) indicates that no specific agent has been identified.

For workers in building construction, mortality was high, both in the 10 percent sample and Washington State.

Table 11. Stomach cancer mortality by occupation and industry

Occupation/industry	Monitoring systems[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
615 Lumbermen, including labourers in logging	1.55* (28)	-	1.15*	-	-	+
654 Miners	2.15* (7)	-	-	-	-	+
751 Carpenters	1.37* (35)	1.33**	1.20**	-	1.56*	+
819 Metalworking occupations, n.e.s.	2.41* (7)	-	-	1.58**	-	
890 Sectionmen and trackmen	3.22* (5)	1.47**	-	-	-	+
Industry:						
061 Coal mines	2.64* (6)	-	-	1.71**	-	+
404 Building construction	3.83* (5)	-	1.35**	-	-	

* $P < 0.05$.

** $P < 0.01$.

1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

4.3.4 Cancer of colon (intestine except rectum)

Occupation

Clerical occupations experienced high mortality from colon cancer in the 10 percent sample, in British Columbia, and the United Kingdom for both mortality and cancer incidence (Table 12). Mortality was high in both the 10 percent sample and the United Kingdom for commercial travellers. Locomotive engineers had consistently high mortality in Washington State and Massachusetts as well as in the 10 percent sample. The excess mortality for brakemen, railroad is supported by the reviews by Decouflé and Alderson. Elevated colon cancer mortality for linemen and s rvicemen in this study corresponded with Washington State data.

Industry

High mortality from colon cancer in the printing and publishing industry was supported by the Washington State data; and for metal stamping, pressing and coating industry, by the Massachusetts study. The finding for shipbuilding and repair was supported by the reviews by Decouflé and by Alderson. High mortality for insurance carriers was consistent with the U.K, Washington State, and the Dubrow and Wegman analysis.

4.3.5 Cancer of rectum (and rectosigmoid junction)

Occupation

Cancer of the rectum (Table 13) was high for butchers in

both the 10 percent sample and in Massachusetts, as well as the Alderson review.

Industry

High mortality for rectal cancer for workers in the food store industry was in agreement with 'grocers, grocery clerks, and retail food stores workers' in the Dubrow and Wegman analysis.

4.3.6 Cancer of liver (and biliary system)

Occupation

Elevated liver cancer in cooks was in agreement with data from B.C., Massachusetts, and the analysis by Dubrow and Wegman (Table 14). For waiters, similar results were seen in Massachusetts and the Alderson review.

Industry

High mortality from liver cancer in the hotels, restaurants and taverns industry corresponded with the Alderson review.

Table 12. Colon cancer mortality by occupation and industry

Occupation/industry	10 % SMR (obs)	Monitoring systems[1] B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
249 Clerical occupations, n.e.s.	1.64* (22)	1.22*	-	1.14*[2]	-	+
314 Commercial travellers	1.56* (23)	-	-	1.45**[3]	-	
531 Locomotive engineers	3.07** (9)	-	1.47**	-	2.90*	
535 Brakemen, railroad	3.79* (5)	-	-	-	-	+
838 Linemen and servicemen - telephone, telegraph and power	1.95* (11)	-	2.09*	-	-	
Industry:						
289 Printing and publishing	2.27* (8)	-	1.40*	-	-	
304 Metal stamping, pressing and coating industry	1.91* (14)	-	-	-	1.20*	
327 Shipbuilding and repair	2.24* (7)	-	-	-	-	+
731 Insurance carriers	2.87* (6)		4.63**[4] 1.39*[5]		-	+

* $P < 0.05$.

** $P < 0.01$.

1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations; '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.
2. All cancer PMR, age group 65-74.
3. PMR.
4. Small intestine.
5. Large intestine.

Table 13. Cancer of the rectum mortality by occupation and industry

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
703 Butchers	2.73* (7)	-	-	-	3.16*	+
Industry:						
631 Food stores	2.89* (6)	-	-	-	-	+

* $P < 0.05$.
** $P < 0.01$.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

Table 14. Liver cancer mortality by occupation and industry

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
413 Cooks	2.78* (6)	3.66**	-	-	3.50*	+
415 Waiters	2.65* (6)	-	-	-	3.06**	+
Industry:						
875 Hotels, restaurants and taverns	1.93* (9)	-	-	-	-	+

* $P < 0.05$.
** $P < 0.01$.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

4.3.7 Cancer of pancreas

Occupation

Logging foremen showed high mortality from cancer of the pancreas in both the 10 percent sample and Washington State (Table 15). For miners, there was agreement with coal miners for cancer incidence, but not mortality, in the U.K. data.

Industry

Pancreas cancer mortality for local administration was high, similar to 'officials and administrators - public administration', in the Dubrow and Wegman analysis.

Table 15. Pancreas cancer mortality by occupation and industry

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
611 Logging foremen	4.30** (5)	-	1.69*	-	-	
654 Miners	2.68** (9)	-	-	-	-	+
Industry:						
951 Local administration	1.48* (22)	-	-	-	-	+

* $P < 0.05$.
** $P < 0.01$.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

4...8 Cancer of larynx

Occupation

Table 16 shows high mortality from cancer of the larynx

in waiters in the 10 percent sample, B.C., and the Alderson review. For truck drivers, consistent findings occurred in Washington, Massachusetts and in the Dubrow and Wegman analysis.

Industry

Excess laryngeal cancer mortality for workers in hotels, restaurants and taverns was in agreement with U.K. publicans and innkeepers.

Table 16. Larynx cancer mortality by occupation and industry

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
415 Waiters	2.73* (5)	4.40**[2]	-	-	-	+
556 Truck drivers	3.40** (7)	-	1.54*	-	2.29**	+
Industry:						
875 Hotels, restaurants and taverns	3.52* (5)	-	-	2.33[3]	-	+

* $P < 0.05$.
** $P < 0.01$.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.
2. Includes waiters and bartenders.
3. All cancer PMR, age 15-64.

4.3.9 Cancer of (trachea, bronchus and) lung

Occupation

There were several occupational categories for which consistent results for lung cancer were seen (in Table 17)

both in the 10 percent sample and in other studies as follows:

- clerical occupations, n.e.s. - B.C.;

- guards and watchmen n.e.s. - B.C., and both mortality and cancer incidence in the U.K.;

- bartenders - B.C., U.K., and Massachusetts;

- truck drivers - B.C., U.K., Washington, Massachusetts, Rhode Island, the Dubrow and Wegman analysis and the Alderson review;

- postmen and mail carriers - B.C. and the U.K.;

- miners - the U.K., and reviews by Cole and Goldman, Decouflé, and Alderson;

- furnacemen and heaters, metal - the U.K., Massachusetts and Alderson;

- moulders - the U.K. and the Dubrow and Wegman analysis;

- plumbers and pipefitters - all monitoring systems and the Alderson review;

- sheet metal workers - B.C., the U.K., Washington and the Dubrow and Wegman analysis; and

- bottlers, wrappers, labelers - the U.K. cancer incidence (1966-67).

Industry

Elevated lung cancer mortality for the following industries in the 10 percent sample was in agreement with other data as follows:

- copper-gold-silver mines - the reviews by Doll and Peto, Decouflé, and Alderson;

- nickel-copper mines - Cole and Goldman, Decouflé, and Alderson;
- iron foundries - Cole and Goldman, Decouflé, and Alderson;
- smelting and refining - Washington;
- machine shops - the U.K.;
- miscellaneous metal fabricating industries - the U.K.;
- shipbuilding and repair - the U.K., Washington, Massachusetts, Cole and Goldman, Doll and Peto, Decouflé, Dubrow and Wegman, and Alderson;
- cement manufacturers - Cole and Goldman, Fraumeni (1975);
- asbestos products manufacturers - Washington, Massachusetts, Cole and Goldman, Doll and Peto, Dubrow and Wegman, and Alderson; and
- truck transport - Alderson (and see truck drivers as an occupation).

4.3.10 Cancer of bone

The only significantly high mortality for bone cancer in the 10 percent sample was seen for the industry of special trade contractors; there were no corresponding findings in any of the other monitoring systems or reviews.

Table 17. Lung cancer mortality by occupation and industry

Occupation/industry	10 % SMR (obs)	Monitoring system[1] B.C. (PMR)	U.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
249 Clerical occupations, n.e.s.	1.87* (10)	1.25**[2]	-	-	-	
405 Guards, watchmen, n.e.s.	1.59** (38)	1.21*	-	1.11*[3]	-	+
414 Bartenders	1.50* (32)	1.33**[4]	-	-	1.56*	+
556 Truck drivers	1.31* (60)	1.30**[5]	1.10*	1.45**	1.73**	+
587 Postmen and mail carriers	2.17* (7)	1.41*	-	-	-	+
554 Miners	1.41* (36)	-	-	-	-	+
781 Furnacemen and heaters, metal	1.69* (22)	-	-	-	1.32*[6]	+
786 Moulders	1.88* (16)	-	-	1.84**	-	+
810 Plumbers and pipefitters	1.72** (29)	1.44**	1.30**	1.26**	1.35*	+
811 Sheet metal workers	3.72* (5)	1.38*[7]	1.28**	1.45**	-	+
913 Bottlers, wrappers, labelers	1.32* (43)	-	-	-	-	+
Industry:						
053 Copper-gold-silver mines	1.49* (22)	-	-	-	-	+
054 Nickel-copper mines	1.57* (17)	-	-	-	-	+
294 Iron foundries	1.48* (23)	-	-	-	-	+
295 Smelting and refining	1.34* (44)	-	1.71**	-	-	
308 Machine shops	2.07* (11)	-	-	1.14*	-	
309 Miscellaneous metal fabricating industries	1.53* (21)	-	-	1.44**	-	
327 Shipbuilding and repair	1.33* (40)	-	1.19**	1.82**	1.51**	+

Table 17. Lung cancer mortality by occupation and industry cont'd

Occupation/industry	10 % SMR (obs)	Monitoring system[1] B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
341 Cement manufacturers	2.30* (11)	-	-	-	-	+
355 Asbestos products manufacturers	6.54* (5)	-	3.27**	-	2.01*	+
507 Truck transport	1.24* (88)	-	-	-	-	+

* P < 0.05.
** P < 0.01.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.
2. Also includes (212) stock clerks and storekeepers.
3. All cancer PMR age 65-74.
4. Also includes (415) waiters.
5. Also includes (554) driver-salesmen, and (563) teamsters.
6. Cancer of the respiratory system (ICD codes 160-163)
7. Also includes (871) boiler firemen (except ship).

4.3.11 Cancer of skin

High mortality from skin cancer (both melanoma and other) was seen in owners and managers, n.e.s.(Table 18). This was consistent with high melanoma in B.C. and the U.K. in similar occupational categories.

4.3.12 Cancer of prostate

Mortality from cancer of the prostate was high for driver salesmen, and in agreement with Washington State data (Table 19).

Table 18. Skin cancer mortality by occupation

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
010 Owners and managers n.e.s.	2.38* (6)	1.42*[2]	-	-		+

* P < 0.05.
** P < 0.01.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.
2. Also includes (006) office managers and (007) postmasters.

Table 19. Prostate cancer mortality by occupation

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
554 Driver salesmen	1.79* (12)	-	1.22*	-	-	

* P < 0.05.
** P < 0.01.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

4.3.13 Cancer of kidney

High kidney cancer mortality for the railway transport industry was consistent with Washington State data (Table 20).

4.3.14 Cancer of bladder

Service station attendants had elevated bladder cancer mortality in the 10 percent sample, Massachusetts and in the Dubrow and Wegman analysis (Table 21). Mortality was high for

truck drivers in the U.K. and the 10 percent sample. Further support for this association was found in a study of occupational factors and the incidence of cancer of the bladder in Canada, where the odds ratio for exposure to diesel or traffic fumes was estimated as 1.69, p = 0.0008 (Risch et al., 1988). High mortality for mechanics and repairmen, motor vehicle corresponded with the Dubrow and Wegman analysis.

4.3.15 Cancer of brain

Mortality from cancer of the brain was high for science and engineering technicians (consistent with the U.K.), and for electricians, wiremen and electrical repairmen (also in Washington, and the Dubrow and Wegman analysis) (Table 22). Brain cancer mortality has been associated with electrical and electronics jobs in the literature (Thomas et al., 1987, Lin et al, 1985).

4.3.16 Hodgkin's disease

Only one industry in the 10 percent sample (communications equipment manufacturers) showed high mortality; there were no consistent results elsewhere.

4.3.17 Non-Hodgkin's lymphoma

High non-Hodgkin's lymphoma mortality for linemen and servicemen was in agreement with Washington state data, as well as other reports in the literature (Milham, 1988) (Table

23).

Table 20. Kidney cancer mortality by industry

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Industry:						
506 Railway transport	1.94* (16)	-	2.51**	-	-	

* $P < 0.05$.
** $P < 0.01$.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

Table 21. Bladder cancer mortality by occupation

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
323 Service station attendants	3.03* (6)	-	-	-	3.30**	+
556 Truck drivers	2.91* (5)	-	-	1.95*	+	
822 Mechanics and repairmen, motor vehicle	2.24* (8)	-	-	-	-	+

* $P < 0.05$.
** $P < 0.01$.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

Table 22. Brain cancer mortality by occupation

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
198 Science and engineering technicians	2.54* (7)	-	-	2.00**[2]	-	
831 Electricians, wiremen and electrical repairman	1.93* (9)	-	1.60**	-	-	

* P < 0.05.
** P < 0.01.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

Table 23. Non-Hodgkin's lymphoma mortality by occupation

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
838 Linemen and servicemen - telephone, telegraph and power	2.43* (7)	-	1.96*	-	-	+

* P < 0.05.
** P < 0.01.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

4.3.18 Myeloma

Only fishermen in the 10 percent sample had high myeloma mortality, but this was not supported in any of the other monitoring systems or reviews.

4.3.19 Leukemia

Occupation

As for non-Hodgkin's lymphoma, linemen and servicemen experienced high mortality from leukemia in both the 10 percent sample and in Washington State, and there is some additional support for this finding in the literature (Coleman and Beral, 1988) (Table 24).

Industry

High leukemia mortality was seen in local administration in the 10 percent sample and in the Dubrow and Wegman analysis.

4.3.20 Other cancer

No attempt was made to compare other cancer with other monitoring systems since there was considerable variation in the ICD codes included under this heading. Of some possible interest were the elevated SMRs for workers in laundries, cleaners and pressers, due to the consistency of the results over 4 years and the increasing magnitude of the SMRs from the first to the 4th year, from 2.44 to 6.12 (see Appendix IV, Table 19). However, these SMRs were based on 7 deaths in the first year and 5 in the other years; therefore an attempt to look at a finer breakdown by cause would result in numbers too small for meaningful analysis (unless they happened all to be due to the same cause).

