Identifying Possible Bladder Cancer Occupational Carcinogens via a Case-Control Study and JEM

by

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Abstract

A significant proportion of cancer development is attributable to exposures to certain chemicals in the workplace. However, examining these occupational exposures is often a difficult and challenging task. In this thesis we use the relatively new approach of applying an extensive JEM (Job Exposure Matrix) to estimate the occupational exposures of 1,062 bladder cancer cases and 8,057 matched other cancer controls. The subjects are all male, and were at least 20 years old and resident in British Columbia when diagnosed with cancer between 1983 and 1990. A self-administered questionnaire provided the occupational histories and confounding information on the study subjects. The cumulative exposure (expected work-years of considerable exposure) to each of 11,132 occupational agents was estimated. The bladder cancer cases were matched to cancer controls of other cancer sites (excluding lung) on age at diagnosis and year of diagnosis. The analysis was performed via conditional logistic regression and the following confounders were taken into account: ethnicity, who completed the questionnaire, smoking duration, and alcohol drinking status.

Of the 5,699 agents with at least 3 bladder cancer cases exposed, a significantly increased (5% level) odds-ratio was seen for ever exposure to 646 of them. Of the 3,450 agents with at least 9 bladder cancer cases exposed, 350 exhibited a significantly (5% level) increasing dose-response relationship. After adjusting for multiplicity, a subset of 30 agents was selected that demonstrated sufficient evidence of bladder carcinogeneity. Principal components analysis was performed on the cumulative exposures of these selected agents and 10 independent groups of agents were identified. The groups were mainly distinguished by job. The cumulative exposures to these 30 agents were mainly due to employment in logging, ship and boat building, and construction industries, and in occupations involving motor vehicles (e.g. gasoline service station attendant, mechanic, and truck driver). The selected 30 agents seem to mainly be of petroleum or mineral oil base.

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Chapter 1

Introduction

Occupational exposures to certain hazards have long been recognised as possible health concerns. During the 18th century concerns arose after physicians noted debilitating and fatal conditions occurring preferentially among workers in certain types of jobs. Percival Pott provided the first unambiguous evidence of chemical carcinogenesis from occupational exposure in 1775. He identified soot as the cause of scrotal cancer in London chimney sweeps based on clinical observations. Subsequently, associations between coal tar product exposures and cancer development have been seen in many studies.

Cancer development is not fully understood and a better appreciation of the factors involved is clearly important. The future risk to the general population of particular occupational exposures can be projected, and public health policies can be steered towards minimising this risk through for example, workplace regulations. Occupational exposures are particularly important as many workers are exposed similarly at the same time and over a significant portion of their lifetime. Large groups of workers with similar exposures makes studying the exposures simpler, and it is also relatively straightforward to minimise and regulate exposures to protect the workers. It is difficult to estimate the percentage of cancers attributable to occupational exposure. Estimates range from 1% to around 40% (Siemiatycki, 1991). The proportion of male bladder cancers in the United States attributed to occupational exposures is estimated as 10% by Doll and Peto (1981), and around 21% to 25% in white males by Silverman et al. (1989). Also, about half of all known carcinogens are primarily industrial chemicals (Tomatis, 1990).

The main approaches to identifying occupational carcinogens are introduced in section 2. Animal studies are scientifically valid, however, the results cannot always be applied to humans. Epidemiological studies are more commonly used to investigate the complex effects of occupational exposure to cancer development in humans. However these studies are difficult to implement when the disease is rare and has many complex and interrelated causes. The most widely used approach is that of a case-control study as introduced in section 2.1.3 and discussed further in section 2.2.

Exposure to a carcinogen may contribute to the initiation of tumour development, or it may hasten the onset of a tumour. Nevertheless, exposure to a carcinogen does not usually make cancer inevitable. Carcinogenesis and cancer biology are introduced in section 2.3. As cancer has a long induction period between exposure and manifestation, exposures need to be considered over most of a subjects lifetime. Various methods to estimate these lifetime occupational exposures are also described in section 2.3. Current research into bladder cancer carcinogens is discussed in section 3. Many animal studies have been undertaken, but conclusive evidence in humans is rare and further research is required.

The approach taken in this thesis to identify possible bladder cancer occupational carcinogens is via a case-control study of bladder cancer cases and cancer controls identified in a BC Cancer Agency (BCCA) study. The approach taken could be repeated for other cancer sites of interest; however, bladder is the cancer site of interest here. A Job Exposure Matrix (JEM) developed in the US was thought most appropriate to estimate the lifetime occupational exposures to a range of agents of the cases and controls. Conditional logistic regression was implemented to estimate the risk of exposure to the occupational agents. Principal component analysis was undertaken to find groups of agents that act synergistically to increase the risk of bladder cancer. The BCCA study used for the case-control data is described in section 4.2 and the JEM used is introduced in section 4.3. The exposure assessment calculations are described in section 5. The statistical approach taken is detailed further in section 6, and the overall results are given in section 7. Finally, a discussion of the whole procedure is presented in section 8.

Chapter 2

Methodology Review

The goal of this thesis is to identify possible occupational carcinogens for bladder cancer. There are many methods to try to accomplish this. The main study methods are discussed next in section 2.1. This thesis looks at this problem from the perspective of an epidemiological case-control study. Some important issues surrounding case-control studies are discussed in section 2.2. The ideas of carcinogenic exposure are discussed in section 2.3.

2.1 Study Methods

Many types of study can be conducted to try and identify possible occupational carcinogens. Ideally an experiment is performed to see if particular exposures give rise to cancer in humans where only the exposure varies between subjects. Firstly, this type of experiment would be unethical in humans. Secondly, it would be near impossible to keep all other factors constant among subjects. Thirdly, chronic diseases have complex etiology and a long study period would be required post exposure before the disease manifested itself. Similar experiments can be undertaken in animals, as described in section 2.1.1, but the results cannot always be extended to humans. These limitations confine most etiologic research to non-experimental epidemiologic varieties. Epidemiological studies are designed to reduce variation from extraneous factors other than those under study. The non-experimental epidemiological studies of cohort, case-control, and proportional mortality are described in sections 2.1.2, 2.1.3 and 2.1.4 respectively.

2.1.1 Animal Experiments

Controlled scientific experiments can be carried out on small animals such as rats and mice to investigate whether certain exposures lead to cancer development. Variation from other factors between animals can be kept minimal by the investigator. In this way hypotheses about particular potential carcinogens can be tested directly.

Humans are genetically very similar to rodents; however, the results from animal experiments cannot be applied to humans with complete confidence. The animal studies are designed to test for carcinogenicity of the substance in that particular animal, not to emulate the human experience. The doses administered, routes of exposure, lifestyle maintained, and induction periods in animal studies are unrealistic compared to the human experience (Siemiatycki, 1991).

The sensitivity of detecting human carcinogens from animal experiments is quite high, however at the expense of the specificity. Most identified human carcinogens show carcinogenic activity in animal experiments, and there is often correlation between the target organs affected and carcinogenic potency (Siemiatycki, 1991). However, for most carcinogens found in animal experiments, equivalent associations have not been seen in human studies. Ashby and Tennant (1988) found a relatively low correlation between those carcinogens found from experiments on rats and those on mice, suggesting weak ability to extrapolate from rodents to humans.

Many studies into potential carcinogens are performed via animal experiments, as the experiments are relatively quick and inexpensive to perform, and can be easily controlled. Experimental animal data on carcinogenicity exists for many substances, while human study data exists for relatively few. From the point of view of deciding public health policies, the animal data cannot be ignored. The International Agency for Research on Cancer (IARC) is the worlds leading authority on assessing evidence for carcinogenicity of substances in humans. The IARC recommends that when there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals, the agent (mixture) be classified as probably carcinogenic to humans (IARC, 1987).

2.1.2 Cohort Studies

In a cohort study design subjects free of disease are selected into groups, or cohorts, according to their exposure to a suspected cause of the disease. The cohorts and then followed over time and the rate of disease compared within each group. Cohort studies, among all of the epidemiologic study designs, are the most accepted by the scientific community, as they mimic the scientific trial by observing disease in different exposure groups (Checkoway, 1989). The cohorts are selected independently to disease outcome, and the sequence of events follows naturally from suspected cause to effect.

The simplest type of cohort study occurs when a group exposed to the suspect hazard, and a group not exposed to the hazard are studied for the same period of time. The amount of diseased subjects is observed in each group. Table 2.1 displays the results for this simple cohort design. Suppose A_1 subjects develop the disease in the exposed group and A_0 subjects develop the disease in the non-exposed group. Also, B_1 subjects are not diseased at the end of the study in the exposed group and B_0 subjects are not diseased in the non-exposed group. So the original exposed cohort consists of subjects $A_1 + B_1$, and the not exposed cohort consists of subjects $A_0 + B_0$.

The overall measure of risk in the cohort study is calculated as the relative risk (RR). The relative risk is simply the ratio of the probability of disease in the exposed to the probability of disease in the non-exposed. Using the notation in table 2.1, the relative risk is calculated as:

$$RR = \frac{A_1(A_0 + B_0)}{A_0(A_1 + B_1)}$$

The relative risk will equal 1 when there is no difference in the risk of developing the disease between the exposed and the non-exposed. The relative risk will be greater than one when the risk of developing the disease is greater for those exposed. When the non-exposed are at greater risk, the relative risk will lie between 0 and 1. The relative risk cannot be negative as it is a ratio of probabilities. Other factors affecting the outcome and exposure, called confounders, can be incorporated in the analysis and the resulting relative risk adjusted for these. Also the analysis and thus relative risk can account for the usual situation where subjects are followed for differing periods of time by comparing rates per person-years of follow-up rather than rates per person. Rates can also be compared to those in the general population, to see if there is any increased risk in the particular cohort (Checkoway, 1989). However, the members of occupational cohorts may differ from the general population in more respects than just the exposure.

Cohort studies can either have a prospective or retrospective design. The intuitive design is prospective where the cohorts are selected and then follow-up proceeds into the future. In this way, the exposure estimates and estimates of other potential confounders can be accurately measured directly. Diseases are often rare in a population, meaning it would take time to see enough diseased cases develop in a cohort. This is even truer for chronic diseases, such as cancers. Either a lengthy study period or a large cohort is required due to their long induction and latent periods. The prospective cohort study then becomes a costly and timely exercise (Checkoway, 1989).

A common approach to minimise the cost and time commitments in a prospective cohort study is to perform a retrospective (historical) cohort study. Here a cohort is enumerated as starting some time in the past, and follow-up is observed until the present time. The difficulty now comes in estimating exposures and confounding factors for cohort members retrospectively in time (Checkoway, 1989). This information may not be available or complete, and will certainly be less accurate than in the prospective cohort study.

Issues surrounding estimating exposure retrospectively are discussed in section 2.3.

2.1.3 Case-Control Studies

A case-control study is not as intuitively appealing as a cohort study, but is more efficient. A cohort study requires obtaining exposure data on a large number of subjects of which only a small proportion typically develop the disease (Checkoway, 1989). A case-control study gains efficiency by sampling only a small proportion of those that do not develop the disease. For a case-control study, one identifies a representative group of subjects with the disease, the cases, and a comparable group of subjects, but that are not diagnosed with the disease, the controls. The exposure histories and confounding factors are then sought as in a retrospective cohort study, but this time for the case and control groups. If the cases were significantly more exposed to a particular hazard than the controls, given that all other confounding factors are taken into account, one could infer that the hazard was associated with the occurrence of the disease.

Table 2.2 depicts the results of the simplest type of case-control study. Of the cases, a_1 denotes the number exposed to a particular substance, and b_1 denotes the amount of controls exposed to the particular substance. So the total cases sampled is $a_1 + a_0$, and the total controls sampled is $b_1 + b_0$.

As the proportion of diseased to non-diseased subjects is a feature of the case-control design rather than representing the true proportion, the formula used to calculate the relative risk in the cohort study does not produce the true relative risk here. The denominators used in the relative risk formula are unknown; therefore a quantity called the odds-ratio (OR) is calculated instead. The odds-ratio is approximately equal to the relative risk when the disease is rare in the general population. This is true for cancer (Siemiatycki, 1991), so the odds-ratio is considered equal to the relative risk in this thesis. Again, we are interested in a departure from one in the odds-ratio. The odds-ratio is calculated as the ratio of the odds that a case was exposed to the odds that a control was exposed. Using the notation in table 2.2, it is calculated as follows:

$$OR = \frac{a_1/a_0}{b_1/b_0} = \frac{a_1 b_0}{a_0 b_1}$$

The case and control groups can be considered as being drawn from the same hypothetical population as the cohort study groups were drawn (Rothman & Greenland, 1998). However, most of the diseased are sampled as cases for the case-control study, whilst only a small subset of the non-diseased are sampled as controls. When this truly happens and a case-control study is selected from cohort at end-point, it is referred to as a nested case-control study. The nested case-control study then benefits from being able to estimate exposures and confounders more accurately (Siemiatycki, 1991).

Case-control studies can provide as valid results as cohort studies, although controls have to be carefully selected, and attention directed to avoid possible biases (Checkoway, 1989). The control group should form a representative sample from the population in which the cases were drawn. The control group must also be sampled independently of exposure status (Rothman & Greenland, 1998). A population-based disease registry provides a good source of possible cases when the registry contains accurate and up to date basic information about all possible patients with the disease in the population (Checkoway, 1989). More details about case and control selection are described in section 2.2.1.

Case-control studies are susceptible to more biases than cohort studies (Rothman & Greenland, 1998). Selection bias may occur when controls are selected differentially to cases. For example, the controls may suffer from non-response bias. Recall bias may occur due to cases being more willing to provide better quality data than controls (Siemiatycki, 1991). Further discussion of possible biases in case-control studies can be found in section 2.2.2.

2.1.4 Proportionate Mortality Studies

Proportionate mortality studies compare the proportional distributions of causes of death in a subgroup to those in a reference population. Death certificates often contain information on cause of death and main occupation, or a workplace may keep records of the death certificates of its former employees. This method has the advantages of being a relatively quick and inexpensive approach to gauging information about disease excess in certain subgroup populations. It can also be useful when the full information required for a cohort or case-control study is incomplete (Checkoway, 1989).

However, there are many limitations to this type of crude analysis (Siemiatycki, 1991). Information on cause of death may not be complete or accurate. The deaths recorded for a particular subgroup may not be representative of all deaths in that subgroup. Only limited information is available on exposure history and possible confounder variables. The proportional mortality ratio (PMR) of the ratio of deaths in the subgroup due to the disease of interest used as the measure of the effect is influenced by the proportions of deaths due to other diseases in the subgroup. Thus, if lung cancer was particularly prominent in a worker population, then mortality due to bladder cancer may look proportionately low when in fact there was a greater than expected number of absolute deaths due to bladder cancer. Finally, when interested in disease incidence, the proportionate mortality studies investigating associations with mortality will not always be indicative of incidence associations.

2.1.5 Summary of Study Designs

Epidemiological research applies directly to human beings. Animal experiments may be valid at testing hypotheses about animal carcinogens, but these results may not transfer to humans. Observing apparent clusters of excess disease in subgroups has motivated epidemiological research. Occupational Epidemiology study designs are similar in that they attempt to study a group's occupational and disease experience over time and sample from it (Checkoway, 1989). Proportionate mortality studies are quick and simple, but the conclusions regarding cancer incidence associations with occupational hazards may be imprecise and misleading. A more formal approach of a case-control or cohort study is required.

Cohort and case-control studies mainly differ in whom they compare; cohort studies compare the exposed to the non-exposed, whilst case-control studies compare the diseased to the non-diseased. The cohort groups are followed from carcinogenic exposure to manifestation of the disease, whilst retrospective information about possible exposure is sought for case and control groups. Cohort studies are thus more appealing for hypothesis testing, and case-control studies for hypothesis generating (Siemiatycki, 1991). Cohort studies are advantageous when investigating specific associations as a workforce cohort is generally exposed to a narrow range of occupational agents. Case-control studies can evaluate a range of different exposures in a range of different occupations and industries (Breslow & Day, 1980).

Cohort studies can also be prohibitively expensive and time consuming for studying a rare chronic disease, such as bladder cancer. However, case-control studies are susceptible to biases such as selection and recall bias, and care must be taken when planning a study. Occupational exposure assessment is also more difficult, and possible approaches are described in section 2.3.

A case-control study is an appropriate design for investigating associations between occupational exposures and cancer, as required in this predominantly hypothesis generating thesis. More details about performing a case-control study are discussed in the next section.

2.2 Further Issues with Case-Control Studies

As the choice of cases and controls for a case-control study is important this is discussed further in section 2.2.1. As it is also important to be aware of possible sources of bias, these are described in section 2.2.2. Confounders are a special form of bias discussed in section 2.2.3. Possible methods of controlling confounders are introduced as section 2.2.4 discusses matching and section 2.2.5 discusses the analysis method of conditional logistic regression.

2.2.1 Choice of Cases and Controls

Firstly, a clear source population for the cases needs defining. The source population need not be the whole population, and can be restricted to improve information quality, control for possible confounders, and facilitate valid selection of controls (Checkoway, 1989). The group of cases should be a homogeneous etiological entity (Breslow & Day, 1980). To be sure all cases have the particular disease, the diagnosis should also be histologically confirmed (dos Santos Silva, 1999). In a registry-based study, the case group usually consists of all incident cases appearing in the registry during a specified period of time (Checkoway, 1989).

The controls should then be selected from the source population; the same population that gave rise to the cases. The controls should be selected independently from exposure status. This is to prevent the controls being unrepresentative of the source population with respect to exposure. A control should be at risk of becoming a case. So, the specified period of time when a subject is eligible to become a case should be the time during which a subject is eligible to become a control (Rothman & Greenland, 1998).

There are various sources of possible controls: population, neighbour, hospital, or other disease controls. Controls can be sampled from the associated subset of the general population. This is the ideal situation; enabling the study results to be generalised to the subset of the general population. However, the response rate may be low, making the results liable to selection bias. Also, those that respond may not provide as accurate information as they might, introducing possible recall bias.

An extension of this method is to sample controls from the neighbourhood where the cases live or friends of the cases. These people will be more similar to the cases, may be easier to contact and more willing to participate. However, they may be too similar to the cases, in that their exposure status is related to that of the cases (Rothman & Greenland, 1998).

When identifying hospital-based cases, hospital controls have several advantages. They are generally easy to contact and are less likely to be lost to follow-up. They are in a similar position to the cases, have more time and may be more willing to help, thus reducing recall bias. However, care must be taken to avoid selection bias. Many hospitalised patients' exposures will not be representative of the source population's exposures. This bias can be minimised by restricting controls to those with a diagnosis not thought related to the exposure. Also, choosing controls with different diagnoses will tend to balance out the effect of any introduced by a specific disease (Rothman & Greenland, 1998).

The considerations when choosing controls with other diseases are similar to those for hospitalised-controls. This type of control is often chosen in registry-based studies, and in particular with cancers.

2.2.2 Bias

The purpose of the analysis of a case-control study is to quantify the associated risk each factor under study has with the disease (Breslow & Day, 1980). The observed associations may however be affected by bias, confounding and random variation. These problems hinder internal validity and the first aim is to minimise these effects so the true associations can be estimated. There are two main types of bias: selection bias and information bias, which are discussed next. Confounding is an issue much related to bias and is discussed in the next section. Random variation is an artefact of any study and its effects can be minimised by increasing the study size.

Selection bias can be introduced when the cases or controls do not form a representative sample from the source population (Rothman & Greenland, 1998). A common source of this systematic error is non-response bias. When a considerable proportion of the control group chooses not to participate in the study, this proportion may be different in characteristics to those who do choose to participate (Gordis, 2000). The Healthy Worker Effect is also a common selection bias, particularly to occupational cohort studies (Checkoway, 1989). If there is a difference in the proportion of workers between study groups, then the groups may additionally differ due to the Healthy Worker Effect. Workers are known to be generally healthier than the rest of the population, especially those who remain in employment.

To minimise selection bias, the case and control groups should be chosen appropriately (Checkoway, 1989). Attempts should be made to increase response rates, e.g. by providing incentives for compliance, not making compliance too time consuming, etc. If there is non-response in a study, it should be investigated to see if there are significant differences between the characteristics of responders and non-responders.

Information bias consists of misclassification of subjects in two ways: differential or non-differential misclassification. Non-differential information bias occurs when the cases and controls are equally likely to be misclassified according to their exposure or disease status. This will tend to bias the effect estimate towards the null (Checkoway, 1989).

Differential information bias is of greater concern. Here, the likelihood of misclassification differs between the cases and controls. The bias of the effect estimate can then occur in either direction from the truth (Checkoway, 1989). Recall bias is an example of differential information bias common in case-control studies. Case subjects will generally be willing to answer study questions to the best of their knowledge and take time thinking through their exposure histories. Control subjects are generally less likely to do so, particularly if they are population controls, as they have less interest in providing the most accurate information to the study to improve the research in that area. In this way the controls will be subject to more misclassification bias than the cases.

Information bias is minimised by ensuring as accurate data recall amongst cases and controls as possible (Rothman & Greenland, 1998). It is also important to investigate the magnitude of the effect of this bias in the study, such as by questionnaire validation.

2.2.3 Confounding

A confounder is a factor associated with exposure and with the disease, but it is not a step in the causal pathway from exposure to disease (Checkoway, 1989). Common confounders are age, gender, ethnicity and smoking habits. Distortion caused by confounding factors can lead to an overestimation or underestimation of the true effect of the exposure under study (Rothman & Greenland, 1998). Failure to control for confounders can lead to a biased estimate. Mistakenly controlling non-confounders can reduce the precision of an estimate. Misclassification of confounders can also reduce the ability to control for confounding (Checkoway, 1989).

Confounders can be controlled in the study design, in the analysis, or both (Checkoway, 1989). The source population, from which the cases and controls were sampled, can be restricted, thus reducing any possible confounding. However, this will reduce the sample size of cases and controls.

Confounders can be controlled via matching the cases and controls on the main confounders. This will help to optimise the efficiency of the analysis and improve the precision of the effect estimates. Further details about matching are discussed in section 2.2.4.

The analysis can also simultaneously control for potential confounders by including the potential confounder variables in the logistic regression model.

Confounders are identified by previous studies, biological knowledge of the disease, and known features of the study design. In order to assess potential confounders accurately, reliable information is required on them from the cases and control subjects.

2.2.4 Matching

Matching is a method used to attempt to control for the most important confounders. Individual matching involves pairing one or more controls to each case with respect to levels of the matching factors. Frequency matching involves selecting a set of controls to each group of cases within a stratum of matching factor values (Rothman & Greenland, 1998).

Matching attempts to make the distribution of the matching factors for the control group more similar to that of the case group. In this way, the method improves statistical efficiency and increases the precision of the effect estimates (Checkoway, 1989).

However matching is costly; information is lost, in that subjects are excluded from the analysis that did not match. Also, the effect estimate of the matched factors can no longer be estimated as their relationship with disease has been distorted. After matching, the factors matched upon may still be confounders or may introduce selection bias that also needs controlling for in the analysis (Rothman and Greenland, 1998).

Care should be taken not to overmatch so the cases are too similar to the controls apart from on the exposure under study. Matching on a variable associated with exposure but not disease harms statistical efficiency. Matching on an intermediate between exposure and disease may harm the study validity and result in an effect estimate biased towards the null. A third type of overmatching using convenient controls may harm cost efficiency or introduce bias (Rothman and Greenland, 1998).

2.2.5 Analysis of Matched Case-Control Studies

Logistic regression is the usual technique used to analyse case-control studies and allow for confounders. However, when the data is matched, then prior information is known about the distribution of patients across strata, and conditional logistic regression must be used to account for this. Breslow and Day (1980) show that when using logistic regression for a simple matched study design where each case is matched to one control and there is one covariate, the effect estimate is biased by 100%.

For a subject's covariate vector $\mathbf{x}$, the logistic regression model for the probability distribution of the binary dependent variable Y, is:

$$P(y = 1|x) = \frac{e^{\alpha+\beta' x}}{1 + e^{\alpha+\beta' x}}$$

where α is the intercept parameter and the β's are the covariate parameters. So if Y is the indicator variable representing a case with value 1 and a control with value 0, then the above model estimates the probability that a subject with covariate vector $\mathbf{x}$ is a case. The parameter coefficients are estimated via maximum likelihood estimation.

Now a stratum-specific logistic regression model can be specified for a matched case-control study with K strata. Let n_{1k} denote the number of cases and n_{0k} denote the number of controls in stratum k, $k = 1, 2, \ldots, K$. Thus the conditional logistic regression model is:

$$P(y = 1|x) = \frac{e^{\alpha_k+\beta' x}}{1 + e^{\alpha_k+\beta' x}} \tag{2.1}$$

where α_k denotes the stratification variable for the kth stratum.

The conditional likelihood for the kth stratum reflects the probability of the observed data relative to the probability of all possible configurations of the data amongst the cases and controls within that stratum. The number of possible combinations of the cases among all $n_k = n_{1k} + n_{0k}$ subjects, is denoted by c_k and given by the expression:

$$c_k = \frac{n_k!}{n_{1k}!(n_k + n_{1k})!}$$

The subscript j denotes any one of the c_k assignments and i indexes the observed data and i_j indexes the observed data for the jth assignment. Subjects 1 to n_{1k} correspond to the cases and $n_{1k}+1$ to n_k correspond to the controls. So, the conditional likelihood for stratum k can be written as:

$$l_k(\beta) = \frac{\prod_{i=1}^{n_{1k}} P(x_i|y_i = 1) \prod_{i=n_{1k}+1}^{n_k} P(x_i|y_i = 0)}{\sum_{j=1}^{c_k}\{\prod_{i_j=1}^{n_{1k}} P(x_{ji_j}|y_{i_j} = 1) \prod_{i_j=n_{1k}+1}^{n_k} P(x_{ji_j}|y_{i_j} = 0)\}}$$

This conditional likelihood can be simplified by applying Bayes theorem and substituting in the conditional logistic model (2.1):

$$l_k(\beta) = \frac{\prod_{i=1}^{n_{1k}} \frac{P(y_i=1|x_i)P(x_i)}{P(y_i=1)} \prod_{i=n_{1k}+1}^{n_k} \frac{P(y_i=0|x_i)P(x_i)}{P(y_i=0)}}{\sum_{j=1}^{c_k}\{\prod_{i_j=1}^{n_{1k}} \frac{P(y_{i_j}=1|x_{ji_j})P(x_{ji_j})}{P(y_{i_j}=1)} \prod_{i_j=n_{1k}+1}^{n_k} \frac{P(y_{i_j}=0|x_{ji_j})P(x_{ji_j})}{P(y_{i_j}=0)}\}}$$

$$l_k(\beta) = \frac{\prod_{i=1}^{n_{1k}} P(y_i = 1|x_i)P(x_i) \prod_{i=n_{1k}+1}^{n_k} P(y_i = 0|x_i)P(x_i)}{\sum_{j=1}^{c_k}\{\prod_{i_j=1}^{n_{1k}} P(y_{i_j} = 1|x_{ji_j})P(x_{ji_j}) \prod_{i_j=n_{1k}+1}^{n_k} P(y_{i_j} = 0|x_{ji_j})P(x_{ji_j})\}}$$

$$l_k(\beta) = \frac{\prod_{i=1}^{n_k} P(x_i) \prod_{i=1}^{n_{1k}} P(y_i = 1|x_i) \prod_{i=n_{1k}+1}^{n_k} P(y_i = 0|x_i)}{\sum_{j=1}^{c_k}\{\prod_{i_j=1}^{n_k} P(x_{ji_j}) \prod_{i_j=1}^{n_{1k}} P(y_{i_j} = 1|x_{ji_j}) \prod_{i_j=n_{1k}+1}^{n_k} P(y_{i_j} = 0|x_{ji_j})\}}$$

$$l_k(\beta) = \frac{\prod_{i=1}^{n_k} P(x_i) \prod_{i=1}^{n_{1k}} \frac{e^{\alpha_k+\beta' x_i}}{1+e^{\alpha_k+\beta' x_i}} \prod_{i=n_{1k}+1}^{n_k} \frac{1}{1+e^{\alpha_k+\beta' x_i}}}{\sum_{j=1}^{c_k}\{\prod_{i_j=1}^{n_k} P(x_{ji_j}) \prod_{i_j=1}^{n_{1k}} \frac{e^{\alpha_k+\beta' x_{ji_j}}}{1+e^{\alpha_k+\beta' x_{ji_j}}} \prod_{i_j=n_{1k}+1}^{n_k} \frac{1}{1+e^{\alpha_k+\beta' x_{ji_j}}}\}}$$

$$l_k(\beta) = \frac{\prod_{i=1}^{n_k} P(x_i) \prod_{i=1}^{n_{1k}} e^{\alpha_k+\beta' x_i} \prod_{i=n_{1k}+1}^{n_k} \frac{1}{1+e^{\alpha_k+\beta' x_i}}}{\sum_{j=1}^{c_k}\{\prod_{i_j=1}^{n_k} P(x_{ji_j}) \prod_{i_j=1}^{n_{1k}} e^{\alpha_k+\beta' x_{ji_j}} \prod_{i_j=n_{1k}+1}^{n_k} \frac{1}{1+e^{\alpha_k+\beta' x_{ji_j}}}\}}$$

$$l_k(\beta) = \frac{\prod_{i=1}^{n_{1k}} e^{\alpha_k+\beta' x_i}}{\sum_{j=1}^{c_k} \prod_{i_j=1}^{n_{1k}} e^{\alpha_k+\beta' x_{ji_j}}}$$

$$l_k(\beta) = \frac{\prod_{i=1}^{n_{1k}} e^{\beta' x_i}}{\sum_{j=1}^{c_k} \prod_{i_j=1}^{n_{1k}} e^{\beta' x_{ji_j}}} \tag{2.2}$$

The likelihood function is then the product of the $l_k(\beta)$ in (2.2) over all K strata:

$$l(\beta) = \prod_{k=1}^{K} l_k(\beta) = \prod_{k=1}^{K} \frac{\prod_{i=1}^{n_{1k}} e^{\beta' x_i}}{\sum_{j=1}^{c_k} \prod_{i_j=1}^{n_{1k}} e^{\beta' x_{ji_j}}} \tag{2.3}$$

The conditional likelihood estimators for the β parameters are those values that maximise the likelihood in equation (2.3). Statistical software packages, such as SAS, are able to estimate these parameters for matched conditional logistic regression models.

2.3 Assessing Exposure

To perform a case-control study, exposure measurements to the suspected cause of disease are required for each subject. Firstly, the biological meaning of exposure is described and how it may affect cancer development in section 2.3.1. There are many different variables that attempt to model this biological exposure as explained in section 2.3.2. Clear and unambiguous evidence for exposure to potential carcinogens is rare. There are then many approaches to collect the surrogate exposure information which are described in the following sections: workplace records, assessing the current workplace, self-administered questionnaires, personal interviews and expert estimation, or via a JEM.

2.3.1 Cancer Biology

Cancer is essentially the term for a group of diseases characterised by a malignant growth of cells. The first stage of cancer is initiation. This is when a critical gene is irreversibly mutated. Gene mutations may be caused by ageing, exposure to chemicals, radiation, hormones or other factors within the body and the environment. A promoter is then required to encourage the cells to reproduce and grow. The promoter acts after the initiator and acts regularly over a certain period of time. After this a tumour may be visible and invasion and metastases to new body sites can occur. The time between cancer occurrence and detection is called the latent period (Rothman & Greenland, 1998).

It is uncertain what causes cancer initiation and promotion, and when in a given subject (Siemiatycki, 1991). Also, different factors can make a subject more susceptible to the effects of carcinogens, e.g. age, gender, genes, health status, and diet. The initiator may be a carcinogen over the biologically effective dose, or a genetic pre-disposition. Therefore people exposed to an initiating carcinogen at a higher dose over a longer time than others will be more likely to develop cancer. Also those exposed to a promoting carcinogen regularly at a higher dose over a longer time than others will be more likely to develop cancer. Duration of exposure is an important factor when analysing the effects of a carcinogen.

For a subject with cancer, it is difficult to know what contributed to the initiation and promotion of cancer and when. As cancer is a chronic disease, there is also a large time period during which these exposures could potentially have happened. Thus, much of the subject's lifetime exposure needs to be estimated (Siemiatycki, 1991). An exception is the latency period, but this period varies between subjects. An approach called exposure lagging can be used to allow for the latency period (Rothman & Greenland, 1998). As exposures close to cancer diagnosis are unlikely to have contributed to cancer development, only exposures preceding a certain cut-off time before cancer diagnosis are estimated. As the latency period is unknown, analysis can be performed for a range of cut-off values.

2.3.2 Measuring Exposure

Ideally the exposure to each possible carcinogen, in terms of frequency and dose, over each subject's lifetime can be measured. The dose is the actual amount of substance that reaches the biological target (Checkoway, 1989). Given the same exposure to a carcinogen, the dose may vary between people as it depends upon many factors such as inhalation rate, health status, genetics, age, gender, etc. If the dose and exposure are related, then the exposure can be measured as a surrogate.

Exposure measurement of carcinogens is comprised of concentration, duration and frequency (Checkoway, 1989). The concentration of a carcinogen is important, as lower concentrations are less likely to contribute to cancer development. The frequency of exposure to promoting carcinogens is also important, as occasional exposure is less likely to encourage cancer growth. Exposure to a promoting carcinogen over a longer period of time is also more likely to result in cancer growth. Note that these measurements may vary over time. Subjects may be exposed to carcinogens at a differing concentration and frequency as their specific job tasks change. Also, legislation or technical improvements may change the concentration or frequency of exposures over time. A time measure of exposure can be constructed, such as cumulative exposure, which aggregates the concentrations over time. It is also useful to collect data on the nature of the exposures, e.g. the route of contact, and any behaviour that protects against the exposure.

Accurate measurements of exposure, especially past exposures, are difficult to attain. Occupational exposures account for a considerable proportion of lifetime exposures and the exposures can be adequately measured. The main methods of estimating occupational exposures are by workplace records, assessing the current workplace, self-administered questionnaires, interviewing the subject, and job exposure matrices (JEMs).

2.3.3 Workplace Records

Ideally consistent exposure information to all possible carcinogens is available for each study subject at all their past workplaces. Many workplaces maintain exposure records, but collection methods vary between workplaces (Checkoway, 1989). If recent workplace exposures can be estimated, it will still be difficult to find data on early exposures.

2.3.4 Assessing Current Workplace

Given all employers gave consent, current exposures can be consistently measured at all subjects' workplaces. This would be a timely and costly undertaking. Also, earlier workplaces in a subject's job history may no longer exist, and if they do, practices and thus exposures may have altered considerably since the subject was employed there (Siemiatycki, 1991).

2.3.5 Self-Administered Questionnaires

Study subjects can be asked to complete questionnaires about their exposure history. Subjects will have difficulty remembering exposures many years ago, and may not have understood their exposures well enough to describe them accurately. Questionnaire responses from cases and controls are also liable to recall bias (Siemiatycki, 1991). Cases may be more willing to accurately recall past exposures than controls, as they are more interested in furthering knowledge into their particular cancer. Also, sometimes information can only be obtained from proxy respondents (e.g. spouses, family members), who will have even less recall ability.

2.3.6 Personal Interviews

The subjects themselves may have little knowledge of their lifetime occupational exposures, so some other approach is required. One method is to interview subjects and ask them to recall any known exposures or describe their occupations and workplaces in detail (Siemiatycki, 1991). Interviewing subjects may improve their recall ability. The interviewer can also ask additional questions to find more accurate details about important exposures. However, interview bias may be introduced, as interviewers may have pre-conceptions that influence the subject's responses. Many interviewers are usually required, which introduces extra variability between the interviewers' results.

The exposure data can be improved upon by using the knowledge of technical experts (e.g. chemists, engineers, hygienists) and also workplace records. The technical experts may be able to estimate exposures backward in time given current estimates, although the exposure estimates will be lacking in precision.

2.3.7 Job Exposure Matrix (JEM)

Another approach used to assess exposures is to ascertain the occupational histories of the subjects, either via a self-administered questionnaire or interview, and then use a Job Exposure Matrix (JEM) to code the data. A JEM is typically a matrix containing all possible occupations as one dimension, and all possible occupational agents as the other dimension. One can then look up a particular agent for each subject's job and find, depending on the JEM, either an indication, yes or no, whether the subject should have been exposed to the particular agent in that job, or more precisely, an estimate of the probability that they were exposed. Often the exposure is only measured above some pre-defined concentration or frequency.

A problem with JEMs is that they are very costly and timely to complete accurately. Often a study will use a pre-developed JEM, which may not be relevant to the particular group of subjects in the study (Siemiatycki, 1991). A downfall to the JEM is that it can only distinguish between exposures up to the level of the job code (Siemiatycki, 1991). Individuals with the same job are assumed to have the same exposure and no further allowance is made for within job variability. Exposures in a certain job vary between workers depending on the particular work habits of the worker, the workers specific tasks, and the company the worker is employed with. However, exposures will be much more similar within the same industry and occupation, than between different industries and occupations. Occupational exposures vary across time as employment practices and safety regulations change and technology improves. A time dimension can be added, but JEMs commonly only represent one economy type at one particular moment in time.

Chapter 3

Risk Factors for Bladder Cancer

Bladder cancer affects the inner lining of the bladder and develops slowly. As it grows, it may spread to other organs near the bladder. Carcinogenic chemicals are absorbed by the blood and filtered into the urine, which accumulates in the bladder. There were 4,841 new cases (3,636 male, 1,205 female) of bladder cancer diagnosed during 2000 in Canada. There were 1,082 male deaths and 437 female deaths due to bladder cancer. It was the fourth most common cancer in men in terms of incidence (5% of cancers), and the ninth most common in terms of mortality (3% of cancer mortality). It was the thirteenth most common cancer in terms of incidence (2% of cancers) and mortality (1% of cancer mortality) for women (National Cancer Institute of Canada, 2004). Internationally, the highest incidences of bladder cancer occur in Western Europe and North America (Schottenfeld and Fraumeni, 1996).

Non-occupational bladder cancer risk factors are introduced in section 3.1. Section 3.2 describes the occupations with consistent elevated risks of bladder cancer and section 3.3 describes the specific occupational chemicals associated with bladder cancer.

3.1 Non-Occupational Bladder Cancer Risk Factors

The risk of developing bladder is increased in males, those of Caucasian ethnicity and risk increases with age. About three times as many males develop bladder cancer as females in Canada. The disease is more prevalent in Caucasians than other ethnic groups, with the incidence rate for male Caucasians being at least double the incidence rate for any other male ethnic group. Risk increases with age, with about two-thirds of bladder cancer cases occurring among persons aged 65 years and older (Schottenfeld and Fraumeni, 1996).

Lifestyle factors that have associations with increased risk of bladder cancer include smoking, diets high in saturated fat, coffee drinking, artificial sweeteners, drinking water quality and use of hair dyes.

Cigarette and tobacco smoking increase the risk of bladder cancer. Smokers have around two to three times the risk of non-smokers. Risk also increases for increased intensity and duration of smoking (Schottenfeld and Fraumeni, 1996). Cessation of cigarette smoking has been associated with a 30% to 60% reduction in bladder cancer risk in many studies (IARC, 1986).

Increased bladder cancer risks have been associated with diets high in saturated fat. A possible association has been suggested between coffee drinking and bladder cancer risk in case-control studies, but the findings are inconsistent across studies. Artificial sweeteners were suggested as potential human bladder carcinogens based on animal experiments, but epidemiological studies on humans have not substantiated the relation. Most studies that have evaluated alcohol consumption as a risk factor for bladder cancer have not supported a positive association. Epidemiological studies seem to support the association between chlorination by-product levels in drinking water sources and bladder cancer risk (Schottenfeld and Fraumeni, 1996). Use of hair dyes may be associated with bladder cancer risk as animal experiments indicate that some compounds in hair dyes are mutagens and people who dye their hair appear to excrete compounds in their urine. Results from several epidemiological studies, however, have not supported this association (Hartge et al, 1982).

Family or personal history of bladder cancer increases the risk of developing bladder cancer. Repeated or chronic bladder infections, or bladder stones, slightly increase the risk of developing bladder cancer. Changes occur in the bladder as a result of repeated or persistent infection. The excessive use of drugs containing phenacetin and the use of Cyclophosphamide and Chlornaphazine have also been linked to risk of bladder cancer in many case-control studies (Schottenfeld and Fraumeni, 1996).

3.2 Occupations Associated with Bladder Cancer

The associations between certain occupations and bladder cancer risk are unclear. Studying large populations and recording personal occupational exposures accurately is difficult. Some epidemiological studies have consistently found associations with bladder cancer in certain occupations. However, these are often based on small samples and observed relative risks have typically been less than two. Table 3.1 shows the main occupations associated with increased risk of bladder cancer. This table was adapted from Schottenfeld and Fraumeni (1996) to include the IARC monograph occupations classified as having an association with bladder cancer and also lists some of the agents suspected of increasing the risk of bladder cancer within each occupation.

The IARC monographs are a series of independent assessments of animal and human studies into the carcinogenic risks posed to humans by a variety of agents, mixtures and exposure circumstances. For many agents there only exists evidence of carcinogenicity from animal studies, for some there are inconsistent epidemiological studies and for many there is no evidence. Since its inception in 1969 to 2004, the IARC monographs have reviewed more than 885 agents. The IARC classifies each agent according to its potential for human carcinogenicity into one of four categories: 1 - definitely carcinogenic, 2A - probably carcinogenic, 2B - possibly carcinogenic, 3 - not classifiable, or 4 - probably not carcinogenic. Chemicals classified as IARC group 3 are not necessarily non-carcinogenic, for this classification is where the available studies are of insufficient quality, consistency or statistical power to permit a conclusion. Further studies are required to aid the agent's IARC classification.

Bladder cancer has well-established relationships with certain occupational exposures in human studies. These include aromatic amine manufacturing as 2-naphthylamine, benzidine, and 4-aminobiphenyl are considered definitely carcinogenic to humans by IARC, the manufacture of certain dyes as auramine and magenta are considered definitely carcinogenic to humans, rubber industries due to aromatic amines particularly 2-naphthylamine, painters as paints contain aromatic amines as well as other carcinogenic agents, and aluminium and coke production and coal gasification due to coal tar pitches considered definitely carcinogenic to humans by IARC (IARC, 1987).

There are also some occupations with a consistent excess risk of bladder cancer for which causative agents are only hypothesised. Dry cleaning solvent-exposed workers are potentially exposed to many chemicals and risks associated with bladder cancer have been seen in many human studies. Boot and shoe workers have an increased risk of bladder cancer and leather workers have also been associated with risk of bladder cancer, but the causal agents are uncertain between leather dust, dyes, benzene and solvents. Hairdressers and barbers have consistently seen an association with bladder cancer possibly due to hair dyes. Other occupations exposed to petroleum products including polycyclic aromatic hydrocarbons (PAHs) have seen excess bladder cancer incidence such as petroleum refinery workers and truck drivers.

Other occupations for which evidence is limited are machinists, metal workers, chemical workers, textile workers, carpenters, construction workers, miners, mechanics, gas station attendants, medical workers, photographic workers, pulp and paper workers, and welders (Schottenfeld and Fraumeni, 1996).

3.3 Occupational Bladder Carcinogens

Studies into the association of occupation and bladder cancer often only suggest possible agents that may be contributing to the increased risk within the occupation. However, epidemiological studies aimed at examining the relation between the particular agent exposures and bladder cancer are uncommon. Much of the evidence on chemical carcinogens is again based on animal studies. Table 3.2 summarises the agents considered related to bladder cancer risk in humans and includes their IARC classification (if any), whether the evidence is from animal or human studies, and the results (if any) from a study by Siemiatycki, 1991.

The agents the IARC classified as definitely carcinogenic to humans and have asssociations with bladder cancer are the aromatic amines 2-napthlamine, 4-aminobiphenyl and benzidine, magenta, arsenic, coal tar pitches, mineral oils, and drugs Cyclophosphamide and Chlornaphazin.

There are a group of chemicals for which there is little evidence of bladder carcinogenicity in humans, but evidence in animal studies. Bladder tumours have been seen in animals exposed to 1,3-dichloropropene, 2-(2-formylhydrazino)-4-(5-nitro-2-furyl)thiazole, 2-nitroanisole, 4-chloro-ortho- phenylene-diamine, benz(a)anthracene, CI basic red 9, citrus red no. 2, disperse blue 1, n-[4-(5-nitro-2-furyl)-2-thiazolyl]acetamide, niridazole, nitrilotriacetic acid, n-nitrosodi-n-butylamine, oil orange SS, ortho- aminoazotoluene, para-cresidine, para-dimethylaminobenzene, ponceau 3R, and sodium ortho-phenylphenate. The human bladder carcinogenicity of these chemicals requires further research.

Table 3.3 summarises the results of agents showing an association with blader cancer risk from a study by Siemiatycki in 1991. Siemiatycki carried out an extensive study of occupational carcinogens for all major cancer sites. The case-control study consisted of males aged 35 to 70, resident in the Montreal metropolitan area and diagnosed with a histological confirmed cancer between September 1979 and June 1985. Analysis was performed with bladder cancer patients ($n = 484$) and with cancer controls ($n = 1,879$) and with population controls ($n = 533$) separately. In addition, the analysis was repeated for French Canadians only (around 60% of the cases and controls). The occupational history of study subjects was obtained through personal interviews and occupational exposures assessed by experts in occupational hygiene, epidemiology, engineering and chemistry.

Experts assessed each subject's exposure by the concentration, frequency and confidence it occurred during the period the subject was employed. Each criterion was assessed according to a three-point scale as shown in table 3.4. Odds-ratios and 90% confidence intervals were then calculated for 'any exposure' and 'substantial exposure' to each agent individually. The non-occupational confounders accounted for in the analysis were age (less than 55, 55 or older), family income (tertiles), cigarette index (none, 1-800, 800+ cigarette-years), coffee index (0-50, 51+ cup-years), and the respondent to the questionnaires and interviews (proxy, self). The subject was considered to have 'any exposure' if there was reasonable confidence (level 2 or 3) the exposure existed prior to 5 years before diagnosis. The subject was considered to have 'substantial exposure' if they had 'any exposure', concentration x frequency > 3, and at least 5 years of exposure accumulated up to 5 years before diagnosis. So, the exposure was probable or definite, was above a background level, and occurred for at least 5% of the working time (i.e. no exposure criterion was coded as level 1) for at least 5 years.

The odds-ratios shown in table 3.3 for those chemicals tested by Siemiatycki are the most significant out of all 4 possible configurations (cancer or population controls, all ethnicities or French Canadians) with at least 4 exposed cases. Siemiatycki found significant increases (at a 10% level) of risk of bladder cancer for 'substantial exposure' to cadmium compounds, carbon tetrachloride, diesel engine emissions, engine emissions, formaldehyde, ammonia, asphalt (bitumen), chlorine, fabric dust, laboratory products, natural gas combustion products, photographic products, polyester fibres, and polyethylene. Significant results at a 5% level with odds-ratios above 2 were found for 'substantial exposure' to carbon tetrachloride (French, cancer controls), diesel engine emissions (French, population controls) and natural gas combustion products (all, cancer controls), and for 'any exposure' to acrylic fibres (all, population controls), ionizing radiation (French, cancer controls), calcium carbonate (French, cancer controls), and titanium dioxide and titanium compounds (all, cancer controls).

Chapter 4

Data Resources

The BC Cancer Agency (BCCA) has collected occupational and lifestyle data on male cancer patients resident in British Columbia (BC) and diagnosed between 1983 and 1990. The study area of British Columbia, Canada is described in section 4.1 to give an overview of the study subjects and their occupational exposures. The BCCA study is described in more detail in section 4.2.

The National Institute for Occupational Safety and Health (NIOSH) has developed a Job Exposure Matrix (JEM) that gives exposure estimates to many agents in various US jobs. Using the translation system developed by BCCA, the Canadian job codes from the BCCA questionnaire results can be translated to US job codes. These translations can then be used to estimate the lifetime exposure to each agent for each patient, and in turn these exposures can be used in the analysis of the case-control study. The NIOSH JEM is described in section 4.3 and the translations introduced in section 4.4.

4.1 The Study Area - British Columbia, Canada

The province of British Columbia (BC) on the West Coast of Canada has seen rapid popularisation over the last century. In 1931 the population of BC was estimated to be a mere 0.7 million. By 1986, it had grown to 3 million. At the beginning of the 20th century more than half of the population was under the age of thirty and men outnumbered women nearly two to one. The percentage of males and females living in BC has been roughly equal since the 1960s. The population has also been ageing since the post World War II baby boom. Most of the population of BC during the early to mid 1900s descended from European origin. More recently the population has become more multi-cultural, including a significant increase in the proportion of Asian immigrants. In the 1986 census of Canada, 60% of British Columbians reported a single ethnic origin; nearly half of these had British ancestry, nearly 30% had other European ancestry, and 13%

were Asian (Schrier and Ip, 1994).

Over the last century BC's economy has been highly dependent on resource-based industries such as logging, the railway, mining, fishing and agriculture. Manufacturing activities were based on the processing of natural resources, such as canning salmon, or producing lumber and paper. Resource-based industries continued to employ the largest share of the labour population until the early 1990s.

4.2 BCCA Data

The Health and The Workplace study of the BC Cancer Agency (BCCA) provided the patient data for this project. The Health and The Workplace study was initiated in 1983 to provide a population-based occupational study of male cancer patients resident in BC. Only male cancer patients were included in this study, as during the last century men were much more likely to have occupational exposure to carcinogens than women. Women also tended to spend longer periods of time working in households, where exposures were too variable to be studied.

The study consisted of a self-administered questionnaire mailed to all males aged 20 years and older diagnosed with cancer ascertained by BCCA during the period 1983 to 1990. The questionnaire requested detailed job descriptions for up to 10 jobs held for at least a year. It also requested information on socio-demographic factors and lifestyle factors such as drinking and smoking habits. Questions regarding lifetime consumption of alcohol (wine, spirits, and beer) were initially omitted and then added during the fist year of the study. Questionnaires were sent to all new cases for the first 2 years. Subsequently, once 1000 completed questionnaires were returned for a given cancer site, data collection was ceased for that site. More information about the study can be found in Band et al. (1999).

The BCCA sent in total 25,726 questionnaires to eligible male cancer cases, of which 15,463 were returned, giving a response rate of 60.1%. Patients aged over 80 were the only age group with a response rate below 50%. Also, liver, stomach, pancreas and unknown primary cancer sites had response rates below 50%. Response bias was addressed in the article by Band et al. (1999) and was thought to be minimal. Non-responders were not significantly different to the responders in education or smoking status. However, responders were more likely to be employed in the Managerial and Administrative occupational group than non-responders, and this was the only occupational group that was significantly different between the two groups ($p < 0.001$). These patients have low exposure to agents according to the NIOSH JEM, so perhaps the general cancer population has slightly greater occupational exposure than those responders included in the study.

The questionnaire was originally sent to non-cancer regional controls, but the response rate was low. This would have introduced selection bias, with the non-cancer controls that responded being more interested in health research, and therefore healthier. So, internal cancer controls of different sites to the case site were used as controls. This also minimises the recall bias, as the controls should be equally willing to provide complete responses in the questionnaire as the cases. This changes the interpretation of the results however, and instead of identifying possible occupational carcinogens for a particular cancer site per-se, carcinogens identified are those more likely to contribute to cancer in that site rather than in other sites of the body.

The primary tumour site and diagnosis date information was available for all 15,463 patients through the BCCA Registry. Histological confirmation of diagnosis was obtained for all patients. The primary tumour site was coded by the 9th revision of the International Classification of Diseases (WHO) and grouped into 3-digit categories for analysis. Misclassification of case or control status is very unlikely.

The job descriptions given in the questionnaire were coded manually into an industry and an occupation code according to the 1980 Canadian Standard Industrial Classification (CSIC) and the 1980 Standard Occupational Classification (CSOC), respectively (Statistics Canada, 1981). The CSIC consists of 853 possible codes and the CSOC consists of 503 possible codes. The questionnaire also asked for the location, start year, end year and duration of each job, and included a tick box to indicate if the job was part-time or seasonal. If there was no indication in the tick box that the job was part-time or seasonal, the job was assumed to be full-time. If the duration of the job was not given, this was taken as the end year minus the start year. Patients could provide information for a maximum of 10 jobs. So, it was assumed that if a patient reported 10 jobs they had no further jobs. Only 661 patients, or 4.7% of those with jobs, recorded 10 jobs. This would not have too much effect on exposure estimates, as any additional jobs may be of short duration or occur close to the diagnosis date.

The BCCA questionnaire was found to be highly valid. For 81 patients who indicated working in one of two large companies in BC, personnel records from these companies were searched to check the starting year and duration of employment of these patients. The interclass correlation between the company records and questionnaires was 0.996 (95% confidence interval, 0.993 to 0.997) for starting year (excluding 2 patients with missing start date information) and 0.971 (95% confidence interval, 0.954 to 0.981) for duration of employment (excluding 4 patients with missing duration of employment and 3 patients that were not reported as being employed by the company records). A list of all employees employed for at least 3 years was also available from one of the companies. From the list of all questionnaire respondents, there were no further patients employed in that company than those that had reported so in the questionnaire.

The questionnaire was also found to be very reliable by comparing the responses of 87 patients who filled out the questionnaire on two occasions. Here the kappa statistic was 0.94 for smoking (ever/never) and the interclass correlation for age started smoking and number of cigarettes smoked per day were 0.92 and 0.81, respectively. The interclass correlation for the number of years worked in the most common occupations recorded (construction, farming, clerical, and sales) were 0.92, 0.93, and 0.96, respectively; missing information ranged from 2% (construction) to 14% (clerical and sales). When all occupational information was recorded (80% of the pairs), the interclass correlation was 0.92 for work start year and 0.89 for total years worked (Band et al., 1999).

There were other factors thought related to cancer development that the questionnaire did not inquire about, such as coffee drinking, diet, drinking water, use of hair dyes, history of cancer in the family, genetic pre-dispositions, and overall health status. It would be difficult to ask questions about such factors without making the questionnaire very long. This should also not make much difference to the analysis as information was sought on the most important risk factors.

The estimation of occupational exposures given all the occupational information from the patients' questionnaires is detailed in section 5. Firstly, the questionnaire data is edited and prepared for analysis as described in section 4.2.1 and the inclusion criteria for analysis is stipulated in section 4.2.2.

4.2.1 Data Editing

The questionnaire data was edited for errors and inconsistencies before analysis. The protocol for coding the initial questionnaire responses included entering the start year at age 12 if the patient was raised or worked on a farm from birth. The questionnaire data still included jobs before age 12, however, and 290 patients had jobs before they were 12 and 230 patients had jobs before they were 11. The patients with childhood jobs were reasonably randomly distributed across the cancer sites. Many of these patients reported working or living on farms during their childhood. Data is included for those childhood jobs given so as to provide as accurate a summary of personal lifetime exposure as possible. Five patients had their first job coded as starting before they were born, so the birth dates were assumed correct as they came from two sources (the questionnaire and the BCCA patient record), and the job dates were adjusted so the job started when the patient was born.

4.2.2 Analysis Inclusion Criteria

The criteria for the BCCA questionnaire mailing were BC males over 20 years old diagnosed with cancer between 1983-1990.

The inclusion criteria for the analysis were that the questionnaire was completed and the primary cancer site was known. There was only one patient who did not complete the questionnaire. Patients who completed only part of the questionnaire are discussed in section 5.2.1. When the primary cancer site was unknown in a patient, the tumour will have a true site, but it was just undetectable at the time. Patients with unknown primary cancer sites were excluded, as they could not serve as controls for other cancer sites. Some of the primary unknown cancer sites could truly be the same site as the cancer case site. This would result in additional misclassification errors amongst the cases and controls. Therefore, 708 patients with an unknown primary cancer site were excluded. This resulted in a total of 709 patients failing to meet the inclusion criteria, leaving 14,754 patients for analysis.

Age criteria were also considered; such as excluding older patients due to questionnaire recall inability, a low questionnaire response rate and it being unlikely their cancer was due to occupational exposure. The latent period of cancer is not known precisely, so some cancers in old age could be due to occupational exposure up to retirement, and also many patients worked after retirement. There are few old patients, and matching of cases to controls on age later in the analysis will decrease their proportion further. The exclusion of younger patients was considered, as their cancers are also unlikely to be due to occupational exposures. Many younger patients were brought up on farms and thus exposed to many agents. All patients aged 20 and above were included so the study results could be generalised to all BC male cancer patients aged 20 and over.

4.3 NIOSH JEM

The JEM developed by the National Institute of Occupational Safety and Health (NIOSH) in the US was chosen for the estimation of exposure probabilities for the BCCA data. A JEM based in North America was desired so the occupational exposures approximately represented those in BC and Canada. The NIOSH JEM constructed from the National Occupational Exposure Survey (NOES) covered a broad range of agents and estimated exposure probabilities from actual measurements taken in a representative sample of US workplaces. Some jobs were excluded from the JEM, however, and the JEM does not measure the changes in exposure over time.

From 1981 to 1983, NIOSH conducted the National Occupational Exposure Survey (NOES) to develop estimates of the number of workers potentially exposed to 12,945 chemical, physical, and biological agents in selected industries. Of the 12,945 agents, 9,557 (74%) have corresponding Chemical Abstracts Service (CAS) codes, 4,952 (38%) have corresponding Registry of Toxic Effects of Chemical Substances (RTECS) codes, allowing the substances to be compared across different studies. Jobs were classified according to the US 1980 Census of Population Industrial Classification (USCENIND), and the US 1980 Census of Population Occupational Classification (USCENOCC). The US 1980 Census of Population consists of 231 Industrial Classifications, and 503 Occupational Classifications. The NOES survey involved visits to 4,490 establishments in 121 industry groups (52%) employing approximately 1,800,000 workers in 377 occupational categories (75%). The field guidelines and sampling methodology are discussed next, and further details can be found in NIOSH (1988) and NIOSH (1989) respectively.

4.3.1 Field Guidelines

Specifically trained surveyors collected exposure data via walk-through inspections of each facility. Exposure to an agent was only recorded if the agent had been observed in sufficient proximity to an employee so that one or more physical phases of the agent were likely to enter or contact the body of the employee. In addition, an employee was classified as exposed to an agent if the exposure occurred for at least 30 minutes per week (on an annual average) or once per week for 90% of the weeks of work year. Thus, the JEM does not measure the level of exposure, but exposure above a certain concentration and frequency. This JEM exposure level can be thought of 'considerable exposure' and throughout this thesis shall be referred simply as 'exposure'.

The presence of engineering controls over potential exposure was also recorded. The amount of employees exposed for more than 4 hours a day or at least 90% of the working year was recorded and defined as full-time exposure. The exposures were classified into trade name or actual agents. Approximately 70% of the data collected were from trade name products, and ingredients were determined for 85% of these.

4.3.2 Sampling Methodology

The target establishments were those within an industry on a list of target USCENIND codes, located in the United States, and reporting 8 or more employees at the time of the survey. Businesses with less than 8 employees were considered too numerous and transient to survey accurately. To construct a sample of the target establishments a two-stage systematic selection procedure was employed involving stratification by number of employees, SIC and geographical location.

The first stage of the sampling procedure identified establishments from 604 geographical combinations of contiguous counties within metropolitan or urbanised areas. These were stratified by employee concentration by USCENIND code and geography into 98 strata. The second stage involved systematically selecting the 4,894 facilities to be surveyed from the strata by selecting independently across different sizes of facilities, where the number of employees defined the size. A total of 4,490 facilities co-operated with the study and were ultimately surveyed for the NOES JEM.

A downfall of the JEM is that the list of target USCENIND codes excluded 110 (48%) industries. Many of the employees in these industries were thought by NIOSH to have little agent exposure, so were not surveyed, e.g. finance, insurance, and real estate. Some industries were thought to be so large and heterogeneous that they warranted surveys of their own, e.g. mining. While others, such as private households, were not surveyed as they were thought to be difficult to survey accurately. Agricultural production, railroad transportation, federal, state and municipal government industries were also excluded from the NOES survey.

The final NIOSH NOES JEM gives, for each job (industry and occupation code) and agent, the ratio of the expected number of employees considerably exposed nationally, to the amount employed in that job nationally. The estimation of the number of employees exposed nationally, given the survey results involved weighting each survey facility according to the probability of including a facility like it in the sample. The weightings were determined by ratio estimation, with ratio factors determined using outside sources such as the Bureau of the Census publication County Business Patterns (CBP), or the Dun Master Inventory (DMI). The amount employed in each job nationally was estimated via Duns Marketing Index (Dun and Bradstreet, 1980).

The NIOSH JEM is essentially a 3-dimensional array with the USCENIND codes on one axis, the USCENOCC codes on another axis, and the agent codes on the final axis. The elements of the array are the exposure probabilities, however, only exposure probabilities greater than zero are recorded. Therefore, when a job-agent exposure estimate is missing from the NIOSH JEM, it is difficult to distinguish between the situations: the job-agent was surveyed with no exposure, there were no employees in that industry and occupation in the US, or the industry was not studied by NIOSH.

4.4 BCCA Canadian to US Job Translations

To translate the Canadian job codes to US equivalents, the BCCA translations were used (Svirchev, 1993). Experts in occupational coding designed a system to translate the 853 CSIC codes to 231 USCENIND equivalents, and to translate the 503 CSOC codes to 499 USCENOCC equivalents.

The occupational categories are generally similar for the CSOC and USCENOCC, apart from for fabrication, processing, assembly, and machine operating occupations. Here, the CSOC classifies the occupations according to the product produced, whereas the USCENOCC classifies according to the equipment used (Svirchev, 1993). The CSIC also has more specific categories than the broader USCENIND categories. For example, the USCENIND defines all hospitals in one category: 831 Hospitals. Whereas the CSIC includes eight categories distinguishing between the type of hospital: 8619 Other Specialty Hospitals, 8617 Children's (Paediatric) Hospitals, 8616 Nursing Stations and Outpost Hospitals, 8615 Addiction Hospitals, 8614 Mental (Psychiatric) Hospitals, 8613 Extended Care Hospitals, 8611 General Hospitals, and 8612 Rehabilitation Hospitals.

Industry titles corresponding to each CSIC code were matched to US industry title equivalents. The matching industry titles were verified and those equivalents that did not correspond well or appeared infrequently were excluded. This resulted in a group of USCENIND codes relating to each CSIC code, and similarly a group of USCENOCC codes relating to each CSOC code.

Many translations are not one-to-one relationships. The relationship between the Canadian and US codes is often many-to-many. For example CSOC 2181 Mathematicians, Statisticians, Actuaries, translates to three USCENOCC codes: 066 Actuaries, 067 Statisticians, and 068 Mathematical Scientists n.e.c.. However, USCENOCC 068 Mathematical Scientists n.e.c. translates back to two CSOC codes: 2181 Mathematicians, Statisticians, Actuaries, and 2189 Occupations in Mathematics, Statistics, Systems Analysis, and related fields n.e.c.. Here, n.e.c. denotes Not Elsewhere Classified. All translations for a particular job were considered equal and no indication was given of which translation was more likely or closer to the 'truth'. Translations of the patients' jobs are described further in section 5.2.4.

Chapter 5

Exposure Assessment

In order to analyse the agents for associations with bladder cancer incidence, a measure of exposure to many separate agents for each patient is required. For each US job, the NIOSH JEM gives the probability of a person employed in that job being considerably exposed to many agents. Considerable exposure is exposure that occurs for at least 30 minutes per working week or at least once per week for 90% of the weeks of the working year (see section 4.3.1). The BCCA questionnaire data includes the duration and type of jobs held by each patient in the study. As all jobs held by the study subjects are coded according to the Canadian job codes, and the JEM is coded by US job codes, each Canadian job needs translating into US equivalents first.

The JEM probabilities in conjunction with the duration of each job provide a measure of cumulative exposure. The cumulative exposure to a given agent for a patient is estimated as the aggregation across all jobs of the product of that job's exposure probability estimate and the duration of that job. This gives an expected number of work-years with considerable exposure to each agent. The cumulative exposure estimate will give a higher weighting to the agent exposure probabilities in a patient's main job.

Firstly the cumulative exposure definition is explained in more detail in section 5.1. The process of actually calculating the cumulative exposure index is then described in section 5.2.

5.1 Cumulative Exposure

For each agent, the cumulative exposure for a patient is defined as the aggregation over the patient's jobs of the product of the probability of considerable exposure and the job duration. Let i denote the ith patient ($i = 1, \ldots, 15463$), j denote the jth job ($j = 1, \ldots, 10$) and k denote the kth agent ($k = 1, \ldots, 12945$). So, the cumulative exposure, E_{ik}, to agent k for patient i, is estimated as:

$$E_{ik} = \sum_{j=1}^{10} e_{ijk} t_{ij}$$

where t_{ij} is the duration (in job-years) of job j, and e_{ijk} is the exposure probability estimate for job j. A job-year is defined as one year in a full-time job. If a job is part-time, it is considered half as much work time as a full-time job and thus the duration in years is divided by two. So t_{ij} is calculated as:

$$t_{ij} = \begin{cases} d_{ij} & \text{if PT=0} \\ d_{ij}/2 & \text{if PT=1} \end{cases}$$

where d_{ij} is the duration of job j, which is divided by two if the job was indicated to be seasonal or part-time ($PT = 1$). If the duration of the job is not given, then the job duration is approximated by the end year minus the start year.

The exposure probability estimates, e_{ijk}, now need calculating. Before using the JEM to look up the exposure probabilities, each Canadian job needs to be translated to US equivalents. Each Canadian job consists of a CSIC industry (x_{ij}) and CSOC occupation (y_{ij}) code. As discussed in section 4.4, the Canadian and US job codes do not have a one-to-one relationship. The relationship is often many-to-many: for each CSIC, there can be many USCENIND equivalents and for each USCENOCC, there may be many CSOC equivalents.

Using the BCCA translation rules, let g_{IND} denote the function that translates x_{ij} into S_{ij} different US industry codes, and g_{OCC} denote the function that translates y_{ij} into T_{ij} US occupation codes. Every possible permutation of the translated industry and occupation codes is considered equal for each Canadian job. For example, if one Canadian job translates to 2 US industry codes and 3 US occupation codes, then there are 2 x 3 = 6 possible permutations of US industry-occupation combinations. The set of all possible combinations of $g_{IND}(x_{ij})$, $g_{OCC}(y_{ij})$ is then the translation of Canadian job j for person i to US equivalents. The term 'job-translation' will be used to refer to each of these possible US industry-occupation combinations in this thesis.

Each of the possible job-translations will not always be of equal value. Some of the US job-translations will be closer to the true meaning of the Canadian job than others. Some of these job-translations may not even exist in practice in the US. Estimating differing weights for each job-translation possibility, however, is very difficult. The amount employed in each industry and occupation combination in the US could be estimated. Given the amount employed in a US job, however, the proportion that corresponds with each of many Canadian job equivalents could not be estimated, as the relationship between US and Canadian job codes is often many-to-many. Also the proportions employed in each group would change over time.

Therefore, each job-translation is weighted equally, so that the JEM probabilities are averaged over all translations. So, e_{ijk} is calculated as:

$$e_{ijk} = \frac{\sum_{s=1}^{S_{ij}} \sum_{t=1}^{T_{ij}} f_{JEM,k}\{g_{IND,s}(x_{ij}) g_{OCC,t}(y_{ij})\}}{S_{ij} T_{ij}}$$

where x_{ij} and y_{ij} are the CSIC and CSOC codes respectively, for patient i's jth job. The function that gives the sth translation of CSIC code x_{ij} is denoted by $g_{IND,s}(x_{ij})$, and the function that gives the tth translation of CSOC code y_{ij} is given by $g_{OCC,t}(y_{ij})$. The NIOSH JEM matrix function that gives the exposure probability estimate to agent k for each US industry and occupation code combination given, is denoted by $f_{JEM,k}$.

5.2 Calculating Cumulative Exposure

Figure 5.1 depicts the flowchart displaying the approach used to calculate the cumulative exposure estimates for each eligible patient. Initially 14,754 patients met the inclusion criteria with completed questionnaire data and a known cancer diagnosis. Some further patients were excluded from the study as described below. The analysis was designed so any major cancer site could be chosen as the basis for the case series and potential occupational carcinogens could be analysed for that site. To enable analysis of possible carcinogens for any cancer site, exposure estimates were calculated for all eligible cancer cases and controls.

5.2.1 Providing Adequate Job Information

To calculate the cumulative exposure estimates for each patient, much information was required from the questionnaire. Each patient needed to adequately describe each occupation they had and report the industry, so it could be coded into a CSIC and CSOC code. Also, for each job they needed to provide the start year and end year, and indicate whether the job was part-time or seasonal. The start and end year was required to see if the job occurred within 5 years of diagnosis. If any of this information was missing or unclear then the exposure estimate could not be calculated. Only 705 (4.8%) patients did not complete all the necessary data, so these patients were excluded from the remainder of the study. Patients were excluded if any of the job information (industry, occupation, duration or start and end year) was missing or unclear.

The job end date, start date and codes are the most important pieces of information for calculating the cumulative exposure. Table 5.1 shows the distribution of patients and the extent to which they completed the job codes and job end and start dates.

The exclusions only form a small proportion (4.8%) of the patients. However, they should form a random sample from the patients so they do not affect the later case-control analysis. The consequences of excluding these 705 patients from the study did not make a considerable difference to the types of matched cases and controls in the later bladder cancer analysis as described in section 6.3.2.

5.2.2 Canadian Jobs and Latency

The job history data was adjusted to allow for a 5-year latency period. All jobs starting less than 5 years before the patient's year of diagnosis were deleted. All jobs with end dates less than 5 years before diagnosis were reduced so they ended 5 years prior to diagnosis. The durations of the jobs were then adjusted accordingly, that is, exposure in the 5 year period preceding diagnosis was not considered. Originally 26 patients had no jobs recorded. After the deletion of jobs within 5 years of diagnosis, 100 patients had no jobs.

There are now 14,049 patients eligible for analysis, for which exposure estimates needed calculating. The 100 patients that reported no jobs are estimated to be unexposed to all agents. The remaining patients reported 63,638 jobs that started more than 5 years before their diagnosis; this is an average and standard deviation of 4.6 and 2.5 jobs per patient respectively. These patients contributed 483,138 work-years or an average and standard deviation of 34.6 and 12.2 work-years per patient reporting jobs.

5.2.3 Coding the Canadian Jobs According to the CSOC/CSIC

Some Canadian occupations were not included in the CSOC classifications, and thus could not be translated to US equivalents. The two occupations excluded from the CSOC coding were occupations in the armed forces and students.

There were 2,927 jobs (4.6%) reported in the armed forces (commissioned officers and other ranks). From the dates given, many of these jobs were during World War II, and some were during World War I. Some patients were also employed in the armed forces for their entire working life, as 31 patients reported no other jobs than those in the armed forces. These exposures occurred in different countries, in different wars and at different times and are thus very difficult to estimate, and therefore were assumed to be zero in this study. Also, some men may not have considered this work a job and may not have reported it.

The 2,927 jobs in the armed forces belong to 2,667 patients. Employment in the armed forces contributes 16,685.5 work-years (3.5% of all work-years reported). This is an average and standard deviation of 6.3 and 6.1 work-years per patient respectively. The distribution of work-years in the armed forces per patient is right-skewed with a median of 5 work-years. Assuming no exposure for armed forces occupations means the cumulative exposures for these 2,667 patients may be slightly underestimated. Table 5.2 shows the distribution of cancer sites for the work-years in occupations in the armed forces compared to the work-years in other occupations. The number of patients reporting any employment in the armed forces, and the work-years employed in the armed forces seem to form the same distribution across cancer sites as the other occupations.

Additionally, 2 patients were coded as full-time students for 3 and 4 years and are assumed to have no exposure as teachers were by NIOSH.

Therefore, of the 14,049 patients included for analysis, 100 reported no jobs before 5 years prior to diagnosis, and 31 reported only armed forces jobs. So, 131 are estimated as not exposed to all agents, and exposures need calculating for the remaining 13,918 patients.

5.2.4 Translating Canadian Jobs to US Equivalents

Using the BCCA translations described in section 4.4, each Canadian industry given was translated into an average of 1.2 US industry translations and each occupation was translated into an average of 2.7 US occupation translations. This resulted in 214,189 possible US job-translations for the 60,709 Canadian jobs (an average and standard deviation of 3.5 and 4.8 US job-translations per Canadian job respectively). This large number of job-translations per Canadian job was partly due to considering each permutation of translated industry and occupation code. The number of job-translations may have been reduced if the BCCA translations were performed on the Canadian job industry and occupation pairs rather than the two independently.

Table 5.3 shows a summary of the proportion of jobs, work-years, and patients employed in each CSIC major group (2-digit code). The construction industry employed the largest proportion, 10.9% of the 60,709 Canadian jobs, had the largest proportion, 29.3%, of patients ever employed within it, and contributed the largest proportion, 10%, of work-years. Agriculture and manufacturing industries were also large employers of the 13,918 patients.

To assess the translation accuracy, table 5.4 shows the number of job-translations and work-years contributed by each USCENSIC translation grouping. The US industry equivalent for Canadian job CSIC code x_{ij} is considered to be the average of the S_{ij} USCENSIC equivalent translations. The work-years contributed by CSIC code x_{ij}, is the job's work-years, t_{ij}. Therefore, each USCENSIC translation equivalently contributes t_{ij}/S_{ij} of work-years. The US industry translations seem adequate, as the proportion of work-years in each major industrial grouping remains approximately equal before and after translation.

Table 5.5 shows the proportions of jobs and work-years in each major CSOC group (2-digit code) and table 5.6 shows the proportion of translations in approximately equivalent USCENSOC groupings. Most patients were employed in occupational groups managerial and administrative, sales, farming, product fabricating, assembling, repairing and construction. Of the 60,709 jobs, 39% were in these occupations, and 41% of the work-years were in these occupations. Again, the US translations look adequate, as the proportion of work-years in each major occupational grouping is approximately equal before and after translation, although the US major occupational group definitions are not as consistent with the Canadian ones as the major industrial groupings were.

5.2.5 US Industries Studied by NIOSH

Many US industries were not included in the JEM, as discussed in section 4.3.2. This resulted in 100,444 (47%) of the job-translations not on the JEM because the US industry was not studied by NIOSH. Agent exposures will be underestimated in some jobs, but many of these jobs should be truly non-exposed.

5.2.6 US Job-Translations on the JEM

For 25% of US job-translations the industry was studied by NIOSH, but the industry and occupation combination was not found on the JEM for any agents. It is difficult to distinguish between the possibilities that 1) NIOSH studied the job and found no exposure to all agents, 2) there were no employees in that industry and occupation in the US, and 3) NIOSH did not study the job, as they believed it would not have considerable exposure to any agents. Zero exposure could be assumed for cases 1 and 3. However, for case 2 the job-translation is not valid, so it should be excluded from the analysis and thus the average. As these different possibilities were not detectable, and cases 1 and 3 are more likely, it was assumed that the exposure was zero for all agents. Again exposure may be underestimated for some jobs. For a Canadian job, with any US translations of case 3, which are not valid, then the exposure estimate will be underestimated by averaging over too many translations.

Of the 214,189 job-translations, 60,356 (28%) could be found on the NIOSH JEM. These 29,306 Canadian jobs belong to 10,420 patients, leaving 3,629 (26%) patients estimated as unexposed to all agents. Table 5.7 shows the distribution of jobs and work-years in each major CSIC grouping for all Canadian jobs and those with any exposure estimated by the JEM. The construction industry had the greatest proportion, 96.4% of jobs with exposures on the JEM. The industries of fishing and trapping and finance, insurance and real estate had no jobs on the JEM, as they were not studied by NIOSH. The agriculture, mining and government services industries also had a very small proportion of jobs exposed. Table 5.7 also shows the work-years contributed in each industry and the equivalent amount of work-years accounted for on the JEM. A lesser proportion of work-years were accounted for on the JEM, due to many translations having zero exposure. Overall, 32.9% of work-years were accounted for on the JEM, or equivalently, were considered exposed on the JEM, whilst 48.3% of jobs were exposed. Table 5.8 shows the same variables for the Canadian major occupational groupings. No jobs in teaching, religion or fishing and trapping occupations were considered exposed. A small proportion of those jobs in social science, farming, sales, services, and mining occupations were considered exposed. A large proportion of those jobs in materials processing, machining, and construction were considered exposed.

As the JEM is assumed representative of jobs located in North America, the locations of the Canadian jobs with exposures estimated from the JEM should be examined. Table 5.9 shows the locations of the 29,306 Canadian jobs with any JEM exposures estimates, and the 153,618.6 work-years accounted for on the JEM. Of the 29,306 jobs at least 66.8% were in BC, and at least 71.4% of the work-years accounted for were in BC. At least 87.4% of the jobs and 88.2% of the work-years were in Canada. A maximum of 8.4% of the jobs and 7.9% of the work-years were outside Canada, and 4.2% of the jobs and 3.9% of the work-years had unknown locations. Therefore, a very small proportion of the exposures were estimated for jobs outside Canada, and many may still have been located in North America. The few work-years employed outside North America may have different levels of exposure, but it should make little difference to the results.

5.2.7 Applying the JEM

Firstly a subset of the NIOSH JEM was created to enable easier electronic data handling. The JEM subset was restricted to the probabilities of exposure in males only. The exposure probabilities were calculated as the ratio of the NIOSH estimate of those exposed in that job nationally, to the amount employed in that job nationally according to Dun's Marketing Index (Dun and Bradstreet, 1980). Sometimes this was slightly larger than 1 when NIOSH observed more employees than actually recorded as employed in Dun's Marketing Index. A maximum of 1 was set for these proportions so they represented true probabilities. In addition, the JEM was restricted to only those US job-translations found in the study. Therefore, the NIOSH male JEM subset consisted of 405,183 industry-occupation-agent combinations, with 12,688 agents.

The JEM subset was then applied to the 60,356 US job-translations. This resulted in over 9 million person-job-translation-agents.

5.2.8 Calculating Cumulative Exposure

The person-job-translation-agents data were then compiled into the required cumulative agent estimates. Firstly, for each person-job-agent, the probability estimates for each US job translation were averaged. This resulted in a probability of considerable exposure to each agent for each Canadian job. Next, each probability estimate associated with each job was multiplied by its duration and divided by 2 if the job was part-time.

These estimates were then aggregated across jobs for each patient and agent to give the final cumulative exposure estimates to each agent.