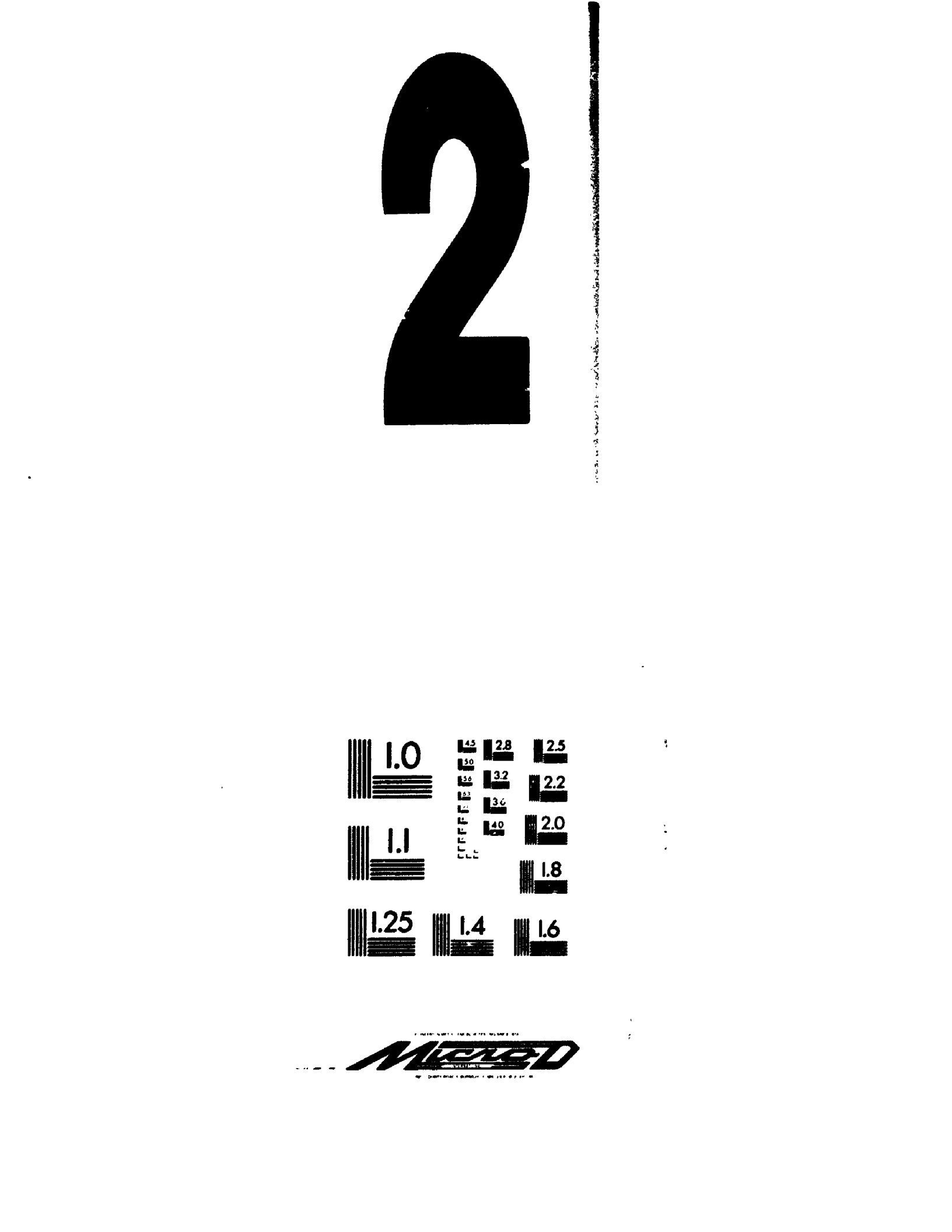
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Table 24. Leukemia mortality by occupation and industry

Occupation/industry	Monitoring system[1]					
	10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
838 Linemen and service-men - telephone, telegraph and power						
All leukemia	2.43* (7)	-	2.59**	-	-	+
Industry:						
951 Local administration						
All leukemia	1.52* (24)	-	-	-	-	+

* P < 0.05.
** P < 0.01.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

4.3.21 All cancer

Occupation

Elevated mortality from all cancer in the 10 percent sample corresponded with other studies for the following occupations (see Table 25):

- insurance salesmen and agents - Washington;
- guards and watchmen, n.e.s. - B.C. and Washington;
- driver salesmen - Washington;
- plumbers and pipefitters - B.C.;
- painters except construction and maintenance - B.C..
- insulation appliers - B.C. and Washington; and
- stationary enginemen - B.C.

Table 25. All cancer mortality by occupation and industry

Occupation/industry	Monitoring system[1] 10 % SMR (obs)	B.C. (PMR)	W.S. (PMR)	U.K. (SMR)	Mass. (sMOR)	Other
Occupation:						
331 Insurance salesmen and agents	2.23	-	1.11*	-	-	
405 Guards, watchmen, n.e.s.	1.14** (561)	1.10*	0.88*	-	-	
554 Driver salesmen	1.26** (199)	-	1.12**	-	-	
810 Plumbers and pipe-fitters	1.34* (66)	1.18**	-	-	-	
843 Painters except construction and maintenance	1.39* (56)	1.12**	-	-	-	
857 Insulation appliers	1.90* (15)	1.34**	1.86**	-	-	
872 Stationary enginemen	1.86* (12)	1.09*	-	-	-	
Industry:						
145 Breweries (39)	1.42*	-	1.22*	-	-	
355 Asbestos products manufacturers	2.76* (6)	-	1.86**	-	-	

* P < 0.05.
** P < 0.01.
1. 10 % = 10 percent sample; B.C. = British Columbia mortality data; W.S. = Washington State mortality data; U.K. = United Kingdom decennial supplement on occupational mortality; Mass. = Massachusetts mortality data; Other = U.K. decennial supplement cancer incidence data and reviews of occupation cancer associations. '+' = agreement with 1 or more of these sources. sMOR = Standardized mortality odds ratio.

Industry

High cancer mortality in the breweries industry was consistent with brewery workers in Washington State. Asbestos products manufacturers' mortality in the 10 percent sample was

in agreement with asbestos and insulation workers in Washington.

4.4 Results within social class

As discussed in section 3.4, an attempt was made to control for lifestyle factors by allocating individuals to 'social classes' according to their occupation. The assumption was made that people in similar economic and occupational circumstances tend to be similar in other ways which influence susceptibility to cancer such as smoking habits, diet, etc. To examine this theory, all occupations were coded to a social class in the same manner as in the U.K. decennial supplement (see Table 5, Section 3.4). Some causes of death other than cancer were included in the results presented in order to examine more causes of death known to be related to lifestyle factors, and hence the usefulness of using social class as an approximation of lifestyle variables.

Table 26 shows the number of individuals, person years and deaths in each social class in the 10 percent sample. Note that 1 indicates high social class and 4, low social class.

Table 26. Number of persons, person years and deaths by social class

Social class[1]	Persons	Person years	Deaths
1	23678	306486	2048
2	42763	554451	4052
3	117468	1560461	11577
4	129005	1657764	14920

1. See table 5, page 54.

Table 27 shows SMRs by social class for causes of death that are associated with smoking. Lung cancer, bronchitis and emphysema show generally increasing SMRs with decreasing social class. There was no trend for bladder cancer.

Table 27. SMR and (number of deaths) for smoking related causes of death

Cause of death	Social class[1]			
	1	2	3	4
Lung cancer	0.74 (145)	0.81 (243)	1.09 (1022)	1.03 (1155)
Bladder cancer	1.20 (20)	0.98 (27)	1.10 (87)	0.81 (89)
Bronchitis	0.55 (13)	1.03 (40)	0.94 (104)	1.17 (177)
Emphysema	0.64 (17)	1.07 (46)	0.96 (121)	1.09 (184)

1. See table 5, page 54.

Table 28 shows causes of death related to alcohol (cirrhosis and alcoholism), and alcohol in combination with smoking (cancer of buccal cavity and esophagus). There is some indication of increasing alcohol related mortality with lower social class. The pattern is somewhat uneven, and appears to reflect a tendency to classify alcohol-related deaths in the lowest class to alcoholism rather than cirrhosis. The trend is smoother when the two are combined. Cancer of the buccal cavity and pharynx, and esophagus do not appear to be correlated with social class.

Table 28. SMR and (number of deaths) for alcohol (and alcohol and smoking) related deaths

Cause of death	Social class[1]			
	1	2	3	4
Cirrhosis	0.66 (45)	1.08 (106)	1.05 (341)	1.00 (324)
Alcoholism	0.54 (9)	0.75 (19)	0.86 (70)	1.50 (119)
Cirrhosis and alcoholism	0.63 (54)	1.01 (125)	1.01 (411)	1.10 (443)
Buccal cavity and pharynx	0.86 (16)	1.21 (34)	1.06 (64)	0.98 (98)
Esophagus	1.26 (16)	0.76 (15)	1.06 (64)	0.95 (69)

1. See Table 5, page 54.

Table 29. SMR and (number of deaths) for selected causes of death by social class

Cause of death	Social class[1]			
	1	2	3	4
Cancer of colon	1.32 (63)	1.51 (116)	0.98 (225)	0.84 (244)
Cancer of stomach	0.80 (39)	0.71 (55)	0.95 (225)	1.16 (338)
All cancer	0.91 (524)	1.03 (938)	1.02 (2829)	1.00 (3385)
All causes	0.85 (2048)	1.03 (4052)	1.00 (11577)	1.05 (14920)

1. See Table 5, page 54.

In table 29, colon cancer, which has been associated with sedentary jobs (Gerhardsson et al., 1986) is positively correlated with social class. Stomach cancer is negatively correlated with social class which is in agreement with a previous study (Billette and Hill, 1978). All cancer and all causes are somewhat negatively correlated with social class.

Comparison of SMRs calculated with the total cohort and social class as comparison group for selected causes

SMRs with the total cohort, and with the social class in which the occupation fell as comparison group were compared for lung and bladder cancer. These sites were chosen because there are established associations with occupation, and also with smoking (a strong association for lung cancer and a weaker one for bladder cancer). The data presented in tables 30 and 31 were restricted to occupations for which there were significant results with one year of 'exposure' (i.e. the occupation was recorded for at least 1 year between 1965 and 1969). This was for consistency with the results for which social class was the comparison group. (Records were excluded from a social class if occupations fell in different classes; therefore there were fewer records for analysis.)

It would be expected that SMRs which are related to occupation would maintain their strength within social class, whereas those related to lifestyle would be weaker within social class. This is based on the assumption that members of a social class would tend to have similar lifestyles. In

general, it can be seen that the SMRs within social class were comparable to those where the comparison group was the total cohort, regardless of whether there is any apparent occupational exposure.

Table 30. Lung cancer mortality by occupation with the total cohort and social class as reference groups (for 1 year of 'exposure')

Occupation	Comparison to total cohort		Comparison within social class	
	No. of deaths	SMR	No. of deaths	SMR
Social class 3				
556 Truck drivers	172	1.15	112	1.14
781 Furnacemen and heaters, metal	22	1.69	9	1.51
786 Moulders	16	1.88	14	2.53
810 Plumbers and pipe-fitters	58	1.57	45	1.48
Social class 4				
405 Guards, watchmen, n.e.s.	197	1.27	156	1.29
414 Bartenders	32	1.50	25	1.60
587 Postmen and mail carriers	7	2.17	4	2.51
659 Quarriers and related workers	17	1.77	15	2.24
913 Bottlers, wrappers, labelers	43	1.32	31	1.32

Table 31. Bladder cancer mortality by occupation with the total cohort and social class as reference groups (for 1 year of 'exposure')

Occupation	Comparison to total cohort		Comparison within social class	
	No. of deaths	SMR	No. of deaths	SMR
Social class 1				
010 Owners and managers n.e.s.	23	1.55	12	1.18
Social class 3				
554 Driver salesmen	9	2.24	3	1.19
822 Mechanics and repair men, motor vehicle	13	2.04	10	1.99

CHAPTER 5

DISCUSSION AND CONCLUSIONS

5.1 Introduction

There are many ways in which the 10 percent sample could be evaluated as a system of monitoring associations between occupation and cause of death, and the results interpreted. Generally when a single industry or occupation is studied, one examines the association(s) according to their level of statistical significance and the strength of the ratio(s) of observed to expected cases or deaths. The situation is more complicated when there are dozens of statistically significant associations. Ideally, each association would be examined in detail, and a decision made regarding the need for further study.

However, for a monitoring system this evaluation can be simplified by selecting for further consideration only those associations which meet specific criteria. The 10 percent sample results will be evaluated according to the magnitude of the SMR, the consistency of the association with results observed in other studies, evidence of a dose-response curve, and whether there are known exposures associated with the occupation or industry under study which are established carcinogens.

In addition, it is necessary to examine the adequacy of the data and the effectiveness of computerized record linkage

as the basis for monitoring occupation-cancer associations. A number of decisions were made to make the evaluation manageable; these decisions are explained at the beginning of each section. The next three sections (5.2 - 5.4) address the following: 1) limitations of the data and interpretation of results; 2) ways of evaluating the effectiveness of the 10 percent sample as a monitoring system; and 3) discussion and interpretation of the study results according to specified criteria. Finally, conclusions and recommendations are presented in section 5.5.

5.2 Limitations concerning interpretation

Several factors limit the interpretation of the results produced by the 10 percent sample.

1) Occupational histories: It has to be assumed that a necessary latent period has passed. The present data relate to mortality occurring within at most 15 years of the first recorded exposure to a particular occupation or industry.

A second consideration regarding occupational histories was the attainment of a level of exposure sufficient to increase risk. Numerous studies indicate that for many occupation-cancer associations the minimum period of exposure necessary is very small (Miller, 1975). Inclusion in an exposure group of individuals whose level of exposure was insufficient to increase risk would, of course, lead to a misclassification bias which would in turn lead to an

underestimation of risk.

2) Confounders: Lack of data concerning possible confounders such as smoking or socioeconomic factors makes it impossible to distinguish indirect from direct associations. In addition, interpretation of results controlling for social class may be of limited value if the classes are not homogeneous with respect to lifestyle factors.

3) Multiple comparisons: In the interpretation of associations among the 274 different occupation codes, 294 industry codes and 33 different cancer causes of death, the problem associated with multiple comparisons arises. On average, 1 in 20 of the associations observed (Appendix IV) may be due to chance at the 5 percent level of significance.

4) Length of follow-up: Because of the limited number of years of death records available for this analysis and the relatively young age of the cohort as a whole (mean age = 35.6 as of 1965), several occupation-cancer associations which are well established in the literature are not yet apparent in the cohort. However, as seen in the results, several significantly high SMRs correspond with findings in other occupational cancer monitoring systems and studies. It is reasonable to assume that discrepancies between the literature and the observation of the cohort would be reduced by further follow-up.

Despite the limitations of the data, cautious interpretation of the results should yield valuable

information on which to base more detailed studies.

5.3 Evaluation of the 10 percent sample as a monitoring system

There are many aspects of the 10 percent sample as a monitoring system which could be evaluated, and many ways of evaluating these different aspects. As mentioned, some limitations were imposed on the evaluation in order to keep it within the scope of the thesis. In the following sections, the efficacy of the computerized record linkage system as a means of follow-up is discussed first. Secondly, the results of the 10 percent sample are compared with those of the study of British Columbia mortality. Thirdly, examples of generally well known occupation-cancer associations which are, and are not observed in the 10 percent sample are considered. Finally, the effectiveness of controlling for social class is examined.

5.3.1 Assessment of the efficacy of the generalized iterative record linkage system (GIRLS)

The GIRLS system is capable of performing as well as the quality of data and the validity of the comparison rules permit. The following are reasons that the success rate of the linkage in any study cannot be 100 percent:

1. Deaths occur to Canadian residents outside Canada and the United States, and are not reported to Canadian officials; and

2. Surnames on records can be misspelled in such a way that the NYSIIS code changes, and these records are not compared with records containing the properly spelled surname.

It is not possible to assess the percent of true, false positive and false negative links obtained in the linkage of the 10 percent sample to the mortality data base. In some other cohort studies in which follow-up has been conducted by the use of computerized record linkage, some members of the cohort are known to be dead, so the success of the linkage can be measured according to the proportion of 'known deads' that link successfully. There were no 'known deads' in the 10 percent sample, so the success of the linkage could not be assessed in this manner. It has been demonstrated that computerized record linkage performs very well in relation to manual follow-up (Shannon et al., 1989). Also, it is known that the completeness of the identifying information on the records of the 10 percent sample was higher than most other files used in linkage in other studies. Therefore it is reasonable to assume that the quality of the linkage was high.

5.3.2 Comparison of the findings of the 10 percent sample with those of the British Columbia study

There are two types of error in the data which could affect the quality of the 10 percent sample as a system for monitoring occupational cancer mortality: random error and systematic error.