5.2.9 Final Cumulative Exposure Estimates

The process resulted in over 4 million person-agent exposure estimates, E_{ik}, greater than zero. All remaining person-agent exposures were estimated to be zero. 10,420 patients (74%) had cumulative exposures greater than zero for some agents. The 4 million person-agent estimates consisted of 11,882 different agents. Therefore none of the patients in the study were estimated as being considerably exposed to 1,091 of the NIOSH agents.

The exposure estimates to each agent for each patient tended to be quite small. The average cumulative exposure for an exposed patient to each of the 11,882 agents was calculated. The average and standard deviation of these average cumulative exposures were 0.36 and 0.61 respectively. Similarly, the average and standard deviation of the maximum cumulative exposure for an exposed patient of all 11,882 agents was 5.13 and 8.58 respectively, with the overall maximum exposure being 67.60 for a patient exposed to continuous noise. The histograms of cumulative exposure across all patients for each agent are generally very right-skewed with the majority of patients having a cumulative exposure of zero or near zero. Taking the natural logarithm of the positive cumulative exposures tends to make them normally distributed.

Chapter 6

Statistical Approach

Chapter 5 described how the cumulative exposure to each agent for each patient was estimated. Before testing for associations between cumulative exposure and bladder cancer incidence, possible confounders must be considered. The most important confounders of age at diagnosis and year of diagnosis are first used as matching variables. They and additional factors are taken into account in the conditional logistic regression analysis. The matching as discussed in section 6.1 identifies the case and control patient groups. Possible confounders considered are discussed in section 6.2 and the characteristics of the cases and controls are outlined in section 6.2.1. A conditional logistic regression base model is developed to account for the most important confounders and is described in section 6.3. The consequences of the subjects excluded due to missing occupational data previously in section 5.2.1 on this base model are investigated in section 6.3.2.

Finally each agent is tested independently whilst simultaneously adjusting for the important confounders as described in section 6.4. In addition, the agents are grouped into components that may act synergistically on bladder cancer development via principal component analysis as outlined in section 6.5.

6.1 Matching

The analysis of potential occupational carcinogens involves matching bladder cases to cancer controls on exact age at diagnosis and year of diagnosis. Age is a well-known important risk factor for all cancers; bladder cancer risk increases with age. Age is also associated with occupational exposures; on average older patients will have had greater exposure to carcinogens than younger patients and they may have also been out of the workforce for longer. In addition age is associated with most risk factors, such as smoking habits, alcohol drinking habits, level of education, etc. Matching on age to make the control comparison group more similar to the case group in age distribution was considered the best method to deal with these problems.

There are also differences between patients diagnosed in different years due to questionnaire collection ceasing in later years for some cancer sites. The questionnaire questions also differed in early years. Again, matching on year of diagnosis was used to allow for these. Frequency matching was used to maximise the number of cases and controls used in the analysis.

Patients with lung cancer were excluded from the control series for the bladder cancer analysis, as lung cancer is too strongly associated with cigarette smoking. After removing the 2,808 lung cancers and those 705 patients with missing occupational data (see section 5.2.1) there are 1,066 possible bladder cases and 10,175 eligible controls. Matching on age and year of diagnosis leads to 1,062 bladder cancers and 8,057 controls. These matched subjects were all diagnosed between 1983 and 1987, as all bladder cancers were diagnosed during this period. Also matching restricted the age range to 21 to 95. Further characteristics of the cases and controls are discussed in section 6.2.1.

6.2 Possible Confounder Variables

When analysing each occupational exposure for its association with bladder cancer, there are many other factors that could potentially act as confounding variables and thus need controlling for in the analysis in addition to those already matched upon. Information was sought on potential confounders in the BCCA questionnaire. This included information on who completed the questionnaire, ethnic origin, marital status, years of formal education, smoking habits and alcohol consumption habits of the patient.

Caucasian men are known to be at greater risk of developing bladder cancer than men of other ethnicity (see section 3.1). Therefore a simple ethnicity variable (Caucasian/Non-Caucasian) was considered in the analysis.

Smoking is also a known risk factor for bladder cancer. Therefore, many variables attempting to model lifetime exposure to smoking, in particular cigarette smoking, were considered in the analysis. The continuous variables were categorised, as there may not be a linear relationship between the variable and bladder cancer, with sensible cut-offs chosen. Most variables also have an unknown category for when the patient did not provide an answer. Variables considered were ever smoker versus never smoker (cigarettes, pipes, or cigars), cigarettes smoked per day (0, 1-19, 20-29, 30+), years smoked cigarettes (0, 1-29, 30-44, 45+), cigarette pack-years defined as the packs smoked per day multiplied by the years smoked, where 1 pack contains 20 cigarettes (0, 1-24, 25-49, 50+), and whether the patient quit smoking before diagnosis and if so, the number of years they have quit for (non-smoker, current smoker, 1-4, 5-9, 10+). The responses to some of these smoking variables were quite varied, particularly pack-years. These variables are not as reliable or valid as possible as people may be unwilling or unable to provide true answers. Also, smoking habits differ across a patient's lifetime and this was not reflected in the questionnaire.

Although alcohol consumption is not thought associated with bladder cancer, it is associated with many other cancer sites. The occurrence of malignant tumours of the oral cavity, pharynx, larynx, oesophagus and liver is causally related to the consumption of alcoholic beverages (IARC, 1987). Knowledge of whether the patient drinks alcohol or not, was the only alcohol variable considered. An alcohol score variable was recorded as the aggregation across beer, wine and spirits of the units drank per week multiplied by the years drank. Much of this information was unknown, especially for the controls, leading to much misclassification and some differential misclassification. The reported units per week are also liable to much error and fluctuated greatly across a patient's lifetime.

An important variable in the analysis of questionnaire data is who completed the questionnaire. Proxy responders are known to not complete the questionnaire as well as the patient themselves and also tend to leave more questions unanswered. Therefore the simple variable, person completing the questionnaire (patient, proxy) was considered in the analysis.

Educational level is related to occupation, age and income and associated with life-style confounders like smoking, diet, and access to healthcare. The education variable ($<$ 8 years, 8-11 years, high school graduate, post secondary education) was considered in the analysis. Marital status is also related to age, occupation and life-style confounders and so the marital status variable (single, married or common-law, widowed, separated or divorced) was also considered in the analysis.

Naturally age and year of diagnosis are adjusted for in the analysis by performing conditional logistic regression conditional upon the matched distributions of these variables.

6.2.1 Characteristics of Cases and Controls

Table 6.1 shows the characteristics of the cases and controls on the main possible confounding variables. The bladder cases are still slightly older than the controls after matching. Whereas the cases are almost uniformly distributed across year of diagnosis, the controls are more concentrated across earlier years, which is to be expected due to many cancer sites ceasing questionnaire collection before the end of the study. The average amount of work-years contributed by each case and control is relatively similar. Also, 0.3% of both cases and controls had no jobs.

The bladder patients are more likely to be of Caucasian ethnicity and to have smoked. If they smoked cigarettes, bladder cancer patients were more likely to still be smokers at diagnosis. They also smoked slightly more cigarettes per day and for more years than the controls. If the cases had quit by diagnosis, they had quit for a shorter period of time than the controls. The patient himself was more likely to have completed the questionnaire if he was a bladder case than if he was a control. Cases and controls are relatively similar on marital status and education and whether they drink alcohol.

6.3 Developing the Base Model

A base model is required to model the probability of a subject being a case whilst taking into account the most important confounders and the matched variables. As described in section 2.2.5, conditional logistic regression is the most appropriate model for this situation. A parsimonious model that still explains the data is necessary so the model is more stable and more easily generalised. Backwards stepwise selection was the regression modelling technique implemented here. Maximum likelihood estimation was used to estimate the model parameters using the SAS procedure PHREG. The Wald statistic was used to test the hypothesis that a model parameter was zero and this was rejected when the resulting p-value was less than 0.20. The Wald statistic for a parameter is the square of the parameter estimate divided by its standard error. This is asymptotically distributed as a chi-square distribution (Hosmer and Lemeshow, 2000). However, the disadvantage of the Wald statistic is that for large parameter estimates, the estimated standard error is inflated, resulting in failure to reject the null hypothesis when the null hypothesis is false (Menard, 2002). For categorical variables, the p-value testing the global null hypothesis that the coefficient for each dummy variable was zero was considered.

Stepwise selection strategies are common in regression modelling. It is possible for forward selection methods to exclude variables such as those involved in suppressor effects. A suppressor effect is when one variable may appear to have a statistically significant effect only when another variable is controlled. Backwards selection methods may not miss these variables, as they are all included in the initial model. However, the method is sensitive to the choice of initial model. Research has shown that the choice of alpha level of 0.05 is too stringent, often excluding important variables from the model. Choosing a value for alpha in the range from 0.15 to 0.20 is highly recommended (Hosmer and Lemeshow, 2000).

All the possible confounding variables (ethnic origin, marital status, education, who completed the questionnaire, smoking status, cigarettes per day, years smoked cigarettes, cigarette pack-year, years quit smoking, and alcohol status) were entered into the conditional logistic regression model where year of diagnosis and age at diagnosis were the strata variables. The variables were deleted from the model with the largest p-value in the following order: education, marital status, cigarette pack-year, cigarettes per day, smoking status, then years quit smoking.

6.3.1 The Base Model

The method described above resulted in a base model including the variables; who completed the questionnaire, years of smoking cigarettes, ethnic group and alcohol status. Table 6.2 shows the resulting odds-ratios for these variables in the base model.

A feature of the questionnaire responses was that questionnaires completed by proxies were significantly less likely to be bladder cases than controls after taking into account age, year of diagnosis, ethnicity, and smoking and drinking habits. This difference is due to the prognosis for bladder cancer being much better than for other cancers in the control group. Thus bladder cancer patients are more willing or able to answer the questionnaire than other cancer patients.

Patients reporting their ethnicity as non-Caucasian were less likely, although not significantly at a 5% level, to develop bladder cancer than other control cancers when taking all other important confounders into account. This is as expected as Caucasians are at greater risk of bladder cancer than other ethnic groups.

Alcohol drinking was associated with a decreased risk of bladder cancer here (but ever drinking alone is not significant, $p = 0.29$), as alcohol drinking is a risk factor for other cancers serving as controls.

There was a definite dose-response relationship between smoking and risk of bladder cancer. The risk was significantly increased with each increased category of cigarette smoking duration.

Other models were tested and the previous base model was best in terms of log likelihood. Table 6.3 shows the log likelihood for the base model and some related models. The least significant variable in the base model was ethnicity. Adding ethnicity to model 1 excluding it was significant at the 20% level. Replacing the cigarette year variable with any other smoking variable did not improve the log likelihood. No remaining variables were significant (all had p-values > 0.3) when added to base model. When the more complex alcohol score variable was added to the model, or replaced the simple alcohol status variable, it was not significant at the 20% level. Many interaction terms were added to the base model such as cigarette years and alcohol status, and smoking status and alcohol status, but none were significant at the 20% level.

6.3.2 Consequences of the Missing Data Exclusions on the Base Model

In section 5.2.1 705 subjects were excluded from analysis due to missing occupational information. If these had not been deleted, matching on age and year of diagnosis would result in 1,125 cases and 8,492 controls. Their characteristics on the possible confounding variables are compared with the cases and controls after exclusions in table 6.4. The distributions across all variables for cases and controls matched from all subjects and after exclusions are very similar. The only differences are that the cases and controls after exclusions are slightly younger and a marginally greater proportion reported jobs (99.7%, rather than 99.3%). A decrease in the average age is expected, as the older patients may be more susceptible to recall difficulties. The proportion of questionnaires completed by the patient increases after exclusions as much of the missing occupational data was from proxy questionnaires. The proportion of unknown responses in the variables is also slightly decreased after exclusions, as patients who did not complete their occupational histories often also did not complete the lifestyle factor questions.

Table 6.5 shows the distribution of cancer sites across the controls before and after exclusions. The distribution of cancer sites comprising the control group remains very similar after excluding subjects with missing occupational information.

Using the same method as in the previous section, the cases and controls without exclusions resulted in the same variables in the base model. Table 6.6 shows base model comparison of the significant confounding variables. The odds-ratios differ only slightly before and after exclusions. The risk for non-Caucasian patients is just significantly decreased with all subjects included, than with only those with complete occupational data.

The alcohol score variable is actually significant (p-value = 0.17) when added to the base model before exclusions. However, the alcohol score is not a reliable variable as discussed in section 6.2. Also, the Pearson correlation between alcohol score and alcohol status is quite high at 0.63. Replacing the alcohol status variable by the alcohol score variable does not improve the log-likelihood. Hence, the base model resulting from the cases and controls was considered approximately the same regardless of missing occupational data exclusions.

6.4 Testing the Agents Individually

Now the 9,119 cases and controls are identified, the cumulative exposure estimates from section 5 for these patients can be used to analyse each agent's relation with bladder cancer risk whilst taking into account the important confounders via the base model. Firstly, those agents the cases and controls are exposed to are summarised in section 6.4.1.

Each agent is tested separately using conditional logistic regression and the base model, but there are many possible ways to analyse the cumulative exposure variable. First section 6.4.2 introduces an indicator ever/never exposure variable. As it is unlikely that the continuous cumulative exposure variable has a linear relationship with bladder cancer risk, the cumulative exposure is split into tertiles according to the exposed controls and a dose-response analysis is performed as described in section 6.4.3.

Another consideration is that when testing many agents, there are bound to be significant results by chance alone. This can be taken into account with multiple testing techniques, where various methods are described in section 6.4.4.

6.4.1 Agents with Exposed Cases

There needs to be sufficient bladder cases exposed to an agent to enable analysis of the exposure-disease relationship and to have confidence in the results. Here exposed means that the cumulative exposure estimate is greater than zero. Of all 11,882 agents that any patients included in the study were exposed to (see section 5.2.9), only 8,986 agents had at least one bladder cancer case exposed. Table 6.7 shows the distribution of bladder cases exposed to the 8,986 agents. On average 40 bladder cases were exposed to each agent with a standard deviation of 91 and a median of 5. Of all 8,986 agents, each patient was exposed to an average and standard deviation number of agents of 440 and 390 respectively. The median number of agents exposed to was 340. The 5,699 agents with at least 3 bladder cases exposed are considered for analysis. The 3,450 with at least 9 bladder cases exposed are considered for the dose-response analysis.

6.4.2 Ever/never

Any exposure versus no exposure is a simple indicator variable to analyse and interpret. However, in this study a cumulative exposure above zero does not mean the subject was ever exposed. All exposures in the NIOSH JEM were given a probability of exposure, and the majority of occupation-agent combinations had a low exposure probability estimate or were based on small numbers. The ever/never of the cumulative exposure indicates whether the patient ever had a probability above zero of being exposed (across all job translations) to the agent. Alternatively, the ever/never variable indicates whether NIOSH studied any of the patient's US job-translations and found any employees exposed to that agent in their sample. The ever/never analysis is restricted to only those 5,699 chemicals with at least three bladder cancer cases ever exposed to that chemical to ensure sufficient numbers for analysis.

6.4.3 Dose-Response

Each agent can be tested in the conditional logistic regression base model using the continuous cumulative exposure variable. However, this assumes the association between cumulative exposure and bladder cancer risk is linear. As this relationship is unlikely to be linear, the cumulative exposure is categorised instead.

A dose-response relationship can be investigated by categorising the cumulative exposure according to biological risk levels, e.g. low, medium and high. However, there are no biological cut-off values that will apply to all agents separately or as a group. Instead the groups are devised based on the cumulative exposure distributions. When the groups are divided according to the controls' cumulative exposures, the null hypothesis is that if there were no association with bladder cancer risk then the cases should separate equally into the groups and no differences between the cases and controls could be detected. So, the unexposed constitute one group and the exposed are divided into tertiles according to the cumulative exposures of the controls. Thus four groups are created: unexposed (reference group), low exposure (lower 33% of exposed controls), medium exposure (mid 33% of exposed controls), and high exposure (top 33% of exposed controls). If there is a truly increasing dose-response relationship between the agent and bladder cancer then the low, medium and high exposure groups should have an odds-ratio significantly greater than 1 and with the risk increasing across the groups.

An agent is considered a carcinogen here if the true dose-response relationship with cumulative exposure is increasing or has a threshold so the risk remains relatively flat until the threshold where it increases significantly. Additionally, an ordinal test was performed to test for a linearly increasing risk across the four exposure groups. This involved assigning labels of 0, 1, 2 and 3 to the reference, low, medium and high exposure groups respectively and tested the hypothesis that the slope amongst them in the conditional logistic regression model was zero. Assigning group medians as the ordinal score was considered, but as the scale of cumulative exposure is not linear with risk then the simple 0, 1, 2, 3 scoring was preferred.

The dose-response analysis is restricted to only those chemicals with at least nine bladder cancer cases ever being exposed to that chemical to ensure sufficient numbers for the low, medium and high exposure groups for analysis.

6.4.4 Multiple Comparisons

The p-value resulting from testing the association of one chemical exposure with the incidence of bladder cancer, is the type I error, the probability of a false positive. However, when multiple chemicals are tested and multiple p-values result, many positive results are expected by chance alone. If multiple chemicals are tested, but interest lies in looking at the results of only one, then this is not a concern. However, if a list of possible bladder cancer carcinogens is required, as is the case here, then the multiple testing must be taken into account.

The most conservative way to allow for multiple comparisons is to make a Bonferroni style adjustment to control the Family-Wise Error Rate (FWER). The FWER is the probability of at least one false positive from all chemicals tested. The Bonferroni adjustment involves multiplying each p-value by the number of chemicals tested and comparing this to the desired FWER, usually 5%. Effectively chemical exposures are declared significant when their p-values are extremely small. This method lacks power and there will many true bladder carcinogens that do not get detected.

Hochberg (1988) provides strong control (under all configurations of the true and false hypotheses) of the FWER, but with greater power. If m hypotheses $H_1, H_2, \ldots, H_m$ are tested with corresponding p-values $P_1, P_2, \ldots, P_m$, then the p-values are ordered $P_{(1)} \leq P_{(2)} \leq \ldots \leq P_{(m)}$ and $H_{(i)}$ denotes the null hypothesis corresponding to $P_{(i)}$. Hochberg's step-up procedure controls the FWER at a rate of α as follows:

$$\text{let } k \text{ be the largest } i \text{ for which } P_{(i)} = \frac{\alpha}{m+1-i};$$
$$\text{then reject all } H_{(i)}\ i = 1, 2, \ldots, k.$$

Control of the FWER is a conservative requirement that is often not necessary. Alternatively, the False Discovery Rate (FDR) can be controlled allowing more power than the FWER controlling procedures. The FDR is the expected rate of false positives among the rejected hypotheses. Whereas the Hochberg procedure guarantees that the probability of at least one false positive is less than α, the Benjamini and Hochberg (1995) controls the rate of false discoveries at an expected value of α%. Thus, in reality the true rate of false discoveries could be much larger (or smaller) than α. Although the Benjamini and Hochberg procedure has greater power than the Hochberg procedure, the overall type I error could be much higher than α. Note that when the FWER is controlled at rate α, the expected rate of false positives (FDR) is less than α%. Benjamini and Hochberg control the FDR at a rate of α when the hypotheses are independent as follows:

$$\text{let } k \text{ be the largest } i \text{ for which } P_{(i)} = \frac{i\alpha}{m};$$
$$\text{then reject all } H_{(i)}\ i = 1, 2, \ldots, k.$$

Controlling for the FDR essentially declares the same or, more usually, a greater number of hypothesises significant than controlling the FWER. The FDR is intuitively appealing here as it looks at the error rate in the list of chemicals selected, and has greater power than other procedures, so the Benjamini and Hochberg procedure is favoured in this thesis. Although the hypotheses to be tested here are not all independent, the Hochberg and Benjamini and Hochberg procedures should provide a guideline to the control of the multiplicity problem.

6.5 Testing the Agents in Groups: Principal Components Analysis

NIOSH provided exposure estimates for many agents, many of which are related to each other or have the same exposure probabilities across all jobs. Firstly, an attempt was made to construct natural groups from the agents. This organisation task has not been completed by NIOSH for their agents. The CAS (Chemical Abstracts Service) Registry is the largest substance identification system in existence. The registry contains records for more than 23 million organic and inorganic substances each assigned a unique CAS registry number, yet there is no defined grouping structure to the CAS registry numbers. Grouping the NIOSH agents would be difficult because agents with similar names could have different compositions or functions, or ones with similar functions or make-up could have different names. To distinguish between all possible different carcinogenic effects of chemicals, the groups would have to be quite small so that each agent is almost considered separately anyway. The process would require experts, be very complex, costly, and time consuming.

Given that grouping based on the agent names would be complex; grouping based on the cumulative exposure distributions across subjects can be undertaken. One approach to group the agents in this way is via principal component analysis. The ideas of principal component analysis are discussed in section 6.5.1. The components extracted can then be used in the conditional logistic regression model and the analysis approach taken is described in section 6.5.2.

6.5.1 Principal Component Analysis

The aim of principal component analysis (PCA) is to reduce the dimensionality of a data set which consists of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set. This is achieved by transforming to a new set of variables, the principal components (PCs), which are uncorrelated, and which are ordered so that the first *few* retain most of the variation present in *all* the original variables (Jolliffe, 1986). The terms component and factor are often used interchangeably in PCA.

The first PC is found by seeking a linear combination of the original variables that extracts the maximum variation from the data. This variation is removed and the second PC is sought explaining the maximum variation remaining in the data, and so on. Rotation methods serve to make the resulting PCs more interpretable. Varimax rotation is an orthogonal rotation method that minimises the number of variables that have high component loadings on each PC so that each PC has variables with either large or small loadings. The component loadings produced are the correlation coefficients between the variables and

PCs. Variables highly correlated with a PC are the defining constituents of that PC. A common rule is that a component loading is considered "weak" is less than 0.4 and "strong" if greater than 0.6.

The percent of variation explained by a PC is the average of the squared component loadings across all variables. The total variation explained by a PC is its eigenvalue. The important PCs to extract are those that combined account for most of the variation in the data. The Kaiser rule (Kaiser, 1960) is the most commonly used method to decide which PCs to extract. This criterion recommends extracting those PCs with eigenvalues of at least one.

The variable scores are standardised across subjects and combined according to the linear combination of variables described by the component to calculate the component score for each subject. These components scores can then be used in place of the original variable scores in other analysis such as logistic regression. The multicollinearity problems no longer exists for multiple regression as the components are independent of each other and the dimensionality of the regression has been reduced considerably.

It is important to include all variables relevant to uncovering the latent structure in PCA and exclude irrelevant variables. PCA does not require multivariate normality apart from for significance testing. Including more variables into the PCA is not a good idea when there is a possibility of suboptimal factor solutions ("bloated factors"). Too many similar variables will mask the true underlying factors. To avoid suboptimization, PCA should start with a small set of the most defensible variables that represent the range of each component. For algebraic reasons it is essential that there are more subjects than variables. There should be at least twice as many subjects as variables (Kline, 1994).

6.5.2 Grouping of Agents and Analysis Approach

There were many more possible agents (11,132) than subjects (9,119) to include in a PCA to uncover the latent structure of the data and many of the agents were not thought to be possible bladder carcinogens. The agents with the greatest potential of being bladder carcinogens were instead identified via the individual testing described in section 6.4 and principal components analysis performed on the continuous cumulative exposures of this subset. The cumulative exposure across these selected agents may be correlated as some patients were exposed to more than one agent at a time with some agents always occurring together in certain jobs.

PCA with varimax rotation was performed. Those PCs with eigenvalues greater than one were extracted. Agents were assigned to the component with which they had the greatest component loading and a component loading was considered "weak" if less than 0.4 and "strong" if greater than 0.6. Component scores were also calculated for each patient, and these each have a zero mean and unit standard deviation across patients.

Component cumulative exposures were created using a weighted average of the cumulative exposures of those agents assigned to each component using the component loading as the weighting. The dose-response and ordinal analysis could then be repeated comparing components rather than the agents individually. Also, an ever/never style analysis was performed where a dichotomous variable for each component indicated whether the patient was ever exposed to any of the agents assigned to that component, versus the patient was never exposed to the assigned agents. Similarly, a dichotomous variable for each component indicated whether the patient was ever exposed to all of the agents assigned to that component, versus the patient was never exposed to at least one of the assigned agents. The analyses of ordinal dose-response, ever exposed to any, and ever exposed to all, were also each combined in a multivariate conditional logistic regression. The correlations amongst the newly created variables were checked for no significant multicollinearity.

Chapter 7

Results

The results are reported in the order described in chapter 6. Firstly section 7.1 reports individual agent results. The agents selected that exhibit a significant association with bladder cancer risk are described in section 7.2. Section 7.3 then reports the results of the principal component analysis on the selected agents. The selected agents and their properties are discussed further in section 7.4. Finally, section 7.5 also provides a comparison of the results from this study for those IARC classified carcinogens with bladder cancer associations and those possible bladder carcinogens identified by Siemiatycki (1991).

7.1 Individual Agent Results

Section 7.1.1 reports the ever versus never exposed results for the 5,699 agents with at least 3 bladder cases exposed. Section 7.1.2 reports the dose response results for those 3,450 agents with at least 9 bladder cases exposed. Both the ever/never and dose-response results for those 3,450 agents with at least 9 bladder cases exposed are listed in the appendix in table A.1. Note that to save space, only the NIOSH agent codes are given in the table, so the associated NIOSH agent names can be found at the following website: www.cdc.gov/noes/srch-noes.html.

7.1.1 Ever/never

Table 7.1 summarises the results for the 5,699 agents with at least 3 bladder cases exposed with the ever versus never exposure as the exposure variable tested. A significantly (at the 5% level) increased odds-ratio was seen for 646 agents, of which 163 have odds-ratios above 2. Table 7.2 lists the 7 agents that remain significant at a 5% level after adjusting for multiplicity using the Benjamini and Hochberg procedure. The top 2 agents (2, 5- pyrrolidinedione, 1-(2-((2-((2-((2-aminoethyl)amino)ethyl)amino)ethyl) amino)ethyl)-, monopolyisobutenyl derivs, and natural gas, liquified) with the smallest p-values are also significant at the 5% level for the Hochberg multiple testing procedure.

7.1.2 Dose-Response

The cumulative exposure estimates for the 3,450 agents with at least 9 bladder cases exposed are divided into tertiles according to the controls. To give an idea of the values of these cut-off values, the average and standard deviation of the cumulative exposure estimate for the 33rd percentile was 0.05 and 0.14 respectively, and the average and standard deviation for the 67th percentile was 0.25 and 0.48 respectively.

Table 7.3 shows the distribution of p-values for the dose-response variables. The p-values and odds-ratios associated with the ordinal test of a linear dose-response trend (by assigning scores of 0, 1, 2 and 3 to the non-exposed, low, medium, and high cumulative exposures respectively) are included in the table. Of the 3,450 agents, 350 had a significant (5% level) linear increasing dose-response relationship; 22 and 2 of which were significant at the 5% level after adjusting for multiplicity using the Hochberg and Benjamini and Hochberg multiple testing procedures respectively. The results for the top 22 significant agents are shown later in table 7.5. The top 2 significant agents are 1, 2-ethanediamine, reaction products with chlorinated isobutylene homopolymer, and natural gas, liquified.

Table 7.3 also shows the distribution of p-values for the odds-ratio for the low, medium and high exposure groups. There were 377 agents with a significantly (5% level) increased risk for the low exposure group, 290 agents with a significantly (5% level) increased risk for the medium exposure group, and 215 agents with a significantly (5% level) increased risk for the high exposure group. None of the p-values were significant (5% level) after adjusting for multiple testing using the Hochberg or Hochberg and Benjamini procedures when looking at the results for each exposure group separately.

Table 7.4 compares the results from the ever versus never exposure and dose-response analysis. Significantly (5% level) increased odds-ratios for both the ever versus never exposure variable and ordinal variable were seen for 307 agents. Also, 107 agents had significantly increased odds-ratios for both the ever/never and ordinal variable at a 1% level.

7.2 Selecting Significant Associations

It is useful to select a small subset of agents that exhibit sufficient evidence indicating possible bladder carcinogenic properties that warrant further research. Many of the agents tested exhibited some positive relationship with bladder cancer risk. To provide a shorter selected list of agents with less chance of false positives, those agents with a significantly increased ever exposure risk or a significantly increasing linear dose-response relationship after separately adjusting for multiplicity via the Hochberg and Benjamini procedure were selected. In order to have adequate numbers for dose-response analysis, the selection process was restricted to those 3,450 agents with at least 9 cases exposed. This enabled greater power in the ever/never analysis meaning that now 25 and 4 agents were significant at the 5% level after adjusting for multiplicity using the Hochberg and Benjamini and Hochberg multiple testing procedures respectively.

This selection procedure resulted in 30 selected agents, as listed in table 7.5. All of the agents had an ever/never p-value less than 0.2% and ordinal p-value less than 0.8%. Of the agents selected 20 had ever/never odds-ratios greater than 1.3. Only 9 agents did not have all three dose-response levels with odds-ratios significantly greater than one at a 20% level, whereas 22 agents did not have all three dose-response levels with odds-ratios significantly greater than one at a 5% level.

7.2.1 Linear Exposure

As mentioned previously in section 5.2.9, the distribution of the positive cumulative exposures for most agents is highly right-skewed. Figure 7.1 shows the histograms of the positive cumulative exposures for each of the 30 selected agents. However, a logarithm transformation results in normally distributed positive cumulative exposures for most agents. A linear conditional logistic regression fit through the original cumulative exposures would be highly dependent on extreme observations. A linear regression through the transformed cumulative exposures would be a much more robust fit. However, a logarithmic transformation leaves the question of what to do about the zeros, the non-exposed patients. The results of a linear regression fit would vary depending on the score assigned to the non-exposed patients.

The Box-Cox transformation (Box and Cox, 1964) is used instead as it tends to a logarithmic transformation as λ tends to zero. The box-cox transformation is as follows:

$$x(\lambda) = \begin{cases} \frac{x^{\lambda}-1}{\lambda} & \text{if } \lambda \neq 0 \\ log(\lambda) & \text{if } \lambda = 0 \end{cases}$$

A value of λ of 1/100 or 0.01 was chosen as sufficiently small to transform the distributions of the original positive cumulative exposures to be approximately normal. Figure 7.2 shows the histograms of the transformed positive cumulative exposures for the 30 selected agents. Table 7.6 shows the results of fitting a straight line through these transformed cumulative exposures for the top 30 agents. As expected, all 30 agents have a very significant increasing linear trend, all with a p-value less than 0.0014. If all 3,450 agents were tested, then the top 4 agents (sulfonic acids, petroleum, magnesium salts; natural gas liquefied; phosphorodithioic acid, mixed O, O-bis(sec-Bu and 1,3-dimethylbutyl) esters, zinc salts; 1, 2-ethanediamine, reaction products with chlorinated isobutylene homopolymer) would remain significant after adjusting for multiplicity using the Hochberg procedure.

7.3 Grouped Agent Results: Principal Components Analysis

The exposures to the chosen 30 significant agents may not be independent. For example, some agents may always occur together, so if a patient was exposed to one agent then they were also exposed to the partnering ones. It would then be difficult to distinguish which agent is truly associated with the bladder cancer risk. Also, the analysis of the chosen 30 agents has been only univariate thus far. A multivariate analysis could be performed to allow the effects of an agent's exposure to be jointly adjusted for all the effects of the other agent exposures. The patients' cumulative exposures to many of the selected agents are highly correlated with each other (12 of the agents have a Pearson correlation coefficient greater than 0.9 with at least one other agent), and hence multicollinearity is a potential problem. Therefore, principal components analysis was performed to examine the relationships between the agents.

Performing principal components analysis on the 30 agents resulted in 10 components with an eigenvalue greater than one. Table 7.7 lists the component loadings for each agent and identifies those loadings greater than 0.4. The largest component accounts for 26.3% of the total variance, and the first 3 components combined account for more than 50% of the total variance.

The component scores were used to create a cumulative exposure variable for each component by using the component scores of those agents associated with a component as the weights and computing a weighted average of the agents' cumulative exposure. The following sections provide the results of a dose-response analysis, an 'any exposure' analysis and an 'all exposure' analysis.

7.3.1 Component Groups - Dose-Response

Table 7.8 shows the results of the dose-response analysis on the component groups. As expected all components show a significantly linearly increasing dose-response relationship. Table 7.9 shows that components 2, 4 and 9 remain significant (5% level) after backwards selection when all 10 component ordinal variables are entered into a multivariate conditional logistic regression model.

7.3.2 Component Groups - Any Exposure

Table 7.10 shows the results of the 'any exposure' analysis on the component groups where 'any exposure' is defined as cumulative exposure greater than zero for any members of the component. As expected all components show a significantly increased risk if a patient was ever exposed to any members of the component. Table 7.11 shows that components 3, 6 and 10 are significant (5% level) from backwards selection when all 10 component 'any exposure' variables are entered into a multivariate conditional logistic regression model.

7.3.3 Component Groups - All Exposure

Table 7.12 shows the results of the 'all exposure' analysis on the component groups where 'all exposure' is defined as cumulative exposure greater than zero to all of the members of the component. As expected all the components show a significantly increasing risk when a patient is exposed to all members of the component. The odds-ratio for the 25 patients ever exposed to all 5 agents in component 2 is large at 3.11. Table 7.13 shows that components 1 and 2 remain significant (5% level) after backwards selection when all 10 component ordinal variables are entered into a multivariate conditional logistic regression model.

7.4 Properties of the Selected Agents

The cumulative exposures of the agents were derived from a JEM that distinguished exposure probabilities according to job type. So it was suspected that the selected 30 agents would be grouped in some way according to jobs. If workers in a job are exposed to a particular agent that is a bladder carcinogen, but they are always exposed to other agents alongside the carcinogen, then it would be difficult to distinguish between the agents. This effect can be seen to some extent in the selected agents. Figure 7.3 shows a breakdown of the total cumulative exposure to each agent contributed by all study patients according to US job (industry and occupation pair). As an example, 85% of the total cumulative exposure to X2307 (alkenes, C15-18 alpha-, reaction products with sulfurized dodecylphenol calcium salt, sulfurized) experienced by the 9,119 patients was due to employment in a timber cutting or logging occupation in the logging industry. All agents comprising the first principal component have a substantial proportion of their cumulative exposure due to employment in this job. In fact, timber cutting or logging occupations in the logging industry accounted for the largest proportion (32%) of the total cumulative exposure to all 30 agents.

Interestingly, all cumulative exposure to Y1006 (natural gas, liquified) was due to employment in gasoline service station related occupations. Furthermore, a proportion of the participants of the NIOSH NOES study employed in this occupational group were exposed to 28 of the agents selected, all but 73075 (SN, tin - MF unknown) and 90590 (clay, nec). It must be noted that these jobs are the US classifications, and there may be more than one possible Canadian job translation equivalent. However, the gasoline service station related occupations only translate to one Canadian equivalent; Gasoline Service Stations - Service

Station Attendants. As expected, many of the agents seem to form principal component groupings according to the distribution of the US job equivalents they occurred in. The cumulative exposures across all 9,119 patients for X2305 (2,5-pyrrolidinedione, 1-(2-((2-((2-((2-aminoethyl)amino)ethyl)amino)ethyl)amino)ethyl)-, monopolyisobutenyl dervis., reaction pr) and X2308 (sulfonic acids, petroleum, magnesium salts) comprising the fourth principal component have a correlation of 0.999. Their similarity can also be seen across their job distributions.

Table 7.14 lists the agents in order of the principal components as per table 7.7. The US job that contributes most to the cumulative exposure of that agent and what percentage it contributes (as seen in figure 7.3) is given. Additionally, it provides the JEM proportion of employees exposed to that agent in the listed job. For example, just over 50% of people in the NIOSH NOES study employed in timber cutting and logging occupations were exposed to each of the agents comprising the first principal component. However, a very small proportion (1-3%) of people employed in gasoline service station related occupations were exposed to each of the agents comprising the second principal component.

Table 7.14 also lists the number of bladder cancer cases exposed to each agent and the CAS (Chemical Abstracts Service) number for each NIOSH agent if applicable. The CAS number was used to identify an IARC classification, which is also provided if available. An IARC classification could not be found for most agents mainly due to the complexity of the agents involved. There is very little information available on many of these complex chemicals.

7.4.1 Discussion of the Selected Agents

First Principal Component. Most (52%) of the cumulative exposure to agents in this component was due to employment in timber cutting and logging occupations. Just over half of the NIOSH NOES study participants employed in timber cutting and logging occupations were exposed to each of these agents. X2298 (phenol, dodecyl-, sulfurized, carbonates, calcium salts, overbased) has not been classified by IARC. It is an ingredient (1-5%) in "Energol CLO 50M" (diesel engine oil). X2293 (sulfonic acids, petroleum, calcium salts, overbased) is not classified by IARC, but is 100% of the ingredients of "Syndustrial P Compressor Oil (All Grades)". X2295 (phosphorodithioic acid, O, O-bis(2-ethylhexyl) ester, zinc salt) is not classified by IARC, but comprises 0.5-1% of "CHAMPION SUPER GRADE 5W20 (4229)" (petroleum based lubricating oil). X2689 (1, 2-ethanediamine, reaction products with chlorinated isobuylene homopolymer) is not classified by IARC, but comprises 40-50% of "VANLUBE 869" (industrial antioxidant). Here 60713 (products of combustion - gasoline (leaded)) is considered the same IARC classification, possibly carcinogenic, as gasoline engine exhaust (IARC monographs Vol.: 46 (1989) (p. 41)). X5263 (products of combustion - jet fuel and gasoline, unleaded) has not been classified by IARC. However, as gasoline engine exhaust is classified as possibly carcinogenic and jet fuel is classified as not classifiable, then X5263 may have carcinogenic properties. The agents comprising the first principal component seem to be petroleum or mineral oil based, and occur frequently in the logging industry.

Second Principal Component. Most (52%) of the cumulative exposure to agents in this component was due to employment in gasoline service station related occupations. Very few (less than 4%) of the NIOSH NOES study participants employed in gasoline service station related occupations were exposed to these agents. Few bladder cancer cases were exposed to these agents, with the maximum being 35 cases exposed to X1401 (2-butenedioic acid (E)-, polymer with 1,3-butadiene and ethenylbenzene). This agent has not been classified by IARC, but ethenylbenzene is classified as possibly carcinogenic, and 1,3-butadiene is classified as probably carcinogenic. Thus, agent X1401 may have possible carcinogenic properties.

83048 (nonylphenoxyethanol) is not classified by IARC, however it is an alkylphenol ethoxylate. Alkylphenol ethoxylates are used in industrial detergents (such as those used for wool washing and metal finishing), in some industrial processes, and in some liquid clothes detergents (Warhurst, 1995). Alkylphenols are an environmental concern as they do not break down in the environment and accumulate in rivers, fish and birds, and they have oestrogenic properties. The effects of nonylphenol on cultured human breast cells (Soto et al., 1991) also led to health concerns in humans. Subsequently, many European countries have brought in controls on alkylphenols, and Switzerland has banned the use of all alkylphenol ethoxylates.

X4267 (ether, tert - butyl methyl) is classified as not classifiable by IARC. Methyl tert-butyl ether is a volatile synthetic chemical that has been used widely since the 1980s in proportions up to 15% as a component of gasolines for its octane-enhancing and air pollution-reducing properties. In service stations where fuels containing $>$ 10% methyl tert-butyl ether are delivered, the average concentration to which attendants are exposed is about 0.5 ppm (2 mg/m3) (IARC monographs Vol.: 73 (1999) (p. 339)). No epidemiological studies have directly addressed the relationship between methyl tert-butyl ether exposure and human cancer risk. However, inhalation of methyl tert-butyl ether resulted in increased incidence of renal tubular tumours in male rats.

Perhaps the relationship seen between the cumulative exposure to agents in the second component and bladder cancer risk in this study is due to the possible carcinogenic effects of X4267 (ether, tert - butyl methyl). Alternatively, some other chemical exposures involved in the gasoline service station attendant job could make these employees at greater risk of bladder cancer.

Third Principal Component. Much (27%) of the total cumulative exposure to this component comes from employment as a plumber pipefitter and streamfitter apprentice in the construction industry. Agent

90320 (asphalt) is classified by IARC as not classifiable (IARC monographs Supplement 7 (1987) (p. 133)). There have been no epidemiological studies looking directly at the association with asphalt exposure and human cancer risk. However, a cohort study of US roofers indicated an increased risk for cancer of the lung and suggests increased risks for bladder cancer. The asphalt group is on the priority list of agents to consider in future IARC monographs due to several ongoing epidemiological studies. For example, Randem, et al. (2003) recently found increased lung cancer incidence rates in a cohort of male Norwegian asphalt workers. Siemiatycki (1991) also found a significantly increased risk of bladder cancer for substantial exposure to asphalt.

The relationship seen between the cumulative exposure to agents in the third component and bladder cancer risk in this study could be due to the possible carcinogenic effects of 90320 (asphalt).

Fourth Principal Component. Much (25%) of the total cumulative exposure to this component is due to employment as a carpenter in the ship and boat building industry. A further 23% of the total cumulative exposure is due to employment as a miscellaneous electronic equipment repairer in the pulp paper and paperboard mill industry, and 18% of the total cumulative exposure to this component is due to employment as a heavy truck driver in the trucking service industry.

Fifth Principal Component. X1075 (phosphorodithioic acid, O-(2-ethylhexyl) O-isobutyl ester, zinc salt) is not classified by IARC, but is <10% of the ingredients of "multi-purpose lubricant (dri-side)". Agent 36955 (hexane) is not classified by IARC, but is chemical made from crude oil and often used to produce solvents.

Sixth Principal Component. M1150 (cyclohexylamine, n - ethyl -) is not classified by IARC, although cyclohexylamine is not classifiable (IARC monographs Supplement 7: (1987) (p. 178)). The classified IARC group is for cyclamates, which are artificial sweeteners. The IARC states that the evidence that the risk of bladder cancer is increased among users of artificial sweeteners is inconsistent. Exposure to M1150 could have associations with increased risk of bladder cancer. M0984 (ethanol, 2-(2-(2-butoxyethoxy) ethoxy)-) has not been classified by IARC, but it is a triethylene glycol ether. Some monoethylene glycol ethers are nominated for IARC review, so it is possible that M0984 could have some carcinogenic effects.

Seventh Principal Component. Agent 90590 (clay, nec) has not been classified by IARC, however Siemiatycki (1991) found a significantly increased risk of bladder cancer for ever exposure to clay dust. Perhaps inhalation of the dust of agent 90590 has an effect on bladder cancer development here. Agent T1475 (solvent refined heavy paraffinic distillate (petroleum)) has been classified by IARC. It is either classified as definitely carcinogenic or not classifiable depending upon whether it is untreated and mildly treated mineral oil or a highly-refined mineral oil respectively (IARC monographs Vol.: 33 (1984) (p. 87)).

Eighth Principal Component. Cumulative exposure to T1909 (nonylphenol ethylene oxide adduct) was mostly due (64%) to employment as a lathe and turning machine set-up operator in the ship and boat building industry. It has not been classified by IARC, but it is also an alkylphenol ethoxylate as agent 83048 is from the second component.

Ninth Principal Component. Agent 92500 (oil, hydraulic) is a mineral oil and depending upon whether it is untreated and mildly treated or highly-refined, then it is classified as definitely carcinogenic or not classifiable respectively (IARC monographs Vol.: 33 (1984) (p. 87)). Agent P0620 (impact noise) is probably an example of an agent that always occurs alongside the possible carcinogen (here, hydraulic oil).

Tenth Principal Component. Most (51%) of the total cumulative exposure to X1894 (2-propenoic acid, 2-me-, C12 ester, poly w/ C16 2me2propenoate, iso-C10 2me2propenoate, me 2me2propenoate, C18 2me2propenoate, C14 2me2propenoate) is due to employment as a power plant operator in a hospital. All of the NIOSH NOES subjects employed in this job were exposed to agent X1894. A further 23% of the total cumulative exposure is due to employment as a knitting, looping, taping, and weaving machine operator in the apparel and accessories (except knit) industry.

7.5 IARC and Siemiatycki Results Comparison

It would be useful to see how the results compare for those agents that are already considered bladder carcinogens. Table 7.15 shows table 3.2 from section 3.3 updated with corresponding agent results where possible. The chemicals listed are those IARC has classified that include bladder as one the cancer sites affected by the chemical. Most chemicals were translated into a NIOSH equivalent via the CAS number. When there were multiple CAS numbers for the chemical, or multiple NIOSH equivalents, then all are provided. Often there were no NIOSH equivalent chemicals. Often if there was a NIOSH equivalent chemical then it had very few cases exposed possibly because the use of the chemical had been restricted.

The results for the IARC classified definitely carcinogenic chemicals do not seem to support that classification, although the odds-ratios are not significant and the numbers are small. It could be the case that these chemicals are more carcinogenic for other cancer sites so are not showing a result for bladder. However, the results for the IARC classified possibly carcinogenic chemicals are much more consistent. Lead is the only possibly carcinogenic classified agent to show consistent results.

Table 7.16 shows the Siemiatycki potential bladder carcinogens from table 3.3 updated with corresponding agent results where possible. Finding equivalent NIOSH results was more difficult here as often Siemiatycki would group chemicals in broad categories. There were then no such NIOSH categories to compare with. The results in this study were consistent with Siemiatycki's for titanium dioxide, engine emissions, diesel engine emissions, calcium carbonate, formaldehyde, and asphalt. Other agents showed results similar to Siemiatycki's, but were not statistically significant, often due to small numbers.

Chapter 8

Discussion

Identifying occupational carcinogens is a difficult task. Cancer is a chronic disease, so a long time period may elapse between occupational carcinogen exposure and cancer symptoms. In order to observe enough study subjects that develop cancer, estimation of the occupational exposures and other confounders is often imprecise or may involve many assumptions. Despite some concerns over the validity of epidemiological studies, it is clear that formal attempts at examining the human experience are required when extrapolating the results of animal experiments is difficult.

Whilst many assumptions were made in this study, and the methodology and JEM applied not perfectly precise, we have been as rigorous as possible to provide as valid results as we could given the difficult problem and data available. In testing so many chemical exposures we were bound to find many positive associations by chance alone, however allowance for multiplicity was made in the calculations. Section 8.1 provides a summary of the study's findings. In section 8.2 issues of bias and confounding are discussed and the validity of the study methodology is discussed in section 8.3. Further research directions are outlined in section 8.4.

8.1 Summary of Findings

Many of the patients in our study were potentially exposed to many of the NIOSH agents investigated. There were 5,699 agents for which at least 3 bladder cancer cases had potentially been exposed, of which 3,450 had at least 9 bladder cancer cases exposed. Positive associations with bladder cancer were seen in many agents. A significantly (5% level) increased odds-ratio was seen for ever exposure to 646 agents. A significantly (5% level) increasing linear dose-response was seen in 350 agents.

A subset of 30 agents was selected as exhibiting sufficient results to indicate possible bladder carcinogenic properties requiring further research. The agent exposures were correlated, mainly amongst jobs, and 10 independent groups of agents were identified. Most of the selected agents seemed to have some petroleum or mineral oil base. IARC has classified occupational exposures in petroleum refining (IARC monographs Vol. 45; 1989) and diesel engine exhaust (IARC monographs Vol. 46; 1989) as probably carcinogenic, marine diesel fuel (IARC monographs Vol. 45; 1989), gasoline engine exhaust (IARC monographs Vol. 46; 1989), heavy residual fuel oils (IARC monographs Vol. 45; 1989), and gasoline (IARC monographs Vol. 45; 1989) as possibly carcinogenic. Excess bladder cancer risk has also been observed frequently among truck and motor vehicle drivers (Silverman, 1989). This cancer risk is thought to be partly due to exposure to the polycyclic aromatic hydrocarbons (PAHs) contained in exhaust emissions. A significant (5% level) odds-ratio of 1.92 for ever exposure to the PAH benz(a)anthracene was found in this study. Only a small number of bladder cancer cases were ever exposed to the other PAHs.

Most of the cumulative exposures to the 30 agents occurred due to employment in timber cutting and logging occupations, ship and boat building and construction industries, and occupations involving motor vehicles (gasoline service station attendant, mechanic, truck driver, motor vehicle production). Significantly increased bladder cancer risks were seen for these occupations and industries when an analysis was performed on the same BCCA occupational data as in this study, but when looking at ever or usual employment in an occupation or industry (Band et al, 2004). We hope to have provided some further insight into what particular chemicals within these occupations may contribute to the increased bladder cancer risk.

8.2 Bias and Confounding

Issues of bias and confounding are discussed further in the following sections.

8.2.1 Comparability of Source Populations for Cases and Controls

The bladder cases were obtained from a well-defined source population of males resident in BC aged over 20 when diagnosed with cancer between 1983 and 1990 and ascertained by BCCA. BCCA receives information from every newly diagnosed cancer case in the province. So the bladder cases are approximately an exhaustive group of eligible subjects diagnosed with bladder cancer within the study period. The controls came from the same source population and are almost an exhaustive group of those patients diagnosed with cancer within the study period, apart from the primary unknown sites and the lung cancer patients are excluded from analysis. Thus the controls represent those in the source population that would have been cases if their primary cancer were diagnosed as bladder cancer.

8.2.2 Selection Bias

Non-response bias was minimal as the response rate was quite high (64.7% of bladder cancers responded and 64.1% of possible control cancer sites responded) and there were no major differences between non-responders and responders apart from responders were more likely to have managerial or administrative as their usual occupation. The cases and controls may not represent the source population fully with respect to occupational exposure, as the source population may be slightly more exposed to potential occupational carcinogens than the cases and controls. This difference should not be large and the results should still extend to the entire source population. Patients with missing occupational data were excluded from analysis, but they were a small subgroup and did not differ from the remaining patients substantially.

The source population contains all males aged over 20; so those that worked for many years in few jobs, those that changed jobs frequently, those with few work-years, and those non-workers. Healthy worker bias is unlikely here as both the cases and controls had the same proportion (0.3%) of non-workers, both had reported a similar amount of jobs (the cases reported an average and standard deviation of 4.6 and 2.5 jobs and the controls reported an average and standard deviation of 4.9 and 2.6 jobs), and both had a similar duration of work-years for each patient.

8.2.3 Information Bias

Little recall bias was expected as all responders from the source population used in the analysis responded to the questionnaire as if they were a case. The information gained on the cases and controls would have contained some error, but very little, if any of this would have been differential.

Misclassification of case and control status is very unlikely as diagnoses were classified using the ICD-9 codes and all were histologically confirmed. The patients with a primary unknown cancer site were also removed from the analysis to avoid this misclassification. The questionnaire was considered valid and reliable. However, the questionnaire data will contain much misclassification. Data is often unknown for some patients, some patients could have accidentally answered incorrectly or have been unwilling to answer truthfully. However the degree of the misclassifications should not differ between cases and controls. A variable that may have suffered from differential misclassification was the alcohol score variable, so this variable was excluded from the analysis. A greater proportion of controls received the early questionnaire that omitted questions regarding alcohol drinking habits so the controls were likely to have greater misclassification on the alcohol score variable than the cases.

Misclassification of occupational exposure is expected due to the difficulty in approximating the true exposure. Again, this misclassification should not be differential. Patients with missing occupational data were excluded from analysis, however the occupational data given by the remaining patients could be with error. The larger errors occur in approximating the occupational exposure from the occupational histories. The JEM used to estimate exposures in different US jobs has limitations, for example, it was only applicable to one period in time, the jobs were located in the US, there was no allowance for exposure variability within a job, and many industries were excluded from the JEM. The calculation method will have incorporated error also; all job translations were considered equally adequate, the average was considered an appropriate method to combine exposures across job-translations, a part-time job was considered half as any work-hours as a full-time job, exposures missing from the JEM were considered zero, and the exposures were considered to have equal weight across a persons lifetime (e.g. here childhood and early exposures are as important as late exposures or exposures after retirement, when it could be the case that early exposures are much more important than late exposures).

8.2.4 Confounding by Non-Occupational Variables

Non-occupational confounders were taken into account in the matching and conditional logistic regression base model. The confounders were consistent with current knowledge of bladder cancer and the questionnaire design. Information was not sought for some other possible bladder cancer non-occupation confounders, but they may not have had much effect on the base model beyond the main confounders identified.

8.2.5 Confounding by Occupational Exposure

Occupational exposure to known bladder cancer carcinogens may confound the effect of other occupational exposures. Different occupational exposures may cluster together within a job and it would be hard to distinguish which agents actually contributed to the exposure-disease association. These problems are addressed in part by the principal component analysis, which considers groups of agents that group together according to the cumulative exposure estimates.

8.3 Evaluation of Methods

The methodology used in this study had many limitations. The greatest possibly being the use and applicability of the NIOSH JEM. As discussed in chapters 4 and 5, some important industries were excluded from the NIOSH NOES study. The NIOSH JEM only covered a short period in time, whilst we were estimating exposures over patients' lifetimes, during which time many workplace conditions have changed. Assumptions were made that the NIOSH JEM probabilities represented the lifetime probabilities of exposure for the BCCA patients. Assumptions that the US jobs were comparable to Canadian jobs seem fair and the great majority of the BCCA patients' jobs occurred within Canada. The results of this study indicate another limitation of the JEM, in that it only differentiates up to the level of the job. No allowances are made for exposure variability or different working habits within a job. Also, in this study we were unable to distinguish between different concentrations and frequencies of exposure, as was the case in Siemiatycki (1991) study. However, using a JEM with probability assessments enabled us to put a much more precise estimate on the actual exposure of a patient rather than that obtained through interviewing the patient.

There were also many possible ways of analysing the results. Two additional methods, which were not considered as relevant as the ever/never variable and dose-response analysis, are discussed in the next two sections.

8.3.1 Ever/never 0.5

As mentioned before in section 6.4.2, the ever/never variable used in the analysis does not indicate definite exposure to an agent. In an attempt to find a variable that more truly measures ever versus never exposure, a possible cut-off value for the cumulative exposure estimates was hypothesised. A cut-off value of 0.5, so ever exposure represented those patients expected to be exposed for at least half a work-year (or a part-time work-year) versus those expected to be exposed for less, was a natural cut-off value. However, very few patients had exposures that high. Of the 2,772,021 exposed bladder cases and controls and agent pairs, 622,560 (22%) had a cumulative exposure greater than 0.5. Of all 8,986 agents, only 2,237 (25%) had at least three bladder cases with cumulative exposure above 0.5.

The value of 0.5 was chosen as an attempt to capture those patients with likely exposure in a job (i.e. probability of exposure greater than 0.5) and those with a large amount of expected exposed years. However, if a patient's true chance of exposure in their Canadian job was at least 50%, they did not necessarily have a cumulative exposure greater than 0.5. This is because the probability of exposure calculated for the Canadian job was the average over all those for the US translation combinations and some of these may have had zero exposures. Therefore the results for the analysis on cumulative exposures above 0.5 versus those below 0.5 were not provided in this thesis, and instead the results from the simple ever/never variable were presented.

8.3.2 Siemiatycki Comparison

The study undertaken by Siemiatycki (1991) was described in section 3.3. Exposure variables comparable to his 'any exposure' and 'substantial exposure' were considered. His definition of 'any exposure' was exposure that was at least probable, at least at a background level and occurred at least 1% of the time. This was not easily comparable to the calculated cumulative exposure as NIOSH measured exposures occurring at least 1.4% of the time at any concentration and the confidence was measured by the JEM probability. Siemiatycki's definition of 'substantial exposure' was exposure that was at least probable, above a background level and occurred at least 5% of the time for at least 5 years. The 'any exposure' and 'substantial exposure' classified exposures were different in terms of the frequency of exposure, and these differences were not detectable from the NIOSH JEM.

This thesis could have involved recording the NIOSH JEM data in categories similar to that of Siemiatycki, e.g. by labelling confidence of an exposure as those JEM probabilities less than 0.5 as 'possible', those 0.5 - 1 as 'probable', and those equal to 1 as 'definite'. However, this throws away information, and the majority of JEM estimates would be labelled 'possible' and those 'definite' would be unreliable, as they would be based on small samples. Also, combining the confidence codes of each US job-translation possibilities for each Canadian job would be difficult.

Siemiatycki's 'any exposure' and 'substantial exposure' definitions constitute cut-off values consistent across all agents tested. A consistent cut-off value for cumulative exposure across all agents in the study was considered inappropriate as the agents have different exposure distributions. To apply to many agents, a very low cut-off value with little practical meaning would be required. As there is no biological method to define a cut-off value for each agent's cumulative exposure, cut-offs based on the individual distribution of exposure to each agent were considered. For example, this could involve labelling the top 10% exposures for each agent as being 'exposed' and the remaining 90% as not.

The exposure distributions of Siemiatycki's study subjects should be very similar to those experienced by the BCCA subjects as they are both male Canadian subjects exposed over roughly the same period in history. A suggestion was that the proportions used for Siemiatycki's definitions of 'any exposure' and 'substantial exposure' could be transferred to each agent in the current study. For example, 'substantial exposure' could refer to the top 10% of exposures and 'any exposure' to the top 30%. However, the proportions vary across chemicals and it would be very difficult to find equivalent proportions for each of the thousands of chemicals studied by NIOSH, so an average was considered. Depending on which chemicals were averaged over and what Siemiatycki design configuration was used (population or cancer controls, French Canadian population or all ethnicities); the proportion of 'any exposure' and 'substantial exposure' ranged from 1.5 - 2.9% and 4.8 - 8.2% respectively.

However, applying any of the cut-off proportions in the ranges calculated to all agents in the study will result in some agents having patients classified as exposed when they have zero cumulative exposure.

The clearest distinction in the cumulative exposure estimates could be made between those with a value of zero (no exposure) and those with a value above zero (exposed). Given these two groups were different, they were separated in the analysis of the ever/never variable and the dose-response analysis.

8.4 Future Directions

An immediate step to take is to assess the impact of any measurement error in the cumulative exposure variables. The cumulative exposure assessments were composed of the duration of employment, obtained from questionnaire responses, which are known to often contain error, and the JEM probabilities of exposure, which more importantly were often based on small numbers and certainly contained a margin of error. The positive cumulative exposures were normally distributed after taking a Box-Cox transformation. So, a multiplicative measurement error model could be fit to the data and Bayesian methods used to assess the implications of different levels of measurement error (Gustafson, Le and Vallée, 2002).

As most of the uncertainty in the results is due to the JEM used, a more comprehensive one could be applied to the data in the future if one became available that contained more information on the exposures, allowed for changes in time, gave some measure of error or variability, and studied exposures in more industries. Alternatively, industry specific JEMs created in Canada, or ideally within the BCCA, could be applied in conjunction with the current NIOSH JEM to improve some of the estimates or provide estimates for the industries that were not studied.

Other improvements beyond the JEM include conducting pairwise (industry and occupation code combined) translations of the Canadian jobs that could include weightings as to which translations are more likely. Further information could be sought via questionnaires on the patients, such as family history of cancer, body weight, stress levels, fitness levels, diet, etc.

Finally, the 30 agents identified in this study warrant further research. Perhaps animal studies could be undertaken on exposure to the chemicals, or specific cohort studies conducted to examine the relationships seen.

Chapter 9

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Chapter 10

Tables and Figures

Table 2.1: Two by Two Contingency Table for Cohort Studies

	Diseased	Not Diseased	Total Sample
Exposed	A_1	B_1	$A_1 + B_1$
Not Exposed	A_0	B_0	$A_0 + B_0$

Table 2.2: Two by Two Contingency Table for Case-Control Studies

	Diseased	Not Diseased
Exposed	a_1	b_1
Not Exposed	a_0	b_0
Total Sample	$a_1 + a_0$	$b_1 + b_0$

Table 3.1: Occupations Associated with Bladder Cancer

Occupation or Industry	IARC[a]	Suspected agents
Aluminium production	1	Pitch violates, coal-tar pitch volatiles, aromatic amines
Aromatic amine manufacturing workers	N/A	2-naphthylamine, benzidine, 4-aminobiphenyl. Possibly: MDA (4,4-methylene-dianiline), MBOCA (4,4-methylene-bis(2-chloroaniline), 4-cholor-o-toluidine (4-COT).
Boot and shoe manufacture and repair	1	Leather dust, dyes, benzene and other solvents
Leather workers	3	Leather dust, dyes, solvents
Coal gasification	1	Coal tar, coal-tar fumes, individual PAHs
Coke production	1	Coal-tar fumes, polynuclear aromatic hydrocarbons (PAHs)
Drivers of trucks and other motor vehicles	N/A	Motor exhaust (polycyclic aromatic hydrocarbons, nitro-PAHs)
Dry cleaning solvent-exposed workers	2B	Benzene, naphtha, gasoline, stoddard solvent (mineral or white spirits), carbon tetrachloride, trichloroethylene, tetrachloroethylene, chlorofluorocarbon solvents, chlorinated solvents, amyl acetate, bleaching agents, acetic acid, aqueous ammonia, oxalic acid, hydrogen peroxide and dilute hydrogen fluoride solutions
Dyestuffs workers and dye users	N/A	3 aromatic amines (2-naphthylamine, benzidine, 1-naphthylamine), o-toluidine, 4,4-methylene bis(2-methylaniline).
Auramine manufacture	1	2-naphthylamine, auramine, other chemicals
Magenta manufacture	1	Magenta, ortho-toluidine, 4,4-methylene bis(2-methylaniline), ortho-nitrotoluene
Hairdresser or barber	2A	Some compounds in hair dyes, aromatic amines, aminophenols, hydrogen peroxide, aminoanthraquinones, azo dyes, lead acetate, volatile solvents, propellants, aerosols, formaldehyde, methacrylates
Painters	1	Paints (benzidine, polychlorinated biphenyls, formaldehyde, asbestos) and solvents (benzene, dioxane, methylene chloride).
Petroleum refining	2A	Aliphatic hydrocarbons, aromatic hydrocarbons, hydrogen sulfide, polycyclic aromatic compounds
Printing processes	2B	Carbon black, titanium dioxide, azo, anthraquinone and triarylmethane dyes, and phthalocyanines
Rubber industry	1	Aromatic amines, solvents, 2-naphthylamine, phenyl-b-naphthylamine (PBNA).
Textile manufacturing	2B	Textile-related dusts, dyes, optical brighteners, organic solvents and fixatives, benzidine, formaldehyde, flame retardants (including organophosphorus and organobromine compounds)

[a] IARC classification where 1 is definitely carcinogenic, 2A is probably carcinogenic, 2B is possibly carcinogenic, and 3 is not classifiable

Table 3.2: Chemicals Associated with Bladder Cancer

Chemical Name	Siemiatycki ORs		IARC	
	Any	Substantial	Class[a]	Evidence
1,3-Dichloropropene			2B	Animal
2-(2-Formylhydrazino)-4(5N2F)T[b]			2B	Animal
2-Naphthylamine			1	Human
2-Nitroanisole			2B	Animal
3,3'-Dichlorobenzidine			2B	Human
3,3'-Dimethoxybenzidine			2B	Human
4,4'-Methylenebis(2-chloroaniline)			2A	Animal
Adriamycin			2A	Animal
4-Aminobiphenyl (xenylamine)			1	Human
4-chloro-ortho- phenylenediamine			2B	Animal
Arsenic			1	Human
Auramine			2B	Human
Benz(a)anthracene			2A	Animal
Benzidine			1	Human
Benzidine based dyes			2A	Animal
Carbon black	2.2*	1.8	2B	Human
Chlordane			2B	Human
Chloroform (in drinking water)	†	†	2B	Human
CI Basic Red 9			2B	Animal
Citrus Red No. 2			2B	Animal
Coal tar pitches	0.9	2.3	1	Human
Cyclophosphamide			1	Human
Diesel engine emissions	1.4	2.3**	2A	Human
Disperse Blue 1			2B	Animal
Engine emissions	1.2*	1.3*	2A	Human
Gasoline	1.1	0.9	2B	Human
Lead			2B	Human
Magenta			1	Human
Mineral oils[b]	1.2	2.2	1	Human
N-[4-(5-Nitro-2-Furyl)2TZ]A[b]			2B	Animal
Niridazole			2B	Animal
Nitrilotriacetic Acid			2B	Animal
N,N-Bis(2-CE)-2-NL[b] (Chlornaphazine)			1	Human
N-Nitrosodi-n-butylamine			2B	Animal
Oil Orange SS			2B	Animal
ortho-Aminoazotoluene			2B	Animal
para-Chloro-ortho-Toluidine			2A	Human
para-Cresidine			2B	Animal
para-Dimethylaminobenzene			2B	Animal
Phenacetin			2A	Human
Ponceau 3R			2B	Animal
Sodium ortho-phenylphenate			2B	Animal
Tetrachloroethylene	†	†	2A	Human
Trichloroethylene	0.6	0.7	2A	Human

[a] IARC classification where 1 is definitely carcinogenic, 2A is probably carcinogenic, 2B is possibly carcinogenic, and 3 is not classifiable

[b] 2-(2-Formylhydrazino)-4(5N2F)T = 2-(2-Formylhydrazino)-4-(5-Nitro-2-Furyl) Thiazole, N-[4-(5-Nitro-2-Furyl)2TZ]A = N-[4-(5-Nitro-2-Furyl)-2-Thiazolyl] Acetamide. Mineral oils = Minerail oils, untreated or mildly treated. N,N-Bis(2-CE)-2-NL = N,N-Bis(2-Chloroethyl)-2-naphthylamine

† Less than 4 cases exposed

* Significant at p=0.10, one-sided, with at least 4 exposed cases

** Significant at p=0.05, one-sided, with at least 5 exposed cases

Table 3.3: Siemiatycki Chemicals Associated with Bladder Cancer

Chemical Name	Siemiatycki ORs Any	Siemiatycki ORs Substantial	IARC Class[a]	IARC Evidence
Acrylic fibres	3.9**	3.3		
Aliphatic aldehydes	1.4*	1.6		
Ammonia	1.2	2.1*		
Asphalt (bitumen)	0.9	2.2*	3	Animal
Cadmium compounds	1.6	4.9*	1	Human
Calcium carbonate	1.9**	1.6		
Carbon black	2.2*	1.8	2B	Human
Carbon tetrachloride	1.6	2.5**	2B	Human
Chlorine	1	2.7*		
Clay dust	2.2*	1.8		
Creosote	2.6*	2.6		
Diesel engine emissions	1.4	2.3**	2A	Human
Engine emissions	1.2*	1.3*	2A	Human
Fabric dust	1	3.7*		
Formaldehyde	1.2	1.7*	2A	Human
Hydrogen cyanide	3.4*	0		
Ionizing radiation	4.4**	0	1	Human
Laboratory products	1.5	5.5*		
Lead chromate	1.8*	2.2	2B	Human
Lead compounds	1.3*	1.1	2B	Human
Natural gas comb. products	1.6*	3.8**		
Photographic products	2.5	2.9*		
Polyester fibers	1.4	2.5*		
Polyethylene	2.5*	13	3	Animal
Titanium compounds	1.7**	2.2		
Titanium dioxide	1.7**	4.5	3	Animal

[a] IARC classification where 1 is definitely carcinogenic, 2A is probably carcinogenic, 2B is possibly carcinogenic, and 3 is not classifiable
* Significant at p=0.10, one-sided, with at least 4 exposed cases
** Significant at p=0.05, one-sided, with at least 5 exposed cases

Table 3.4: Siemiatycki Exposure Coding

Code	Confidence	Concentration	Frequency
1	Possible Exposure	Low: background level	Low: 1-5% of working time
2	Probable Exposure	Medium: intermediate situations	Medium:5-30% of working time
3	Definite Exposure	High: agent in concentrated form	High: >30% of working time

Figure 5.1: Calculating Cumulative Exposure Analysis Design

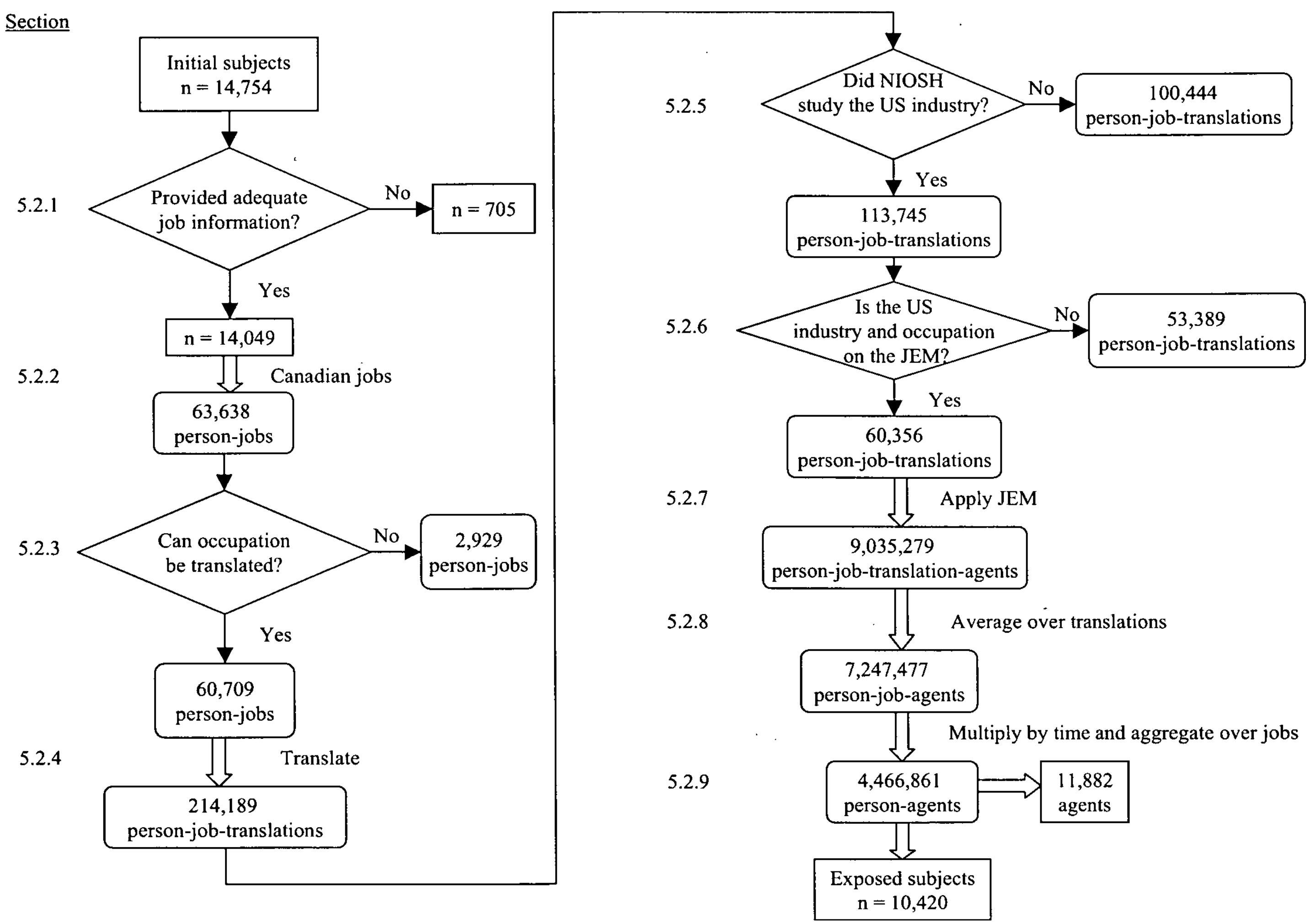

Table 5.1: Distribution of Missing Job Code, and Start and End Year Data

Start and End Years	**Job Codes** All Missing	**Job Codes** Some Missing	**Job Codes** All Complete	**Total**
All Missing	18	7	111	136
Some Missing	0	27	389	416
All Complete	17	136	14,049	14,202
Total	35	170	14,549	14,754

Table 5.2: Cancer Site Distribution of Jobs in the Armed Forces

		Armed Forces Employment				Total Work-Years			
Primary tumour site	**IDC-9[a]**	**Ever**	**%**	**Never**	**%**	**Armed Forces**	**%**	**Other**	**%**
Oral cavity and pharynx	140-149	78	2.9	482	4.2	441.0	2.6	17,224.5	3.7
Esophagus	150	31	1.2	145	1.3	145.0	0.9	6,122.5	1.3
Stomach	151	111	4.2	459	4.0	663.5	4.0	19,646.0	4.2
Colon	153	224	8.4	881	7.7	1,299.0	7.8	39,553.5	8.5
Rectum	154	202	7.6	849	7.5	1,169.0	7.0	37,396.0	8.0
Liver	155	4	0.1	40	0.4	17.0	0.1	1,313.5	0.3
Pancreas	157	27	1.0	110	1.0	203.0	1.2	4,619.0	1.0
Larynx	161	68	2.5	244	2.1	398.0	2.4	10,482.0	2.2
Lung	162	618	23.2	2,195	19.3	4,061.0	24.3	96,771.5	20.7
Soft tissue sarcoma	171	18	0.7	136	1.2	103.0	0.6	3,782.0	0.8
Melanoma skin	172	89	3.3	557	4.9	595.0	3.6	17,006.5	3.6
Non-melanoma skin	173	288	10.8	924	8.1	1,996.5	12.0	41,110.0	8.8
Prostate	185	294	11.0	1,161	10.2	1,761.5	10.6	55,460.0	11.9
Testis	186	13	0.5	213	1.9	69.0	0.4	2,797.5	0.6
Bladder	188	218	8.2	848	7.5	1,468.5	8.8	37,678.5	8.1
Kidney	189	92	3.4	461	4.1	524.0	3.1	18,360.5	3.9
Brain	191	39	1.5	288	2.5	309.0	1.9	8,119.5	1.7
Hodgkin's disease	201	4	0.1	104	0.9	15.0	0.1	1,781.0	0.4
Non-Hodgkin's lymphoma	202	128	4.8	626	5.5	821.5	4.9	23,159.0	5.0
Multiple myeloma	203	24	0.9	104	0.9	140.0	0.8	4,558.0	1.0
Leukemia	204-208	33	1.2	205	1.8	153.0	0.9	6,994.0	1.5
Other sites	-	64	2.4	350	3.1	333.0	2.0	12,517.5	2.7
Total		2,667	100.0	11,382	100.0	16,685.5	100.0	466,452.5	100.0

[a] IDC-9, International Classification of Diseases, 9th Revision

Table 5.3: Distribution of Patients' Canadian Industries

Industrial Group	**CDN Code**[a]	**Jobs**	**%**	**Work-Years**	**%**	**Ever Industry**	**%**
Agriculture	01-02	4,845	8.0	46,067.5	9.9	3,557	25.6
Fishing, Trapping	03	652	1.1	5,317.0	1.1	513	3.7
Logging, Forestry	04-05	2,945	4.9	17,216.0	3.7	1,759	12.6
Mining, Quarrying, Oil Well	06-09	2,802	4.6	14,093.5	3.0	1,545	11.1
Manufacturing							
Food, beverage, tobacco	10-12	1,694	2.8	12,449.5	2.7	1,100	7.9
Rubber, plastic, leather, textile, clothing	15-24	419	0.7	3,023.0	0.6	276	2.0
Wood, furniture, paper, printing	25-28	5,616	9.3	43,103.0	9.2	3,377	24.3
Other	29-39	5,969	9.8	40,885.0	8.8	3,988	28.7
Construction	40-44	6,591	10.9	46,339.0	9.9	4,084	29.3
Transportation	45-47	5,690	9.4	46,492.0	10.0	3,249	23.3
Communication, Utility	48-49	1,707	2.8	16,247.0	3.5	1,035	7.4
Wholesale	50-59	3,345	5.5	24,543.0	5.3	2,108	15.1
Retail	60-69	5,270	8.7	39,676.5	8.5	3,327	23.9
Finance, Insurance, Real Estate	70-76	2,101	3.5	16,657.5	3.6	1,306	9.4
Services							
Business	77	1,297	2.1	10,399.5	2.2	827	5.9
Government	81-84	3,900	6.4	35,600.5	7.6	2,633	18.9
Education, Health	85-86	2,455	4.0	23,524.0	5.0	1,528	11.0
Other	91-99	3,411	5.6	24,812.0	5.3	2,404	17.3
Total		60,709	100.0	466,445.5	100.0		

[a] Canadian 1980 Standard Industrial Classification

Table 5.4: Distribution of Patients' US Industry Translations

Industrial Group	US Code[a]	Job-translations	%	Work-Years[b]	%
Agriculture	010-020	19,827	9.3	46,138.1	9.9
Fishing, Hunting, Trapping	031	800	0.4	5,317.0	1.1
Forestry	030	419	0.2	1,192.0	0.3
Mining	040-050	10,053	4.7	14,093.5	3.0
Manufacturing					
Food, beverage, tobacco	100-130	6,360	3.0	12,370.5	2.7
Rubber, plastic, leather, textile, clothing	132-150, 210-220	2,213	1.0	3,115.9	0.7
Wood, furniture, paper, printing	160-170, 230-240	21,999	10.3	59,109.2	12.7
Other	180-200, 250-390	25,968	12.1	40,656.8	8.7
Construction	060	17,943	8.4	45,884.8	9.8
Transportation	400-430	14,574	6.8	50,119.9	10.7
Communications, Utilities	440-470	6,165	2.9	13,233.3	2.8
Wholesale	500-570	13,526	6.3	20,865.0	4.5
Retail	580-690	24,212	11.3	37,350.0	8.0
Finance, Insurance, Real Estate	700-712	3,984	1.9	16,667.5	3.6
Services					
Business, Repair	721-760	12,099	5.6	18,578.4	4.0
Public Administration	900-932	10,876	5.1	33,993.3	7.3
Professional	812-892	3,104	1.4	9,567.5	2.1
Personal Services	761-791	3,920	1.8	3,814.0	0.8
Entertainment, Recreation	800-802	16,147	7.5	34,378.9	7.4
Total		214,189	100.0	466,445.5	100.0