Systematic error (or bias) is 'that due to factors other than chance, such as faulty measuring instruments' (Last, 1983). Fortunately, cohort studies such as the 10 percent sample are much less prone to biases than case-control studies. Systematic error could, however, arise from systematic miscoding of particular occupation titles or certain causes of death. Such error could result in either over- or underestimation of occupation-cancer associations. Little can be done to detect or correct such systematic errors.

Random error (sampling error) is 'that due to chance, when the result obtained in the sample differs from the result that would be obtained if the entire population ("universe") were studied' (Last, 1983). Random error includes type I, or alpha error (false positive results), and type II, or beta error (false negative results).

The British Columbia data were selected for comparison for the following reasons: 1) the occupation codes were the same in both studies; and 2) the complete analysis (including all associations whether significant or not) was available. A complete comparison of the results with each of the other monitoring systems (Washington State, the U.K. Decennial Supplement and Massachusetts) would have been preferred, but was not feasible since only the positive results were available in some of these reports. These positive findings were taken into consideration in this evaluation. A second

reason for excluding the other systems from a more detailed comparison was that some occupation codes were not directly comparable.

Procedure:

The comparison of the 10 percent sample with British Columbia mortality data was limited to occupation-cancer associations; industry-cancer associations were excluded because no B.C. data were available for comparison. In the 10 percent sample, 113 statistically significant ($P < 0.05$) occupation-cancer associations were observed in which at least 5 observed deaths occurred. These findings were compared with the B.C. data. Next, statistically significant associations ($P < 0.05$ with at least 5 observed deaths) in the B.C. data were compared with the 10 percent sample. The results of these comparisons are presented in Table 32.

Statistically significant associations in the 10 percent sample:

In 78 percent of the associations which were statistically significant in the 10 percent sample and were comparable to the B.C. data, the B.C. results were either statistically significantly high (22 percent) or in the same direction (PMR above 1.00) but not significant (56 percent). In 22 percent of the comparable associations, the B.C. results were in the opposite direction to those of the 10 percent sample, but not significant.

Statistically significant associations in B.C.

In 62 percent of associations that were statistically significant in the B.C. data and comparable to the associations in the 10 percent sample, the corresponding associations in the 10 percent sample were significant (30 percent) or above 1.00 but not significant (32 percent). Thirty-five percent of the comparable associations had an SMR of less than 1.00 in the 10 percent sample, but were not statistically significant; 3 percent were statistically significantly low.

Lack of agreement between findings of the two studies weakens to some extent the credibility of the associations which are discrepant. Such disagreements may indicate the occurrence of random error, although systematic error could also be responsible. When the 10 percent sample was compared with data from other monitoring systems and reviews of occupational-cancer associations, an additional 30 associations found agreement; however, 62 statistically significant associations in the 10 percent sample did not agree with other sources. These are more likely to be false positive results.

Table 32. Comparison of findings of the 10 percent sample with British Columbia mortality

Category	Number	Percent
<u>10 percent sample</u>		
Statistically significant associations	113	
- associations not comparable with B.C. data[1]	17	
Comparable associations[2]	96	100
Agreement:		
Full (P < 0.05 in B.C. data)	21	22
Partial (PMR > 1.00 in B.C. data, P > 0.05)	54	56
Subtotal	75	78
Disagreement:		
Partial (PMR < 1.00 in B.C. data, P > 0.05)	21	22
<u>British Columbia</u>		
Statistically significant associations	126	
- associations not comparable with 10 percent sample[1]	55	
Comparable associations[2]	71	100
Agreement:		
Full (P < 0.05 in 10 percent sample)	21	30
Partial (SMR > 1.00 in 10 percent sample, P > 0.05)	23	32
Subtotal	44	62
Disagreement:		
Partial (SMR < 1.00 in 10 percent sample, P > 0.05)	25	35
Complete (SMR < 1.00 in 10 percent sample, P < 0.05)	2	3
Subtotal	27	38

1. Largely due to < 5 observed deaths; in a few cases, because of broad groupings of occupations in B.C. data.
2. Associations in comparable occupations with at least 5 observed deaths.

5.3.3 Comparison with well established associations

A full comparison of the results of the 10 percent sample with all known occupation-cancer associations was not attempted for two reasons: 1) it would represent a major undertaking which exceeds the scope of this thesis; and 2) most reviews of occupation-cancer associations refer to a substance to which the worker is exposed rather than the job title. Again, it is beyond the scope of this thesis to attempt to apply a job-exposure matrix to the occupation codes used. Therefore, a few of the better known associations are discussed; some of which were seen in the 10 percent sample and some of which were not.

Among the better known occupation-cancer associations which were observed in the 10 percent sample are:

1) lung cancer with asbestos (Decouflé, 1982);

2) stomach cancer with coal mining (Decouflé, 1982, Alderson, 1986); and

3) lung cancer among iron foundry workers (Decouflé, 1982).

The association between lung cancer and asbestos was demonstrated by the elevated lung cancer mortality in the shipbuilding and repair industry and among asbestos products manufacturers. Coal mining and stomach cancer were strongly associated in the 10 percent sample, as was lung cancer with iron foundry work.

Examples of established associations which did not appear in the 10 percent sample data include:

1) bladder cancer and manufacture of certain dyes (Decouflé, 1982);

2) bladder cancer and the rubber industry (Decouflé, 1982); and

3) liver cancer among plastic workers (Cole and Goldman, 1975), exposed to vinyl chloride (Decouflé, 1982).

Examination of the 10 percent sample data revealed that in all cases of occupations and industries involving dyes, rubber or plastic, there were too few expected deaths for an association to be seen. It is also possible that working conditions have improved over time with respect to exposure to dyes and vinyl chloride monomer, resulting in lower levels of mortality.

5.3.4 Assessment of social class analysis

If lifestyle factors such as smoking, alcohol consumption and diet, which might be initiators or promotors of cancer, are consistent within social class, it would be expected that SMRs reflecting occupation-cancer associations would retain their strength when social class was used as the comparison group. Conversely, associations which were actually related to lifestyle factors would be weaker when social class was used as the reference group.

It has been established that the percentage of smokers is inversely related to level of education (Health and Welfare Canada, 1980). It would therefore be expected that mortality from smoking related causes of death would be inversely

correlated with social class. This was indeed the case for lung cancer, bronchitis and emphysema. This relationship was not borne out for bladder cancer, which is less strongly associated with smoking. Alcohol-related causes were also lower in the higher social classes. However, causes related to the combination of smoking and alcohol consumption, as well as all cancers combined do not demonstrate an entirely clear or consistent correlation with social class (see tables 27 and 29). The risk of cancer of the colon was clearly higher in the higher social classes, whereas stomach cancer was inversely related to social class. It has been suggested that colon cancer is associated with sedentary jobs (Gerhardsson et al., 1986), which would correspond with higher rates among white collar workers. Stomach cancer has previously been shown to be negatively correlated with social class (Billette and Hill, 1978). The 10 percent sample is therefore consistent with a number of established correlations.

With regard to the associations of lung cancer and occupations (table 30), whether the reference group was the total cohort or the social class appears to make little difference to the value of the SMR. The theory that occupationally-related elevations in SMRs would be maintained within social class and SMRs that were actually the result of lifestyle factors, e.g. smoking, would be weaker within social class does not seem to hold true. For example, the lung cancer SMR for plumbers and pipefitters, for which there is

strong implication of occupational exposure (see sections 5.3.2, 5,3.3) went from 1.57 (with the total cohort as the reference group) to 1.48 within social class. On the other hand, the lung cancer SMR for guards and watchmen, where there is no apparent occupational exposure, went from 1.27 (with the total cohort as the reference group) to 1.29 within social class. In the case of bladder cancer, the SMRs within social class are generally weaker than in the comparison to the total cohort. The analysis by social class for Canadian data does not seem as easily interpretable as in the U.K. decennial supplement (Registrar General, 1978), where a weaker SMR within a social class was construed as a clear indication that lifestyle factors were more relevant to the association than the occupation.

5.3.5 Assessment of the comparison of mortality of the 10 percent sample with that of the Canadian population

Comparison of the mortality of the 10 percent sample with that of the Canadian population for three 5-year calendar periods (see Table 8, page 61) showed SMRs well below 1.00 for the earliest calendar period, with an increase to 1.00 or more for 1975-1979. The low SMRs in the earlier years can be interpreted as evidence of the 'healthy worker effect'. The healthy worker effect is the observation that cohort studies of employed persons usually have lower mortality rates than the general population (Howe et al., 1988). The healthy

worker effect has been described as having three components: 1) the selection of healthy workers for employment, 2) the survival in the job, of the healthier workers, and 3) the length of time the population has been followed up (Fox and Collier, 1976). In the 10 percent sample, the selection effect can be seen in the low SMRs in the earlier calendar periods. Since the occupational history ends in 1969, the data include those who ceased to be employed as well as those who continue to work. Thus, a survivor effect cannot be assessed. Fox and Collier described a progressive increase in the SMR with the length of time since entry, with the healthy worker effect disappearing after 15 years. Since 1965 is only an approximation of date of entry into the job for the 10 percent sample, and many would have been employed before, it seems reasonable that the healthy worker effect has disappeared by the 3rd calendar period.

5.4 Assessment of results

The value of the 10 percent sample for monitoring occupation-cancer mortality lies in identifying associations which merit further study, according to a number of characteristics which affect the strength and believability of associations. The framework which has been used for assessing the associations is that presented by A.B. Hill in 1965, in a well known paper entitled, 'The environment and disease: association or causation'. It should be emphasized

that in relating selected results of the 10 percent sample analysis to Hill's framework, no attempt has been made to distinguish association from causation. Rather, Hill's criteria have been used to highlight some of the results of this study that appear to merit further investigation, and serve as bases for assessing the possible importance of the results of a monitoring system. The criteria proposed by Hill are strength, consistency, specificity, temporality, biological gradient, plausibility, coherence, experimental evidence and analogy. Experimental evidence (e.g. modifying work conditions, then studying the results) and analogy (which would require assumptions regarding exposure data) have not been considered here, since the nature of this study does not allow it.

5.4.1 Strength of association

Strength of association is assessed by the magnitude of the ratio of the observed to expected number of cases, in Hill's examples, or deaths in the 10 percent sample. Hill considered strength of association to be the primary consideration in the interpretation of results, and gave examples of the mortality of chimney sweeps from scrotal cancer, and of smokers from lung cancer. Examples of some of the stronger associations seen in the 10 percent sample are presented in Table 33.

Table 33. Selected occupation-cancer associations in the 10 percent sample, based on strength

Cancer site and occupation	Years[1]	# of deaths	SMR	P value
Buccal cavity and pharynx				
414 Bartenders	1	10	5.05	< 0.0001
415 Waiters	1	19	5.17	< 0.0001
	2	10	6.69	< 0.0001
	3	6	7.83	0.0001
	4	5	15.02	< 0.0001
145 (ind) Breweries	1	6	6.76	0.0003
Pancreas				
381 (ind) Scientific and professional equipment manufacturers	1	5	2.71	0.0398
	2	5	3.97	0.0094
	3	5	5.47	0.0025
Hodgkin's disease				
335 (ind) Communications equipment manufacturers	1	5	5.25	0.0030

1. 'Years' indicates the number of years a person was coded as being in the occupation or industry.

The results in table 33 represent several of the highest SMRs revealed in the analysis. Although the reasons for the magnitude of these associations are not always clear, their strength argues for further investigation.

5.4.2 Consistency of association

Hill considered the consistency of the observed association with other studies to be the second most important criterion. According to this, repetition of the circumstances and observations is important in deciding that an observation was not due to chance. The following table shows associations

from the 10 percent sample which agreed with the greatest number findings from the other 4 monitoring systems to which they were compared. All of these associations were also discussed in at least one review of occupation-cancer relationships.

Table 34. Selected occupation-cancer associations observed in the 10 percent sample, based on consistency with findings from other studies

Cancer site and occupation	# of corresponding monitoring systems
Lung	
556 Truck drivers	5/5
810 Plumbers and pipefitters	5/5
811 Sheet metal workers	4/5
327 (ind) Shipbuilding and repair	4/5
Buccal cavity and pharynx	
414 Bartenders	4/5
Stomach	
751 Carpenters	4/5

The high level of consistency for truck drivers and lung cancer was borne out in the synthesis of surveillance studies by Dubrow and Wegman (1983). They postulate that the excess in lung cancer is associated with exposure to diesel and gas fumes among these workers, with or without exposure to smoking, and they recommend further study.

Elevations in SMRs of lung cancer among plumbers and pipefitters also agreed completely with the findings from other monitoring systems. Kaminski et al. (1980) listed the following substances to which plumbers and pipefitters are

exposed, which are known to be associated with lung cancer: acrylonitrile, arsenic, asbestos, beryllium, cadmium, lead, nickel and vinyl chloride. Their study of 3,369 unionized plumbers and pipefitters who died in 1971 also found an excess mortality from lung cancer. The authors considered that asbestos exposure was an important factor, since pipes are insulated and the insulation must be removed before repairs are done. Since there are numerous potential exposures, further studies should attempt to quantify these exposures and assess the risks of each to plumbers and pipefitters.

Sheet metal workers showed high lung cancer in 3 monitoring systems in addition to the 10 percent sample. Metal workers may be exposed to arsenic, beryllium, cadmium, iron and nickel, all of which have been associated with lung cancer (Alderson, 1986, 1987). These findings provide further evidence of the consistency of the association which is thus not likely to be due to chance.

Bartenders had elevated rates of cancer of the buccal cavity and pharynx in 3 other monitoring systems. The obvious agents to which they are occupationally exposed are tobacco smoke and alcohol, which in combination, are established risk factors for oral cavity cancer (Mahboubi and Sayed, 1982).

The elevation of stomach cancer among carpenters agreed with the results of 3 other monitoring systems. This finding is also strengthened by other studies which implicate wood

dust exposure as the likely cause (Alderson, 1987).

5.4.3 Specificity of association

Hill defined specificity of association to mean that the association is limited to specific workers and to particular sites and types of disease, and that there is no association between the work and other causes of death. The results of the 10 percent sample analysis were examined for occupations within which elevations in mortality occurred for particular causes, but in which overall cancer mortality, mortality from all causes, and/or from other related causes was not high. Table 35 shows examples of associations which appear to be specific.

The association between carpenters and elevated stomach cancer mortality, already noted for its consistency, is presented as an example of specificity. Low SMRs for all cancer and all causes of death indicate that overall, carpenters do not have excess mortality rates; their risk seems to be specific to stomach cancer.

The example of plumbers and pipefitters and lung cancer is less clear with regard to specificity. Their overall cancer mortality was high but the SMR from all causes was 1.00. More interesting were the low SMRs for pneumonia,

Table 35. Selected occupation-cancer associations in the 10 percent sample, based on specificity

Occupation and cause of death	Year	Number of deaths	SMR
751 Carpenters			
Stomach cancer	1	58	1.31
	2	35	1.37
All cancer	1	464	0.89
All causes	1	1703	0.82
810 Plumbers and pipefitters			
Lung cancer	1	58	1.57
Pneumonia	1	3	0.52
Bronchitis	1	4	0.97
Emphysema	1	4	0.86
All cancer	1	129	1.03
All causes	1	472	1.00
198 Science and engineering technicians			
Brain cancer	1	7	2.54
All cancer	1	64	0.91
All causes	1	259	0.75
831 Electricians, wiremen and electrical repairmen			
Brain cancer	1	9	1.93
All cancer	1	134	0.95
All causes	1	601	0.96

bronchitis and emphysema, even though they were based on small numbers. If plumbers and pipefitters had high rates of smoking, rates of death due to these 3 particular causes would

be expected to be high. The fact that they are not suggests that smoking is not confounding the observed relationship between the occupation and lung cancer mortality, and that the occupational exposures are specific to cancer of the lung rather than to lung disease in general.

Both science and engineering technicians, and electricians, wiremen and electrical repairmen had elevated SMRs due to lung cancer, but low mortality from all cancer and all causes.

5.4.4 Temporality of association

Hill cautions that it is important to remember to note whether the horse actually does come before the cart. It is clear that occupational exposures occurred before death due to cancer. However, there may be selection to some jobs due to ill health which has been induced by other jobs or other factors. For example, guards and watchmen had elevated SMRs for lung cancer over 4 years (of being recorded in the occupation) of 1.27, 1.31, 1.34 and 1.59. Since there is no obvious agent of exposure which is inherent to this occupation and since the occupation appears to be sedentary, more likely explanations include high rates of smoking or previous occupational exposures.

5.4.5 Biological gradient

Biological gradient refers to the presence of a dose-

response curve (Hill, 1965). The 10 percent sample does not attempt to measure occupational exposure, so direct estimates are not available. However, a proxy indication of exposure is provided by the number of years from 1965 to 1969 for which individuals were recorded as being in the same occupation. Statistically significant associations that hold for 3 to 5 years are considered here as examples of a dose-response effect. Examples are presented in Table 36. Not only are these examples consistent over at least 3 years, but the SMRs increase with the number of years of employment in the occupation.

Both waiters and scientific and professional equipment manufacturers provided examples of strength of association, as well as biological gradient, thus increasing the overall credibility of these associations. Sheet metal workers showed high correspondence with other monitoring systems in addition to a dose response effect, again giving this association greater overall strength. The association of cancer of the larynx with employees of hotels, restaurants and taverns suggests high rates of smoking and alcohol consumption. Smoking alone has shown a relative risk for laryngeal cancer of 7.7, and when smoking is combined with alcohol consumption, a relative risk of 20.1 has been estimated (Austin, 1982). In spite of the absence of direct exposure data, it is reasonable to assume that employment in hotels, restaurants and taverns involved appreciable exposure to tobacco smoke and

alcohol, particularly in the 1960s and earlier. The reason for the elevation of bone cancer mortality among special-trade

Table 36. Selected occupation-cancer associations in the 10 percent sample, demonstrating biological gradient (dose-response)

Cancer site and occupation	Years[1]	# of deaths	SMR	P value
Buccal cavity and pharynx				
415 Waiters	1	19	5.17	<0.0001
	2	10	6.69	<0.0001
	3	6	7.93	0.0001
	4	5	15.02	<0.0001
Pancreas				
381 (ind) Scientific and professional equipment manufacturers	1	5	2.71	0.0398
	2	5	3.97	0.0094
	3	5	5.47	0.0025
Larynx				
875 (ind) Hotels, restaurants and taverns	1	13	2.06	0.0128
	2	8	2.10	0.0405
	3	6	2.46	0.0381
	4	5	3.52	0.0151
Lung				
811 Sheet metal workers	2	20	1.70	0.0179
	3	15	2.02	0.0096
	4	10	2.52	0.0077
	5	5	3.72	0.0122
Bone				
421 (ind) Special-trade contractors	1	8	2.41	0.0204
	2	6	3.48	0.0085
	3	5	4.78	0.0044
	4	5	8.93	0.0003

1. 'Years' indicates the number of years a person was coded as being in the occupation or industry.

contractors is unclear, but the strong biological gradient indicates a need for further investigation.

5.4.6 Plausibility

Hill defines biological plausibility of an association as the support of current biological knowledge for the association observed between exposure and disease. He maintains that while plausibility can be helpful in determining causation, it is not requisite, since biological knowledge is frequently insufficient. Rothman (1986) states that biologic knowledge about epidemiologic hypotheses is often scant, making hypotheses little more than vague statements about the relationship between exposure and disease. Since the 10 percent sample does not contain exposure data, possible hypotheses consist only of statements of associations between occupation or industry and disease. Although likely exposures can, in some cases, easily be assumed, precision is not possible. For example, plumbers and pipefitters might be at high risk of lung cancer due to exposure to any or all of the substances acrylonitrile, arsenic, asbestos, beryllium, cadmium, lead, nickel and vinyl chloride (Kaminski et al., 1980). To systematically assess biological plausibility of the results of the 10 percent sample, it would be necessary to apply an occupation-exposure matrix to the results, and examine the literature for evidence in animal studies and other studies of humans, of biological plausibility. However, this is generally beyond the scope of this thesis.

Examples of biological plausibility are the associations

of lung cancer with the industries of shipbuilding and repair, and asbestos products manufacturers and asbestos. It has been observed that asbestos fibres can be found in the lungs of those exposed many years after exposure (Morgan and Holmes, 1982). This, in addition to knowledge of the chemical properties of asbestos (Yuspa and Harris, 1982) makes its association with lung cancer biologically plausible.

The association of truck drivers with lung cancer provides another example of biological plausibility, since diesel exhaust has been demonstrated to be a pulmonary carcinogen in rats chronically exposed to diesel exhaust inhalation (Mauderly et al., 1987).

5.4.7 Coherence

Hill defines coherence as accordance of study findings with the generally known facts of the natural history and biology of the disease under consideration. Examples of biological plausibility also constitute examples of coherence. Examples of coherence in the 10 percent sample results include associations of occupations with cancers where there is a known occupational exposure, e.g. among plumbers and pipefitters, and sheet metal workers, who are exposed to the numerous carcinogens listed in section 5.4.2.

5.5 Conclusions and recommendations

Conclusions:

1. The 10 percent sample provides a valuable basis for

monitoring occupational cancer mortality. Results of the analysis have shown good agreement with known occupation-cancer associations, and have also supported some less well established associations which are plausible.

2. The value of the 10 percent sample as system for monitoring occupational cancer mortality would be enhanced by further follow-up. The cohort was still fairly young as of 1979; additional years of follow-up should elucidate risks which were not apparent as of 1979.

3. Social class appears to be a moderately useful proxy for lifestyle factors, although the results were not totally consistent. The inverse correlation between smoking-related causes of death and social class corresponded with an inverse correlation of levels of smoking and education in Canadians (Health and Welfare Canada, 1980). Since the numbers of deaths within social class were often too small for analysis, re-analysis after additional years of follow-up would be warranted.

Recommendations:

1. A job title-exposure matrix should be applied to 1961 job titles so that risks can be more comprehensively assessed.

2. The following associations are among those that merit more detailed study:

   Plumbers and pipefitters and lung cancer: This

association provided a good example of strength, consistency, specificity, biological gradient, plausibility and coherence. Further study could be particularly useful in quantifying exposures and recommending preventive measures.

Truck drivers and lung cancer: The evidence from the 10 percent sample adds to the data presented by Dubrow and Wegman (1983), and supports their recommendation for further study.

Waiters, and bartenders and cancer of the buccal cavity and pharynx: The evidence for these occupations and cancer of the buccal cavity and pharynx is strong, consistent, and should be largely preventable. In order to assess preventability, it would be important to quantify the effects of direct versus second hand smoke.

Carpenters and stomach cancer: This association demonstrated consistency among the monitoring systems and specificity (carpenters otherwise experienced low mortality). There is additional support for this association in the literature (Siemiatycki et al., 1986), but it is not an association that appears to be well established in the literature (Decouflé, 1982, Cole and Goldman, 1975, Milham, 1974). Therefore additional study would be warranted.

3. The 1961 and 1971 occupation code differences should be reconciled so that 1971 data can be included in the

analysis after the follow-up is updated.

4. After further follow-up, the mortality of the females in the 10 percent sample should be analysed, since there should be sufficient data to permit meaningful analysis.

In conclusion, the results produced by the analysis of the 10 percent sample have demonstrated that the system is capable of generating occupation-cancer associations which are consistent with other sources of information, and which appear to deserve further study. It should be emphasized that exclusion of specific results as examples of Hill's criteria does not mean they are not worthy of further study. However, those that fit one or more of Hill's criteria may be considered among those that are most suitable for further study.

Appendix I

Occupation Codes and Titles, and Number of Persons, Person Years and Deaths

Appendix I. Persons, person years and deaths by occupation

Occ. Code	Division and occupation	Persons	Person years	Deaths
	Division 1 - Managerial			
001	Advertising managers	116	1560	10
002	Credit managers	428	5853	31
004	Sales managers	1609	21499	142
005	Delivery managers	28	381	1
006	Office managers	1038	13920	103
007	Postmasters	7	100	-
008	Purchasing agents and buyers	1344	18025	139
010	Owners and managers, n.e.s.	18218	243087	1735
	Division 2 - Professional and technical			
101	Civil engineers	500	6569	41
102	Mechanical engineers	354	4730	25
104	Industrial engineers	428	5659	42
105	Electrical engineers	433	5706	13
107	Mining engineers	107	1387	8
108	Chemical engineers	66	859	5
109	Professional engineers, n.e.s.	260	3447	20
111	Chemists	445	5950	23
112	Geologists	94	1222	2
114	Physicists	1	13	-
119	Physical scientists, n.e.s.	46	621	2
121	Biological scientists	13	154	1
124	Veterinarians	7	96	-
129	Agricultural professionals, n.e.s.	63	825	4
131	Professors and college principals	25	311	1
135	School teachers	201	2554	8
139	Teachers and instructors, n.e.s.	210	2712	19
140	Physicians and surgeons	28	330	4
141	Dentists	6	85	-
142	Nurses, graduate	25	340	1
143	Nurses-in-training	-	-	-
144	Physical and occupational therapists	22	285	1
145	Optometrists	14	177	2
146	Osteopaths and chiropractors	-	-	-
147	Pharmacists	187	2230	42
148	Medical and dental technicians	247	3283	18

Occ. Code	Division and occupation	Persons	Person years	Deaths
149	Other health professionals	5	55	1
151	Judges and magistrates	5	46	3
153	Lawyers and notaries	89	1161	6
161	Clergymen and priests, n.o.r.	2	27	-
163	Nuns and brothers, n.o.r.	-	-	-
169	Religious workers, n.o.r.	11	144	-
171	Artists, commercial	441	5971	21
172	Artists (except commercial), art teachers	52	693	3
174	Authors, editors and journalists	798	10659	49
176	Musicians and music teachers	76	956	13
181	Architects	47	610	3
182	Draughtsmen	3347	45113	112
183	Surveyors	978	13214	29
184	Actuaries and statisticians	100	1353	6
186	Economists	151	1992	6
187	Computer programmers	328	4427	6
188	Accountants and auditors	4534	61674	302
191	Dieticians	2	27	-
192	Social welfare workers	332	4364	31
194	Librarians	59	774	5
195	Interior decorators and window dressers	297	3957	24
196	Photographers	258	3426	18
198	Science and engineering technicians, n.e.s.	6355	85817	259
199	Professional occupations, n.e.s.	2359	31435	155
	Division 3 - Clerical			
201	Bookkeepers and cashiers	5679	75950	470
203	Office appliance operators	1677	22786	79
212	Stock clerks and storekeepers	7374	98406	765
214	Shipping and receiving clerks	9680	130847	822
221	Baggagemen and expressmen, transport	168	2266	18
223	Ticket, station and express agents, transport	1149	15484	100
232	Stenographers	649	8533	77
234	Typists and clerk-typists	460	6167	33
241	Attendants, doctors' and dentists' offices	19	255	-
249	Clerical occupations, n.e.s.	36189	482082	3217

Occ. Code	Division and occupation	Persons	Person years	Deaths
	Division 4 - Sales			
301	Foremen, trade	2000	27330	179
303	Auctioneers	13	168	1
307	Canvassers and other door-to-door salesmen	2930	39180	307
312	Hawkers and pedlars	5	65	1
314	Commercial travellers	9112	122691	741
316	Newsvendors	19	242	2
323	Service station attendants	6053	80074	358
325	Sales clerks	17386	231674	1301
327	Advertising salesmen and agents	264	3550	18
331	Insurance salesmen and agents	1026	13824	59
334	Real estate salesmen and agents	208	2687	25
336	Security salesmen and brokers	692	9247	39
338	Brokers, agents and appraisers, n.e.s.	589	7892	45
339	Other sales occupations	28	363	2
	Division 5 Service and recreation			
401	Firemen, fire protection	1006	13644	64
403	Policemen and detectives	1339	17374	156
405	Guards, watchmen, n.e.s.	7643	92182	2402
407	Commissioned officers, armed forces	-	-	-
408	Other ranks, armed forces	1	15	-
411	Lodging and boarding house keepers	1	11	-
412	Housekeepers (except private household), matrons, stewards	916	11943	140
413	Cooks	4522	59309	454
414	Bartenders	2128	27992	326
415	Waiters	5317	69905	588
416	Nursing assistants and aides	565	7398	63
417	Porters, baggage and pullman	1335	17356	186
418	Baby sitters	1	5	1
419	Maids and related service workers, n.e.s.	5146	66162	460
431	Actors, entertainers and showmen	96	1288	4
433	Athletes and sports officials	182	2338	22
451	Barbers, hairdressers, manicurists	1279	16795	94
452	Launderers and dry cleaners	1310	17466	134
453	Elevator tenders, building	454	5577	123

Occ. Code	Division and occupation	Persons	Person years	Deaths
454	Janitors and cleaners, building	12211	157263	2347
455	Funeral directors and embalmers	185	2433	20
456	Guides	221	2830	38
457	Attendants, recreation and amusement	978	12548	126
459	Service workers, n.e.s.	360	4563	71
	Division 6 - Transport and communication			
510	Inspectors and foremen	3013	40359	425
520	Air pilots, navigators and flight engineers	209	2746	17
531	Locomotive engineers	996	13265	155
532	Locomotive firemen	424	5837	50
534	Conductors, railroad	590	7872	94
535	Brakemen, railroad	1006	13641	99
537	Switchmen and signalmen	800	10869	95
541	Deck officers, ship	487	6537	53
543	Engineering officers, ship	486	6480	51
545	Deck ratings (ship), barge crews and boatmen	1544	20772	155
547	Engine-room ratings, firemen and oilers (ship)	381	5107	52
551	Bus drivers	3289	44564	344
552	Taxi drivers and chauffeurs	2270	29563	313
554	Driver-salesmen	10229	139414	752
556	Truck drivers	25378	345307	2203
561	Operators, electric street railway	45	583	8
563	Teamsters	399	5456	42
569	Transport occupations, n.e.s.	685	9186	65
570	Inspectors and foremen, communication	197	2680	23
581	Radio and television announcers	259	3563	2
582	Radio and television equipment operators	346	4603	19
584	Telephone operators	273	3723	26
585	Telegraph operators	312	4183	44
587	Postmen and mail carriers	892	12017	53
588	Messengers	1569	20132	214
	Division 7 - Farmers and farm workers			
601	Farmers and stockraisers	36	464	3

Occ. Code	Division and occupation	Persons	Person years	Deaths
603	Farm managers and foremen	354	4569	44
605	Farm labourers	3748	45505	370
607	Gardeners (except farm) and groundskeepers	2700	34965	348
609	Other agricultural occupations	879	11536	83
	Division 8 - Loggers and related workers			
611	Logging foremen	483	6412	80
613	Forest rangers and cruisers	584	7627	70
615	Lumbermen, including labourers in logging	11236	151144	1003
	Division 9 - Fishermen, trappers and hunters			
631	Fishermen	4250	56192	464
633	Trappers and hunters	7	82	1
	Division 10 - Miners, quarrymen and related workers			
651	Foremen - mine, quarry, petrol, well	737	9938	77
652	Prospectors	84	1112	5
653	Timbermen	216	2926	23
654	Miners, n.e.s.	5586	75705	560
655	Millmen	1119	15192	120
656	Well drillers and related workers	1188	15924	69
657	Labourers, mine	4093	54873	291
659	Quarriers and related workers, n.e.s.	1132	15317	129
	Division 11 - Craftsmen, production process and related			
701	Millers of flour and grain	357	4911	26
702	Bakers	1603	21698	144
703	Butchers and meat cutters	3207	43377	296
704	Meat canners, curers, packers	694	9500	48
705	Fish canners, curers, packers	1158	15271	124
706	Fruit and vegetable canners and packers	230	3133	17
707	Milk processors	1105	15091	100