[a] US 1980 Census of the Population Industrial Classification

[b] Work-years contributed

Table 5.5: Distribution of Patients' Canadian Occupations

Occupational Group	**CDN Code**[a]	**Jobs**	**%**	**Work-Years**	**%**	**Ever Occupation**	**%**
Managerial and Administrative	11	5,923	9.8	54,044	11.6	3,099	22.3
Natural Sciences, Engineering, Mathematics	21	2,005	3.3	14,034	3.0	959	6.9
Social Sciences	23	298	0.5	2,759	0.6	191	1.4
Religion	25	179	0.3	1,966	0.4	81	0.6
Teaching	27	965	1.6	8,511	1.8	589	4.2
Medicine and Health	31	735	1.2	9,208	2.0	454	3.3
Artistic, Literary, Recreational	33	686	1.1	5,534	1.2	423	3.0
Clerical	41	3,770	6.2	25,223	5.4	2,257	16.2
Sales	51	5,470	9.0	42,231	9.1	3,076	22.1
Services	61	3,672	6.0	27,392	5.9	2,344	16.8
Farming, Horticultural, Animal Husbandry	71	4,929	8.1	46,544	10.0	3,583	25.7
Fishing, Trapping	73	523	0.9	4,631	1.0	442	3.2
Forestry, Logging	75	2,229	3.7	13,028	2.8	1,454	10.4
Mining, Quarrying	77	1,568	2.6	7,213	1.5	927	6.7
Materials Processing	81-82	4,629	7.6	32,819	7.0	3,187	22.9
Machining	83	2,314	3.8	16,709	3.6	1,326	9.5
Product Fabricating, Assembling, Repairing	85	6,020	9.9	43,966	9.4	3,224	23.2
Construction	87	6,560	10.8	48,779	10.5	3,580	25.7
Transport Equipment Operating	91	4,998	8.2	37,180	8.0	2,937	21.1
Material Handling	93	1,715	2.8	12,019	2.6	1,316	9.5
Other Crafts and Equipment Operating	95	1,207	2.0	10,902	2.3	734	5.3
Not Elsewhere Classified	99	314	0.5	1,761	0.4	290	2.1
Total		60,709	100.0	466,446	100.0		

[a] Canadian 1980 Standard Occupational Classification

Table 5.6: Distribution of Patients' US Occupation Translations

Occupational Group	**US Code**[a]	**Job-translations**	**%**	**Work-Years**[b]	**%**
Executive, Administrative, Managerial	003-037	11,991	5.6	54,260	11.6
Natural Sciences, Engineering, Mathematics	043-083, 213-235	9,446	4.4	21,355	4.6
Social Sciences	166-175, 178-179	485	0.2	2,479	0.5
Religion	176-177	179	0.1	1,966	0.4
Teaching	113-163	12,196	5.7	8,686	1.9
Medicine and Health	084-106, 203-208	572	0.3	7,092	1.5
Artistic, Literary, Recreational	164-165, 183-199	1,528	0.7	5,029	1.1
Administrative Support, Clerical	303-389	11,375	5.3	26,286	5.6
Sales	243-285	25,168	11.8	37,630	8.1
Services	403-469	10,733	5.0	27,276	5.8
Farming	473-489	18,337	8.6	45,275	9.7
Fishing, Trapping	497-499	523	0.2	4,631	1.0
Forestry, Logging	494-496	2,188	1.0	10,232	2.2
Extractive occupations	613-617	2,182	1.0	2,609	0.6
Precision production	633-699	11,542	5.4	24,696	5.3
Machine Operators	703-779	16,495	7.7	30,883	6.6
Fabricators, Assemblers, Mechanics, Repairers	503-549, 783-799	31,144	14.5	43,120	9.2
Construction	553-599	16,531	7.7	39,790	8.5
Transport Equipment Operating	803-834	9,749	4.6	36,252	7.8
Material Moving	843-859	9,006	4.2	17,203	3.7
Handlers, Equipment Cleaners, Helpers, Laborers	863-889	12,819	6.0	19,697	4.2
Total		214,189	100.0	466,446	100.0

[a] US 1980 Census of the Population Occupational Classification

[b] Work-years contributed

Table 5.7: Distribution of Patients' Industries and those on the JEM

Industry Group	CDN Code[a]	Jobs JEM	Jobs All	Jobs %	Work-Years JEM[b]	Work-Years All	Work-Years %
Agriculture	01-02	56	4,845	1.2	328.7	46,067.5	0.7
Fishing, Trapping	03	0	652	0.0	0.0	5,317.0	0.0
Logging, Forestry	04-05	2,167	2,945	73.6	11,128.9	17,216.0	64.6
Mining, Quarrying, Oil Well	06-09	151	2,802	5.4	528.2	14,093.5	3.7
Manufacturing							
Food, beverage, tobacco	10-12	1,311	1,694	77.4	7,205.2	12,449.5	57.9
Rubber, plastic, leather, textile, clothing	15-24	321	419	76.6	1,427.6	3,023.0	47.2
Wood, furniture, paper, printing	25-28	5,065	5,616	90.2	29,067.3	43,103.0	67.4
Other	29-39	4,972	5,969	83.3	23,774.5	40,885.0	58.1
Construction	40-44	6,351	6,591	96.4	32,702.7	46,339.0	70.6
Transportation	45-47	3,904	5,690	68.6	24,258.6	46,492.0	52.2
Communication, Utility	48-49	1,119	1,707	65.6	6,049.9	16,247.0	37.2
Wholesale	50-59	962	3,345	28.8	2,522.0	24,543.0	10.3
Retail	60-69	1,541	5,270	29.2	6,373.7	39,676.5	16.1
Finance, Insurance, Real Estate	70-76	0	2,101	0.0	0.0	16,657.5	0.0
Services							
Business	77	204	1,297	15.7	564.1	10,399.5	5.4
Government	81-84	24	3,900	0.6	109.2	35,600.5	0.3
Education, Health	85-86	547	2,455	22.3	4,170.3	23,524.0	17.7
Other	91-99	611	3,411	17.9	3,407.9	24,812.0	13.7
Total		29,306	60,709	48.3	153,618.6	466,445.5	32.9

[a] Canadian 1980 Standard Industrial Classification
[b] Work-years contributed by the JEM

Table 5.8: Distribution of Patients' Occupations and those on the JEM

	CDN	Jobs			Work-Years		
Occupation Group	**Code**[a]	**JEM**	**All**	**%**	**JEM**[b]	**All**	**%**
Managerial and Administrative	11	1,237	5,923	20.9	8,765.2	54,043.5	16.2
Natural Sciences, Engineering, Mathematics	21	580	2,005	28.9	2,676.0	14,034.0	19.1
Social Sciences	23	11	298	3.7	21.4	2,758.5	0.8
Religion	25	0	179	0.0	0.0	1,965.5	0.0
Teaching	27	0	965	0.0	0.0	8,510.5	0.0
Medicine and Health	31	307	735	41.8	2,901.7	9,207.5	31.5
Artistic, Literary, Recreational	33	288	686	42.0	1,602.7	5,534.0	29.0
Clerical	41	1,114	3,770	29.5	4,258.5	25,223.0	16.9
Sales	51	854	5,470	15.6	3,002.0	42,231.0	7.1
Services	61	609	3,672	16.6	2,702.3	27,391.5	9.9
Farming, Horticultural, Animal Husbandry	71	94	4,929	1.9	233.1	46,543.5	0.5
Fishing, Trapping	73	0	523	0.0	0.0	4,630.5	0.0
Forestry, Logging	75	1,726	2,229	77.4	9,784.8	13,027.5	75.1
Mining, Quarrying	77	141	1,568	9.0	354.8	7,213.0	4.9
Materials Processing	81-82	4,054	4,629	87.6	25,009.9	32,818.5	76.2
Machining	83	2,066	2,314	89.3	9,377.9	16,708.5	56.1
Product Fabricating, Assembling, Repairing	85	4,753	6,020	79.0	20,351.6	43,965.5	46.3
Construction	87	5,915	6,560	90.2	29,485.2	48,779.0	60.4
Transport Equipment Operating	91	3,280	4,998	65.6	20,650.8	37,179.5	55.5
Material Handling	93	1,331	1,715	77.6	6,177.4	12,019.0	51.4
Other Crafts and Equipment Operating	95	760	1,207	63.0	5,460.4	10,901.5	50.1
Not Elsewhere Classified	99	186	314	59.2	802.9	1,760.5	45.6
Total		29,306	60,709	48.3	153,618.6	466,445.5	32.9

[a] Canadian 1980 Standard Occupational Classification

[b] Work-years contributed by the JEM

Table 5.9: Location of Canadian Jobs Found on the JEM

Location	Jobs	%	Work Years[a]	%
Alberta	1,723	5.9	7,036.0	4.6
British Columbia	19,562	66.8	109,677.8	71.4
Manitoba	819	2.8	3,528.0	2.3
New Brunswick	82	0.3	251.3	0.2
Newfoundland	29	0.1	91.2	0.1
Northwest Territories	34	0.1	74.1	0.0
Nova Scotia	60	0.2	211.3	0.1
Ontario	1,454	5.0	5,807.1	3.8
Prince Edward Island	14	0.0	25.5	0.0
Quebec	436	1.5	1,983.0	1.3
Saskatchewan	884	3.0	3,717.5	2.4
Yukon Territories	64	0.2	185.8	0.1
Canada	191	0.7	1,159.4	0.8
Canada + BC	252	0.9	1,805.9	1.2
Canada + elsewhere	124	0.4	949.2	0.6
Outside of Canada	2,346	8.0	11,141.1	7.3
Unknown	1,232	4.2	5,974.5	3.9
Total	29,306	100.0	153,618.6	100.0

[a] Work-years contributed on the JEM

Table 6.1: Characterisitics of Cases and Controls

Characteristic	Cases (n = 1062) Patients	%	Mean (± SD)	Controls (n = 8057) Patients	%	Mean (± SD)
Age at diagnosis, years			67.0 (11.4)			65.9 (10.9)
Employment duration, work-years[a]			36.7 (11.0)			35.9 (11.2)
No jobs reported[a]	3	0.3		24	0.3	
Year of diagnosis						
1983	222	20.9		2600	32.3	
1984	215	20.2		1801	22.4	
1985	221	20.8		1475	18.3	
1986	216	20.3		1088	13.5	
1987	188	17.7		1093	13.6	
Ethnic origin						
Caucasian	1027	96.7		7665	95.1	
Non-Caucasian	31	2.9		350	4.3	
Unknown	4	0.4		42	0.5	
Marital status						
Single	42	4.0		385	4.8	
Married or common-law	889	83.7		6706	83.2	
Widowed	66	6.2		492	6.1	
Separated or divorced	57	5.4		403	5.0	
Unknown	8	0.8		71	0.9	
Education						
<8 years	118	11.1		894	11.1	
8-11 years	480	45.2		3583	44.5	
High school graduate	119	11.2		884	11.0	
Post secondary education	298	28.1		2305	28.6	
Unknown	47	4.4		391	4.9	
Years			10.0 (2.3)			10.0 (2.3)
Tobacco smoking						
Never smoker	117	11.0		1,444	17.9	
Ever smoker						
Pipe and cigar only	34	3.2		323	4.0	
Cigarette only	909	85.6		6,268	77.8	
Unknown	2	0.2		22	0.3	
Cigarette smoking only						
Current smoker	314	34.5		1,894	30.2	
Former smoker	564	62.0		4,118	65.7	
Unknown	31	3.4		256	4.1	
Cigarette smoking only						
Cigarettes/day			21.3 (12.7)			20.9 (12.5)
Years/smoked			36.5 (14.9)			33.5 (15.0)
Pack-years			33.6 (29.0)			27.9 (28.3)
Years quit (former smokers)			16.8 (11.9)			18.3 (12.6)
Alcohol consumption						
Never	113	10.6		842	10.5	
Ever	811	76.4		5882	73.0	
Unknown	138	13.0		1333	16.5	
Person completing questionnaire						
Patient	888	83.6		6357	78.9	
Other	150	14.1		1490	18.5	
Unknown	24	2.3		210	2.6	

[a] Prior to 5 years before diagnosis

Table 6.2: Odds Ratios (OR) for Potentially Important[a] Confounding Variables

Confounding Variable	No. of Cases	OR	95% Confidence Interval
Respondent to questionnaire			
Patient	888	1.00	-
Proxy	150	0.65	0.53 - 0.78
Unknown	24	0.92	0.59 - 1.42
Ethnic origin			
Caucasian	1,027	1.00	-
Non-Caucasian	31	0.71	0.48 - 1.05
Unknown	4	0.63	0.22 - 1.79
Alcohol consumption status			
Never drinker	113	1.00	-
Ever drinker	811	0.88	0.70 - 1.11
Unknown	138	1.20	0.87 - 1.67
Cigarette smoking duration, years			
0	151	1.00	-
1-29	262	1.41	1.13 - 1.75
30-44	338	1.93	1.56 - 2.40
45+	300	2.36	1.89 - 2.95
Unknown	11	1.16	0.60 - 2.23

[a] p-value < 20%

Table 6.3: Log Likelihood for Various Base Models

Model	Variables	Degrees of Freedom	-2LL[a]	Deviance from Base Model	p-value
Base	*Who completed questionnaire, ethnicity, alcohol status, cigarette years*	*10*	*5,433*	-	-
1	Who completed questionnaire, alcohol status, cigarette years	8	5,437	4.00	0.14
2	Who completed questionnaire, ethnicity, alcohol status, smoking status	8	5,468	NA	NA
3	Who completed questionnaire, ethnicity, alcohol status, cigarette pack-years	10	5,448	NA	NA
4	Who completed questionnaire, ethnicity, alcohol status, years quitsmoking	11	5,440	NA	NA

[a] LL = Log likelihood

Table 6.4: Characterisitics of Cases and Controls Before and After Exclusions

	All Subjects		**Complete Occupational Data**	
	Cases	**Controls**	**Cases**	**Controls**
	(n = 1125)	**(n = 8492)**	**(n = 1062)**	**(n = 8057)**
Characteristic	**No. (%)**	**No. (%)**	**No. (%)**	**No. (%)**
No jobs reported[a]	8 (0.7)	62 (0.7)	3 (0.3)	24 (0.3)
Year of diagnosis				
1983	240 (21.3)	2,715 (32.0)	222 (20.9)	2,600 (32.3)
1984	229 (20.4)	1,907 (22.5)	215 (20.2)	1,801 (22.4)
1985	228 (20.3)	1,534 (18.1)	221 (20.8)	1,475 (18.3)
1986	231 (20.5)	1,181 (13.9)	216 (20.3)	1,088 (13.5)
1987	197 (17.5)	1,155 (13.6)	188 (17.7)	1,093 (13.6)
Ethnic origin				
Caucasian	1,088 (96.7)	8,073 (95.1)	1,027 (96.7)	7,665 (95.1)
Non-Caucasian	32 (2.8)	370 (4.4)	31 (2.9)	350 (4.3)
Unknown	5 (0.4)	49 (0.6)	4 (0.4)	42 (0.5)
Marital status				
Single	45 (4.0)	415 (4.9)	42 (4.0)	385 (4.8)
Married or common-law	933 (82.9)	7,014 (82.6)	889 (83.7)	6,706 (83.2)
Widowed	74 (6.6)	532 (6.3)	66 (6.2)	492 (6.1)
Separated or divorced	65 (5.8)	448 (5.3)	57 (5.4)	403 (5.0)
Unknown	8 (0.7)	83 (1.0)	8 (0.8)	71 (0.9)
Education				
<8 years	123 (10.9)	972 (11.4)	118 (11.1)	894 (11.1)
8-11 years	508 (45.2)	3,781 (44.5)	480 (45.2)	3,583 (44.5)
High school graduate	129 (11.5)	926 (10.9)	119 (11.2)	884 (11.0)
Post secondary education	312 (27.7)	2,384 (28.1)	298 (28.1)	2,305 (28.6)
Unknown	53 (4.7)	429 (5.1)	47 (4.4)	391 (4.9)
Tobacco smoking				
Never smoker	123 (10.9)	1,503 (17.7)	117 (11.0)	1,444 (17.9)
Ever smoker				
Pipe and cigar only	35 (3.1)	342 (4.0)	34 (3.2)	323 (4.0)
Cigarette only	965 (85.8)	6,621 (78.0)	909 (85.6)	6,268 (77.8)
Unknown	2 (0.2)	26 (0.3)	2 (0.2)	22 (0.3)
Cigarette smoking only				
Current smoker	332 (34.4)	2,020 (30.5)	314 (34.5)	1,894 (30.2)
Former smoker	600 (62.2)	4,326 (65.3)	564 (62.0)	4,118 (65.7)
Unknown	33 (3.4)	275 (4.2)	31 (3.4)	256 (4.1)
Alcohol consumption				
Never	119 (10.6)	881 (10.4)	113 (10.6)	842 (10.5)
Ever	858 (76.3)	6,201 (73.0)	811 (76.4)	5,882 (73.0)
Unknown	148 (13.2)	1,410 (16.6)	138 (13.0)	1333 (16.5)
Person completing questionnaire				
Patient	934 (83.0)	6,644 (78.2)	888 (83.6)	6357 (78.9)
Other	164 (14.6)	1,630 (19.2)	150 (14.1)	1490 (18.5)
Unknown	27 (2.4)	218 (2.6)	24 (2.3)	210 (2.6)

[a] Prior to 5 years before diagnosis

Table 6.4: *Continued*

Characteristic	All Subjects Cases ($n = 1125$) Mean (SD)	All Subjects Controls ($n = 8492$) Mean (SD)	Complete Occupational Data Cases ($n = 1062$) Mean (SD)	Complete Occupational Data Controls ($n = 8057$) Mean (SD)
Age at diagnosis, years	67.3 (11.4)	66.0 (10.9)	67.0 (11.4)	65.9 (10.9)
Employment duration, work-years[a]	36.4 (11.3)	35.6 (11.6)	36.7 (11.0)	35.9 (11.2)
Years of Education	9.9 (2.3)	10.0 (2.3)	10.0 (2.3)	10.0 (2.3)
Cigarette smoking only				
Cigarettes/day	21.2 (12.6)	20.9 (12.5)	21.3 (12.7)	20.9 (12.5)
Years smoked	36.6 (14.9)	33.6 (15.0)	36.5 (14.9)	33.5 (15.0)
Pack-years	33.5 (29.1)	28.1 (28.4)	33.6 (29.0)	27.9 (28.3)
Alcohol score	416.7 (678.9)	422.7 (640.1)	411.7 (662.0)	415.5 (613.2)
Former smokers only				
Years quit	16.1 (12.2)	17.6 (12.9)	16.8 (11.9)	18.3 (12.6)

[a] Prior to 5 years before diagnosis

Table 6.5: Distribution of Control Cancer Sites Before and After Exclusions

Primary tumour site	IDC-9[a]	All Subjects Patients	All Subjects %	Complete Occupational Data Patients	Complete Occupational Data %
Oral cavity and pharynx	140-149	524	6.2	479	5.9
Esophagus	150	176	2.1	159	2.0
Stomach	151	353	4.2	330	4.1
Colon	153	1,101	13.0	1,044	13.0
Rectum	154	892	10.5	841	10.4
Liver	155	39	0.5	36	0.4
Pancreas	157	138	1.6	129	1.6
Larynx	161	304	3.6	284	3.5
Soft tissue sarcoma	171	113	1.3	106	1.3
Melanoma skin	172	479	5.6	460	5.7
Non-melanoma skin	173	1,121	13.2	1,091	13.5
Prostate	185	1,479	17.4	1,415	17.6
Testis	186	91	1.1	86	1.1
Kidney	189	336	4.0	320	4.0
Brain	191	159	1.9	149	1.8
Hodgkin's disease	201	57	0.7	56	0.7
Non-Hodgkin's lymphoma	202	438	5.2	416	5.2
Multiple myeloma	203	123	1.4	116	1.4
Leukemia	204-208	211	2.5	201	2.5
Other sites	-	358	4.2	339	4.2
Total		8,492	100.0	8,057	100.0

[a] IDC-9, International Classification of Diseases, 9th Revision

Table 6.6: Odds Ratios (OR) for Potentially Important[a] Confounding Variables Before and After Exclusions

	All Subjects			Complete Occupational Data		
Confounding Variable	**Cases**	**OR**	**95% CI[b]**	**Cases**	**OR**	**95% CI[b]**
Respondent to questionnaire						
Patient	934	1.00	-	888	1.00	-
Proxy	164	0.64	0.53 - 0.77	150	0.65	0.53 - 0.78
Unknown	27	0.99	0.65 - 1.50	24	0.92	0.59 - 1.42
Ethnic origin						
Caucasian	1088	1.00	-	1027	1.00	-
Non-Caucasian	32	0.68	0.47 - 1.00	31	0.71	0.48 - 1.05
Unknown	5	0.66	0.26 - 1.69	4	0.63	0.22 - 1.79
Alcohol consumption status						
Never drinker	119	1.00	-	113	1.00	-
Ever drinker	858	0.88	0.70 - 1.10	811	0.88	0.70 - 1.11
Unknown	148	1.16	0.85 - 1.59	138	1.20	0.87 - 1.67
Smoking duration, years						
0	159	1.00	-	151	1.00	-
1-29	277	1.43	1.15 - 1.77	262	1.41	1.13 - 1.75
30-44	355	1.93	1.56 - 2.38	338	1.93	1.56 - 2.40
45+	322	2.35	1.90 - 2.92	300	2.36	1.89 - 2.95
Unknown	12	1.08	0.58 - 2.02	11	1.16	0.60 - 2.23

[a] p-value < 20%
[b] CI = Confidence Interval

Table 6.7: Distribution of Bladder Cases Exposed Across the 8,986 Agents

Cases Exposed	**Agents**	**Cumulative Frequency**	**Percentage**	**Cumulative Percentage**
201+	539	539	6.0	6.0
101-200	512	1,051	5.7	11.7
21-100	1,282	2,333	14.3	26.0
10-20	955	3,288	10.6	36.6
9	162	3,450	1.8	38.4
8	275	3,725	3.1	41.5
7	340	4,065	3.8	45.2
6	319	4,384	3.5	48.8
5	552	4,936	6.1	54.9
4	332	5,268	3.7	58.6
3	431	5,699	4.8	63.4
2	1,029	6,728	11.5	74.9
1	2,258	8,986	25.1	100.0

Table 7.1: Distribution of p-values for Ever Exposure of 5,699 Agents

Ever Exposed	**OR ≤ 1**		**1 < OR ≤ 2**		**OR > 2**	
p-value (p)	**Agents**	**%**	**Agents**	**%**	**Agents**	**%**
$p < 0.5\%$	1	0.0	128	2.2	24	0.4
$0.5\% \leq p < 1\%$			56	1.0	14	0.2
$1\% \leq p < 2.5\%$	4	0.1	128	2.2	32	0.6
$2.5\% \leq p < 5\%$	18	0.3	171	3.0	93	1.6
$5\% \leq p < 10\%$	63	1.1	241	4.2	63	1.1
$10\% \leq p < 20\%$	121	2.1	470	8.2	63	1.1
$p \geq 20\%$	1,308	23.0	2,676	47.0	25	0.4
Total	1,515	26.6	3,870	67.9	314	5.5

Table 7.2: Agents Significant After Adjusting for Multiplicity Using the Hochberg and Benjamini Procedure from 5,699

Agent Name	**CAS**	**Cases**	**Ever Exposure**	
			OR	**95% CI**
2,5-PYRROLIDINEDIONE, 12AE MPIB D[a]	67762-72-5	361	1.39	1.21 - 1.60
NATURAL GAS, LIQUIFIED		25	3.11	1.92 - 5.04
PHOSPHORODITHIOIC ACID, MOOB E ZS[a]	68784-31-6	3 35	1.38	1.20 - 1.60
1, 2-ETHANEDIAMINE, RP W C IB HP[a]	68891-84-9	2 5	2.89	1.79 - 4.67
ALKENES, C15-18 ALPHA-, RPW SDP CS S[a]	72275-86-6	301	1.38	1.19 - 1.60
ETHANOL, 2-(2-(2-BE)E)-[a]	143-22-6	176	1.48	1.23 - 1.77
PHENOL, DODECYL-, SULFURIZED, CCSO[a]	68784-26-9	390	1.34	1.16 - 1.53

[a] See appendix table B.1 for agent name abbreviations

Table 7.3: Distribution of p-values Across 3,450 Agents Tested For Dose-Response

	Low Exposure				**Medium Exposure**			
	OR ≤ 1		**OR > 1**		**OR ≤ 1**		**OR > 1**	
p-value (p)	**Agents**	**%**	**Agents**	**%**	**Agents**	**%**	**Agents**	**%**
$p < 0.5\%$			67	1.9			59	1.7
$0.5\% \leq p < 1\%$			47	1.4			42	1.2
$1\% \leq p < 2.5\%$	1	0.0	126	3.7	2	0.1	69	2.0
$2.5\% \leq p < 5\%$	2	0.1	137	4.0	8	0.2	120	3.5
$5\% \leq p < 10\%$	12	0.3	223	6.5	24	0.7	193	5.6
$10\% \leq p < 20\%$	73	2.1	353	10.2	83	2.4	287	8.3
$p \geq 20\%$	1,108	32.1	1,301	37.7	1,005	29.1	1,558	45.2
Total	1,196	34.7	2,140	62.0	1,122	32.5	2,227	64.6

	High Exposure				**Ordinal Trend Test**			
	OR ≤ 1		**OR > 1**		**OR ≤ 1**		**OR > 1**	
p-value (p)	**Agents**	**%**	**Agents**	**%**	**Agents**	**%**	**Agents**	**%**
$p < 0.5\%$			36	1.0			86	2.5
$0.5\% \leq p < 1\%$			25	0.7	1	0.0	38	1.1
$1\% \leq p < 2.5\%$	3	0.1	68	2.0	5	0.1	106	3.1
$2.5\% \leq p < 5\%$	13	0.4	86	2.5	7	0.2	120	3.5
$5\% \leq p < 10\%$	42	1.2	177	5.1	29	0.8	226	6.6
$10\% \leq p < 20\%$	81	2.3	273	7.9	50	1.4	401	11.6
$p \geq 20\%$	1,014	29.4	1,632	47.3	760	22.0	1621	47.0
Total	1,153	33.4	2,236	64.8	852	24.7	2,598	75.3

Table 7.4: Number of Agents With Significant Ever Exposure and Ordinal Trend Results

Ever Exposure		**Ordinal Trend Test**						
		OR ≤ 1			OR > 1			
OR	**p-value**	$p < 1\%$	$1\% \leq p < 5\%$	$p \geq 5\%$	$p < 1\%$	$1\% \leq p < 5\%$	$p \geq 5\%$	**Total**
≤ 1	< 1%	1	0	0	0	0	0	1
	1% - 5%	0	5	1	0	0	0	6
	≥ 5%	0	7	614	0	0	119	740
> 1	< 1%	0	0	0	107	74	20	201
	1% - 5%	0	0	0	15	111	186	312
	≥ 5%	0	0	224	2	41	1,923	2,190
Total		1	12	839	124	226	2,248	3,450

Table 7.5: Selected 30 Agents with Significant Associations

					Dose-Response						
			Ever Exposure		Low		Medium		High		Trend
NIOSH	Agent Name	Cases	OR	95% CI	P[b]	OR	P[b]	OR	P[b]	OR	Test
X9078	1 - Propene, 2 - Methyl - , Sulfurized	397	1.27	1.11-1.46	0.34	1.11	0.01	1.30	0.00	1.39	0.0001
X2689	1, 2-Ethanediamine, RP W C IB HP[a]	25	2.89	1.79-4.67	0.16	1.93	0.01	2.95	0.00	4.00	<.0001
X2305	2,5-Pyrrolidinedione, 12AE MPIB D RP[a]	206	1.38	1.17-1.64	0.17	1.22	0.06	1.32	0.00	1.62	<.0001
X2303	2,5-Pyrrolidinedione, 12AE MPIB D[a]	361	1.39	1.21-1.60	0.00	1.42	0.00	1.42	0.01	1.33	<.0001
X1401	2-Butenedioic Acid (E)-, PW 1,3-B EB[a]	35	2.18	1.47-3.22	0.20	1.62	0.00	2.68	0.02	2.25	0.0001
X1894	2-Propenoic Acid, 2M CEPWC2[a]	48	1.86	1.34-2.60	0.12	1.63	0.06	1.73	0.00	2.20	0.0002
X2307	Alkenes, C15-18 Alpha-, RPW SDP CS S[a]	301	1.38	1.19-1.60	0.00	1.40	0.00	1.39	0.01	1.36	0.0001
90320	Asphalt	499	1.29	1.13-1.47	0.00	1.40	0.24	1.13	0.00	1.34	0.0018
90590	Clay, NEC	375	1.29	1.13-1.48	0.01	1.33	0.03	1.27	0.02	1.28	0.0020
M1150	Cyclohexylamine, N - Ethyl -	28	2.29	1.48-3.54	0.02	2.31	0.00	3.59	0.95	1.03	0.0035
M0984	Ethanol, 2-(2-(2-BE)E)-[a]	176	1.48	1.23-1.77	0.00	1.57	0.06	1.34	0.01	1.52	0.0002
X4267	Ether, Tert - Buty Methyl	32	1.96	1.31-2.93	0.65	1.19	0.01	2.40	0.01	2.56	0.0003
36060	Heptane	457	1.30	1.14-1.49	0.00	1.35	0.05	1.22	0.00	1.33	0.0008
36955	Hexane	477	1.30	1.14-1.48	0.00	1.44	0.02	1.25	0.06	1.21	0.0071
P0620	Impact Noise	545	1.30	1.14-1.48	0.08	1.18	0.00	1.36	0.00	1.34	0.0001
Y1006	Natural Gas, Liquified	25	3.11	1.92-5.04	0.00	2.70	0.28	2.46	0.00	4.12	<.0001
T1909	Nonylphenol Ethylene OA[a]	80	1.63	1.26-2.11	0.52	1.17	0.01	1.76	0.00	2.01	<.0001
83048	Nonylphenoxyethanol	27	2.49	1.59-3.90	0.08	2.08	0.02	2.61	0.01	2.81	0.0001
S2599	OFW Steel	221	1.37	1.16-1.61	0.00	1.45	0.02	1.37	0.08	1.28	0.0022
92500	Oil, Hydraulic	51	1.74	1.26-2.39	0.56	0.80	0.00	2.30	0.00	2.15	<.0001
X2298	Phenol, Dodecyl-, Sulfurized, CCSO[a]	390	1.34	1.16-1.53	0.01	1.33	0.00	1.41	0.03	1.27	0.0004
X2306	Phosphorodithioic Acid, MOOB E ZS[a]	335	1.38	1.20-1.60	0.00	1.40	0.00	1.41	0.01	1.34	0.0001
X2295	Phosphorodithioic Acid, OOB(2E)E ZS[a]	450	1.30	1.14-1.49	0.03	1.25	0.00	1.35	0.01	1.31	0.0003
X1075	Phosphorodithioic Acid, OOZS[a]	161	1.42	1.17-1.71	0.23	1.22	0.00	1.59	0.02	1.44	0.0003
60713	POC - Gasoline (leaded)[a]	617	1.26	1.10-1.44	0.15	1.15	0.01	1.27	0.00	1.36	0.0002
X5263	POC - Jet Fuel & Gasoline, ULD[a]	557	1.28	1.12-1.46	0.03	1.24	0.02	1.24	0.00	1.37	0.0003
73075	SN, Tin - MF Unknown	420	1.30	1.13-1.48	0.06	1.22	0.01	1.30	0.00	1.38	0.0002
T1475	Solvent RD HVY PF DIST (Petroleum)[a]	535	1.24	1.08-1.41	0.09	1.18	0.38	1.09	0.00	1.45	0.0002
X2293	Sulfonic Acids, Petroleum, CSO[a]	375	1.30	1.13-1.49	0.03	1.26	0.01	1.34	0.02	1.30	0.0006
X2308	Sulfonic Acids, Petroleum, MS[a]	208	1.40	1.18-1.66	0.12	1.25	0.04	1.34	0.00	1.61	<.0001

[a] See appendix table B.1 for agent name abbreviations

[b] *p-value*

Figure 7.1: Histograms of Positive Cumulative Exposures for Top 30 Agents

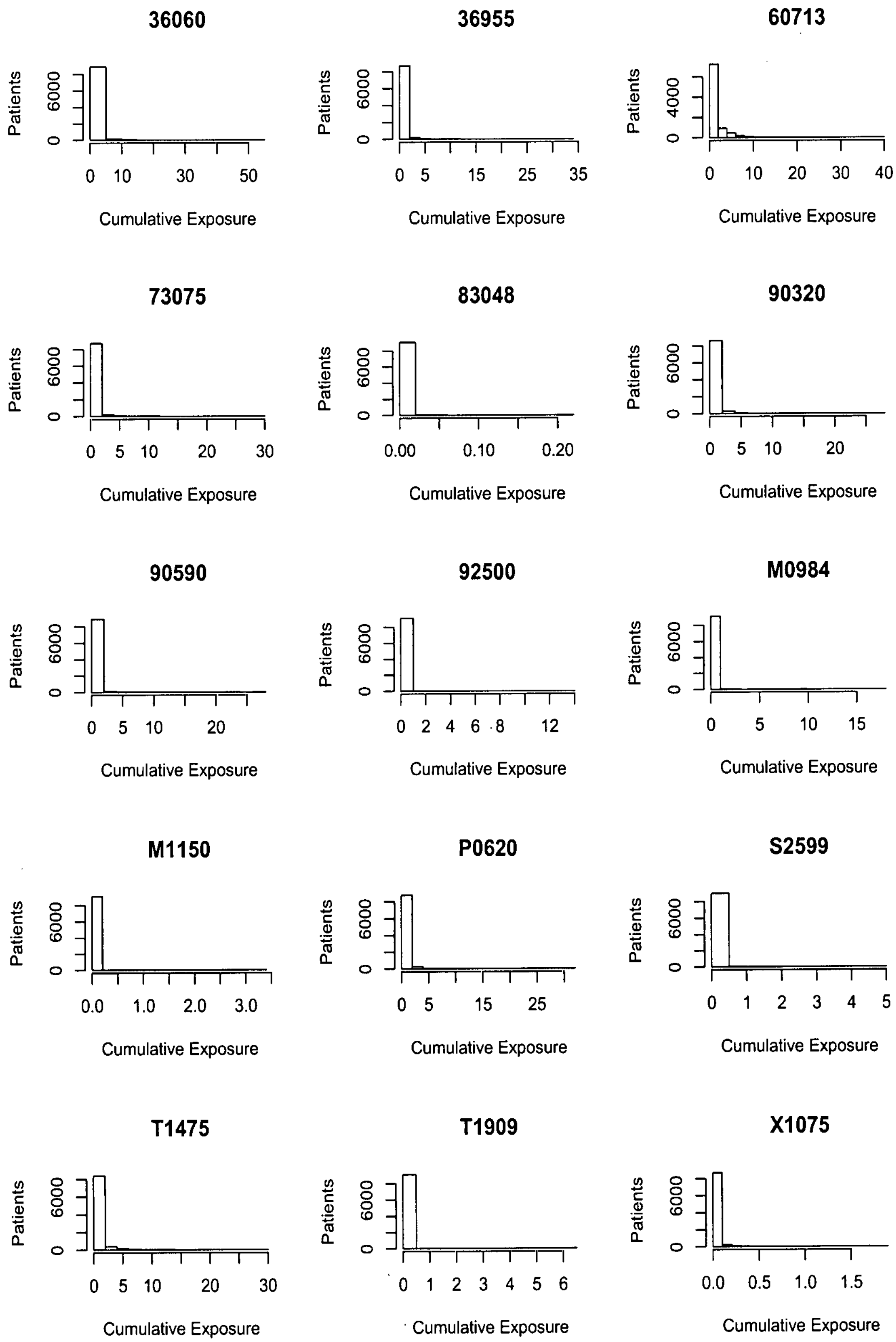

Figure 7.1: *Continued*

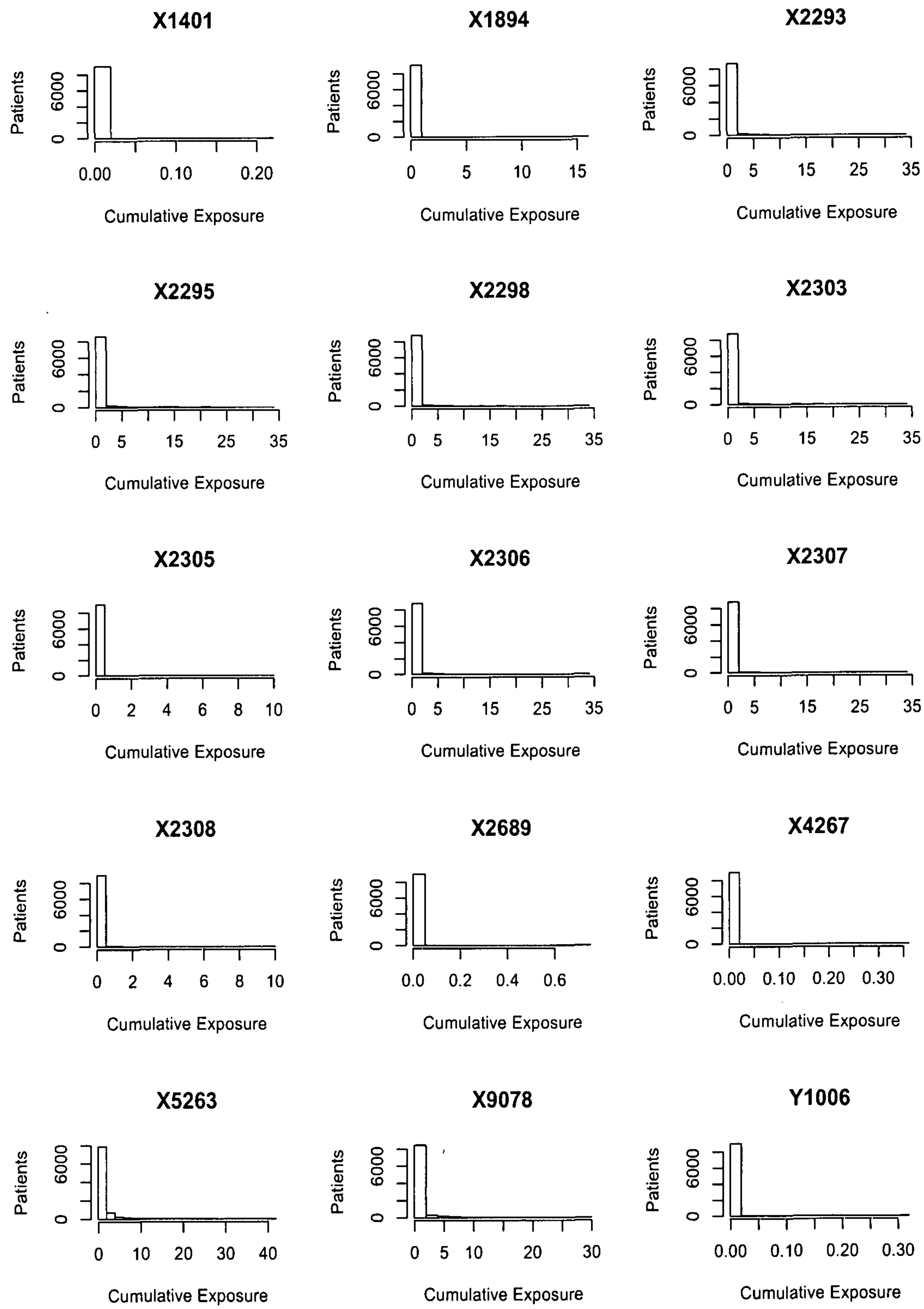

Figure 7.2: Histograms of Transformed Positive Cumulative Exposures for Top 30 Agents