Occ. Code	Division and occupation	Persons	Person years	Deaths
708	Other food processing occupations	1505	20616	117
709	Beverage processors	788	10461	72
711	Tire and tube builders	641	8815	55
713	Vulcanizers	710	9589	52
719	Other rubber workers	908	12404	80
721	Leather cutters	367	4947	36
722	Shoemakers and repairers - factory, n.e.s.	905	12079	87
724	Shoemakers and repairers - not in factory	129	1730	15
729	Other leather products makers	347	4707	23
731	Carders, combers and other fibre preparers	451	6187	36
732	Spinners and twisters	473	6510	27
733	Winders, reelers	285	3898	15
734	Weavers	475	6544	41
735	Loom fixers and loom preparers	528	7257	46
736	Knitters	463	6227	26
737	Bleachers and dyers - textile	358	4861	39
738	Finishers and calenderers	510	6919	46
739	Other textile occupations	1627	22131	134
741	Tailors and tailoresses	424	5718	41
742	Dressmakers and seamstresses - not in factory	80	1106	5
743	Furriers	253	3387	28
744	Milliners; hat and cap makers	6	84	1
745	Cutters, markers - textiles; garment and glove leather	1074	14702	90
746	Sewers and sewing machine operators, n.e.s.	1201	16235	110
747	Upholsterers	873	11971	49
749	Apparel and related products makers, n.e.s.	984	13213	100
751	Carpenters	15256	204711	1703
752	Cabinet and furniture makers - wood	1411	19014	115
754	Sawyers	1812	24614	185
756	Woodworking machine operators, n.e.s.	2030	27663	200
758	Inspectors, graders, scalers, log and lumber	942	12735	104
759	Woodworking occupations, n.e.s.	3812	51595	317
761	Batch and continuous still operators	154	2083	20
762	Roasters, cookers and other heat treaters, chemical	299	4090	36

Occ. Code	Division and occupation	Persons	Person years	Deaths
763	Cellulose pulp preparers, n.e.s.	750	10188	90
765	Paper makers	623	8610	52
766	Paper making occupations, n.e.s.	2178	29976	203
768	Crushers, millers, calenderers, n.e.s. - chemical	316	4327	30
769	Chemical and related process workers, n.e.s.	3669	50287	305
771	Compositors and typesetters	2034	27717	164
772	Pressmen, printing	1554	21123	141
773	Lithographic and photo-offset occupations	560	7684	38
775	Photoengravers	212	2893	14
776	Bookbinders	226	3024	21
778	Other occupations in book-binding	226	3092	11
779	Printing workers, n.e.s.	638	8744	48
781	Furnacemen and heaters, metal	1491	20432	143
782	Heat treaters, annealers, temperers	310	4231	37
783	Rolling mill operators	615	8441	62
784	Blacksmiths, hammermen, forgemen	617	8240	88
786	Moulders	1114	15195	112
787	Coremakers	282	3825	28
788	Metal drawers and extruders	212	2890	19
789	Metal treating occupations, n.e.s.	2016	27575	184
791	Jewellers and watchmakers	407	5378	48
793	Engravers, except photo-engravers	160	2148	15
801	Toolmakers, diemakers	1693	23115	137
802	Machinists and machine tool setters	6184	83486	610
803	Filers, grinders, sharpeners	1777	24323	167
805	Millwrights	2132	28832	259
806	Fitters and assemblers, n.e.s. - metal	6779	92911	510
808	Metalworking machine operators, n.e.s.	8105	110505	682
810	Plumbers and pipefitters	5664	76750	472
811	Sheet metal workers	3500	47479	285
812	Riveters and rivet heaters	129	1767	11
813	Boilermakers, platers and structural metal workers	2394	32452	248
815	Electroplaters, dip platers and related workers	550	7526	45
817	Welders and flame cutters	7836	106963	555

Occ. Code	Division and occupation	Persons	Person years	Deaths
818	Polishers and buffers - metal	514	7010	45
819	Metalworking occupations, n.e.s.	4719	64206	396
821	Mechanics and repairmen, aircraft	738	9926	55
822	Mechanics and repairmen, motor vehicle	13237	179807	981
824	Mechanics and repairmen, office machine	689	9195	31
825	Mechanics and repairmen, railroad equipment	1479	19986	177
829	Mechanics and repairmen, n.e.s.	18759	253516	1912
831	Electricians, wiremen and electrical repairmen	7903	106961	601
832	Fitters and assemblers - electrical and electronics equipment	3394	46343	220
833	Power station operators	946	12858	105
835	Mechanics and repairmen, radio and television receivers	866	11862	39
836	Projectionists, motion picture	180	2293	34
838	Linemen and servicemen - telephone, telegraph and power	4585	62246	282
839	Electrical and electronics workers, n.e.s.	1023	13788	87
841	Painters (construction and maintenance), paperhangers and glaziers	4512	60166	510
843	Painters, except construction and maintenance	2008	27358	183
851	General foremen - construction	2807	37867	322
852	Inspectors - construction	553	7289	71
854	Bricklayers, stonemasons, tile-setters	2700	36820	205
855	Cement and concrete finishers	1001	13647	80
856	Plasterers and lathers	1258	17146	86
857	Insulation appliers	495	6692	46
859	Construction workers, n.e.s.	2517	34180	212
861	Lens grinders and polishers; opticians	266	3532	18
862	Furnacemen and kilnmen, ceramics and glass	185	2505	23
864	Stone cutters and dressers	158	2143	17
869	Clay, glass and stone workers, n.e.s.	1196	16418	101
871	Boiler firemen (except ship)	1163	15372	210
872	Stationary enginemen	3572	47316	532

Occ. Code	Division and occupation	Persons	Person years	Deaths
873	Motormen (vehicle), except railway	486	6577	49
874	Hoistmen, cranemen, derrickmen	3109	42437	324
875	Riggers and cable splicers, except telephone,telegraph and power	794	10700	95
876	Operators of earth-moving and other construction machinery, n.e.s.	7247	98213	653
877	Materials-handling equipment operators	5815	79610	529
878	Oilers and greasers - machinery and vehicles (except ships)	1000	13656	102
881	Longshoremen and stevedores	2425	32104	297
883	Warehousemen and freight handlers, n.e.s.	13095	176516	1054
890	Sectionmen and trackmen	3518	46569	409
900	Foremen, n.e.s.	11128	150944	1260
911	Tobacco preparers and products makers	208	2871	21
912	Patternmakers (except paper)	413	5614	45
913	Bottlers, wrappers, labelers	4964	66345	420
914	Paper products makers	1543	21207	103
915	Photographic processing occupations	411	5532	24
916	Tanners and tannery operatives	327	4370	41
917	Inspectors, examiners, gaugers, n.e.s. - metal	2855	38798	274
918	Inpectors, graders and samplers, n.e.s.	242	3207	37
919	Production process and related workers, n.e.s.	3739	50613	291
	Division 12 - Labourers			
920	Labourers, excl. agricultural, fishing, logging or mining operations	120947	1609383	10717
	Division 13 - Occupation not stated			
980	Occupation not stated	23126	304160	2266

Appendix II

Industry Codes and Titles, and Number of Persons, Person Years and Deaths

Appendix II. Industry codes and titles, and number of persons, person years and deaths

Ind. Code	Division and industry	Persons	Person years	Deaths
	Division 1 - Agriculture			
001	Experimental and university farms	1	15	-
003	Institutional farms	4	51	-
006	Residential and other small holdings	-	-	-
011	Livestock and livestock combination farms	751	9366	71
013	Field crop and field crop combination farms	362	4417	36
015	Fruit and vegetable farms	333	4076	32
017	Other crop and livestock combination farms	1916	23073	179
019	Miscellaneous specialty farms	672	8235	77
021	Services incidental to agriculture	1813	23669	163
	Division 2 - Forestry			
031	Logging	14082	188756	1386
039	Forestry services	1331	17185	172
	Division 3 - Fishing and trapping			
041	Fishing	4203	55604	467
045	Fishery services	127	1732	14
047	Hunting and trapping	6	80	-
	Division 4 - Mines (including milling), quarries and oil wells			
051	Placer gold mines	36	468	6
052	Gold quartz mines	1940	25832	218
053	Copper-gold-silver mines	2248	30306	197
054	Nickel-copper mines	2644	35506	231
055	Silver-cobalt mines	117	1518	19
056	Silver-lead-zinc mines	1125	15215	98
057	Uranium mines	392	5282	26
058	Iron mines	1847	25119	133
059	Other metal mines	354	4812	22
061	Coal mines	1367	18345	195
063	Petroleum and gas wells	793	10757	40
065	Natural gas processing plants	5	64	1

Ind. Code	Division and industry	Persons	Person years	Deaths
066	Oil shale and bituminous sand pits	-	-	-
071	Asbestos mines	857	11515	90
073	Gypsum mines	101	1384	11
077	Salt mines	139	1931	8
079	Other non-metal mines	744	10018	46
083	Stone quarries	720	9731	80
087	Sand pits or quarries	789	10665	82
092	Petroleum prospecting	33	447	3
094	Other prospecting	332	4359	26
096	Contract drilling for petroleum	1269	16739	84
098	Other contract drilling	766	10224	66
099	Other services incidental to mining	1056	14082	84
	Division 5 - Manufacturing industries			
101	Slaughtering and meat processors	3715	49997	310
103	Poultry processors	601	7962	41
105	Dairy factories	4867	65557	420
107	Process cheese manufacturers	202	2813	5
111	Fish products industry	2721	35820	290
112	Fruit and vegetable canners and preservers	1713	22588	166
123	Feed manufacturers	1514	20385	119
124	Flour mills	695	9330	77
125	Breakfast cereal manufacturers	163	2195	15
128	Biscuit manufacturers	1264	17227	125
129	Bakeries	4126	55444	365
131	Confectionery manufacturers	885	11865	72
133	Sugar refineries	292	3933	34
135	Vegetable oil mills	75	1004	9
139	Miscellaneous food industries	1696	22824	146
141	Soft drink manufacturers	2365	31719	128
143	Distilleries	493	6540	49
145	Breweries	1044	13786	138
147	Wineries	93	1257	9
151	Leaf tobacco processing	94	1202	14
153	Tobacco products manufacturers	622	8350	67
161	Rubber footwear manufacturers	303	4048	42
163	Tire and tube manufacturers	1924	26160	145
169	Other rubber industries	1397	18914	111
172	Leather tanneries	441	5891	52
174	Shoe factories	1609	21250	165
175	Leather glove factories	88	1170	10
179	Luggage, handbag and small leather goods manufacturers	618	8314	46

Ind. Code	Division and industry	Persons	Person years	Deaths
183	Cotton yarn and cloth mills	1940	26430	184
193	Wool yarn mills	152	1996	22
197	Wool cloth mills	734	9856	70
201	Synthetic textile mills	2519	33885	215
211	Fibre preparing mills	197	2618	25
212	Thread mills	82	1092	7
213	Cordage and twine industry	122	1584	19
214	Narrow fabric mills	257	3510	18
215	Pressed and punched felt mills	75	966	10
216	Carpet, mat and rug industry	382	5045	30
218	Textile dyeing and finishing plants	357	4758	36
219	Linoleum and coated fabrics industry	283	3726	39
221	Canvas products industry	214	2852	16
223	Cotton and jute bag industry	79	1044	9
229	Miscellaneous textile industries	861	11482	76
231	Hoisery mills	461	6190	27
239	Other knitting mills	849	11153	93
242	Custom tailoring shops	95	1298	12
243	Men's clothing industry	1886	25312	162
244	Women's clothing industry	1169	15585	125
245	Children's clothing industry	295	3977	19
246	Fur goods industry	249	3322	26
247	Hat and cap industry	167	2183	26
248	Foundation garment industry	132	1793	10
249	Other clothing industries	103	1408	7
251	Sawmills	9631	128451	943
252	Veneer and plywood mills	2263	30620	162
254	Sash and door and planing mills	3257	43753	318
256	Wooden box factories	587	7906	47
258	Coffin and casket industry	184	2399	26
259	Miscellaneous wood industries	1153	15486	111
261	Household furniture industry	3757	50341	297
264	Office furniture industry	743	10139	52
266	Other furniture industries	1697	22801	130
268	Electric lamp and shade industry	160	2135	11
271	Pulp and paper mills	10036	135464	1021
272	Asphalt roofing manufacturers	309	4212	20
273	Paper box and bag manufacturers	2435	33093	140
274	Other paper converters	1488	20045	107
286	Commercial printing	3844	51557	324
287	Engraving, stereotyping and allied industries	854	11444	75
288	Publishing only	269	3599	24
289	Printing and publishing	3298	44011	302
291	Iron and steel mills	5976	81053	565
292	Steel pipe and tube mills	690	9371	57

Ind. Code	Division and industry	Persons	Person years	Deaths
294	Iron foundries	1899	25545	191
295	Smelting and refining	5166	69726	506
296	Aluminum rolling, casting and extruding	672	9120	52
297	Copper and alloy rolling, casting and extruding	575	7804	52
298	Metal rolling, casting and extruding, n.e.s.	578	7725	47
301	Boiler and plate works	1109	14946	101
302	Fabricated structural metal industry	3286	44236	260
303	Ornamental and architectural metal industry	2334	31536	168
304	Metal stamping, pressing and coating industry	5053	68326	369
305	Wire and wire products manufacturers	2040	27398	177
306	Hardware, tool and cutlery manufacturers	2048	27519	157
307	Heating equipment manufacturers	1053	14226	100
308	Machine shops	2613	34941	216
309	Miscellaneous metal fabricating industries	3060	41174	270
311	Agricultural implement industry	2249	30264	237
315	Miscellaneous machinery and equipment manufacturers	6880	92831	582
316	Commercial refrigeration and air conditioning equipment manufacturers	422	5665	40
318	Office and store machinery manufacturers	869	11550	43
321	Aircraft and parts manufacturers	4248	56678	388
323	Motor vehicle manufacturers	6174	84663	515
324	Truck body and trailer manufacturers	1576	21172	109
325	Motor vehicle parts and accessories manufacturers	3886	52712	306
326	Railroad rolling stock industry	1297	17594	176
327	Shipbuilding and repair	3009	40423	362
328	Boatbuilding and repair	511	6823	43
329	Miscellaneous vehicle manufacturers	523	6737	34
331	Manufacturers of small electrical appliances	588	7841	44
332	Manufacturers of major appliances (electric and non-electric)	1692	22824	156
334	Manufacturers of household radio and television receivers	1021	13751	80

Ind. Code	Division and industry	Persons	Person years	Deaths
335	Communications equipment manufacturers	3821	51559	207
336	Manufacturers of electrical industrial equipment	3290	44461	245
337	Battery manufacturers	273	3667	26
338	Manufacturers of electric wire and cable	680	9193	62
339	Manufacturers of miscellaneous electrical products	1185	15892	91
341	Cement manufacturers	807	10934	86
343	Lime manufacturers	130	1730	15
345	Gypsum products manufacturers	341	4591	33
347	Concrete products manufacturers	2312	31537	159
348	Ready-mix concrete manufacturers	1306	17715	128
351	Clay products manufacturers	851	11420	83
352	Refractories manufacturers	212	2828	22
353	Stone products manufacturers	186	2536	21
354	Mineral wool manufacturers	163	2209	11
355	Asbestos products manufacturers	722	9718	80
356	Glass and glass products manufacturers	1439	19473	108
357	Abrasives manufacturers	375	4962	50
359	Other non-metallic mineral products industries	134	1796	13
365	Petroleum refineries	1928	25849	152
369	Other petroleum and coal products industries	114	1560	9
371	Explosives and ammunition manufacturers	697	9435	54
372	Manufacturers of mixed fertilizers	550	7404	39
373	Manufacturers of plastics and synthetic resins	560	7643	41
374	Manufacturers of pharmaceuticals and medicines	845	11097	76
375	Paint and varnish manufacturers	1073	14341	84
376	Manufacturers of soap and cleaning compounds	501	6688	46
377	Manufacturers of toilet preparations	319	4300	23
378	Manufacturers of industrial chemicals	2439	33412	211
379	Other chemical industries	1170	15742	95
381	Scientific and professional equipment manufacturers	1872	25027	137
382	Jewellery and silverware manufacturers	487	6458	48
383	Broom, brush and mop industry	234	3181	15
384	Venetian blind manufacturers	38	516	6