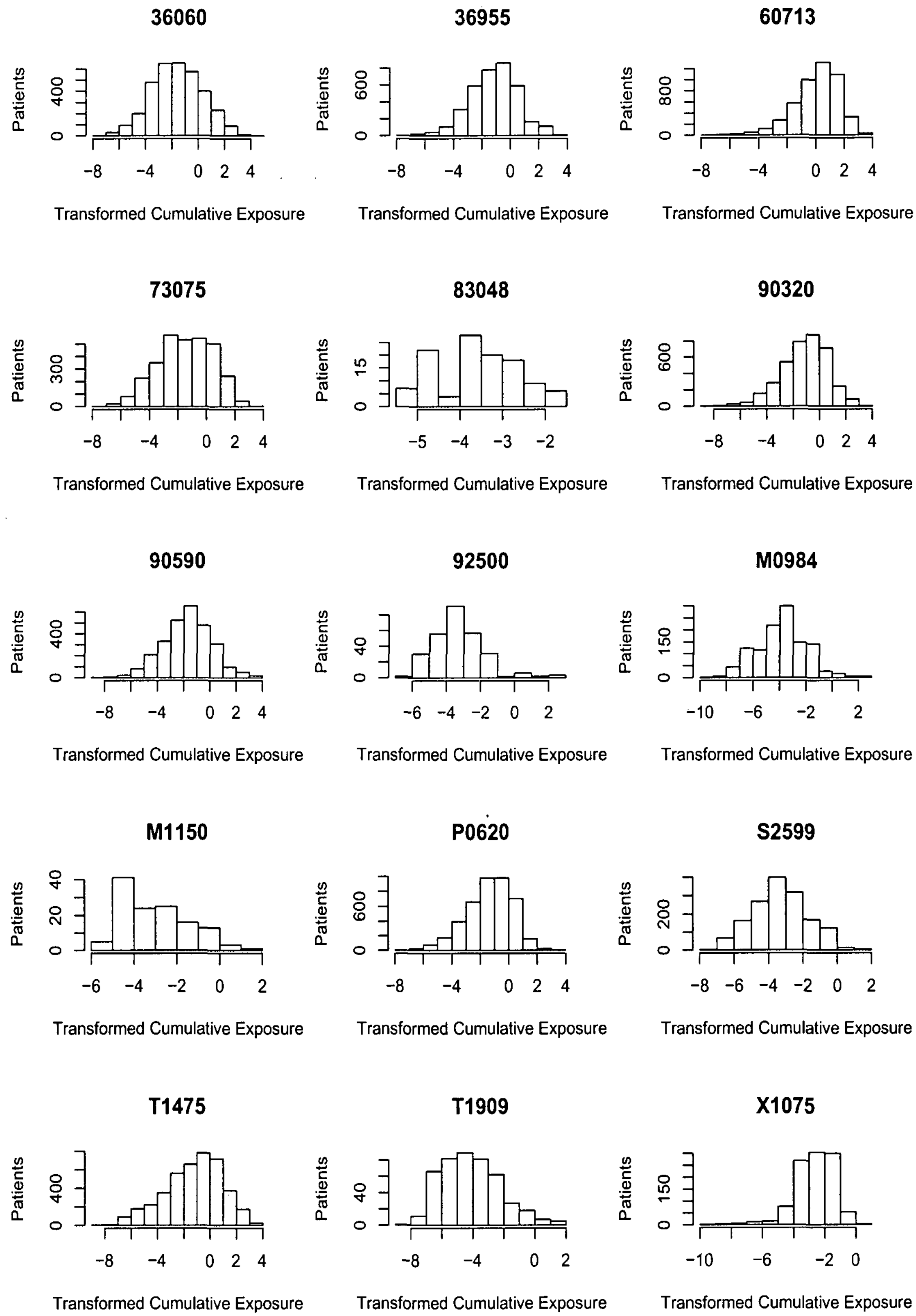

Figure 7.2: *Continued*

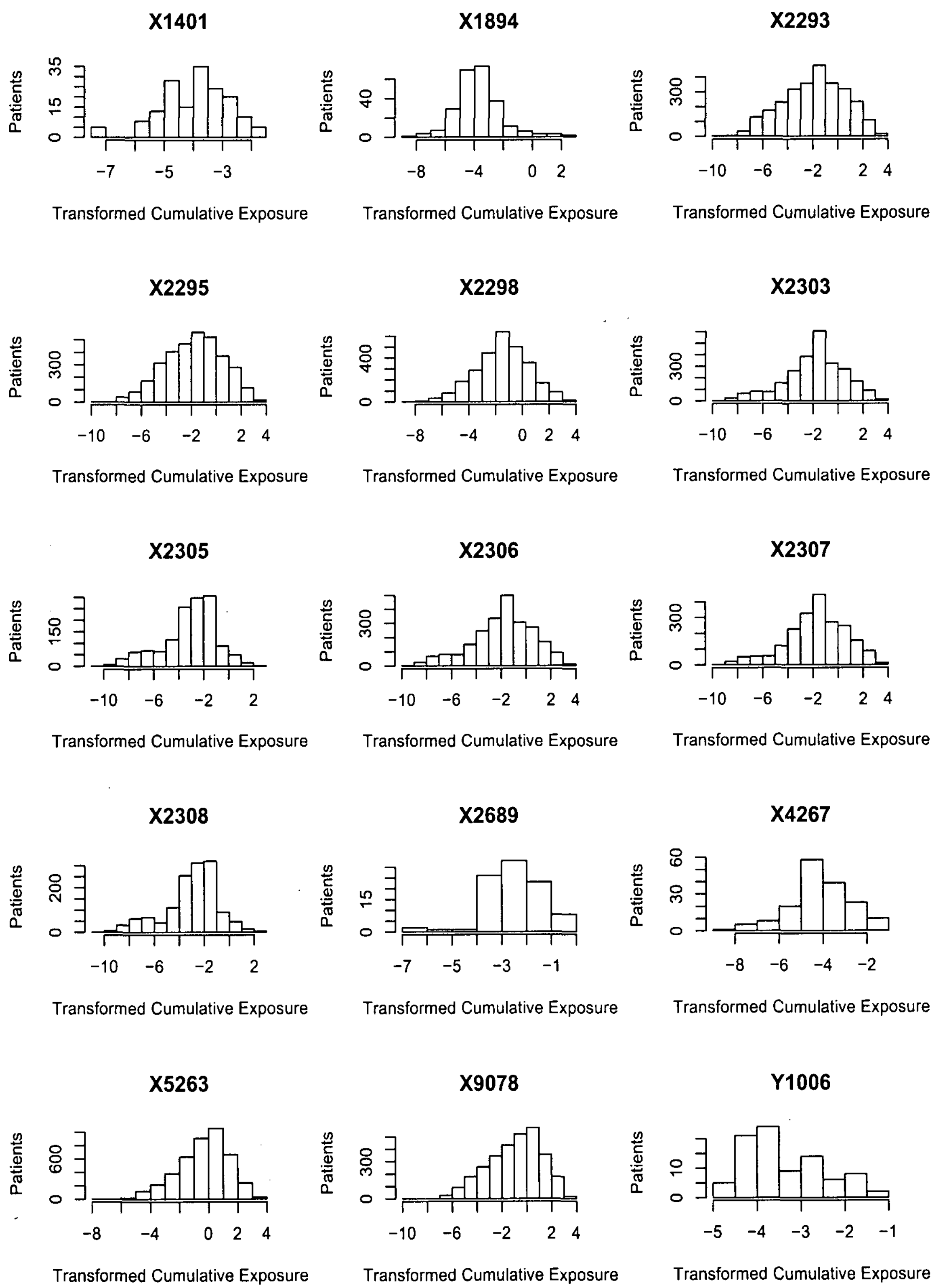

Table 7.6: Results for Linear Fit of Transformed[a] Cumulative Exposure for Top 30 Agents

			Transformed[a] Cumulative Exposure		
NIOSH	Agent Name	Cases	p-value	OR	95% CI
36060	HEPTANE	457	0.0001	1.003	1.001 - 1.004
36955	HEXANE	477	0.0001	1.003	1.001 - 1.004
60713	POC - GASOLINE (LEADED)[b]	617	0.0007	1.002	1.001 - 1.004
73075	SN, TIN - MF UNKNOWN	420	0.0002	1.003	1.001 - 1.004
83048	NONYLPHENOXYETHANOL	27	<.0001	1.010	1.005 - 1.014
90320	ASPHALT	499	0.0002	1.003	1.001 - 1.004
90590	CLAY, NEC	375	0.0003	1.003	1.001 - 1.004
92500	OIL, HYDRAULIC	51	0.0006	1.006	1.002 - 1.009
M0984	ETHANOL, 2-(2-(2-BE)E)-[b]	176	<.0001	1.004	1.002 - 1.006
M1150	CYCLOHEXYLAMINE, N - ETHYL -	28	0.0002	1.009	1.004 - 1.013
P0620	IMPACT NOISE	545	0.0001	1.003	1.001 - 1.004
S2599	OFW STEEL	221	0.0002	1.003	1.002 - 1.005
T1475	SOLVENT RD HVY PF DIST (PETROLEUM)[b]	535	0.0014	1.002	1.001 - 1.004
T1909	NONYLPHENOL ETHYLENE OA[b]	80	0.0002	1.005	1.002 - 1.008
X1075	PHOSPHORODITHIOIC ACID, OOZS[b]	161	0.0002	1.004	1.002 - 1.006
X1401	2-BUTENEDIOIC ACID (E)-, PW 1,3-B EB[b]	35	<.0001	1.008	1.004 - 1.012
X1894	2-PROPENOIC ACID, 2M CEPWC2[b]	48	0.0002	1.006	1.003 - 1.010
X2293	SULFONIC ACIDS, PETROLEUM, CSO[b]	375	0.0002	1.003	1.001 - 1.004
X2295	PHOSPHORODITHIOIC ACID, OOB(2E)E ZS[b]	450	0.0001	1.003	1.001 - 1.004
X2298	PHENOL, DODECYL-, SULFURIZED, CCSO[b]	390	<.0001	1.003	1.002 - 1.004
X2303	2,5-PYRROLIDINEDIONE, 12AE MPIB D[b]	361	<.0001	1.003	1.002 - 1.005
X2305	2,5-PYRROLIDINEDIONE, 12AE MPIB D RP[b]	206	0.0001	1.003	1.002 - 1.005
X2306	PHOSPHORODITHIOIC ACID, MOOB E ZS[b]	335	<.0001	1.003	1.002 - 1.005
X2307	ALKENES, C15-18 ALPHA-, RPW SDP CS S[b]	301	<.0001	1.003	1.002 - 1.005
X2308	SULFONIC ACIDS, PETROLEUM, MS[b]	208	<.0001	1.004	1.002 - 1.005
X2689	1, 2-ETHANEDIAMINE, RP W C IB HP[b]	25	<.0001	1.011	1.006 - 1.016
X4267	ETHER, TERT - BUTYL METHYL	32	0.0010	1.007	1.003 - 1.011
X5263	POC - JET FUEL & GASOLINE, ULD[b]	557	0.0002	1.002	1.001 - 1.004
X9078	1 - PROPENE, 2 - METHYL - , SULFURIZED	397	0.0006	1.002	1.001 - 1.004
Y1006	NATURAL GAS, LIQUIFIED	25	<.0001	1.012	1.007 - 1.017

[a] Box-Cox transformation with $\lambda = 0.01$

[b] See appendix table B.1 for agent name abbreviations

Table 7.7: Component Scores[a] for PCA of the 30 Selected Agents

	Component									
Agent Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ALKENES, C15-18 ALPHA-, RPW SDP CS S[b]	**99**	-2	-3	-5	-3	1	1	-1	-2	0
2,5-PYRROLIDINEDIONE, 12AE MPIB D[b]	**98**	0	-3	10	-2	1	0	0	-2	0
PHOSPHORODITHIOIC ACID, MOOB E ZS[b]	**98**	-1	-3	10	-3	1	0	-1	-2	0
PHENOL, DODECYL-, SULFURIZED, CCSO[b]	**98**	-1	-2	-5	1	2	1	8	-2	0
SULFONIC ACIDS, PETROLEUM, CSO[b]	**97**	-1	1	9	-4	1	-1	0	-4	1
PHOSPHORODITHIOIC ACID, OOB(2E)E ZS[b]	**96**	-2	3	10	-4	1	-1	0	-2	0
1 - PROPENE, 2 - METHYL - , SULFURIZED	**76**	0	**56**	-6	0	-2	3	-4	-2	9
POC - GASOLINE (LEADED)[b]	**67**	17	15	-3	20	-3	13	-4	30	-11
POC - JET FUEL & GASOLINE, ULD[b]	**65**	18	**54**	-6	11	-4	5	-5	15	-4
NATURAL GAS, LIQUIFIED	1	**96**	-1	2	4	-10	0	2	2	0
NONYLPHENOXYETHANOL	2	**94**	0	2	0	22	1	1	0	1
2-BUTENEDIOIC ACID (E)-, PW 1,3-B EB[b]	2	**94**	0	2	1	22	1	1	0	1
1, 2-ETHANEDIAMINE, RP W C IB HP[b]	1	**92**	-1	2	3	-12	0	1	3	0
ETHER, TERT - BUTYL METHYL	2	**74**	2	1	-3	**55**	2	0	-2	2
ASPHALT	12	1	**90**	2	-2	-5	4	-3	2	0
HEXANE	-2	-1	**82**	2	1	2	6	-8	17	2
SN, TIN - MF UNKNOWN	-2	-3	**61**	3	16	6	1	19	-10	-2
2,5-PYRROLIDINEDIONE, 12AE MPIB D RP[b]	7	4	2	**99**	1	0	0	2	1	0
SULFONIC ACIDS, PETROLEUM, MS[b]	7	4	2	**99**	1	0	0	2	1	0
OFW STEEL	0	2	4	-1	**75**	4	-9	-4	-4	-5
HEPTANE	0	-4	8	0	**70**	13	11	0	5	12
PHOSPHORODITHIOIC ACID, OOZS[b]	4	**43**	9	8	**52**	-10	1	**42**	0	-4
CYCLOHEXYLAMINE, N - ETHYL -	1	22	5	1	-6	**85**	4	0	-4	3
ETHANOL, 2-(2-(2-BUTOXYETHOXY)ETHOXY)-	0	1	-2	0	15	**46**	-4	1	5	-4
CLAY, NEC	-3	1	11	1	-2	-3	**95**	-1	1	-2
SOLVENT RD HVY PF DIST (PETROLEUM)[b]	**65**	0	-1	-3	12	3	**65**	9	-1	10
NONYLPHENOL ETHYLENE OA[b]	1	2	4	2	0	2	2	**91**	1	-4
IMPACT NOISE	1	0	15	2	11	0	7	-17	**77**	-20
OIL, HYDRAULIC	0	3	-5	-1	-13	5	-7	23	**61**	27
2-PROPENOIC ACID, 2M CEPWC2[b]	0	2	1	1	7	-4	2	-5	0	**92**
Percentage of Variance	26.30	15.40	8.49	6.75	4.87	4.29	4.09	3.69	3.42	3.35
Cumulative Percentage	26.30	41.70	50.19	56.94	61.82	66.11	70.20	73.89	77.31	80.66

[a] Component scores are multiplied by 100 and rounded to the nearest integer, component scores greater than 0.4 are highlighted

[b] See appendix table B.1 for agent name abbreviations

Table 7.8: Dose-Response Results for Component Groups

		Dose-Response							
		Low		Medium		High		Ordinal	
Component	Cases	P-value	OR	P-value	OR	P-value	OR	P-value	OR
1	666	0.65	1.05	<.01	1.32	<.01	1.39	<.0001	1.13
2	40	0.51	0.73	0.03	1.87	<.01	2.70	<.0001	1.36
3	637	<.01	1.37	<.01	1.32	<.01	1.40	<.0001	1.12
4	208	0.07	1.30	0.05	1.32	<.01	1.59	<.0001	1.17
5	501	0.03	1.24	<.01	1.38	<.01	1.31	0.0002	1.12
6	177	<.01	1.57	0.05	1.35	<.01	1.49	0.0002	1.17
7	585	<.01	1.34	0.03	1.23	<.01	1.37	0.0004	1.11
8	80	0.52	1.17	<.01	1.76	<.01	2.01	<.0001	1.28
9	546	0.19	1.14	<.01	1.40	<.01	1.35	<.0001	1.12
10	48	0.12	1.63	0.06	1.73	<.01	2.20	0.0002	1.32

Table 7.9: Multivariate Ordinal Results[a] for Component Groups

		Ordinal	
Component	Cases	OR	95% CI
2	40	1.25	1.07 - 1.47
4	208	1.11	1.02 - 1.20
9	546	1.10	1.04 - 1.17

[a] p-value < 5%

Table 7.10: Results for Ever Exposure to Any of the Members of each Component Group

		Any Exposure		
Component	Cases	p-value	OR	95% CI
1	666	0.0014	1.25	1.09 - 1.44
2	40	0.0017	1.78	1.24 - 2.55
3	637	<.0001	1.36	1.19 - 1.56
4	208	<.0001	1.40	1.18 - 1.66
5	501	<.0001	1.31	1.15 - 1.50
6	177	<.0001	1.47	1.23 - 1.76
7	585	<.0001	1.31	1.15 - 1.50
8	80	0.0002	1.63	1.26 - 2.11
9	546	0.0001	1.30	1.14 - 1.48
10	48	0.0002	1.86	1.34 - 2.60

Table 7.11: Multivariate Any Results[a] for Component Groups

		Any	
Component	Cases	OR	95% CI
3	637	1.26	1.09 - 1.45
6	177	1.25	1.03 - 1.52
10	48	1.54	1.10 - 2.17

[a] p-value < 5%

Table 7.12: Results for Ever Exposure to All of the Members of each Component Group

		All Exposed		
Component	Cases	p-value	OR	95% CI
1	223	<.0001	1.42	1.21 - 1.67
2	25	<.0001	3.11	1.92 - 5.04
3	295	0.0113	1.21	1.04 - 1.40
4	206	0.0002	1.38	1.17 - 1.64
5	89	0.0020	1.47	1.15 - 1.87
6	27	<.0001	2.49	1.59 - 3.90
7	325	0.0052	1.23	1.06 - 1.41
8	80	0.0002	1.63	1.26 - 2.11
9	50	0.0008	1.74	1.26 - 2.41
10	48	0.0002	1.86	1.34 - 2.60

Table 7.13: Multivariate All Results[a] for Component Groups

		All Exposed	
Component	Cases	OR	95% CI
1	223	1.32	1.12 - 1.57
2	25	2.47	1.49 - 4.08

[a] p-value < 5%

Figure 7.3: Proportion of Cumulative Exposure Due to Employment in Each US Job for the Top 30 Agents

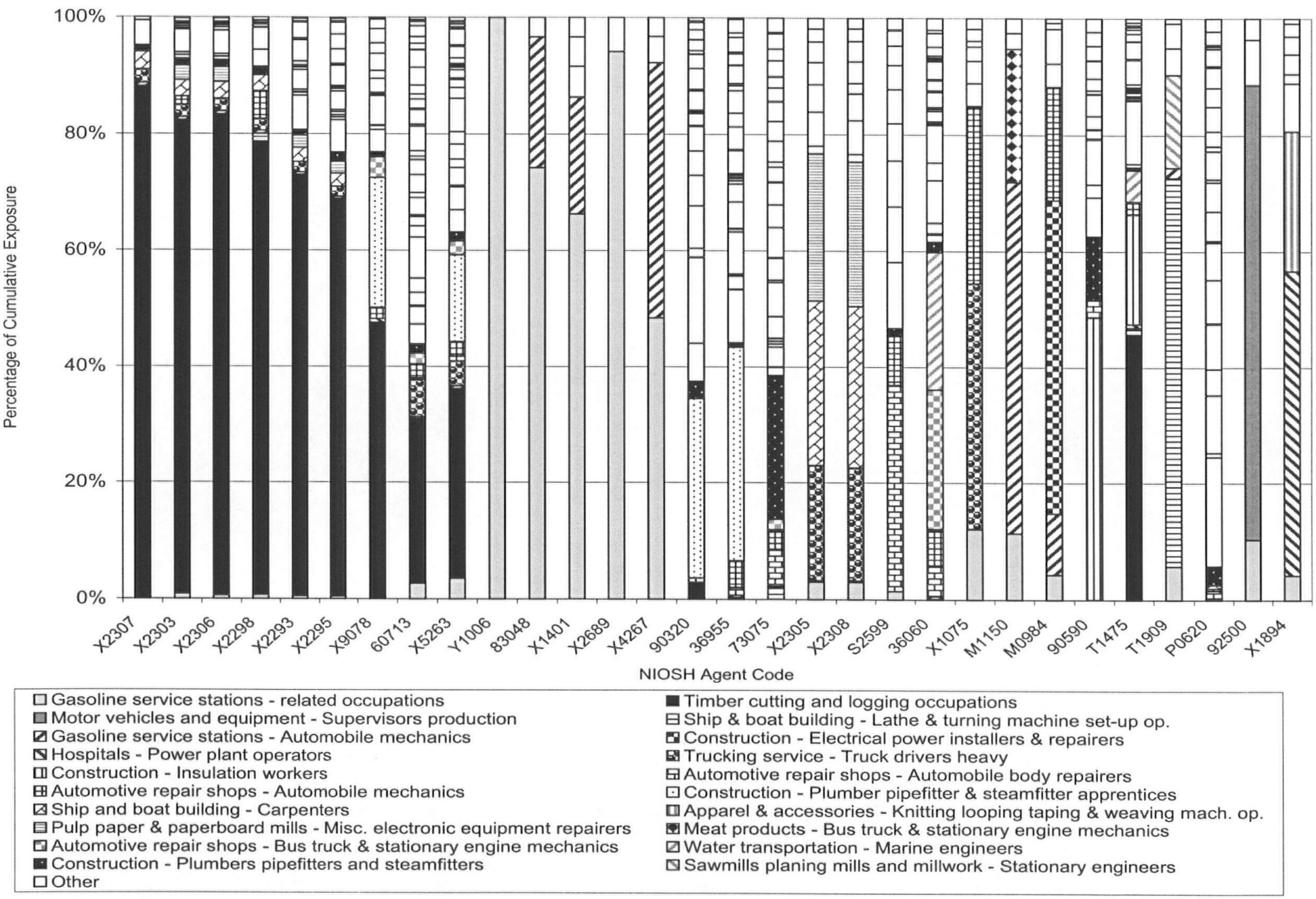

Table 7.14: Properties of the Selected 30 Agents

Agent Name	CAS	IARC[a]	Cases	PC[b]	Most Common US Job	%[c]	JEM%[d]
ALKENES, C15-18 ALPHA-, RPW SDP CS S[e]	72275-86-6		301	1	Timber cutting & logging	85	52
2,5-PYRROLIDINEDIONE, 12AE MPIB D[e]	67762-72-5		361	1	Timber cutting & logging	79	52
PHOSPHORODITHIOIC ACID, MOOB E ZS[e]	68784-31-6		335	1	Timber cutting & logging	80	52
PHENOL, DODECYL-, SULFURIZED, CCSO[e]	68784-26-9		390	1	Timber cutting & logging	73	52
SULFONIC ACIDS, PETROLEUM, CSO[e]	68783-96-0		375	1	Timber cutting & logging	67	54
PHOSPHORODITHIOIC ACID, OOB(2E)E ZS[e]	4259-15-8		450	1	Timber cutting & logging	60	54
1 - PROPENE, 2 - METHYL - , SULFURIZED	68511-50-2		397	1	Timber cutting & logging	44	54
POC - GASOLINE (LEADED)[e]		2B	617	1	Timber cutting & logging	23	64
POC - JET FUEL & GASOLINE, ULD[e]			557	1	Timber cutting & logging	28	56
NATURAL GAS, LIQUIFIED			25	2	Gasoline service station related	100	1
NONYLPHENOXYETHANOL	27986-36-3		27	2	Gasoline service stations related	74	1
2-BUTENEDIOIC ACID (E)-, PW 1,3-B EB[e]	24938-12-3		35	2	Gasoline service station related	66	1
1, 2-ETHANEDIAMINE, RP W C IB HP[e]	68891-84-9		25	2	Gasoline service station related	94	3
ETHER, TERT - BUTYL METHYL	1634-04-4	3	32	2	Gasoline service station related	48	1
ASPHALT	8052-42-4	3	499	3	Con.-Plumber pipe & steam fitter ap.	27	100
HEXANE	110-54-3		477	3	Con.-Plumber pipe & steam fitter ap.	29	100
SN, TIN - MF UNKNOWN	7440-31-5		420	3	Con.-Plumbers pipe & steam fitter	16	40
2,5-PYRROLIDINEDIONE, 12AE MPIB D RP[e]	72269-41-1		206	4	Ship & boat building - Carpenter	26	18
SULFONIC ACIDS, PETROLEUM, MS[e]	61789-87-5		208	4	Ship & boat building - Carpenter	25	18
OFW STEEL			221	5	Automotive repair-body repairers	33	8
HEPTANE	142-82-5		457	5	Automotive repair-Bus truck & stationary engine mechanic	20	95
PHOSPHORODITHIOIC ACID, OOZS[e]	26566-95-0		161	5	Trucking service - Truck drivers heavy	41	2
CYCLOHEXYLAMINE, N - ETHYL -	5459-93-8	3	28	6	Gasoline service stations-mechanic	59	23
ETHANOL, 2-(2-(2-BE)E)-[e]	143-22-6		176	6	Con.-Electrical power installer	53	100
CLAY, NEC			375	7	Construction-Insulation worker	39	32
SOLVENT RD HVY PF DIST (PETROLEUM)[e]	64741-88-4	1/3	535	7	Timber cutting & logging	37	52
NONYLPHENOL ETHYLENE OA[e]	26027-38-3		80	8	Ship & boat building - Lathe & turning machine set-up op.	64	100
IMPACT NOISE			545	9	Construction - Carpenters	13	17
OIL, HYDRAULIC		1/3	51	9	Motor vehicles & equipment - Supervisor production	78	100
2-PROPENOIC ACID, 2M CEPWC2[e]	66057-34-9		48	10	Hospitals - Power plant operator	51	100

[a] IARC classification where 1 is definitely carcinogenic, 2B is possibly carcinogenic, and 3 is not classifiable. [b] Principal component number [c] Percentage of total cumulative exposure of 9119 patients due to employment in the US Job in column 6. [d] Proportion of NIOSH NOES study participants employed in the US job in column 6 exposed to the agent. [e] See appendix table B.1 for agent name abbreviations

Table 7.15: Chemicals Associated with Bladder Cancer with Study Odds Ratios

Chemical Name	IARC[a]	CAS	NIOSH Name	Cases	Ever	Dose-Response			
						Low	Medium	High	Ordinal
4-Aminobiphenyl (xenylamine)	1	92-67-1							
N,N-Bis(2-CE)-2-NL[b]	1	494-03-1							
2-Naphthylamine	1	91-59-8	Naphthylamine, beta-	+					
Benzidine	1	92-87-5	Benzidine	+					
Cyclophosphamide	1	50-18-0	Oxazaphosphorine, 2-(bis[b]	+					
Magenta	1	632-99-5	CI Basic Violet 14, MHC[b]	12	0.69	0.54	0.49	1.07	*0.43*
Arsenic	1	7440-38-2	Arsenic	23	0.80	0.78	0.76	0.86	*0.40*
Coal tar pitches	1	65996-93-2	Pitch, Coal tar	89	1.04	1.10	1.03	1.01	0.84
Mineral oils[b]	1	8002-05-9	Petroleum	152	1.02	1.22	0.98	0.89	*0.70*
4,4'-Methylenebis(2-chloroaniline)	2A	101-14-4	Aniline, 4,4'-methylenebis[b]	+					
Adriamycin	2A	23214-92-8	Adriamycin	+					
para-Chloro-ortho-Toluidine	2A	95-69-2	Toludine, 4-chloro-, ortho-	+					
Phenacetin	2A	62-44-2	Acetophenetidide, para -	4	0.78				
		62-44-2	Phenacetin, powder	+					
Benzidine based dyes	2A	1937-37-7	C.I. Direct black 38, DS[b]	12	1.36	1.55	1.14	1.46	0.39
		2602-46-2	C.I. Direct blue 6, TS[b]	+					
		16071-86-6	C.I. Direct brown 95, DS[b]	+					
Benz(a)anthracene	2A	56-55-3	Benz(a)anthracene	13	1.92*	2.65*	1.38	1.69	0.12
Trichloroethylene	2A	79-01-6	Ethylene, trichloro -	345	1.21**	1.10	1.33**	1.20	<.01
Tetrachloroethylene	2A	127-18-4	Tetrachloroethylene	470	1.25**	1.24*	1.32**	1.19	<.01
Diesel engine emissions	2A		POC - Diesel fuels	605	1.18*	1.14	1.17	1.25*	0.01
Engine emissions	2A		POC - Gasoline (leaded)	617	1.26**	1.15	1.27*	1.36**	<.01
			POC - Gasoline (lead CU)[b]	40	1.11	1.54	0.72	1.06	0.91
N-[4-(5-Nitro-2-Furyl)2TZ]A[b]	2B	531-82-8							
N-Nitrosodi-n-butylamine	2B	924-16-3							
Oil Orange SS	2B	2646-17-5							
para-Cresidine	2B	120-71-8							
2-(2-Formylhydrazino)-4(5N2F)T[b]	2B	3570-75-0							
2-Nitroanisole	2B	91-23-6							
3,3'-Dichlorobenzidine	2B	91-94-1							
4-chloro-ortho-phenylenediamine	2B	95-83-0							
Niridazole	2B	61-57-4							
Citrus Red No. 2	2B	6358-53-8							
Auramine	2B	492-80-8							

Table 7.15: *Continued*

Chemical Name	IARC[a]	CAS	NIOSH Name	Cases	Ever	Dose-Response			
						Low	Medium	High	Ordinal
Chlordane	2B	12789-03-6	Chlordane	+					
Disperse Blue 1	2B	2475-45-8	Anthraquinone, 1,4,5,8-ta-[b]	+					
Gasoline	2B	8006-61-9	Gasoline, natural	+					
ortho-Aminoazotoluene	2B	97-56-3	C.I. Solvent yellow 3	+					
para-Dimethylaminobenzene	2B	60-11-7	C.I. Solvent yellow 2	+					
Ponceau 3R	2B	3564-09-8	Ponceau-3R	+					
CI Basic Red 9	2B	569-61-9	C.I. Basic red 9, MHC[b]	4	2.44				
3,3'-Dimethoxybenzidine	2B	119-90-4	Benzidene, 3, 3' dimethoxy -	8	1.69				
1,3-Dichloropropene	2B	542-75-6	Propene, 1, 3 - dichloro -	12	1.59	1.63	1.58	1.57	0.20
Chloroform (in drinking water)	2B	67-66-3	Chloroform	27	0.99	0.69	1.26	1.06	0.81
Nitrilotriacetic Acid	2B	139-13-9	Nitrilotriacetic Acid	31	1.14	0.71	0.37	0.70	0.55
Sodium ortho-phenylphenate	2B	132-27-4	Biphenol, sodium salt, 2 -	114	1.02	0.96	1.18	0.92	0.88
Lead	2B	7439-92-1	PB, lead - MF Unk	396	1.25**	1.18	1.30*	1.28*	<.01
		7439-92-1	PB, lead powder - MF Unk	14					
		7439-92-1	PB, lead - pure	+					
		7439-92-1	PB, lead fume - MF Unk	+					
Carbon black	2B	1333-86-4	Carbon black	554	1.08	1.10	1.03	1.10	0.32
		1333-86-4	Carbon lampblack, powder	+					

[a] IARC classification where 1 is definitely carcinogenic, 2A is probably carcinogenic, and 2B is possibly carcinogenic.
[b] 2-(2-Formylhydrazino)-4(5N2F)T = 2-(2-Formylhydrazino)-4-(5-Nitro-2-Furyl) Thiazole, N-[4-(5-Nitro-2-Furyl)2TZ]A = N-[4-(5-Nitro-2-Furyl)-2-Thiazolyl] Acetamide. Mineral oils = Mineral oils, untreated or mildly treated. Oxazaphosphorine, 2-(bis = Oxazaphosphorine, 2-(bis(2-chloroethyl) amino)tetrahydro-, 2-oxide, 2H-1, 3, 2-. MHC = monohydrochloride, DS = disodium salt, TS = tetrasodium salt, CU = content unknown, ta = tetraamino. N,N-bis(2-CE)-2-NL = N,N-bis(2-Chloroethyl)-2-naphthylamine (Chlornaphazine).
+ Less than 3 cases exposed
* Significant at a 5% alpha level
** Significant at a 1% alpha level

Table 7.16: Siemiatycki Chemicals Associated with Bladder Cancer with Study Odds Ratios

Siemiatycki Chemical	Any	Sub[a]	CAS	NIOSH Name	Cases	Ever	Low	Medium	High	Ordinal
Natural gas comb. products	1.6*	3.8**								
Carbon tetrachloride	1.6	2.5**	56-23-5	Carbon tetrachloride	229	1.11	1.20	1.12	1.01	0.46
Diesel engine emissions	1.4	2.3**		POC - Diesel fuels	605	1.18†	1.14	1.17	1.25†	0.01
Laboratory products	1.5	5.5*								
Cadmium compounds	1.6	4.9*								
Fabric dust	1	3.7*		Fabric dust-synthetic	+					
Photographic products	2.5	2.9*								
Chlorine	1	2.7*	7782-50-5	Chlorine	136	0.98	1.04	0.93	0.98	*0.80*
Polyester fibers	1.4	2.5*	80595-68-2	Polyester fibers (MF Unk.)	12	0.98	0.90	1.00	1.05	0.98
Asphalt (bitumen)	0.9	2.2*	8052-42-4	Asphalt	499	1.29††	1.40††	1.13	1.34††	<.01
Ammonia	1.2	2.1*	7664-41-7	Ammonia	336	1.06	1.15	1.09	0.94	0.90
Formaldehyde	1.2	1.7*	50-00-0	Formaldehyde	489	1.15†	1.18	1.07	1.18	0.08
Engine emissions	1.2*	1.3*		POC - Gasoline (Leaded)	617	1.26††	1.15	1.27†	1.36††	<.01
(leaded or unleaded)				POC - Gasoline (Lead CU)	40	1.11	1.54	0.72	1.06	0.91
Ionizing radiation	4.4**	0		Ionizing Radiation	18	0.57†	0.49	0.98	0.27†	*0.02*
Acrylic fibres	3.9**	3.3		Acrylic fibers (MF Unk.)	+					
Calcium carbonate	1.9**	1.6	471-34-1	Calcium carbonate, powder	+					
			471-34-1	Carbonic acid, calcium salt	652	1.16†	1.19	1.11	1.18	0.09
			471-34-1	Marble, dust	38	1.35	1.76†	1.34	0.97	0.34
			1317-65-3	Limestone	470	1.22††	1.29††	1.12	1.24†	0.02
			1317-65-3	Limestone, powder	290	1.21†	1.24	1.1	1.28†	0.02
Titanium dioxide	1.7**	4.5	13463-67-7	Titanium oxide (TIO2)	654	1.20††	1.19	1.22†	1.20	0.02
Titanium compounds	1.7**	2.2								
Hydrogen cyanide	3.4*	0	74-90-8	Hydrogen cyanide	13	1.23	1.14	1.21	1.34	0.48
Creosote	2.6*	2.6		Creosote	130	1.08	0.98	1.17	1.12	0.34
Polyethylene	2.5*	13	9002-88-4	Polyethylene wax	194	1.09	1.01	1.13	1.13	0.25
			9002-88-4	Ethylene, polymers	470	1.11	1.11	1.06	1.14	0.15
			9002-88-4	Polyethylene, fiber	11	1.67	3.08†	0.81	1.3	0.40
Carbon black	2.2*	1.8	1333-86-4	Carbon black	554	1.08	1.1	1.03	1.1	0.32
			1333-86-4	Carbon lampblack, powder	+					
Clay dust	2.2*	1.8								
Lead chromate	1.8*	2.2	7758-97-6	Lead chromate	98	1.12	0.99	1.15	1.22	0.23
			7758-97-6	Chromic acid, lead(2+) salt	24	1.03	1.37	0.79	0.98	*0.90*
Aliphatic aldehydes	1.4*	1.6								
Lead compounds	1.3*	1.1								

[a] Odds-ratio for substantial exposure. + Less than 3 cases exposed. † Significant at a 5% alpha level. †† Significant at a 1% alpha level
* Significant at p=0.10, one-sided, with at least 4 exposed cases. ** Significant at p=0.05, one-sided, with at least 5 exposed cases.