Ind. Code	Division and industry	Persons	Person years	Deaths
385	Plastic fabricators, n.e.s.	1715	23017	113
393	Sporting goods and toy industry	827	11016	71
395	Fur dressing and dyeing industry	97	1223	21
397	Signs and displays industry	816	10926	62
399	Miscellaneous manufacturing industries, n.e.s.	1342	17840	127
	Division 6 - Construction			
404	Building construction	24784	332891	2334
406	Highway, bridge and street construction	8555	114525	820
409	Other construction	9622	129452	820
421	Special-trade contractors	31349	422692	2364
	Division 7 - Transportation, communication and other utilities			
501	Air transport	1441	19237	86
502	Services incidental to air transport	287	3869	21
504	Water transport	2813	37720	295
505	Services incidental to water transport	2596	34110	334
506	Railway transport	18968	253140	2137
507	Truck transport	14012	189417	1157
508	Bus transport, interurban and rural	974	13058	117
509	Urban transit systems	2658	36049	302
512	Taxicab operations	1965	25327	276
515	Pipeline transport	299	4032	22
516	Highway and bridge maintenance	4537	60086	514
517	Other services incidental to transport	794	10466	84
519	Other transportation	725	9513	92
524	Grain elevators	1395	18758	116
527	Other storage and warehousing	686	9193	77
543	Radio and television broadcasting	1235	16688	50
544	Telephone systems	2445	32957	113
545	Telegraph and cable systems	966	13072	69
548	Post office	1554	20706	75
572	Electric power	6072	81251	572
574	Gas distribution	1013	13711	86
576	Water systems	481	6411	67
579	Other utilities	684	9068	74

Ind. Code	Division and industry	Persons	Person years	Deaths
	Division 8 - Trade			
602	Wholesalers of livestock	203	2609	23
604	Wholesalers of grain	603	8215	64
606	Wholesalers of coal and coke	101	1286	22
608	Wholesalers of petroleum products	2090	28284	156
611	Wholesalers of paper and paper products	581	7773	47
613	Wholesalers of general merchandise	370	5053	24
614	Wholesalers of food	5838	78505	511
615	Wholesalers of tobacco products	461	6055	41
616	Wholesalers of drugs and toilet preparations	634	8511	57
617	Wholesalers of apparel and dry goods	828	10950	68
618	Wholesalers of furniture and house furnishings	533	7171	38
619	Wholesalers of motor vehicles and accessories	3685	49589	271
621	Wholesalers of electrical machinery equipment and supplies	1631	21914	116
622	Wholesalers of farm machinery and equipment	2158	29049	162
623	Wholesalers of machinery and equipment, n.e.s.	5993	80564	441
624	Wholesalers of hardware, plumbing and heating equipment	2189	29316	199
625	Wholesalers of metal and metal products, n.e.s.	848	11329	61
626	Wholesalers of lumber and building materials	6076	81676	565
627	Wholesalers of scrap and waste materials	1128	14973	126
629	Wholesalers, n.e.s.	4148	55698	371
631	Food stores	12191	161308	619
642	Department stores	6788	89578	458
647	Variety stores	2259	29430	152
649	Other general merchandise stores	2609	34931	200
652	Accessory, parts, tire and battery shops	2379	32054	154
654	Gasoline service stations	7978	106018	506
656	Motor vehicle dealers	11394	152912	938
658	Motor vehicle repair shops	3975	53895	275
663	Shoe stores	1003	13183	68
665	Men's clothing stores	1046	13753	103
667	Women's ready-to-wear stores	361	4731	40

Ind. Code	Division and industry	Persons	Person years	Deaths
669	Clothing and dry goods stores, n.e.s.	837	11031	85
673	Hardware stores	1542	20601	156
676	Household furniture and appliance stores	3328	44606	268
678	Radio, television and electrical appliance repair shops	380	5152	34
681	Drug stores	922	11844	97
691	Book and stationery stores	357	4756	28
692	Florists' shops	238	3113	19
693	Fuel dealers	1621	22111	135
694	Jewellery stores	393	5077	49
695	Watch and jewellery repair shops	24	330	1
696	Liquor, wine and beer stores	540	6923	77
697	Tobacconists	117	1465	23
699	Retail stores, n.e.s.	1692	22387	140
	Division 9 - Finance, insurance and real estate			
702	Savings and credit institutions	6502	86545	410
704	Investment companies and security dealers	1313	17202	137
731	Insurance carriers	2209	29366	151
735	Insurance and real estate agencies	1404	18293	206
737	Real estate operators	2344	30272	426
	Division 10 - Community, business personal service industries			
801	Elementary and secondary schools	3948	51967	510
803	Vocational schools	124	1651	19
805	Universities and colleges	687	8929	73
807	Libraries, museums and other repositories	162	2053	20
809	Education and related services, n.e.s.	23	299	1
821	Hospitals	697	8963	96
823	Offices of physicians	82	1042	17
825	Offices of dentists	31	417	3
827	Other health services	133	1744	12
828	Welfare organizations	428	5385	79
831	Religious organizations	281	3668	48
851	Motion picture theatres and film exchanges	815	10429	111

Ind. Code	Division and industry	Persons	Person years	Deaths
853	Bowling alleys and billiard parlours	490	6339	79
859	Other recreational services	3042	39388	379
861	Accountancy service	1512	20366	48
862	Advertising service	654	8462	80
864	Engineering and scientific service	3926	52119	190
866	Legal service	411	5185	37
869	Other services to business management	2743	35972	211
871	Shoe repair shops	119	1591	11
872	Barber and beauty shops	1267	16657	92
873	Private households	88	1017	26
874	Laundries, cleaners and pressers	2269	30301	200
875	Hotels, restaurants and taverns	16726	216613	1864
876	Lodging houses and residential clubs	305	3928	57
877	Funeral directors	262	3416	28
878	Dressmaking	-	-	-
879	Other personal services	316	3995	61
891	Labour organizations and trade associations	968	12991	126
893	Photography	317	4263	19
894	Blacksmithing and welding shops	664	9016	50
896	Miscellaneous repair shops	485	6429	43
897	Services to buildings and dwellings	2395	31288	266
899	Other miscellaneous services	6180	78185	1174
	Division 11 - Public administration and defence			
902	Defence services	3633	47072	659
909	Other federal administration	5013	65237	439
931	Provincial administration	2691	34585	378
951	Local administration	15191	199174	1965
991	Other government offices	352	4764	38
	Division 12 - Industry unspecified or undefined			
999	Unspecified or undefined	11506	148703	1345

Appendix III

Occupation by social class by occupation code

Appendix III. Occupation by social class by occupation code

Occ. Code	Social class and occupation
	SOCIAL CLASS 1
001	Advertising managers
002	Credit managers
004	Sales managers
005	Delivery managers
006	Office managers
007	Postmasters
008	Purchasing agents and buyers
010	Owners and managers, n.e.s.
101	Civil engineers
102	Mechanical engineers
104	Industrial engineers
105	Electrical engineers
107	Mining engineers
108	Chemical engineers
109	Professional engineers, n.e.s.
111	Chemists
112	Geologists
114	Physicists
119	Physical scientists, n.e.s.
121	Biological scientists
124	Veterinarians
129	Agricultural professionals, n.e.s.
131	Professors and college principals
135	School teachers
139	Teachers and instructors, n.e.s.
140	Physicians and surgeons
141	Dentists
142	Nurses, graduate
143	Nurses-in-training
144	Physical and occupational therapists
145	Optometrists
147	Pharmacists
146	Osteopaths and chiropractors
148	Medical and dental technicians
149	Other health professionals
151	Judges and magistrates
153	Lawyers and notaries
161	Clergymen and priests, n.o.r.
163	Nuns and brothers, n.o.r.
169	Religious workers, n.o.r.
171	Artists, commercial
172	Artists (except commercial), art teachers
174	Authors, editors and journalists
176	Musicians and music teachers
181	Architects

Occ. Code	Social class and occupation
183	Surveyors
184	Actuaries and statisticians
186	Economists
187	Computer programmers
188	Accountants and auditors
191	Dieticians
192	Social welfare workers
194	Librarians
195	Interior decorators and window dressers
196	Photographers
198	Science and engineering technicians, n.e.s.
199	Professional occupations, n.e.s.
301	Foremen, trade
331	Insurance salesmen and agents
334	Real estate salesmen and agents
336	Security salesmen and brokers
338	Brokers, agents and appraisers, n.e.s.
411	Lodging and boarding house keepers
412	Housekeepers (except private household), matrons, stewards
431	Actors, entertainers and showmen
520	Air pilots, navigators and flight engineers
541	Deck officers, ship
543	Engineering officers, ship
581	Radio and television announcers
601	Farmers and stockraisers
603	Farm managers and foremen
613	Forest rangers and cruisers
	SOCIAL CLASS 2
182	Draughtsmen
201	Bookkeepers and cashiers
203	Office appliance operators
223	Ticket, station and express agents, transport
232	Stenographers
234	Typists and clerk-typists
241	Attendants, doctors' and dentists' offices
249	Clerical occupations, n.e.s.
303	Auctioneers
307	Canvassers and other door-to-door salesmen
314	Commercial travellers
325	Sales clerks
327	Advertising salesmen and agents
339	Other sales occupations
403	Policemen and detectives
408	Other ranks, armed forces
416	Nursing assistants and aides

Occ. Code	Social class and occupation
455	Funeral directors and embalmers
570	Inspectors and foremen, communication
582	Radio and television equipment operators
584	Telephone operators
585	Telegraph operators
861	Lens grinders and polishers; opticians
900	Foremen, n.e.s.
917	Inspectors, examiners, gaugers, n.e.s. - metal
918	Inpectors, graders and samplers, n.e.s.
	SOCIAL CLASS 3
323	Service station attendants
401	Firemen, fire protection
413	Cooks
433	Athletes and sports officials
451	Barbers, hairdressers, manicurists
510	Inspectors and foremen
531	Locomotive engineers
532	Locomotive firemen
534	Conductors, railroad
535	Brakemen, railroad
537	Switchmen and signalmen
551	Bus drivers
552	Taxi drivers and chauffeurs
554	Driver-salesmen
556	Truck drivers
561	Operators, electric street railway
563	Teamsters
587	Postmen and mail carriers
611	Logging foremen
651	Foremen - mine, quarry, petrol, well
655	Millmen
702	Bakers
703	Butchers and meat cutters
711	Tire and tube builders
713	Vulcanizers
719	Other rubber workers
721	Leather cutters
722	Shoemakers and repairers - factory, n.e.s.
724	Shoemakers and repairers - not in factory
729	Other leather products makers
734	Weavers
735	Loom fixers and loom preparers
736	Knitters
737	Bleachers and dyers - textile
738	Finishers and calenderers

Occ. Code	Social class and occupation
741	Tailors and tailoresses
742	Dressmakers and seamstresses - not in factory
743	Furriers
744	Milliners; hat and cap makers
745	Cutters, markers - textiles; garment and glove leather
747	Upholsterers
749	Apparel and related products makers, n.e.s.
751	Carpenters
752	Cabinet and furniture makers - wood
754	Sawyers
756	Woodworking machine operators, n.e.s.
758	Inspectors, graders, scalers, log and lumber
759	Woodworking occupations, n.e.s.
761	Batch and continuous still operators
762	Roasters, cookers and other heat treaters, chemical
763	Cellulose pulp preparers, n.e.s.
765	Paper makers
766	Paper making occupations, n.e.s.
768	Crushers, millers, calenderers, n.e.s. - chemical
769	Chemical and related process workers, n.e.s.
771	Compositors and typesetters
772	Pressmen, printing
773	Lithographic and photo-offset occupations
775	Photoengravers
776	Bookbinders
778	Other occupations in bookbinding
779	Printing workers, n.e.s.
781	Furnacemen and heaters, metal
783	Rolling mill operators
784	Blacksmiths, hammermen, forgemen
786	Moulders
787	Coremakers
788	Metal drawers and extruders
791	Jewellers and watchmakers
793	Engravers, except photoengravers
801	Toolmakers, diemakers
802	Machinists and machine tool setters
803	Filers, grinders, sharpeners
805	Millwrights
806	Fitters and assemblers, n.e.s. - metal
810	Plumbers and pipefitters
811	Sheet metal workers
812	Riveters and rivet heaters
813	Boilermakers, platers and structural metal workers
815	Electroplaters, dip platers and related workers
817	Welders and flame cutters
821	Mechanics and repairmen, aircraft
822	Mechanics and repairmen, motor vehicle
824	Mechanics and repairmen, office machine

Occ. Code	Social class and occupation
825	Mechanics and repairmen, railroad equipment
829	Mechanics and repairmen, n.e.s.
831	Electricians, wiremen and electrical repairmen
833	Power station operators
835	Mechanics and repairmen, radio and television receivers
838	Linemen and servicemen - telephone, telegraph and power
839	Electrical and electronics workers, n.e.s.
841	Painters (construction and maintenance), paperhangers and glaziers
843	Painters, except construction and maintenance
851	General foremen - construction
852	Inspectors - construction
854	Bricklayers, stonemasons, tilesetters
855	Cement and concrete finishers
856	Plasterers and lathers
862	Furnacemen and kilnmen, ceramics and glass
864	Stone cutters and dressers
872	Stationary enginemen
873	Motormen (vehicle), except railway
874	Hoistmen, cranemen, derrickmen
875	Riggers and cable splicers, except telephone, telegraph and power
912	Patternmakers (except paper)
914	Paper products makers
916	Tanners and tannery operatives
	SOCIAL CLASS 4
212	Stock clerks and storekeepers
214	Shipping and receiving clerks
221	Baggagemen and expressmen, transport
312	Hawkers and pedlars
316	Newsvendors
405	Guards, watchmen, n.e.s.
414	Bartenders
415	Waiters
417	Porters, baggage and pullman
418	Baby sitters
419	Maids and related service workers, n.e.s.
452	Launderers and dry cleaners
453	Elevator tenders, building
454	Janitors and cleaners, building
456	Guides
457	Attendants, recreation and amusement
459	Service workers, n.e.s.
545	Deck ratings (ship), barge crews and boatmen
547	Engine-room ratings, firemen and oilers (ship)
569	Transport occupations, n.e.s.