Appendix A

Table A.1: Odds-Ratios of Ever Exposure and Dose-Response Results for 3,450 Agents[a]

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
01038	107	0.88	0.83	0.86	0.93	*0.35*	11600	25	0.95	1.57	0.48	0.88	*0.47*
01568	407	1.05	1.13	1.12	0.91	*0.92*	11610	114	1.03	1.25	1.12	0.72	*0.54*
01600	205	1.08	1.18	1.16	0.89	0.86	11770	15	0.93	0.95	0.74	1.10	*0.87*
02740	280	1.24**	1.24	1.36**	1.13	0.02	12783	27	1.14	1.02	0.75	1.68	0.30
02820	559	1.25**	1.24*	1.33**	1.19	<.01	12845	214	1.16	1.10	1.13	1.24	0.06
02900	17	1.12	0.81	0.72	1.88	0.35	12960	324	1.03	1.16	1.13	0.81	*0.50*
03298	119	1.09	1.04	1.21	1.03	0.47	12963	165	0.97	0.83	1.05	1.03	0.92
03530	10	1.85	2.13	1.86	1.41	0.18	13100	61	1.22	1.27	0.90	1.49	0.14
03540	29	1.03	0.79	0.93	1.36	0.59	13410	61	1.12	1.25	0.94	1.17	0.53
03570	238	1.12	1.16	0.99	1.22	0.15	13480	459	1.15*	1.14	1.22*	1.09	0.11
03800	164	1.06	1.24	0.95	0.99	0.91	13850	435	1.18*	1.27*	1.13	1.15	0.08
04280	13	1.30	1.55	0.98	1.35	0.49	13980	514	1.21**	1.20	1.20	1.21*	0.01
04530	14	1.06	1.01	0.95	1.22	0.78	14380	441	1.13	1.12	1.06	1.21	0.06
04580	15	0.82	0.66	0.95	0.86	*0.60*	14400	210	1.12	0.94	1.25	1.18	0.09
04605	63	0.98	1.13	0.97	0.83	*0.61*	14410	181	1.01	0.91	1.13	0.97	0.88
04620	255	1.13	1.37**	0.95	1.09	0.42	14720	223	1.27**	1.10	1.29	1.44**	<.01
04980	494	1.14	1.24*	1.05	1.13	0.20	14730	16	0.95	0.66	0.95	1.19	0.92
05250	336	1.06	1.15	1.09	0.94	0.90	15570	164	1.10	1.24	1.10	0.97	0.63
05270	308	1.05	1.05	1.10	1.01	0.62	15705	652	1.16*	1.19	1.11	1.18	0.09
06063	14	0.89	0.39	1.39	0.86	*0.93*	15720	317	1.14	1.25*	1.05	1.11	0.23
06145	481	1.11	1.13	1.06	1.14	0.17	15743	457	1.24**	1.27*	1.15	1.30**	<.01
06163	105	1.04	1.03	1.07	1.04	0.72	15746	171	1.09	1.05	1.02	1.18	0.28
06175	238	1.13	1.24	1.13	1.03	0.34	15755	464	1.16*	1.10	1.21	1.18	0.03
06580	27	1.41	1.74	0.89	1.49	0.20	15765	378	1.17*	1.19	1.06	1.26*	0.03
07310	288	1.23**	1.13	1.28*	1.28*	<.01	15800	103	1.04	1.09	1.04	0.98	0.90
07325	24	0.96	0.84	1.41	0.68	*0.78*	17366	476	1.21**	1.09	1.29**	1.25*	<.01
07485	108	1.12	1.26	1.14	0.96	0.63	17367	502	1.21**	1.16	1.15	1.31**	<.01
07545	23	0.80	0.78	0.76	0.86	*0.40*	17370	23	1.29	0.16	1.65	2.18*	0.03
08625	19	1.02	1.36	1.19	0.50	*0.66*	17385	29	0.95	0.60	1.12	1.11	0.88
08640	168	1.05	0.83	1.00	1.31*	0.17	17460	271	1.17*	1.20	1.01	1.29*	0.04
08650	71	1.07	1.03	1.09	1.09	0.59	17490	229	1.11	1.20	1.12	1.01	0.46
08655	234	1.10	0.99	1.22	1.08	0.23	17525	372	1.19*	1.18	1.28*	1.11	0.05
09070	285	1.16	1.39**	1.16	0.92	0.57	17683	437	1.15*	1.13	1.10	1.24*	0.03
10210	75	0.99	1.02	0.68	1.30	0.75	17695	248	1.17*	1.43**	0.96	1.12	0.26
11280	169	1.11	1.09	1.08	1.16	0.26	18040	136	0.98	1.04	0.93	0.98	*0.80*
11360	165	1.09	1.17	0.94	1.16	0.41	18045	29	1.07	0.85	1.40	0.97	0.70
11590	45	1.34	1.45	1.36	1.23	0.15	18190	55	1.42*	1.10	1.80*	1.50	0.01

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
18260	119	1.28*	1.33	1.23	1.28	0.04	24615	418	1.15*	1.22*	1.22*	1.01	0.26
18500	27	0.99	0.69	1.26	1.06	0.81	24680	14	1.13	0.98	1.42	0.96	0.71
19130	15	0.84	0.40	0.84	1.20	*0.90*	24930	73	1.05	1.17	1.04	0.94	0.97
19360	88	0.99	1.01	0.83	1.13	0.95	25145	390	1.08	1.06	1.09	1.11	0.23
19380	32	0.93	0.96	1.28	0.53	*0.47*	25210	259	1.24**	1.33*	1.02	1.35*	0.01
19395	363	1.16*	1.27*	1.24*	0.97	0.30	25544	545	1.23**	1.15	1.17	1.37**	<.01
19425	10	1.18	2.42*	0.00	1.22	*0.94*	25820	168	1.00	0.93	1.05	1.01	0.90
19430	71	1.05	1.22	0.98	0.93	*0.97*	26075	207	1.11	0.95	1.18	1.21	0.10
19540	58	0.95	1.18	0.90	0.78	*0.43*	26095	23	1.09	0.99	0.90	1.39	0.54
19680	387	1.12	1.13	1.22*	1.00	0.32	26130	101	1.01	1.08	0.77	1.17	0.85
19710	81	1.03	1.04	1.14	0.93	0.93	26335	67	0.99	1.07	0.83	1.03	*0.88*
19767	94	0.92	1.18	0.83	0.78	*0.22*	26560	237	1.17	1.06	1.20	1.26	0.03
19770	142	1.05	1.00	1.13	1.02	0.63	26615	590	1.19*	1.24*	1.13	1.20	0.04
19935	22	1.02	0.68	1.08	1.32	0.61	26880	10	1.39	1.23	1.86	0.97	0.43
19985	187	1.18	1.31*	1.07	1.17	0.14	26940	56	1.30	1.63*	1.08	1.19	0.23
20115	495	1.21**	1.25*	1.15	1.24*	0.01	27590	179	1.16	1.27	1.03	1.18	0.19
20155	16	1.10	1.73	1.02	0.60	*0.78*	27615	288	1.16*	1.09	1.18	1.22	0.03
20245	13	1.19	0.98	1.31	1.33	0.49	27760	22	1.26	2.09*	1.28	0.49	*0.99*
20265	560	1.23**	1.29**	1.14	1.25*	0.01	27780	130	1.07	1.08	1.17	0.98	0.64
20340	117	1.07	1.04	1.10	1.06	0.57	28510	36	1.12	1.32	1.21	0.83	0.87
20380	193	1.26**	1.29	1.13	1.36*	0.01	29010	206	1.18	1.13	1.18	1.23	0.05
20810	237	1.16	1.13	1.20	1.16	0.08	29325	29	0.93	1.24	1.03	0.49	*0.34*
20850	16	1.16	1.18	1.58	0.73	0.81	29930	565	1.16*	1.20	1.27**	1.03	0.21
20900	117	0.97	1.01	0.97	0.94	*0.72*	31350	248	1.01	1.06	0.98	0.97	*0.87*
21190	87	1.11	0.97	1.37	0.99	0.41	31470	418	1.25**	1.17	1.32**	1.26*	<.01
21560	66	1.03	0.98	1.05	1.05	0.79	31490	186	1.15	1.26	1.12	1.08	0.27
21660	364	1.16*	1.26*	0.93	1.29*	0.05	31500	497	1.11	1.19	1.17	0.98	0.54
22734	38	1.11	1.32	1.02	0.98	0.80	31830	300	1.11	1.22	1.06	1.06	0.38
23180	10	0.67	0.30	1.94	0.38	*0.35*	31900	18	1.25	1.41	1.02	1.33	0.46
23275	34	1.56*	1.08	1.67	1.93*	0.01	31970	136	1.02	1.23	0.98	0.87	*0.69*
23360	9	1.57	1.77	2.32	0.52	0.46	32220	153	1.05	0.97	1.16	1.03	0.55
24003	207	1.17	0.97	1.39*	1.14	0.05	32385	619	1.23**	1.33**	1.17	1.19	0.05
24006	12	0.73	1.33	0.38	0.51	*0.16*	32500	50	0.97	1.53	0.76	0.66	*0.29*
24095	349	1.11	1.18	1.14	1.02	0.39	32550	115	0.87	0.81	0.81	0.97	*0.35*
24130	47	0.92	0.99	0.95	0.81	*0.51*	32590	342	1.23**	1.17	1.29*	1.23	<.01
24235	26	1.27	1.31	1.53	0.93	0.44	32925	52	0.95	0.99	1.17	0.77	*0.58*
24425	11	1.18	1.04	0.69	1.78	0.44	32940	61	0.96	0.89	1.26	0.82	*0.72*

Table A.1 *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
33115	325	1.14	1.35**	1.10	0.97	0.56	38530	13	1.23	1.14	1.21	1.34	0.48
33160	62	1.04	0.78	1.07	1.29	0.40	38550	126	1.24*	1.24	1.26	1.22	0.07
33165	25	0.91	0.92	1.06	0.76	*0.62*	38575	23	1.02	0.99	1.35	0.61	*0.89*
33230	39	0.82	0.60	0.63	1.26	*0.69*	38580	446	1.12	1.20	1.12	1.06	0.30
33235	243	1.09	1.23	1.13	0.91	0.83	38585	161	1.20	1.29	1.11	1.19	0.11
33307	273	1.18*	1.24	1.20	1.09	0.12	38605	327	1.13	1.22	1.04	1.13	0.20
33350	146	1.08	0.98	1.12	1.13	0.33	38620	243	1.29**	1.30*	1.25	1.32*	<.01
33370	20	0.86	0.56	0.28	1.62	0.85	38670	37	1.03	0.80	1.72*	0.52	*0.94*
33415	18	1.03	0.88	1.19	0.99	0.86	38950	14	1.35	1.06	2.13	0.89	0.38
33565	223	1.02	0.87	1.09	1.09	0.48	40030	54	0.93	1.14	0.87	0.74	*0.35*
33595	203	1.27**	1.39*	1.26	1.14	0.04	40297	337	1.21*	1.19	1.21	1.21	0.02
33635	58	0.83	0.79	0.84	0.85	*0.26*	40370	123	1.27*	1.32	1.44*	1.05	0.08
33640	489	1.15*	1.18	1.07	1.18	0.08	40380	52	1.27	1.01	1.56	1.23	0.11
33675	277	1.16	1.16	1.14	1.18	0.08	40410	193	1.24*	1.21	1.35*	1.17	0.03
33720	201	1.00	0.93	0.91	1.16	0.59	40430	274	1.05	1.01	1.15	1.00	0.56
33850	10	1.15	0.72	1.41	1.28	0.56	40910	28	0.97	1.11	0.57	1.27	*0.98*
33940	107	0.89	1.01	0.86	0.81	*0.20*	40984	132	1.31**	1.65**	1.22	1.05	0.13
34120	218	1.16	1.09	1.13	1.26	0.05	40987	664	1.24**	1.27**	1.40**	1.07	0.08
34370	201	1.10	1.13	1.09	1.09	0.34	41775	516	1.26**	1.31**	1.19	1.28**	<.01
34715	142	0.97	1.17	0.95	0.79	*0.31*	42355	44	1.45*	1.82*	1.72	0.90	0.20
35085	511	1.15*	1.09	1.26*	1.11	0.06	42490	396	1.25**	1.18	1.30*	1.28*	<.01
35120	10	1.31	0.45	1.30	2.12	0.21	42685	10	0.91	0.81	0.78	1.17	*0.93*
35260	51	0.81	0.85	0.79	0.79	*0.18*	43040	30	0.87	1.18	0.65	0.82	*0.35*
35455	31	1.18	1.14	1.65	0.78	0.62	43320	274	1.19*	1.03	1.42**	1.12	0.02
35505	213	1.15	1.24	1.12	1.09	0.23	43360	179	1.20*	1.19	1.24	1.17	0.07
35755	13	1.07	1.07	0.90	1.22	0.77	43410	189	1.13	1.33*	1.09	0.96	0.59
35925	49	0.96	0.82	1.03	1.01	*0.94*	43660	100	1.12	1.00	1.28	1.05	0.34
35927	128	1.13	1.30	1.03	1.04	0.54	44000	453	1.18*	1.23*	1.13	1.17	0.05
36060	457	1.30**	1.35**	1.22	1.33**	<.01	44030	93	1.03	1.02	0.87	1.19	0.63
36330	29	1.29	1.57	1.19	1.13	0.40	44440	22	0.88	0.76	1.26	0.66	*0.56*
36340	82	1.16	1.32	0.85	1.32	0.28	44870	38	0.98	1.19	0.97	0.80	*0.66*
36710	19	0.76	1.17	0.56	0.51	*0.12*	45655	18	0.77	0.64	0.82	0.85	*0.42*
36955	477	1.30**	1.44**	1.25*	1.21	<.01	45850	92	1.15	1.08	1.21	1.16	0.24
37330	12	1.25	1.80	0.82	0.92	0.85	45930	584	1.16*	1.19	1.17	1.12	0.12
37510	450	1.17*	1.23*	1.18	1.12	0.08	46240	130	1.04	1.12	0.96	1.04	0.85
37630	394	1.08	1.07	1.01	1.15	0.24	46470	11	1.65	0.52	2.42	1.65	0.09
38110	62	1.04	1.52*	1.00	0.62	*0.44*	46935	13	1.30	0.29	2.18	1.51	0.19

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
46970	595	1.20**	1.23*	1.26*	1.10	0.08	54185	380	1.14	1.03	1.37**	1.02	0.11
47030	128	1.10	1.47*	0.88	0.97	0.93	54243	126	1.18	1.10	1.13	1.31	0.08
47270	537	1.18*	1.20	1.22*	1.14	0.05	54480	110	1.14	0.96	1.20	1.24	0.15
47700	103	1.02	1.01	0.92	1.15	0.70	54790	470	1.25**	1.24*	1.32**	1.19	<.01
48320	309	1.08	1.19	1.13	0.93	0.81	55460	463	1.16*	1.16	1.14	1.18	0.05
48535	395	1.26**	1.44**	0.95	1.39**	<.01	56240	76	1.19	1.01	1.68**	0.91	0.26
48625	282	1.14	1.15	1.16	1.10	0.15	57210	66	1.18	1.38	0.88	1.31	0.30
48910	307	1.14	1.18	1.22	1.02	0.25	57280	22	1.37	1.57	1.69	0.89	0.39
49600	241	1.18*	1.27	1.21	1.06	0.15	57340	194	1.15	1.07	1.27	1.10	0.14
50195	170	1.11	1.49**	1.01	0.81	*0.81*	57740	10	2.08	2.54	2.15	1.62	0.11
50420	397	1.20**	1.24*	1.20	1.16	0.04	58520	513	1.13	1.11	1.17	1.10	0.13
50440	13	0.76	1.37	0.33	0.58	*0.18*	59115	129	0.99	1.07	0.98	0.93	*0.76*
50470	12	1.34	2.67*	0.64	0.71	0.98	59185	58	1.29	1.23	1.38	1.27	0.11
50480	34	0.98	0.71	1.11	1.12	0.80	59210	109	1.28*	1.43*	1.29	1.12	0.11
50510	53	1.18	1.15	1.12	1.27	0.27	59230	113	1.20	1.37	1.06	1.16	0.22
50742	176	1.04	0.90	1.14	1.09	0.42	59450	61	1.22	1.42	0.82	1.38	0.24
50795	9	1.14	0.39	1.36	1.68	0.42	59465	161	1.14	1.29	1.01	1.11	0.35
50865	258	1.00	0.95	1.00	1.04	0.83	60122	145	1.18	1.54**	0.82	1.16	0.38
50870	136	1.27*	1.49*	0.98	1.34	0.05	60125	29	1.56*	2.11*	1.61	0.96	0.19
50888	135	1.31**	1.49*	1.06	1.40*	0.02	60297	33	1.04	1.15	0.89	1.08	0.91
50890	57	0.91	1.00	1.03	0.70	*0.31*	60315	26	0.90	0.75	0.78	1.14	*0.87*
50910	308	1.12	1.12	1.13	1.11	0.17	60350	374	1.12	1.14	1.21	1.01	0.29
51090	17	1.01	1.14	1.10	0.77	*0.87*	60360	208	1.12	1.00	1.23	1.13	0.14
51100	104	1.18	1.30	0.98	1.26	0.21	60370	29	2.01**	2.55**	2.62**	0.92	0.02
51118	171	1.14	1.44**	0.95	1.03	0.57	60400	21	0.85	1.38	0.35	0.86	*0.30*
51705	102	1.24	1.28	1.18	1.25	0.09	60410	35	1.42	2.03*	1.41	0.90	0.34
51910	24	0.99	1.34	0.96	0.71	*0.64*	60420	119	1.28*	1.10	1.44*	1.31	0.02
52132	335	1.15	1.12	1.19	1.13	0.08	60440	519	1.17*	1.26*	1.17	1.08	0.18
52136	17	1.15	1.28	1.23	0.95	0.76	60490	52	1.03	1.41	0.75	0.95	*0.76*
52138	30	1.96**	2.29**	1.54	1.86	<.01	60540	204	1.18	1.24	1.01	1.29	0.06
52141	605	1.27**	1.29**	1.24*	1.27*	<.01	60570	18	1.22	1.77	1.17	0.65	0.93
52142	38	1.08	0.99	1.04	1.18	0.59	60711	87	1.01	1.25	0.73	1.03	*0.82*
52145	117	1.18	1.05	1.21	1.30	0.08	60712	180	1.38**	1.30	1.49**	1.34	<.01
52190	477	1.15*	1.22*	1.20	1.03	0.25	60713	617	1.26**	1.15	1.27*	1.36**	<.01
52480	137	0.95	1.00	0.90	0.95	*0.55*	60714	40	1.11	1.54	0.72	1.06	0.91
53615	21	1.19	1.28	1.18	1.10	0.58	60717	68	0.99	1.07	1.00	0.88	*0.72*
54160	141	1.28*	1.59**	1.17	1.06	0.15	60721	184	1.21*	1.25	1.15	1.21	0.07

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
62000	45	0.90	1.25	1.00	0.49*	*0.17*	69090	203	0.97	0.92	1.20	0.79	*0.49*
62460	34	1.18	1.43	0.90	1.25	0.49	69120	11	0.49*	0.56	0.26	0.67	*0.05*
63265	71	1.11	1.22	1.25	0.88	0.75	69220	434	1.17*	0.97	1.39**	1.16	<.01
63525	603	1.11	1.15	1.13	1.06	0.33	69230	481	1.21**	1.24*	1.35**	1.06	0.06
63550	189	1.09	1.10	1.18	0.99	0.48	69270	110	1.20	1.34	1.18	1.09	0.25
65080	20	1.11	1.11	0.65	1.56	0.52	69330	11	0.65	0.58	1.13	0.31	*0.15*
66495	518	1.22**	1.32**	1.05	1.31**	<.01	69375	29	0.91	0.62	1.18	0.95	*0.87*
66950	61	1.46*	1.60*	1.06	1.69*	0.02	69445	118	1.02	0.83	1.13	1.10	0.53
67220	37	0.75	0.67	0.85	0.74	*0.16*	69460	49	1.14	1.22	1.27	0.96	0.62
67405	23	0.93	0.99	1.51	0.34	*0.41*	69470	168	0.98	1.00	1.01	0.94	*0.77*
67410	30	0.94	0.45	0.70	1.62	0.55	69715	253	1.15	1.14	1.23	1.09	0.13
67537	300	1.26**	1.35**	1.15	1.27*	0.01	69730	20	0.83	0.93	1.18	0.36	*0.26*
67680	46	0.93	1.21	0.88	0.70	*0.34*	69740	490	1.21**	1.26*	1.16	1.22*	0.02
67915	314	1.21**	1.35**	1.12	1.17	0.06	69855	620	1.21**	1.22*	1.26*	1.14	0.05
67918	10	1.90	2.36	2.64	0.61	0.27	70130	310	1.04	1.04	0.94	1.14	0.46
68208	12	1.16	1.67	0.55	1.29	0.82	70131	242	1.03	1.11	0.85	1.12	0.73
68295	16	0.85	1.03	1.16	0.41	*0.32*	70845	431	1.18*	1.12	1.24*	1.18	0.02
68508	32	1.36	1.69	1.10	1.24	0.27	70860	200	1.23*	1.38*	1.19	1.12	0.09
68509	65	0.99	0.97	0.96	1.04	1.00	70865	10	1.96	1.97	1.93	1.97	0.08
68512	110	0.93	0.93	0.95	0.92	*0.54*	70870	379	1.06	1.03	1.08	1.08	0.35
68657	584	1.16*	1.25*	1.06	1.17	0.12	70995	117	1.13	0.97	1.27	1.16	0.18
68695	469	1.23**	1.21	1.22*	1.27*	<.01	71025	11	1.14	0.95	1.33	1.15	0.66
68730	204	1.12	1.20	0.95	1.21	0.22	71055	536	1.13	1.18	1.09	1.12	0.17
68765	298	1.12	1.00	1.20	1.17	0.07	71058	20	0.69	1.02	0.70	0.40	*0.06*
68766	188	1.20*	1.40*	1.05	1.14	0.18	71095	25	1.00	1.23	0.72	1.07	*0.92*
68768	12	1.70	0.00	1.30	4.83**	<.01	71640	20	1.30	1.68	0.96	1.22	0.48
68770	185	1.00	1.23	0.86	0.90	*0.47*	71695	292	1.17*	1.11	1.04	1.37**	0.01
68820	13	0.80	0.81	0.53	1.10	*0.61*	71900	30	0.90	1.02	0.68	0.99	*0.61*
68850	601	1.18*	1.29**	1.18	1.06	0.28	72200	13	0.87	0.24	1.14	1.12	0.99
68870	28	0.90	0.91	0.52	1.30	*0.86*	73075	420	1.30**	1.22	1.30*	1.38**	<.01
68880	515	1.16*	1.24*	1.14	1.11	0.14	73255	271	1.16	1.15	1.27*	1.07	0.12
68900	100	1.22	1.37	1.60**	0.68	0.50	73300	573	1.21**	1.28**	1.15	1.20	0.04
68905	204	1.15	1.24	1.07	1.12	0.24	73390	45	1.60**	2.00*	1.27	1.56	0.02
68950	39	1.09	1.27	1.34	0.66	*0.92*	73470	39	1.01	1.49	0.46	1.10	*0.79*
69000	434	1.14	1.20	1.16	1.05	0.23	73525	168	1.16	1.28	1.23	1.00	0.32
69055	292	1.03	0.99	1.10	1.00	0.74	73730	135	1.20	1.28	1.08	1.23	0.12
69070	599	1.12	1.11	1.16	1.08	0.21	73790	345	1.21**	1.10	1.33**	1.20	<.01

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
74010	204	1.27**	1.54**	1.31	0.99	0.12	80071	115	1.01	1.24	0.81	0.99	*0.74*
74175	78	1.18	1.13	1.29	1.10	0.26	80073	90	1.00	0.72	1.09	1.16	0.57
74430	14	1.42	1.38	1.01	1.96	0.19	80076	394	1.15	1.18	1.26*	1.01	0.22
74635	118	1.15	0.96	1.19	1.29	0.10	80079	417	1.10	1.09	1.14	1.06	0.27
74655	40	1.32	0.80	1.61	1.54	0.05	80083	296	1.06	1.05	1.10	1.02	0.58
74795	342	1.11	1.24*	1.16	0.94	0.64	80090	50	1.17	1.72*	0.77	1.02	0.78
74980	103	1.03	0.99	0.92	1.18	0.58	80092	220	1.18	1.40**	1.12	1.03	0.30
74990	295	1.28**	1.23	1.23	1.39**	<.01	80094	74	1.02	1.07	0.75	1.14	0.83
75158	94	1.03	1.01	0.98	1.10	0.72	80105	78	1.40*	1.21	1.98**	1.09	0.03
76165	128	1.08	1.14	1.02	1.10	0.52	80109	550	1.18*	1.15	1.15	1.24*	0.01
76210	10	0.85	1.24	0.52	0.76	*0.48*	80123	88	1.26	1.08	1.41	1.31	0.05
76355	209	1.13	1.24	0.92	1.23	0.21	80133	15	0.65	0.77	0.71	0.49	*0.10*
76445	90	1.01	0.90	1.22	0.92	0.92	80140	197	1.15	1.22	1.12	1.12	0.20
76510	180	1.11	1.29	0.95	1.09	0.51	80142	64	1.01	0.88	1.68*	0.52*	*0.71*
76720	624	1.21**	1.23*	1.21*	1.18	0.04	80143	17	2.16**	2.65*	2.04	1.70	0.03
77115	413	1.21**	1.22	1.29*	1.14	0.03	80144	365	1.15	1.37**	1.05	1.02	0.45
77150	252	1.06	0.95	1.12	1.10	0.32	80145	11	0.63	0.70	0.39	0.76	*0.19*
77190	402	1.16*	1.22	1.23*	1.04	0.16	80148	9	0.67	0.93	0.61	0.49	*0.19*
77215	353	1.16*	1.20	1.16	1.10	0.12	80153	89	1.11	1.29	0.77	1.27	0.45
77220	45	1.12	1.29	1.24	0.84	0.84	80157	34	1.10	0.85	1.17	1.28	0.42
77265	106	1.12	1.27	0.80	1.31	0.32	80158	187	1.04	1.09	0.92	1.13	0.61
80004	13	1.08	1.57	0.52	1.06	*0.94*	80164	366	1.15	1.17	1.25*	1.03	0.18
80017	605	1.18*	1.14	1.17	1.25*	0.01	80165	292	1.16*	1.31*	1.03	1.14	0.17
80032	215	1.07	1.30*	0.82	1.08	0.82	80169	34	0.85	0.52	0.69	1.38	*0.96*
80037	328	1.13	1.26*	1.00	1.13	0.24	80175	100	1.10	0.90	1.04	1.36	0.16
80041	237	1.19*	1.23	1.20	1.15	0.07	80177	12	0.90	0.74	0.24	1.61	0.88
80047	164	1.11	1.16	1.04	1.15	0.30	80181	15	1.54	0.81	2.31	1.62	0.08
80048	147	1.06	1.14	1.10	0.93	0.89	80182	10	1.20	0.93	2.21	0.69	0.69
80049	62	0.91	0.85	0.99	0.89	*0.55*	80194	15	0.93	1.17	0.50	1.16	*0.81*
80051	438	1.19*	1.20	1.32**	1.04	0.08	80197	37	0.76	0.64	0.77	0.87	*0.25*
80053	382	1.17*	1.20	1.16	1.14	0.07	80199	18	1.00	0.73	1.51	0.69	*0.98*
80056	318	1.12	1.00	1.22	1.13	0.09	80200	45	0.95	0.88	1.31	0.70	*0.62*
80058	31	1.14	1.37	0.79	1.32	0.55	80201	38	0.78	1.14	0.31*	0.91	*0.13*
80059	150	1.23*	1.16	1.41*	1.13	0.06	80202	88	0.92	0.92	0.85	0.98	*0.59*
80061	342	1.16*	1.17	1.17	1.14	0.08	80203	23	1.00	0.74	0.87	1.37	0.68
80064	68	1.22	1.17	1.09	1.44	0.11	80206	23	1.13	1.32	1.30	0.76	0.89
80069	386	1.05	1.04	1.08	1.04	0.51	80214	296	1.07	1.17	1.09	0.96	0.76

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
80215	42	1.70**	0.84	2.75**	1.43	<.01	80310	11	0.71	0.81	0.90	0.49	*0.24*
80216	442	1.14	1.23*	1.08	1.12	0.17	80314	19	1.01	0.51	1.03	1.43	0.56
80218	45	0.95	0.79	1.09	0.94	*0.87*	80323	16	0.70	0.79	0.96	0.36	*0.12*
80219	69	1.14	1.25	1.05	1.11	0.49	80331	9	0.97	0.25	2.84*	0.33	0.96
80220	64	1.24	1.07	1.50	1.17	0.13	80332	140	1.02	1.23	0.97	0.88	*0.70*
80223	434	1.10	1.25*	1.09	0.98	0.67	80341	143	1.14	1.18	1.09	1.14	0.27
80224	305	1.08	1.01	1.41**	0.83	0.62	80343	436	1.08	1.00	1.13	1.11	0.17
80231	361	1.08	1.24*	1.00	1.00	0.80	80346	50	1.30	1.48	1.28	1.13	0.24
80235	188	1.08	0.85	1.11	1.25	0.12	80347	75	1.35*	1.15	1.74**	1.14	0.04
80237	43	1.23	1.36	1.09	1.21	0.34	80349	245	1.05	1.11	1.07	0.97	0.85
80243	455	1.21**	1.34**	1.13	1.16	0.05	80350	60	1.33	1.18	1.53	1.28	0.06
80244	277	1.09	1.17	1.00	1.12	0.35	80354	236	1.12	1.13	1.16	1.08	0.24
80248	357	1.12	1.30*	1.06	1.00	0.56	80358	17	0.79	0.32	1.06	0.94	*0.65*
80249	468	1.17*	1.08	1.16	1.25*	0.01	80365	118	1.08	0.98	1.22	1.06	0.41
80251	125	1.09	1.21	1.12	0.93	0.78	80368	228	1.08	1.02	1.29*	0.94	0.47
80257	50	0.82	1.14	0.50*	0.81	*0.11*	80369	45	0.82	0.55	1.00	0.92	*0.48*
80258	195	1.06	1.07	1.14	0.97	0.67	80371	14	0.85	1.56	0.35	0.68	*0.32*
80260	12	1.42	1.08	1.49	1.67	0.22	80372	14	0.99	1.00	0.70	1.26	0.91
80261	51	1.13	1.57	1.03	0.84	0.97	80381	15	0.74	0.18	1.07	0.88	*0.56*
80265	64	1.15	0.95	1.47	1.04	0.33	80389	28	0.83	0.92	0.24*	1.37	*0.63*
80268	124	1.05	1.07	1.12	0.97	0.77	80390	321	1.11	1.00	1.14	1.18	0.08
80270	22	1.11	1.09	1.16	1.10	0.67	80393	45	1.18	1.15	1.34	1.06	0.39
80273	17	1.21	1.21	1.57	0.94	0.62	80417	24	1.28	0.92	1.48	1.44	0.20
80276	11	1.24	1.35	1.71	0.64	0.75	80419	16	0.64	1.06	0.47	0.38	*0.04*
80282	26	1.42	1.65	1.51	0.99	0.28	80421	11	1.10	0.93	2.38	0.46	1.00
80283	232	1.03	0.98	1.06	1.04	0.67	80439	134	1.13	1.27	0.93	1.19	0.33
80285	46	1.47*	2.05**	0.86	1.54	0.08	80441	526	1.17*	1.29**	1.06	1.15	0.13
80286	133	1.12	1.20	1.11	1.03	0.47	80447	125	1.03	1.05	0.93	1.11	0.71
80287	97	1.07	1.23	0.94	1.04	0.77	80452	20	1.02	0.86	1.05	1.14	0.82
80288	274	1.13	1.29*	1.01	1.10	0.33	80461	141	1.05	1.20	1.01	0.95	0.99
80293	165	1.09	1.25	1.00	1.03	0.63	80487	18	0.94	0.75	0.97	1.11	1.00
80295	13	1.59	2.55*	0.95	1.34	0.35	80488	32	0.98	0.90	0.80	1.24	0.86
80298	466	1.20**	1.24*	1.15	1.21	0.02	80496	167	1.03	1.11	1.02	0.97	0.94
80299	332	1.17*	1.12	1.15	1.26*	0.02	80507	157	1.05	0.93	1.06	1.16	0.37
80300	20	0.98	0.48	1.42	0.96	0.82	80517	66	0.98	1.24	0.98	0.72	*0.45*
80301	13	0.89	1.17	0.87	0.62	*0.51*	80527	17	0.62	0.94	0.22*	0.72	*0.06*
80305	57	1.34	1.69*	1.22	1.04	0.26	80530	313	1.16*	1.22	1.26*	1.02	0.19

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
80531	38	1.12	1.05	1.30	0.98	0.61	81085	11	0.76	0.43	0.64	1.21	*0.73*
80538	9	1.37	0.48	2.60*	0.60	0.38	81115	17	1.06	1.82	0.60	0.83	*0.73*
80542	333	1.20*	1.28*	1.14	1.17	0.05	81120	46	1.08	1.16	1.61	0.56	*0.85*
80545	19	0.93	0.77	0.29	1.79	0.70	81125	114	1.02	0.96	1.18	0.92	0.88
80549	17	1.21	0.67	1.71	1.15	0.37	81135	9	1.09	2.82*	0.38	0.27	*0.40*
80563	9	1.45	1.94	1.49	0.99	0.51	81350	252	1.15	1.13	1.09	1.25	0.06
80564	26	0.81	0.66	0.69	1.09	*0.56*	81355	11	0.85	0.47	1.15	0.91	*0.80*
80570	202	1.15	1.17	1.06	1.22	0.12	81390	242	0.97	1.11	1.03	0.77	*0.20*
80573	16	1.17	0.79	1.79	1.04	0.51	81440	13	0.57	0.53	0.46	0.69	*0.10*
80574	14	0.78	0.70	0.78	0.87	*0.50*	81455	18	0.62	0.84	0.41	0.60	*0.05*
80579	27	0.99	0.95	0.60	1.45	0.77	81460	279	1.19*	1.35*	1.10	1.12	0.13
80585	9	0.65	0.42	0.43	1.10	*0.44*	81510	140	1.10	1.06	1.10	1.16	0.28
80587	80	1.07	1.02	1.30	0.88	0.77	81515	225	1.06	1.14	0.86	1.18	0.43
80588	101	1.08	1.20	1.17	0.88	0.85	81560	10	1.03	1.03	1.28	0.80	*0.97*
80589	216	1.08	1.19	0.91	1.15	0.43	81650	302	1.14	1.25	1.15	1.02	0.33
80595	39	0.83	0.86	0.79	0.83	*0.30*	81651	74	0.99	0.81	1.13	1.03	0.84
80596	17	0.84	1.46	0.79	0.28	*0.14*	81663	497	1.18*	1.18	1.21*	1.13	0.05
80602	284	0.99	1.14	1.08	0.77*	*0.24*	81664	66	1.08	1.28	1.02	0.93	0.91
80611	291	1.14	1.11	1.19	1.12	0.11	81667	22	0.88	0.80	0.62	1.21	*0.82*
80612	134	1.10	1.17	1.13	1.01	0.54	81668	387	1.18*	1.26*	1.18	1.09	0.11
80625	378	1.18*	1.23	1.12	1.19	0.05	81671	128	1.30*	1.43*	1.48*	1.00	0.09
80675	290	1.21*	1.31*	1.22	1.09	0.08	81675	33	1.06	1.02	0.74	1.44	0.57
80680	71	1.10	0.99	1.16	1.16	0.39	81676	162	1.13	1.02	1.07	1.31	0.08
80685	94	1.12	1.51*	0.75	1.14	0.67	81679	103	1.09	0.94	1.04	1.29	0.24
80705	413	1.14	1.09	1.05	1.27*	0.02	81680	31	0.93	1.01	0.74	1.04	*0.76*
80720	12	1.36	2.26	0.69	1.05	0.72	81683	83	0.95	0.93	1.08	0.83	*0.58*
80725	94	1.15	1.04	1.26	1.14	0.24	81684	9	0.91	0.91	0.92	0.90	*0.80*
80780	23	1.27	1.74	0.91	1.21	0.51	81692	10	1.24	1.71	1.87	0.00	*0.93*
80785	99	1.23	1.59**	0.98	1.08	0.35	81695	12	0.84	0.23	1.27	0.93	*0.87*
80790	21	1.27	2.01	1.12	0.75	0.81	81696	17	0.73	0.99	0.69	0.53	*0.15*
80828	47	1.00	0.96	0.85	1.20	0.81	81698	24	1.16	1.65	1.23	0.59	*0.95*
80836	137	1.09	1.48**	1.11	0.69	*0.59*	81700	11	0.76	0.69	0.92	0.70	*0.44*
80900	23	1.26	1.01	1.28	1.47	0.24	81702	15	1.07	1.12	1.45	0.64	*0.98*
80945	21	0.88	0.80	1.02	0.83	*0.64*	81710	11	0.99	0.29	1.46	1.18	0.70
81005	20	1.07	1.37	0.96	0.84	*0.93*	81711	21	1.29	1.86	1.22	0.90	0.66
81040	248	1.08	1.17	1.07	1.00	0.63	81713	80	1.21	1.43	1.30	0.88	0.47
81080	42	0.95	0.61	1.06	1.24	0.72	81715	66	1.08	1.22	0.93	1.07	0.75

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
81720	32	1.14	1.21	1.43	0.77	0.78	81887	205	1.03	1.02	1.11	0.96	0.88
81721	105	1.39**	1.50*	1.19	1.49*	<.01	81891	13	0.95	0.27	1.27	1.20	0.78
81724	16	0.79	0.97	0.78	0.61	*0.29*	81894	36	1.09	1.37	1.02	0.92	0.93
81731	24	1.32	1.33	2.01	0.80	0.43	81905	13	0.97	1.24	0.91	0.72	*0.70*
81736	22	1.12	1.90*	0.86	0.63	*0.74*	81908	21	0.92	0.94	0.80	1.03	*0.77*
81741	101	1.04	0.99	1.16	0.98	0.75	81914	14	0.67	0.77	0.56	0.70	*0.19*
81751	169	1.23*	1.32	1.32	1.05	0.11	81915	252	1.08	1.07	1.02	1.16	0.25
81753	13	1.21	1.15	1.29	1.20	0.56	81921	144	1.03	1.14	0.90	1.05	0.91
81754	172	1.19	1.27	1.05	1.26	0.08	81922	30	1.16	0.82	1.52	1.13	0.37
81755	105	1.19	1.38	1.10	1.07	0.34	81931	17	1.91*	1.10	2.09	2.48*	<.01
81763	9	1.16	0.90	1.93	0.84	0.70	81935	15	1.04	0.74	0.97	1.42	0.61
81767	25	0.85	0.79	0.71	1.05	*0.62*	81945	20	0.97	0.98	0.61	1.28	0.94
81770	10	1.36	0.84	2.43	0.50	0.47	81949	14	0.92	0.75	0.79	1.40	0.97
81777	13	0.98	1.28	0.51	1.08	*0.85*	81953	37	0.94	0.92	0.99	0.90	*0.72*
81779	422	1.13	1.08	1.21	1.10	0.11	81957	12	0.89	0.81	1.07	0.83	*0.74*
81787	27	1.46	1.13	1.48	1.78	0.05	81963	10	0.88	0.74	0.53	1.40	*0.96*
81800	28	1.36	1.48	1.62	0.95	0.31	81964	103	1.09	1.06	1.15	1.07	0.48
81806	108	0.97	0.81	0.99	1.10	0.84	81971	147	1.22*	1.41*	1.15	1.11	0.16
81811	54	0.97	0.98	1.17	0.83	*0.70*	81974	19	0.82	0.73	0.44	1.24	*0.71*
81815	357	1.09	0.97	1.19	1.09	0.17	81975	29	1.32	1.49	1.32	1.17	0.29
81821	54	0.98	0.98	1.17	0.87	*0.80*	81986	13	0.93	1.26	0.61	0.93	*0.67*
81826	10	0.83	1.40	0.55	0.49	*0.32*	81987	233	0.99	0.96	0.93	1.07	0.90
81830	16	0.96	1.77	0.66	0.40	*0.34*	81990	396	1.14	1.19	1.25*	0.99	0.28
81836	259	1.10	1.25	0.91	1.13	0.45	81991	338	1.20*	1.23	1.25*	1.12	0.05
81843	24	0.93	1.24	0.59	0.93	*0.58*	81992	275	1.24**	1.24	1.00	1.47**	<.01
81851	557	1.20**	1.26*	1.13	1.20*	0.04	81993	233	1.17	1.28	1.08	1.14	0.16
81853	19	1.66	1.92	1.65	1.41	0.11	81999	103	0.98	1.00	1.01	0.93	*0.78*
81855	30	0.76	0.83	0.98	0.47	*0.11*	82001	12	1.23	0.95	1.94	0.66	0.63
81857	24	1.03	0.75	0.95	1.39	0.57	82002	41	1.12	1.13	1.32	0.88	0.68
81873	24	0.87	1.04	0.81	0.78	*0.44*	82006	12	1.70	0.40	2.69*	2.20	0.04
81876	24	1.03	1.37	0.79	0.98	*0.90*	82009	204	1.11	1.20	1.13	1.02	0.43
81877	33	1.34	1.53	1.26	1.19	0.26	82013	12	0.79	0.63	0.86	0.87	*0.57*
81879	295	1.13	1.06	1.20	1.14	0.09	82030	23	1.12	0.56	1.60	1.22	0.38
81882	119	1.18	1.38	1.10	1.07	0.31	82035	12	1.32	1.25	1.87	0.92	0.51
81884	47	0.80	0.82	0.87	0.73	*0.16*	82037	282	1.19*	1.11	1.15	1.31*	0.01
81885	44	1.07	1.21	0.96	1.05	0.81	82056	34	1.03	0.92	0.88	1.31	0.66
81886	13	0.97	0.68	1.05	1.17	0.88	82057	51	1.26	1.16	1.23	1.40	0.12