Occ. Code	Social class and occupation
588	Messengers
605	Farm labourers
607	Gardeners (except farm) and groundskeepers
609	Other agricultural occupations
615	Lumbermen, including labourers in logging
631	Fishermen
633	Trappers and hunters
652	Prospectors
653	Timbermen
654	Miners, n.e.s.
655	Well drillers and related workers
657	Labourers, mine
659	Quarriers and related workers, n.e.s.
701	Millers of flour and grain
704	Meat canners, curers, packers
705	Fish canners, curers, packers
706	Fruit and vegetable canners and packers
707	Milk processors
708	Other food processing occupations
709	Beverage processors
731	Carders, combers and other fibre preparers
732	Spinners and twisters
733	Winders, reelers
739	Other textile occupations
746	Sewers and sewing machine operators, n.e.s.
782	Heat treaters, annealers, temperers
789	Metal treating occupations, n.e.s.
808	Metalworking machine operators, n.e.s.
818	Polishers and buffers - metal
819	Metalworking occupations, n.e.s.
832	Fitters and assemblers - electrical and electronics equipment
836	Projectionists, motion picture
857	Insulation appliers
859	Construction workers, n.e.s.
869	Clay, glass and stone workers, n.e.s.
871	Boiler firemen (except ship)
876	Operators of earth-moving and other construction machinery, n.e.s.
877	Materials-handling equipment operators
878	Oilers and greasers - machinery and vehicles (except ships)
881	Longshoremen and stevedores
883	Warehousemen and freight handlers, n.e.s.
890	Sectionmen and trackmen
911	Tobacco preparers and products makers
913	Bottlers, wrappers, labelers
915	Photographic processing occupations

Occ. Code	Social class and occupation
919	Production process and related workers, n.e.s.
920	Labourers, excl. agricultural, fishing or mining operations

Appendix IV

Results by cancer site, occupation and industry

Appendix Table 1. Cancer of buccal cavity and pharynx mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
249 Clerical occupations, n.e.s.	1	34	1.56 (1.15-2.08)	0.0089
405 Guards, watchmen, n.e.s.	2	12	2.06 (1.19-3.34)	0.0166
414 Bartenders	1	10	5.05 (2.74-8.57)	<0.0001
415 Waiters	1	19	5.17 (3.39-7.59)	<0.0001
	2	10	6.69 (3.63-11.35)	<0.0001
	3	6	7.83 (3.41-15.45)	0.0001
	4	5	15.02 (5.92-31.58)	<0.0001
556 Truck drivers	1	25	1.67 (1.16-2.33)	0.0109
703 Butchers	1	6	2.70 (1.18-5.33)	0.0259
	2	5	3.59 (1.41-7.55)	0.0139
Industry:				
145 Breweries	1	6	6.76 (2.94-13.34)	0.0003
321 Aircraft and parts manufacturers	1	8	2.57 (1.28-4.64)	0.0146
631 Food stores	2	7	2.79 (1.31-5.24)	0.0146
869 Other services to business management	1	5	3.93 (1.55-8.26)	0.0098
875 Hotels, restaurants and taverns	1	35	2.81 (2.08-3.73)	<0.0001
	2	23	3.17 (2.17-4.49)	<0.0001
	3	15	3.22 (1.98-4.96)	0.0001
	4	9	3.31 (1.73-5.78)	0.0020
899 Other miscellaneous services	1	16	2.28 (1.43-3.46)	0.0025

Appendix Table 2. Cancer of the esophagus mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
405 Guards, watchmen, n.e.s.	1	18	1.74 (1.12-2.58)	0.0188
554 Driver salesmen	1	9	2.66 (1.39-4.64)	0.0080
822 Mechanics and repairmen, motor vehicle	1	12	2.34 (1.35-3.79)	0.0066
Industry:				
421 Special-trade contractors	1	19	1.64 (1.07-2.41)	0.0274
509 Urban transit systems	[redacted]	5	2.82 (1.11-5.93)	0.0343
899 Other miscellaneous services	1	11	2.08 (1.17-3.44)	0.0198
	3	5	2.54 (1.00-5.34)	0.0499

Appendix Table 3. Stomach cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
415 Waiters	1	17	1.67 (1.06-2.50)	0.0311
615 Lumbermen, including labourers in logging	1	28	1.55 (1.10-2.13)	0.0181
654 Miners	2	12	1.97 (1.14-3.19)	0.0223
	3	11	2.37 (1.33-3.92)	0.0082
	4	7	2.15 (1.01-4.04)	0.0485
751 Carpenters	1	58	1.31 (1.04-1.63)	0.0284
	2	35	1.37 (1.01-1.82)	0.0438
819 Metalworking occupations, n.e.s.	2	7	2.41 (1.13-4.53)	0.0287
838 Linemen and servicemen - telephone, telegraph and power	1	12	2.17 (1.25-3.52)	0.0115
874 Hoistmen, cranemen, derrickmen	3	6	2.55 (1.11-5.03)	0.0327
	4	5	3.65 (1.44-7.67)	0.0131
877 Materials-handling equipment operators	3	5	2.81 (1.11-5.91)	0.0349
890 Sectionmen and trackmen	1	17	1.73 (1.10-2.59)	0.0230
	2	13	1.81 (1.07-2.88)	0.0316
	3	5	3.22 (1.27-6.77)	0.0213

Appendix Table 3. Stomach cancer mortality by occupation and industry cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Industry:				
061 Coal mines	1	9	2.21 (1.15-3.86)	0.0235
	2	8	2.24 (1.11-4.04)	0.0298
	3	8	2.70 (1.34-4.87)	0.0111
	4	6	2.64 (1.15-5.21)	0.0285
304 Metal stamping, pressing and coating industry	1	13	1.78 (1.05-2.83)	0.0354
356 Glass and glass products manufacturers	2	5	3.40 (1.34-7.15)	0.0173
404 Building construction	1	67	1.29 (1.04-1.58)	0.0261
	2	36	1.40 (1.04-1.85)	0.0327
	4	11	1.83 (1.03-3.03)	0.0437
	5	5	3.83 (1.51-8.05)	0.0109
931 Provincial administration	1	16	2.25 (1.41-3.42)	0.0028
951 Local administration	1	54	1.34 (1.05-1.68)	0.0218

Appendix Table 4. Colon cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
249 Clerical occupations, n.e.s.	1	91	1.47 (1.23-1.75)	0.0003
	2	37	1.41 (1.05-1.85)	0.0277
	3	22	1.64 (1.11-2.34)	0.0196
314 Commercial travellers	1	23	1.56 (1.07-2.21)	0.0285
531 Locomotive engineers	1	9	3.07 (1.60-5.36)	0.0033
535 Brakemen, railroad	1	5	2.61 (1.03-5.49)	0.0456
	2	5	3.79 (1.49-7. .)	0.0113
838 Linemen and servicemen - telephone, telegraph and power	1	11	1.95 (1.09-3.23)	0.0293
913 Bottlers, wrappers, labelers	1	15	1.86 (1.15-2.86)	0.0182
	2	9	2.67 (1.39-4.66)	0.0079
914 Paper products makers	1	6	2.94 (1.28-5.80)	0.0181
Industry:				
105 Dairy factories	3	9	2.07 (1.08-3.61)	0.0336
128 Biscuit manufacturers	1	6	2.39 (1.04-4.72)	0.0427
201 Synthetic textile mills	3	6	2.59 (1.13-5.11)	0.0306
289 Printing and publishing	1	14	2.21 (1.34-3.46)	0.0058
	2	11	2.37 (1.33-3.92)	0.0082
	3	8	2.27 (1.13-4.10)	0.0279

Appendix Table 4. Colon cancer mortality by occupation and industry cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
304 Metal stamping, pressing and coating industry	1	14	1.91 (1.15-2.99)	0.0184
315 Miscellaneous machinery and equipment manufacturers	2	14	1.92 (1.16-3.00)	0.0177
327 Shipbuilding and repair	3	9	1.99 (1.04-3.47)	0.0416
	4	7	2.24 (1.05-4.21)	0.0398
626 Wholesalers of lumber and building materials	1	19	1.57 (1.03-2.30)	0.0401
731 Insurance carriers	1	8	2.19 (1.09-3.95)	0.0332
	2	6	2.87 (1.25-5.66)	0.0200

Appendix Table 5. Cancer of the rectum mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
325 Sales clerks	1	17	1.58 (1.01-2.37)	0.0487
556 Truck drivers	2	14	1.76 (1.06-2.75)	0.0327
588 Messengers	1	6	3.54 (1.54-6.99)	0.0079
703 Butchers	1	7	2.73 (1.28-5.13)	0.0161
843 Painters except construction and maintenance	1	-	3.45 (1.36-7.25)	0.0163
Industry:				
201 Synthetic textile mills	1	6	3.60 (1.57-7.11)	0.0073
	2	5	3.87 (1.52-8.14)	0.0104
251 Sawmills	2	10	2.02 (1.10-3.43)	0.0301
365 Petroleum refineries	1	5	3.84 (1.51-8.07)	0.0107
507 Truck transport	1	19	2.48 (1.62-3.64)	0.0004
	2	11	2.38 (1.33-3.94)	0.0082
	3	8	2.43 (1.21-4.38)	0.0194
627 Wholesalers of scrap and waste materials	1	5	4.90 (1.93-10.30)	0.0040
631 Food stores	1	12	2.63 (1.52-4.26)	0.0027
	2	7	2.44 (1.15-4.58)	0.0273
	3	6	2.89 (1.26-5.70)	0.0195
673 Hardware stores	1	6	4.17 (1.82-8.23)	0.0037

Appendix Table 6. Liver cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
413 Cooks	1	6	2.78 (1.21-5.49)	0.0231
415 Waiters	1	6	2.65 (1.15-5.23)	0.0281
872 Stationary enginemen	1	6	2.34 (1.02-4.62)	0.0467
919 Production process and related workers, n.e.s.	1	5	3.69 (1.45-7.76)	0.0125
Industry:				
254 Sash and door and planing mills	1	5	3.15 (1.24-6.62)	0.0230
875 Hotels, restaurants and taverns	2	9	1.93 (1.01-3.37)	0.0478
909 Other federal administration	1	7	3.26 (1.53-6.12)	0.0066

Appendix Table 7. Pancreas cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
314 Commercial travellers	1	17	1.60 (1.02-2.40)	0.0429
	2	10	2.03 (1.10-3.44)	0.0291
419 Maids and related service workers	1	12	1.75 (1.01-2.84)	0.0464
454 Janitors	1	52	1.49 (1.17-1.88)	0.0042
611 Logging foremen	1	5	4.30 (1.69-9.04)	0.0068
654 Miners	2	9	2.04 (1.06-3.56)	0.0361
	3	9	2.68 (1.40-4.68)	0.0077
819 Metalworking occupations, n.e.s.	1	13	2.24 (1.32-3.56)	0.0068
833 Power station operators	1	5	3.21 (1.26-6.75)	0.0214
Industry:				
302 Fabricated structural metal industry	2	6	2.50 (1.09-4.93)	0.0355
	3	5	2.90 (1.14-6.10)	0.0311
381 Scientific and professional equipment manufacturers	1	5	2.71 (1.07-5.70)	0.0398
	2	5	3.97 (1.56-8.35)	0.0094
	3	5	5.47 (2.16-11.50)	0.0025
505 Services incidental to water transport	2	6	2.38 (1.04-4.70)	0.0434
902 Defence services	1	15	1.75 (1.08-2.69)	0.0286
	2	11	1.89 (1.06-3.13)	0.0360
951 Local administration	2	22	1.48 (1.00-2.11)	0.0479

Appendix Table 8. Larynx cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
249 Clerical occupations, n.e.s.	1	19	1.73 (1.13-2.54)	0.0175
	2	10	2.14 (1.16-3.63)	0.0212
	3	6	2.50 (1.09-4.93)	0.0357
415 Waiters	1	5	2.73 (1.08-5.74)	0.0388
556 Truck drivers	3	7	3.40 (1.60-6.39)	0.0053
806 Fitters and assemblers, n.e.s., metal	1	7	3.58 (1.68-6.72)	0.0040
	2	5	4.74 (1.87-9.97)	0.0046
Industry:				
629 Wholesalers, n.e.s.	1	5	3.62 (1.43-7.61)	0.0135
875 Hotels, restaurants and taverns	1	13	2.06 (1.22-3.28)	0.0128
	2	8	2.10 (1.04-3.79)	0.0405
	3	6	2.46 (1.07-4.86)	0.0381
	4	5	3.52 (1.39-7.40)	0.0151

Appendix Table 9. Lung cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
249 Clerical occupations, n.e.s.	5	10	1.87 (1.01-3.17)	0.0466
405 Guards, watchmen, n.e.s.	1	197	1.27 (1.12-1.43)	0.0006
	2	91	1.31 (1.09-1.56)	0.0078
	3	55	1.34 (1.06-1.68)	0.0205
	4	38	1.59 (1.19-2.08)	0.0048
414 Bartenders	1	32	1.50 (1.09-2.01)	0.0190
535 Brakemen, railroad	3	9	1.98 (1.03-3.46)	0.0424
556 Truck drivers	1	172	1.15 (1.01-1.31)	0.0376
	2	95	1.25 (1.05-1.48)	0.0212
	3	60	1.31 (1.04-1.62)	0.0241
587 Postmen and mail carriers	1	7	2.17 (1.02-4.08)	0.0463
654 Miners	2	36	1.41 (1.05-1.86)	0.0289
659 Quarriers and related workers	1	17	1.77 (1.13-2.65)	0.0192
	2	10	3.26 (1.77-5.53)	0.0013
781 Furnacemen and heaters, metal	1	22	1.69 (1.14-2.41)	0.0140
786 Moulders	1	16	1.88 (1.18-2.86)	0.0138
810 Plumbers and pipefitters	1	58	1.57 (1.25-1.95)	0.0008
	2	36	1.51 (1.12-1.99)	0.0123
	3	29	1.72 (1.23-2.35)	0.0044

Appendix Table 9. Lung cancer mortality by occupation and industry - cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
811 Sheet metal workers	2	20	1.70 (1.13-2.47)	0.0179
	3	15	2.02 (1.25-3.11)	0.0096
	4	10	2.52 (1.37-4.27)	0.0077
	5	5	3.72 (1.47-7.82)	0.0122
872 Stationary enginemen	3	22	1.50 (1.02-2.14)	0.0441
	5	6	2.73 (1.19-5.39)	0.0250
913 Bottlers, wrappers, labelers	1	43	1.32 (1.01-1.70)	0.0452
Industry:				
053 Copper-gold-silver mines	1	22	1.49 (1.01-2.13)	0.0474
054 Nickel-copper mines	2	17	1.57 (1.00-2.35)	0.0493
083 Stone quarries	2	8	2.57 (1.28-4.64)	0.0145
	3	5	2.62 (1.03-5.51)	0.0448
105 Dairy factories	2	33	1.37 (1.00-1.83)	0.0493
141 Soft drink manufacturers	1	14	1.84 (1.11-2.88)	0.0240
	2	10	1.88 (1.02-3.19)	0.0444
211 Fibre preparing mills	1	5	3.22 (1.27-6.77)	0.0212
231 Hosiery mills	1	6	2.47 (1.08-4.88)	0.0374
291 Iron and steel mills	2	48	1.29 (1.00-1.64)	0.0496
294 Iron foundries	1	23	1.48 (1.01-2.10)	0.0448
295 Smelting and refining	2	44	1.34 (1.03-1.72)	0.0369

Appendix Table 9. Lung cancer mortality by occupation and industry - cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
304 Metal stamping, pressing and coating industry	1	43	1.46 (1.11-1.88)	0.0111
308 Machine shops	2	16	1.94 (1.22-2.95)	0.0105
	3	11	2.07 (1.16-3.43)	0.0200
309 Miscellaneous metal fabricating industries	1	29	1.44 (1.03-1.96)	0.0361
	2	21	1.53 (1.03-2.20)	0.0399
321 Aircraft and parts manufacturers	4	24	1.51 (1.04-2.12)	0.0341
327 Shipbuilding and repair	1	40	1.33 (1.00-1.73)	0.0495
341 Cement manufacturers	1	13	2.06 (1.22-3.28)	0.0129
	2	11	2.30 (1.29-3.81)	0.0103
347 Concrete products manufacturers	3	10	2.01 (1.09-3.41)	0.0310
355 Asbestos products manufacturers	1	11	1.91 (1.07-3.16)	0.0337
	3	6	3.74 (1.63-7.38)	0.0061
	4	5	6.54 (2.58-13.75)	0.0012
382 Jewellery and silverware manufacturers	1	8	2.16 (1.07-3.90)	0.0354
421 Special-trade contractors	1	202	1.13 (1.00-1.27)	0.0422
507 Truck transport	1	88	1.24 (1.03-1.48)	0.0302

Appendix Table 9. Lung cancer mortality by occupation and industry - cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
821 Hospitals	1	13	1.85 (1.09-2.94)	0.0277
	2	8	2.58 (1.28-4.66)	0.0144
	3	5	2.84 (1.12-5.97)	0.0335
853 Bowling alleys and billiard parlours	1	12	2.47 (1.43-4.00)	0.0044
	2	7	3.13 (1.47-5.88)	0.0082
899 Other miscellaneous services	1	101	1.30 (1.09-1.53)	0.0062
	2	60	1.35 (1.08-1.67)	0.0151
	3	42	1.45 (1.10-1.88)	0.0140
	4	30	1.62 (1.17-2.20)	0.0088
	5	11	1.86 (1.04-3.08)	0.0386

Appendix Table 11. Skin cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
010 Owners and managers n.e.s.	2	6	2.38 (1.04-4.70)	0.0431
802 Machinists and machine tool setters	1	5	2.56 (1.01-5.38)	0.0486
	2	5	4.69 (1.85-9.86)	0.0048
Industry:				
623 Wholesalers of machinery and equipment, n.e.s.	1	5	3.47 (1.37-7.30)	0.0160

Appendix Table 12. Prostate cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I)	P value
Occupation:				
249 Clerical occupations, n.e.s.	4	10	2.22 (1.20-3.77)	0.0172
301 Foremen - trade	1	6	2.41 (2.41-1.05)	0.0411
325 Sales clerks	1	31	1.81 (1.31-2.44)	0.0017
	2	14	1.74 (1.05-2.72)	0.0349
554 Driver salesmen	1	12	1.79 (1.03-2.90)	0.0411
822 Mechanics and repairmen, motor vehicle	2	11	1.88 (1.05-3.11)	0.0363
	3	9	2.44 (1.27-4.26)	0.0135
883 Warehousemen and freight handlers, n.e.s.	3	6	2.44 (1.06-4.8?)	0.0394
Industry:				
053 Copper-gold-silver mines	1	5	2.70 (1.06-5.68)	0.0404
271 Pulp and paper mills	3	14	1.79 (1.08-2.80)	0.0295
	5	5	2.57 (1.01-5.40)	0.0479
614 Wholesalers of food	1	13	2.01 (1.19-3.20)	0.0156
	2	10	2.77 (1.50-4.70)	0.0041
619 Wholesalers of motor vehicles and accessories	1	8	2.67 (1.33-4.82)	0.0119
	2	5	2.77 (1.09-5.82)	0.0367

Appendix Table 12. Prostate cancer mortality by occupation and industry cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
626 Wholesalers of lumber and building materials	2	9	2.17 (1.13-3.79)	0.0259
	3	9	3.27 (1.71-5.71)	0.0021
	4	7	4.22 (1.98-7.93)	0.0016
656 Motor vehicle dealers	4	7	2.16 (1.01-4.06)	0.0470

Appendix Table 13. Bladder cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
010 Owners and managers n.e.s.	1	23	1.55 (1.06-2.20)	0.0289
	2	14	2.21 (1.34-3.46)	0.0057
	3	8	2.60 (1.29-4.69)	0.0138
323 Service station attendants	1	6	3.03 (1.32-5.98)	0.0158
554 Driver salesmen	1	9	2.24 (1.17-3.91)	0.0220
556 Truck drivers	4	5	2.91 (1.15-6.12)	0.0307
822 Mechanics and repairmen, motor vehicle	1	13	2.04 (1.21-3.24)	0.0138
	2	8	2.24 (1.11-4.04)	0.0294
Industry:				
254 Sash and door and planing mills	1	7	2.73 (1.28-5.13)	0.0161
309 Miscellaneous metal fabricating industries	1	6	3.41 (1.49-6.73)	0.0093
421 Special-trade contractors	1	22	1.55 (1.05-2.21)	0.0329
	2	13	1.82 (1.08-2.89)	0.0305
	3	10	2.34 (1.27-3.97)	0.0124
	4	7	3.02 (1.42-5.67)	0.0097
631 Food stores	1	8	2.27 (1.13-4.10)	0.0276
654 Gasoline service stations	1	8	2.89 (1.44-5.21)	0.0076
	2	6	4.29 (1.87-8.47)	0.0032

Appendix Table 13. Bladder cancer mortality by occupation and industry cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
737 Real estate operators	1	8	2.03 (1.01-3.66)	0.0472
	2	5	2.65 (1.04-5.57)	0.0431
902 Defence services	3	5	2.62 (1.03-5.51)	0.0446

Appendix Table 14. Kidney cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
454 Janitors	1	21	1.58 (1.06-2.28)	0.0307
Industry:				
294 Iron foundries	1	5	4.55 (1.79-9.57)	0.0054
506 Railway transport	1	21	1.68 (1.13-2.42)	0.0169
	2	19	1.90 (1.24-2.79)	0.0071
	3	16	1.94 (1.22-2.95)	0.0105

Appendix Table 15. Brain cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
198 Science and engineering technicians	1	7	2.54 (1.19-4.77)	0.0227
831 Electricians, wiremen and electrical repairmen	1	9	1.93 (1.01-3.37)	0.0479
890 Sectionmen and trackmen	3	5	3.22 (1.27-6.77)	0.0213
913 Bottlers, wrappers, labelers	1	7	2.42 (1.14-4.55)	0.0282
Industry:				
183 Cotton yarn and cloth mills	1	5	4.15 (1.64-8.73)	0.0079
404 Building construction	1	27	1.51 (1.07-2.08)	0.0258

Appendix Table 16. Non-Hodgkin's lymphoma mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
551 Bus drivers	1	6	2.42 (1.05-4.78)	0.0408
	2	5	2.97 (1.17-6.25)	0.0286
822 Mechanics and repairmen, motor vehicle	2	9	2.26 (1.18-3.94)	0.0207
	3	6	2.36 (1.03-4.66)	0.0445
829 Mechanics and repairmen, n.e.s.	2	12	1.94 (1.12-3.14)	0.0244
	3	8	2.38 (1.18-4.29)	0.0215
838 Linemen and servicemen - telephone, telegraph and power	1	7	2.43 (1.14-4.56)	0.0279
919 Production process and related workers, n.e.s.	1	6	2.89 (1.26-5.70)	0.0194
Industry:				
656 Motor vehicle dealers	2	9	2.18 (1.14-3.80)	0.0252

Appendix Table 17. Myeloma mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
631 Fishermen	1	5	3.06 (1.21-6.43)	0.0257
Industry:				
041 Fishing	1	5	3.08 (1.21-6.48)	0.0249
315 Miscellaneous machinery and equipment manufacturers	1	5	3.09 (1.22-6.50)	0.0248

Appendix Table 18. Leukemia mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
413 Cooks				
All leukemia	1	11	2.63 (1.47-4.35)	0.0040
415 Waiters				
All leukemia	2	5	3.05 (1.20-6.41)	0.0259
552 Taxi drivers and chauffeurs				
All leukemia	1	5	2.80 (1.10-5.89)	0.0354
554 Driver salesmen				
Other leukemia	1	6	2.66 (1.16-5.25)	0.0275
All leukemia	1	12	1.80 (1.04-2.92)	0.0392
556 Truck drivers				
AL leukemia	1	5	3.47 (1.37-7.30)	0.0160
All leukemia	1	29	1.64 (1.17-2.24)	0.0083
754 Sawyers				
All leukemia	1	5	3.10 (1.22-6.52)	0.0243
808 Metalworking machine operators, n.e.s.				
AM leukemia	1	6	3.37 (1.47-6.65)	0.0099
All leukemia	1	12	1.85 (1.07-3.00)	0.0331
838 Linemen and service-men - telephone, telegraph and power				
All leukemia	1	7	2.43 (1.14-4.56)	0.0279
Industry:				
031 Logging				
Other leukemia	1	8	2.15 1.07-3.88)	0.0365
All leukemia	2	10	1.85 (1.00-3.14)	0.0490
183 Cotton yarn and cloth mills				
All leukemia	1	5	3.34 (1.32-7.02)	0.0185

Appendix Table 18. Leukemia mortality by occupation and industry cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
365 Petroleum refineries				
All leukemia	1	5	3.61 (1.42-7.59)	0.0185
676 Household furniture and appliance stores				
All leukemia	1	6	2.51 (1.09-4.95)	0.0352
875 Hotels, restaurants and taverns				
All leukemia	1	23	1.52 (1.04-2.15)	0.0360
	3	10	1.91 (1.04-3.24)	0.0410
951 Local administration				
All leukemia	1	24	1.52 (1.05-2.14)	0.0325

Appendix Table 19. Other cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
412 Housekeepers (except private household, matrons, stewards	1	5	2.60 (1.02-5.47)	0.0459
452 Launderers and dry cleaners	1	6	3.24 (1.41-6.40)	0.0118
554 Driver salesmen	1	17	1.59 (1.01-2.38)	0.0446
556 Truck drivers	4	9	1.96 (1.02-3.42)	0.0447
771 Compositors and typesetters	2	5	2.70 (1.06-5.68)	0.0400
Industry:				
071 Asbestos mines	1	5	3.44 (1.36-7.23)	0.0164
145 Breweries	1	5	2.88 (1.13-6.06)	0.0319
	2	5	3.40 1.34-7.15)	0.0171
	3	5	4.11 (1.62-8.64)	0.0082
286 Commercial printing	3	6	2.51 (1.09-4.95)	0.0348
321 Aircraft and parts manufacturers	3	8	2.09 (1.04-3.77)	0.0417
	4	7	2.49 (1.17-4.68)	0.0250
365 Petroleum refineries	1	6	2.46 (1.07-4.86)	0.0382
421 Special-trade contractors	4	11	1.86 (1.04-3.08)	0.0398
608 Wholesalers of petroleum products	1	6	2.40 (1.05-4.74)	0.0419
649 Other general merchandise stores	2	5	3.14 (1.24-6.60)	0.0232

Appendix Table 19. Other cancer mortality by occupation and industry cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
874 Laundries, cleaners and pressers	1	7	2.44 (1.15-4.58)	0.0274
	2	5	2.96 (1.17-6.22)	0.0288
	3	5	4.18 (1.65-8.79)	0.0077
	4	5	6.12 (2.41-12.87)	0.0015
899 Other miscellaneous services	1	21	1.54 (1.03-2.22)	0.0393
951 Local administration	5	5	3.59 (1.41-7.55)	0.0140

Appendix Table 20. All cancer mortality by occupation and industry

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Occupation:				
101 Civil engineers	1	19	1.94 (1.94-1.27)	0.0058
201 Bookkeepers and cashiers	2	51	1.28 (1.00-1.62)	0.0482
331 Insurance salesmen and agents	2	12	1.93 (1.11-3.13)	0.0257
	3	7	2.23 (1.05-4.19)	0.0412
405 Guards, watchmen, n.e.s.	1	561	1.14 (1.06-1.22)	0.0011
412 Housekeepers (except private household), matrons, stewards	3	10	1.94 (1.05-3.29)	0.0375
	4	5	3.20 (1.26-6.73)	0.0216
414 Bartenders	1	88	1.40 (1.16-1.67)	0.0015
415 Waiters	1	159	1.33 (1.16-1.52)	0.0003
	2	62	1.30 (1.04-1.61)	0.0260
	4	21	1.98 (1.33-2.85)	0.0031
535 Brakemen, railroad	2	24	1.45 (1.00-2.04)	0.0495
	3	22	1.71 (1.16-2.44)	0.0128
	4	16	1.79 (1.12-2.72)	0.0205
554 Driver salesmen	1	199	1.26 (1.12-1.42)	0.0010
556 Truck drivers	1	513	1.15 (1.07-1.24)	0.0009
	2	264	1.18 (1.06-1.31)	0.0052
	3	165	1.24 (1.09-1.41)	0.0037
588 Messengers	1	60	1.38 (1.10-1.71)	0.0094

Appendix Table 20. All cancer mortality by occupation and industry cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
659 Quarriers and related workers	2	16	1.82 (1.14-2.76)	0.0183
709 Beverage processors	1	26	1.53 (1.07-2.12)	0.0256
	2	13	1.72 (1.02-2.73)	0.0445
810 Plumbers and pipe-fitters	1	129	1.18 (1.01-1.37)	0.0328
	2	88	1.25 (1.04-1.49)	0.0223
	3	66	1.34 (1.08-1.64)	0.0128
811 Sheet metal workers	1	76	1.22 (1.00-1.48)	0.0473
	2	51	1.46 (1.14-1.84)	0.0064
	4	19	1.64 (1.07-2.41)	0.0274
819 Metalworking occupations, n.e.s.	1	119	1.21 (1.03-1.41)	0.0232
	2	49	1.43 (1.11-1.81)	0.0108
836 Projectionists, motion picture	3	8	2.21 (1.10-3.99)	0.0316
843 Painters except construction and maintenance	1	56	1.39 (1.10-1.74)	0.0104
857 Insulation appliers	1	15	1.90 (1.17-2.93)	0.0157
872 Stationary enginemen	4	33	1.43 (1.05-1.91)	0.0310
	5	12	1.86 (1.07-3.01)	0.0323
913 Bottlers, wrappers, labelers	1	121	1.25 (1.07-1.45)	0.0107
914 Paper products makers	3	14	1.83 (1.11-2.86)	0.0250
	4	10	2.55 (1.38-4.33)	0.0072

Appendix Table 20. All cancer mortality by occupation and industry cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
Industry:				
105 Dairy factories	3	66	1.26 (1.02-1.55)	0.0404
145 Breweries	1	39	1.42 (1.07-1.85)	0.0213
193 Wool yarn mills	2	5	2.81 (1.11-5.91)	0.0352
218 Textile dyeing and finishing plants	1	14	2.05 (1.24-3.20)	0.0107
291 Iron and steel mills	1	154	1.18 (1.03-1.35)	0.0226
304 Metal stamping, pressing and coating industry	1	113	1.28 (1.09-1.50)	0.0071
308 Machine shops	2	34	1.36 (1.00-1.81)	0.0492
335 Communications equipment manufacturers	2	44	1.31 (1.00-1.68)	0.0460
351 Clay products manufacturers	4	13	1.87 (1.11-2.97)	0.0261
355 Asbestos products manufacturers	4	6	2.76 (1.20-5.45)	0.0237
373 Manufacturers of plastics and synthetic resins	4	6	2.63 (1.15-5.19)	0.0291
505 Services incidental to water transport	4	24	1.55 (1.07-2.18)	0.0262
507 Truck transport	1	259	1.20 (1.08-1.33)	0.0027
512 Taxicab operations	3	23	1.92 (1.31-2.72)	0.0030
	4	13	2.32 (1.37-3.69)	0.0053
623 Wholesalers of machinery and equipment, n.e.s.	3	36	1.37 (1.02-1.81)	0.0419
803 Vocational schools	2	5	3.69 (1.45-7.76)	0.0125

Appendix Table 20. All cancer mortality by occupation and industry cont'd

Occupation/industry	Years	No. of deaths	SMR (90% C.I.)	P value
821 Hospitals	2	18	1.93 (1.25-2.86)	0.0075
	3	13	2.44 (1.44-3.88)	0.0035
	4	8	2.42 (1.20-4.37)	0.0198
841 Motion picture theatres and film exchanges	5	5	2.88 (1.13-6.06)	0.0318
866 Legal service	3	6	2.41 (1.05-4.76)	0.0416
875 Hotels, restaurants and taverns	1	475	1.13 (1.05-1.22)	0.0049
	2	281	1.13 (1.02-1.25)	0.0222
891 Labour organizations and trade associations	5	5	2.89 (1.14-6.08)	0.0316
899 Other miscellaneous services	1	292	1.22 (1.10-1.34)	0.0006
	2	162	1.17 (1.02-1.33)	0.0280

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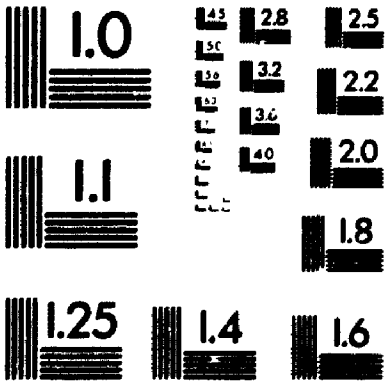

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