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
82065	28	1.40	0.42	1.47	2.44**	<.01	82806	49	0.84	0.98	0.93	0.63	*0.15*
82078	10	0.88	1.96	0.00	0.73	*0.35*	82807	91	1.08	1.05	0.84	1.36	0.31
82082	10	0.72	0.42	0.67	1.10	*0.60*	82815	13	1.08	1.61	0.83	0.84	*0.90*
82097	28	0.80	1.01	1.10	0.28*	*0.10*	82819	69	0.94	0.98	1.11	0.72	*0.45*
82100	186	1.12	1.11	1.22	1.03	0.31	82834	164	1.17	1.26	1.39*	0.91	0.34
82101	9	1.12	2.12	0.81	0.38	*0.66*	82840	74	1.03	1.01	0.95	1.13	0.74
82113	218	1.17	1.18	1.40**	0.95	0.22	82841	178	1.14	1.18	1.13	1.11	0.23
82118	15	1.38	1.40	1.20	1.59	0.27	82849	226	1.21*	1.37*	1.28	0.98	0.20
82120	18	0.64	0.67	0.54	0.69	*0.10*	82859	9	1.53	2.81*	0.00	1.61	0.54
82127	380	1.07	1.18	0.98	1.04	0.70	82861	187	1.24*	1.28	1.32*	1.12	0.05
82134	110	1.05	0.84	1.06	1.25	0.31	82869	10	1.07	0.58	1.27	1.44	0.57
82135	23	0.83	0.99	0.64	0.85	*0.37*	82871	36	0.93	0.95	1.03	0.81	*0.64*
82136	11	1.15	1.06	1.76	0.67	0.82	82880	276	1.13	1.05	1.13	1.20	0.08
82156	29	0.87	1.10	0.79	0.71	*0.33*	82886	33	1.16	1.89*	0.64	0.92	*0.98*
82164	11	0.66	0.37	0.91	0.72	*0.34*	82889	19	1.04	0.82	1.17	1.12	0.76
82177	25	0.74	1.09	0.50	0.67	*0.10*	82897	38	0.83	0.58	1.31	0.64	*0.38*
82181	140	1.15	1.48**	1.08	0.89	0.76	82905	397	1.19*	1.26*	1.24*	1.07	0.10
82184	130	1.09	0.94	1.11	1.22	0.22	82907	40	1.19	0.88	1.45	1.27	0.22
82187	18	0.64	0.50	0.87	0.54	*0.10*	82917	19	1.07	1.55	0.86	0.80	*0.82*
82206	20	1.24	0.36	1.69	1.75	0.13	82920	163	1.07	1.19	1.01	1.02	0.71
82207	12	1.12	0.53	1.91	0.73	0.64	82924	100	1.03	1.28	1.13	0.67	*0.53*
82208	46	1.28	1.09	1.77*	0.95	0.21	82927	74	1.01	0.98	1.20	0.89	*0.99*
82210	42	1.02	0.78	1.44	0.82	0.92	82934	81	0.86	0.75	1.11	0.72	*0.24*
82214	48	1.22	1.01	1.09	1.57	0.11	82942	115	0.96	0.68	1.02	1.17	0.66
82224	16	1.20	0.88	1.70	0.95	0.55	82946	130	1.14	1.37*	1.14	0.88	0.67
82233	12	1.20	0.64	1.60	1.30	0.43	82948	49	0.95	1.07	1.21	0.58	*0.42*
82253	176	1.05	0.95	1.12	1.08	0.46	82949	18	1.42	2.08	0.99	1.17	0.43
82254	194	1.24*	1.05	1.42**	1.24	0.01	82951	27	0.97	1.38	0.52	1.07	*0.74*
82256	21	0.97	1.56	0.78	0.58	*0.44*	82953	20	1.03	1.05	0.46	1.58	0.66
82272	34	1.13	1.32	1.80*	0.28*	*0.81*	82955	275	1.16	1.13	1.06	1.29*	0.03
82274	14	1.45	1.85	0.66	2.42	0.21	82960	25	1.73*	2.93**	1.05	1.42	0.11
82276	36	1.07	1.17	0.90	1.12	0.78	82963	169	1.29**	1.26	1.48**	1.13	0.02
82786	153	1.13	1.13	1.31	0.97	0.37	82967	9	1.26	1.93	1.14	0.81	0.84
82789	422	1.10	1.12	1.20	0.98	0.46	82978	112	1.16	1.24	1.23	1.00	0.37
82792	36	1.30	1.39	1.42	1.08	0.29	82994	9	0.91	0.89	0.57	1.33	*0.95*
82795	58	0.99	1.00	0.89	1.04	*0.96*	82995	305	1.14	1.21	1.11	1.09	0.20
82798	26	1.02	1.20	1.01	0.85	*0.85*	82998	143	1.08	1.31	1.08	0.84	*0.93*

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
83002	104	1.11	1.18	1.07	1.09	0.46	83184	121	1.11	1.10	1.25	0.98	0.49
83007	99	1.13	1.08	1.05	1.26	0.23	83185	50	1.13	0.97	1.61*	0.81	0.58
83017	128	1.10	0.99	1.20	1.10	0.30	83186	12	0.86	0.26	1.23	1.00	*0.93*
83019	140	1.14	1.10	1.32	0.99	0.33	83189	11	1.90	2.08	1.57	2.06	0.09
83024	205	1.18*	1.33*	1.15	1.08	0.19	83190	123	1.34**	1.40	1.62**	0.99	0.05
83030	63	1.38*	1.32	1.67*	1.15	0.06	83193	15	2.04*	2.81*	1.97	1.47	0.07
83032	243	1.16	1.03	1.18	1.25	0.04	83194	10	1.61	1.52	3.03*	0.43	0.38
83033	60	1.19	0.93	1.52	1.13	0.19	83196	13	0.98	1.56	0.90	0.46	*0.52*
83038	117	1.22	1.37	1.04	1.25	0.12	83197	85	1.03	1.00	1.01	1.07	0.77
83046	280	1.05	1.08	1.04	1.04	0.62	83198	19	1.00	0.80	1.23	0.95	0.94
83048	27	2.49**	2.08	2.61*	2.81**	<.01	83199	54	1.03	1.67*	0.62	0.88	*0.55*
83062	14	1.06	0.48	0.97	1.68	0.43	83200	37	1.06	0.91	1.18	1.09	0.66
83065	10	1.12	0.65	1.65	1.11	0.61	83201	39	1.21	1.18	1.31	1.14	0.35
83066	90	1.00	1.18	1.01	0.80	*0.57*	83204	101	1.29*	1.56*	1.13	1.20	0.10
83079	23	1.34	1.02	1.09	1.92	0.11	83205	15	1.20	1.22	1.76	0.53	0.77
83085	128	1.09	1.03	1.16	1.06	0.44	83207	10	1.38	1.54	1.11	1.52	0.40
83102	409	1.15*	1.16	1.18	1.10	0.11	83208	409	1.23**	1.24*	1.19	1.25*	<.01
83104	26	1.17	0.80	1.57	1.13	0.38	83209	87	0.89	1.00	0.76	0.90	*0.30*
83105	52	1.34	1.32	1.18	1.51	0.06	83213	9	1.61	0.52	2.46	1.83	0.12
83110	261	1.25**	1.29*	*1.26*	*1.21*	*0.01*	83217	39	0.93	0.95	0.92	0.92	*0.68*
83111	156	1.11	0.89	1.24	1.19	0.13	83218	23	1.45	2.02	1.67	0.72	0.42
83115	16	1.41	0.80	0.55	2.81**	0.05	83224	150	1.06	1.24	1.16	0.79	*0.80*
83124	25	1.27	1.11	1.22	1.46	0.24	83233	10	1.73	1.97	2.14	1.06	0.24
83128	10	1.69	1.04	2.44	1.53	0.14	83248	9	1.16	0.66	2.56	0.39	0.77
83138	19	0.84	1.18	0.58	0.69	*0.30*	83252	30	0.79	0.86	0.43*	1.12	*0.38*
83140	19	1.09	1.20	0.95	1.13	0.79	83258	45	0.85	1.02	0.67	0.86	*0.27*
83142	274	1.20*	1.19	1.29*	1.11	0.06	83262	11	1.16	0.96	0.67	1.85	0.43
83150	9	1.84	1.48	1.12	2.89	0.08	83265	108	1.16	1.05	1.10	1.31	0.12
83151	24	1.31	1.56	1.14	1.29	0.34	83271	218	1.20*	1.22	1.22	1.16	0.06
83152	14	0.96	1.34	0.21	1.33	*0.91*	83275	118	1.11	1.04	1.29	1.02	0.37
83162	14	1.79	1.54	2.35	1.37	0.09	83276	129	1.13	1.14	1.16	1.08	0.34
83166	133	1.10	1.28	1.13	0.87	0.88	83277	169	1.09	1.29	0.87	1.10	0.63
83170	43	1.65**	1.74	1.48	1.71	<.01	83278	122	1.04	1.16	0.94	1.02	0.93
83177	98	1.03	1.24	1.08	0.76	*0.68*	83279	22	1.11	0.84	1.36	1.15	0.54
83180	11	0.77	0.27	0.81	1.11	*0.74*	83280	269	1.08	1.19	1.13	0.91	0.87
83181	33	1.07	0.83	1.34	1.03	0.64	83290	152	1.11	1.21	1.13	0.99	0.55
83182	156	1.06	1.23	1.05	0.90	1.00	83293	304	1.20*	1.34**	1.03	1.25	0.04

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
83299	99	1.01	0.99	1.02	1.03	0.87	83496	16	1.01	0.74	1.25	1.18	0.74
83302	10	2.22*	0.66	4.47**	0.86	0.03	83497	40	1.33	1.42	1.24	1.33	0.16
83307	199	1.14	0.99	1.25	1.18	0.08	83506	10	1.36	0.92	1.17	1.95	0.25
83308	14	1.07	0.63	1.54	1.05	0.65	83508	308	1.23**	1.23	1.26*	1.22	0.01
83323	24	1.23	1.22	0.83	1.73	0.26	83509	388	1.18*	1.14	1.27*	1.13	0.04
83331	152	1.11	1.18	1.03	1.12	0.38	83512	279	1.10	1.02	1.19	1.10	0.17
83332	146	1.36**	1.48*	1.42*	1.17	0.02	83513	35	0.92	1.08	0.95	0.73	*0.47*
83335	12	1.10	0.53	1.30	1.56	0.45	83514	177	1.06	1.00	1.34*	0.84	0.81
83351	136	1.10	0.93	1.22	1.15	0.22	83515	23	1.19	0.66	1.74	1.27	0.27
83353	19	1.26	0.66	1.39	1.67	0.19	83517	15	0.89	1.16	0.84	0.70	*0.52*
83354	16	0.59*	0.83	0.30*	0.65	*0.05*	83551	9	0.95	1.08	1.16	0.61	*0.74*
83355	81	1.26	1.25	1.31	1.20	0.11	83553	163	1.04	0.84	1.03	1.24	0.24
83364	22	0.84	0.77	1.10	0.62	*0.41*	83554	304	1.19*	1.17	1.38**	1.03	0.08
83365	35	1.05	1.02	1.15	0.97	0.85	83562	136	1.33**	1.53**	1.25	1.20	0.03
83369	28	0.80	1.01	1.10	0.28*	*0.10*	83571	47	1.23	1.50	1.15	1.03	0.46
83376	15	1.00	0.72	1.24	1.01	0.90	83572	30	1.19	1.07	1.00	1.52	0.28
83379	18	1.13	1.23	1.04	1.11	0.72	83573	20	1.16	0.74	1.96	0.95	0.46
83383	463	1.12	1.08	1.24*	1.03	0.22	83574	27	1.46	1.50	1.49	1.41	0.12
83404	12	1.10	0.70	1.46	1.20	0.61	83581	119	1.12	1.29	1.07	0.99	0.61
83413	74	1.30	1.02	1.71**	1.15	0.05	83587	30	1.09	1.39	1.05	0.84	*0.98*
83433	79	1.14	1.29	0.97	1.18	0.41	83589	40	0.93	0.62	1.53	0.67	*0.73*
83434	272	1.17*	1.14	1.11	1.25	0.04	83596	23	1.13	1.47	0.59	1.31	0.74
83435	17	1.08	1.60	0.80	0.88	*0.90*	83598	9	0.84	0.63	0.57	1.31	*0.90*
83436	34	1.25	1.52	0.91	1.27	0.38	83600	9	0.58	1.09	0.00	0.56	*0.08*
83440	119	1.31*	1.20	1.42*	1.32	0.01	83609	68	1.26	1.67*	1.01	1.09	0.35
83441	87	1.27	1.54*	1.18	1.06	0.23	83626	243	1.10	1.13	1.11	1.06	0.35
83444	142	1.28*	1.50**	1.09	1.24	0.06	83628	34	1.07	0.70	1.05	1.43	0.38
83446	16	0.85	0.76	0.96	0.84	*0.62*	83629	52	1.29	1.45	1.27	1.13	0.23
83447	103	1.32*	1.28	1.30	1.37	0.02	83639	106	1.24	1.21	1.29	1.22	0.08
83449	175	1.12	1.20	1.03	1.15	0.27	83641	13	1.28	1.61	1.32	0.87	0.70
83451	97	0.98	0.96	0.92	1.05	*0.97*	83643	68	0.97	1.01	1.04	0.88	*0.73*
83453	235	1.09	1.02	1.19	1.07	0.27	83646	80	1.20	1.21	0.82	1.60*	0.08
83461	42	1.11	1.19	0.83	1.29	0.53	83649	19	1.01	0.51	1.03	1.43	0.56
83475	208	1.11	1.15	1.10	1.08	0.34	83660	62	1.05	1.00	1.28	0.88	0.85
83477	53	1.22	1.09	1.38	1.20	0.20	83664	17	0.93	1.41	0.78	0.64	*0.48*
83480	38	1.48*	1.91*	1.16	1.41	0.10	83665	188	0.96	1.13	0.94	0.81	*0.25*
83495	155	1.28*	1.20	1.22	1.42*	<.01	83669	154	1.12	1.11	1.28	0.99	0.38

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
83676	9	1.02	0.61	1.56	1.00	0.81	83937	68	1.18	1.31	1.34	0.90	0.48
83678	155	1.06	1.00	1.11	1.08	0.47	83946	258	1.17*	1.05	1.15	1.32*	0.01
83681	104	1.27*	1.50*	1.29	1.01	0.20	83951	14	1.41	2.71*	1.34	0.31	0.93
83685	189	1.21*	1.11	1.28	1.25	0.03	83952	29	0.85	1.10	0.72	0.73	*0.28*
83705	18	1.02	1.62	0.66	0.83	*0.71*	83967	12	0.78	0.61	0.94	0.80	*0.53*
83718	21	1.08	0.70	1.02	1.48	0.46	83987	49	1.30	1.75*	0.80	1.20	0.33
83726	12	0.42**	0.52	0.35*	0.38	*<.01*	84001	139	1.31**	1.29	1.24	1.39*	<.01
83731	13	1.08	1.57	0.91	0.78	*0.89*	84030	141	1.19	1.05	1.33	1.18	0.08
83732	14	0.69	0.80	0.30	0.97	*0.29*	84031	9	1.26	0.40	1.94	1.55	0.32
83734	51	1.23	1.74*	1.15	0.80	0.75	84035	12	1.07	1.78	0.80	0.73	*0.78*
83736	356	1.22**	1.15	1.35**	1.16	0.01	84037	11	0.48*	0.24*	0.74	0.52	*0.06*
83739	19	1.10	0.54	0.86	1.85	0.29	84048	17	1.11	1.29	1.61	0.41	*0.90*
83741	70	1.26	0.96	1.78**	1.05	0.09	84063	18	0.92	1.36	0.59	0.82	*0.51*
83748	159	1.17	1.11	1.16	1.23	0.09	84077	69	1.27	1.25	1.07	1.49	0.07
83758	138	1.07	1.00	1.01	1.19	0.35	84081	9	1.95	1.76	2.04	2.11	0.09
83760	28	0.92	0.87	0.80	1.08	*0.83*	84086	14	0.85	0.68	1.02	0.81	*0.64*
83765	14	1.53	0.36	3.21**	1.08	0.13	84090	25	1.28	1.81	1.61	0.45	0.84
83770	78	1.03	0.92	0.99	1.18	0.57	84093	98	1.25	1.50*	1.02	1.21	0.18
83786	90	1.19	1.17	1.22	1.18	0.19	84097	15	0.98	0.83	1.02	1.07	0.96
83788	108	1.28*	1.16	1.32	1.37	0.02	84100	56	0.95	0.96	1.09	0.86	*0.67*
83800	18	0.76	0.65	0.65	1.07	*0.48*	84105	14	1.30	1.38	0.00	2.46*	0.22
83818	142	1.06	1.23	1.06	0.91	0.98	84116	206	1.13	1.27	1.07	1.06	0.35
83820	172	1.22*	1.29	1.32	1.05	0.11	84118	12	0.69	0.54	0.49	1.07	*0.43*
83823	25	1.12	1.24	1.16	0.97	0.76	84133	9	0.96	0.95	0.72	1.19	0.99
83830	16	1.11	1.30	0.87	1.14	0.79	84153	28	1.26	1.18	1.86	0.82	0.44
83831	127	1.10	1.19	1.09	1.03	0.54	84154	351	1.16*	0.98	1.30*	1.21	0.01
83835	22	0.96	0.80	1.49	0.55	*0.74*	84160	23	1.04	0.77	1.52	0.85	0.85
83844	50	1.13	1.53	1.26	0.67	*0.90*	84180	9	0.59	0.64	0.33	0.87	*0.21*
83849	15	0.85	0.41	0.98	1.11	*0.90*	84183	69	1.28	1.19	1.39	1.25	0.09
83866	10	0.90	0.80	1.36	0.54	*0.69*	84192	10	0.83	0.91	0.66	0.93	*0.62*
83871	168	1.22*	1.56**	1.03	1.07	0.25	84195	28	0.90	0.54	0.74	1.45	0.78
83872	79	1.04	0.94	0.81	1.33	0.44	84203	46	1.15	1.01	1.17	1.27	0.31
83889	36	1.09	1.27	0.97	1.03	0.83	84204	352	1.12	1.15	1.07	1.15	0.15
83904	175	1.12	1.39*	1.01	0.97	0.71	84233	125	1.21	1.26	1.10	1.25	0.10
83906	15	0.93	1.01	0.84	0.94	*0.79*	84235	41	1.15	1.41	1.01	1.00	0.71
83911	19	0.95	1.25	0.78	0.79	*0.61*	84238	45	1.14	1.76*	0.95	0.69	*0.81*
83919	13	0.96	0.39	1.43	1.15	0.77	84240	21	1.30	0.77	1.59	1.55	0.16

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
84269	30	1.43	1.33	1.47	1.50	0.09	84475	14	1.52	1.36	1.97	1.30	0.21
84274	22	1.27	1.39	0.98	1.40	0.37	84477	133	1.21	1.44*	1.24	0.96	0.33
84287	28	1.91**	2.64**	1.75	1.38	0.04	84478	11	1.37	1.60	1.09	1.38	0.46
84295	196	1.16	1.30	1.01	1.17	0.18	84479	14	0.68	0.69	0.46	0.88	*0.26*
84296	9	0.91	2.32	0.00	0.49	*0.29*	84480	14	0.84	1.94	0.69	0.15	*0.12*
84313	11	0.84	0.66	0.87	1.01	*0.76*	84494	141	1.08	1.19	1.09	0.94	0.79
84314	9	1.25	1.95	1.33	0.47	0.94	84495	73	1.31*	1.34	1.20	1.38	0.06
84318	122	1.18	1.37	1.13	1.04	0.35	84499	59	0.98	0.99	0.98	0.97	*0.87*
84326	10	1.15	1.26	0.69	1.52	0.64	84505	35	1.01	0.96	0.86	1.21	0.81
84330	24	1.40	1.90	0.98	1.33	0.30	84508	37	1.13	1.11	1.44	0.84	0.71
84335	65	1.32	1.21	1.56	1.21	0.07	84513	85	1.03	0.78	1.11	1.19	0.47
84341	83	1.29*	1.56*	1.20	1.10	0.18	84515	9	1.10	1.48	0.97	0.99	0.93
84349	33	0.77	1.18	0.44*	0.71	*0.08*	84526	194	1.08	1.14	1.02	1.08	0.51
84352	21	1.22	1.78	0.94	0.97	0.75	84535	12	0.91	0.89	0.81	1.06	*0.85*
84364	32	1.27	0.83	2.06*	0.96	0.22	84537	256	1.19*	1.07	1.22	1.29*	0.01
84370	9	1.51	0.48	2.37	1.68	0.16	84544	39	1.05	1.01	0.79	1.40	0.55
84376	264	1.13	1.20	1.19	1.01	0.31	84549	70	1.34*	1.36	1.42	1.23	0.07
84381	24	1.04	1.11	1.22	0.82	*0.96*	84563	318	1.15	1.14	1.18	1.11	0.11
84383	139	1.27*	1.24	1.26	1.30	0.03	84566	10	1.60	2.20	1.09	1.74	0.27
84386	135	1.04	1.29	1.06	0.80	*0.68*	84569	16	0.70	0.68	0.83	0.58	*0.20*
84407	13	0.93	1.38	0.65	0.71	*0.54*	84613	16	1.30	1.55	1.15	1.23	0.47
84414	10	0.86	0.74	0.73	1.14	*0.82*	84620	130	1.13	1.08	1.25	1.05	0.32
84425	182	1.22*	1.04	1.25	1.37*	<.01	84628	18	0.78	0.89	0.28	1.15	*0.48*
84426	37	1.02	0.74	0.96	1.36	0.52	84646	20	1.11	1.29	0.40	1.53	0.59
84427	94	1.15	0.89	1.50*	1.08	0.19	84662	150	1.26*	1.32	1.08	1.38*	0.02
84428	34	1.11	1.17	1.29	0.86	0.79	84674	136	1.10	1.15	1.10	1.05	0.47
84443	74	1.04	1.20	1.08	0.81	*0.78*	84696	217	1.16	1.27	1.17	1.06	0.22
84445	11	1.23	0.90	1.34	1.51	0.40	84705	10	0.91	0.30	1.51	0.84	*0.99*
84446	9	2.20*	1.74	2.96*	1.61	0.06	84716	210	1.13	1.17	1.03	1.21	0.15
84447	12	0.96	1.33	0.29	1.02	*0.73*	84718	13	1.32	1.57	1.40	0.85	0.56
84458	17	1.06	1.14	0.42	1.54	0.65	84736	25	1.32	0.67	1.65	1.59	0.10
84462	15	2.01*	2.73*	1.38	2.09	0.05	84743	138	1.15	1.03	1.20	1.23	0.11
84463	9	1.10	0.66	1.46	1.25	0.62	84745	26	0.82	0.77	0.58	1.08	*0.55*
84468	73	0.83	0.79	0.90	0.81	*0.21*	84754	10	1.28	1.29	1.70	0.85	0.62
84470	13	1.54	1.20	3.16**	0.27	0.38	84755	97	1.08	0.95	1.07	1.22	0.34
84472	45	0.94	0.98	1.08	0.77	*0.57*	84758	38	1.12	0.92	1.25	1.18	0.44
84473	9	1.92	3.72**	1.35	0.61	0.48	84765	12	0.93	0.87	1.07	0.85	*0.83*

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
84772	124	1.08	1.08	1.09	1.08	0.50	92740	117	0.92	1.05	0.83	0.88	*0.31*
84789	46	1.34	1.16	2.15*	1.12	0.11	92780	248	1.19*	1.22	1.15	1.22	0.04
84805	15	0.93	0.68	1.02	1.12	0.98	92850	82	1.41**	1.54*	1.65*	1.04	0.05
84809	45	1.23	1.59	0.73	1.38	0.34	92910	15	1.39	1.59	1.35	1.22	0.37
84830	72	1.27	1.51	1.00	1.30	0.17	92930	12	1.56	1.26	2.02	1.41	0.19
84832	23	1.02	0.93	1.40	0.70	*0.95*	92960	10	1.32	0.91	0.78	2.14	0.25
90310	337	1.20*	1.34**	1.07	1.18	0.08	92980	9	0.87	0.81	0.30	1.51	*0.96*
90320	499	1.29**	1.40**	1.13	1.34**	<.01	94140	313	1.03	1.03	0.97	1.08	0.64
90340	471	1.26**	1.33**	1.21	1.24*	<.01	94220	481	1.21**	1.18	1.15	1.30**	<.01
90410	10	1.35	0.00	1.78	2.66	0.10	A1021	97	1.12	0.83	1.62**	0.92	0.30
90590	375	1.29**	1.33**	1.27*	1.28*	<.01	A1049	22	0.65	0.72	1.15	0.16*	*0.02*
90620	39	1.42	1.50	1.27	1.49	0.08	A1053	10	1.29	0.88	1.48	1.46	0.38
90800	38	1.35	1.33	1.46	1.28	0.14	A1065	184	1.08	1.00	1.09	1.15	0.29
90820	215	1.13	1.14	1.06	1.20	0.14	A1070	10	0.93	1.24	0.00	1.74	0.97
90870	291	1.24**	1.13	1.46**	1.13	<.01	A1073	169	1.21*	1.35*	1.16	1.15	0.12
90880	552	1.23**	1.15	1.23*	1.31**	<.01	A1075	33	1.28	1.31	1.23	1.28	0.26
90883	148	1.20	1.14	1.10	1.37*	0.04	A1082	19	0.89	0.39	1.66	0.76	*0.86*
90885	507	1.27**	1.26*	1.28*	1.27*	<.01	A1091	17	1.39	0.64	1.15	2.75*	0.04
90900	156	1.08	1.08	1.09	1.06	0.49	A1112	149	1.10	1.35*	0.98	0.97	0.82
90980	228	1.19*	1.19	1.19	1.20	0.05	A1165	24	1.26	1.46	0.62	1.70	0.28
91095	559	1.25**	1.40**	1.17	1.19	0.04	A1167	18	1.20	0.96	1.62	1.11	0.45
91110	83	1.31*	1.08	1.27	1.60*	0.01	A1179	131	1.13	1.34	1.17	0.89	0.68
91115	15	1.20	0.97	1.09	1.59	0.38	A1200	79	1.39*	1.65*	0.96	1.54*	0.03
91120	45	0.83	0.59	0.98	0.92	*0.47*	A1204	223	1.10	1.08	1.01	1.21	0.18
91150	13	0.76	0.54	1.57	0.31	*0.31*	A1214	67	1.12	1.08	1.09	1.19	0.39
91190	15	0.97	1.32	0.68	0.98	*0.78*	A1216	17	0.87	0.94	0.77	0.90	*0.60*
92150	54	0.93	0.99	1.08	0.75	*0.45*	A1220	87	1.14	1.33	1.15	0.92	0.66
92255	56	0.98	0.97	1.19	0.76	*0.71*	A1221	17	1.57	2.12	1.23	1.39	0.22
92290	35	1.23	1.18	1.41	1.11	0.33	A1242	58	1.28	1.21	1.48	1.15	0.14
92310	12	1.06	1.23	0.94	1.01	0.94	A1259	20	1.05	1.99*	0.49	0.72	*0.55*
92320	15	0.82	0.73	1.02	0.72	*0.50*	A1262	10	0.60	1.25	0.00	0.51	*0.06*
92355	133	1.14	1.41*	0.99	1.03	0.55	A1278	9	1.22	0.77	2.57	0.46	0.68
92470	44	1.08	1.04	0.97	1.21	0.57	A1279	93	1.10	1.05	1.43*	0.83	0.66
92500	51	1.74**	0.80	2.30**	2.15**	<.01	A1324	19	1.29	1.17	1.50	1.20	0.36
92630	54	0.97	0.99	1.16	0.84	*0.73*	A1328	15	1.42	1.97	1.30	0.88	0.56
92650	24	1.30	1.99*	0.86	0.92	0.73	A1329	23	1.23	1.05	0.63	2.07*	0.17
92685	42	1.05	1.47	1.30	0.47	*0.50*	A1337	12	1.44	2.09	2.07	0.49	0.72

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
A1339	93	1.21	1.21	1.50*	0.93	0.26	M0238	15	0.64	0.77	0.93	0.24	*0.06*
A1346	207	1.10	1.11	1.17	1.01	0.44	M0239	98	1.29*	1.32	1.27	1.28	0.05
A1353	66	1.23	1.26	1.14	1.29	0.18	M0244	25	1.04	1.46	0.44	1.29	0.96
A1355	44	0.86	0.91	1.02	0.66	*0.27*	M0256	147	0.97	0.90	0.90	1.12	0.88
A1356	22	1.06	1.33	1.56	0.39	*0.69*	M0259	176	1.14	1.31	1.02	1.10	0.33
A1357	15	0.80	0.49	1.63	0.42	*0.42*	M0260	513	1.16*	1.15	1.27*	1.08	0.09
A1358	81	1.17	1.21	1.20	1.09	0.34	M0262	209	1.05	0.90	1.14	1.10	0.34
A1359	17	1.29	1.43	1.17	1.25	0.44	M0264	23	1.04	0.95	0.53	1.68	0.52
A1360	13	1.03	1.59	0.47	1.02	*0.82*	M0321	16	0.84	0.38	1.19	0.86	*0.73*
A1458	15	1.10	0.65	0.91	1.79	0.39	M0327	29	1.27	1.12	1.83	0.97	0.35
A1463	65	0.98	1.04	0.85	1.02	*0.85*	M0347	321	1.13	1.11	1.27*	1.02	0.20
A1466	31	1.27	0.93	1.23	1.72	0.11	M0377	59	1.20	1.33	1.38	0.85	0.50
A1481	11	1.19	1.19	0.36	1.94	0.42	M0386	71	0.98	0.89	1.12	0.92	*0.92*
A1491	12	1.69	2.82*	0.80	1.55	0.28	M0421	149	1.14	1.27	0.79	1.37*	0.16
A1515	41	1.28	0.92	1.78*	1.12	0.15	M0430	115	1.17	1.10	1.14	1.26	0.13
A1604	79	1.27	1.20	1.83**	0.85	0.19	M0451	20	1.22	0.54	1.61	1.56	0.20
A1642	32	0.98	1.01	0.81	1.12	*0.98*	M0461	21	0.98	1.31	0.78	0.86	*0.70*
A1667	11	1.29	0.71	1.09	2.05	0.23	M0462	55	0.93	0.98	0.79	1.02	*0.68*
A1728	29	1.24	1.03	1.63	1.05	0.33	M0478	16	0.95	1.23	0.72	0.89	*0.71*
A1771	27	1.54*	1.94*	1.59	1.00	0.18	M0527	209	1.27**	1.46**	1.27	1.08	0.06
A1827	25	1.25	0.96	1.74	1.04	0.33	M0529	109	1.20	1.46*	1.08	1.07	0.32
A1874	18	0.90	0.72	0.50	1.55	0.92	M0538	74	1.31*	1.65*	1.12	1.09	0.23
B0043	9	0.64	0.44	0.65	0.82	*0.34*	M0539	85	1.23	1.32	0.75	1.56*	0.08
B0044	175	1.14	1.20	1.01	1.21	0.18	M0577	176	1.12	1.26	0.88	1.19	0.33
B0045	13	1.92*	2.65*	1.38	1.69	0.12	M0578	94	1.12	1.18	0.79	1.38	0.26
B0105	317	1.10	1.24*	1.15	0.91	0.81	M0579	306	1.15	1.16	1.24	1.06	0.13
L0035	20	0.95	0.54	0.98	1.37	0.73	M0599	106	1.03	1.32	0.93	0.83	*0.61*
L0112	20	0.98	0.97	0.68	1.36	0.88	M0600	423	1.11	1.08	1.12	1.12	0.15
M0006	95	0.88	0.78	0.91	0.96	*0.48*	M0602	334	1.13	1.27*	1.05	1.07	0.35
M0073	153	1.11	1.40*	1.00	0.95	0.80	M0603	467	1.16*	1.19	1.25*	1.03	0.18
M0125	85	1.05	1.06	0.90	1.20	0.59	M0609	138	1.06	1.06	1.01	1.12	0.52
M0126	114	1.12	0.97	1.21	1.18	0.21	M0626	18	1.43	1.69	0.84	1.83	0.20
M0130	145	1.10	1.01	1.26	1.02	0.37	M0627	11	1.10	1.01	1.15	1.13	0.75
M0132	59	0.91	1.10	0.68	0.95	*0.43*	M0628	454	1.25**	1.27*	1.20	1.28*	<.01
M0155	111	0.92	1.06	0.79	0.91	*0.36*	M0644	71	1.04	1.29	0.89	0.90	*0.80*
M0156	97	0.94	0.90	0.88	1.03	*0.75*	M0645	90	1.33*	1.63**	1.28	1.04	0.16
M0218	265	1.14	1.20	1.09	1.13	0.19	M0646	21	1.13	1.02	1.02	1.37	0.51

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
M0647	554	1.08	1.10	1.03	1.10	0.32	M0789	15	1.20	1.61	0.00	2.10	0.43
M0648	15	1.17	0.87	0.99	1.68	0.36	M0794	166	1.38**	1.18	1.51**	1.44*	<.01
M0650	41	1.03	1.23	0.75	1.08	0.99	M0799	245	1.10	0.98	1.25	1.07	0.20
M0651	368	1.20*	1.15	1.29*	1.15	0.02	M0812	71	1.10	1.12	0.72	1.48	0.31
M0652	19	0.86	0.96	0.66	0.97	*0.57*	M0826	32	1.32	1.07	1.74	1.16	0.17
M0653	363	1.13	1.18	1.20	1.01	0.30	M0833	131	1.10	1.05	1.16	1.11	0.32
M0661	512	1.22**	1.16	1.20	1.30**	<.01	M0850	190	1.04	1.27	0.95	0.92	*0.79*
M0662	149	1.08	1.03	1.08	1.12	0.38	M0863	10	0.89	1.86	0.24	0.76	*0.42*
M0674	100	1.30*	1.52*	1.18	1.19	0.10	M0867	16	0.92	1.00	1.15	0.64	*0.60*
M0675	9	0.86	0.59	1.71	0.28	*0.59*	M0870	94	1.21	1.00	1.48*	1.16	0.10
M0679	56	1.19	1.27	0.91	1.34	0.27	M0873	92	1.08	0.96	1.09	1.18	0.38
M0680	80	1.04	0.95	0.93	1.22	0.54	M0877	9	1.29	0.44	1.47	2.08	0.24
M0682	415	1.20**	1.25*	1.20	1.16	0.03	M0879	10	1.43	0.89	1.36	2.17	0.19
M0683	59	1.11	1.19	1.29	0.83	0.80	M0881	386	1.14	1.14	1.17	1.12	0.11
M0689	35	1.25	1.16	1.35	1.22	0.26	M0888	78	1.26	1.13	1.40	1.29	0.07
M0692	107	1.27*	1.51*	1.54*	0.79	0.29	M0892	17	1.18	0.98	0.46	2.03	0.27
M0698	39	1.11	1.66*	0.95	0.73	*0.77*	M0894	31	1.00	0.47	1.19	1.37	0.47
M0699	18	1.50	2.21	1.84	0.48	0.51	M0899	37	1.17	1.08	0.96	1.46	0.28
M0700	464	1.17*	1.34**	1.10	1.07	0.26	M0900	161	1.09	1.06	0.94	1.28	0.21
M0701	398	1.25**	1.26*	1.44**	1.07	0.02	M0905	14	0.74	0.68	0.63	0.90	*0.41*
M0708	58	1.04	0.85	1.35	0.93	0.73	M0909	26	1.03	1.07	1.26	0.76	*0.93*
M0716	20	1.12	0.80	1.34	1.24	0.49	M0912	328	1.08	1.10	1.03	1.12	0.30
M0717	16	1.54	2.45*	1.00	1.27	0.35	M0913	654	1.20**	1.19	1.22*	1.20	0.02
M0720	12	0.81	1.10	0.20	1.15	*0.56*	M0916	225	1.10	1.07	1.14	1.10	0.26
M0725	176	1.13	0.96	1.35*	1.06	0.18	M0918	16	1.20	1.61	1.16	0.79	0.83
M0745	235	1.24**	1.50**	0.98	1.25	0.06	M0920	31	1.30	1.74	1.01	1.10	0.45
M0747	366	1.12	1.15	1.11	1.11	0.17	M0926	323	1.11	1.16	1.15	1.03	0.34
M0749	24	0.73	0.87	0.61	0.72	*0.15*	M0927	19	0.91	0.48	0.90	1.30	0.89
M0752	29	1.33	0.90	1.17	2.05*	0.05	M0928	15	0.95	1.05	0.62	1.26	*0.95*
M0756	71	1.01	0.99	0.82	1.21	0.73	M0930	624	1.23**	1.33**	1.15	1.23*	0.03
M0760	288	1.18*	1.34*	1.04	1.17	0.11	M0937	9	0.91	1.19	0.60	0.95	*0.72*
M0773	331	1.23**	1.31*	1.08	1.29*	0.01	M0939	88	1.05	1.46*	0.78	0.91	*0.71*
M0774	39	1.13	1.20	0.74	1.49	0.39	M0947	39	1.34	1.02	1.81*	1.19	0.10
M0779	27	1.03	1.02	1.15	0.92	0.96	M0950	47	1.20	0.98	1.32	1.32	0.19
M0783	22	0.85	1.02	0.72	0.82	*0.42*	M0951	132	1.12	0.92	1.53**	0.91	0.33
M0785	21	0.99	0.57	1.43	1.14	0.69	M0952	10	0.64	0.56	0.58	0.80	*0.28*
M0787	40	1.07	0.70	1.24	1.25	0.41	M0959	16	1.15	1.03	0.82	1.57	0.45

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
M0960	83	1.08	1.07	1.08	1.10	0.52	M1190	66	1.26	1.11	1.49	1.21	0.10
M0961	17	1.12	1.17	1.60	0.61	0.93	M1199	26	1.22	0.99	1.10	1.59	0.23
M0969	235	1.11	1.14	1.17	1.01	0.41	M1202	118	1.11	1.38	1.01	0.97	0.76
M0983	11	1.15	2.04	0.91	0.60	*0.83*	M1203	74	1.01	1.01	1.10	0.93	*0.99*
M0984	176	1.48**	1.57**	1.34	1.52**	<.01	M1205	14	1.50	0.31	1.93	2.36	0.04
M0985	101	1.03	0.94	1.10	1.06	0.67	M1207	89	1.12	1.19	0.99	1.16	0.44
M1000	744	1.20*	1.22*	1.15	1.21*	0.06	M1211	235	1.22*	1.43**	1.15	1.09	0.13
M1002	77	1.41**	1.95**	1.33	0.97	0.15	M1217	82	1.03	1.51*	0.99	0.63	*0.35*
M1010	12	0.92	1.17	1.22	0.42	*0.52*	M1218	125	1.10	1.24	1.14	0.94	0.69
M1023	46	0.89	0.90	1.12	0.66	*0.34*	M1226	245	1.18*	1.08	1.14	1.30*	0.02
M1026	29	0.95	0.58	1.11	1.16	0.83	M1232	19	0.97	0.76	0.16	1.97*	0.52
M1027	90	1.23	1.21	1.41	1.06	0.17	M1289	80	1.16	1.32	1.04	1.10	0.43
M1028	21	1.15	0.68	1.63	1.13	0.43	M1300	96	1.11	1.64**	0.82	0.90	*0.89*
M1030	261	1.06	1.08	1.09	1.02	0.56	M1309	174	1.08	1.22	0.95	1.07	0.62
M1042	88	1.04	0.86	1.22	1.02	0.62	M1312	225	1.11	1.21	0.98	1.12	0.36
M1047	207	1.15	1.13	0.99	1.34*	0.05	M1320	11	0.72	1.81	0.19	0.19	*0.06*
M1051	16	0.77	0.17	1.02	1.00	*0.67*	M1327	100	0.99	0.91	0.90	1.16	0.74
M1055	187	1.00	1.21	0.94	0.85	*0.45*	M1341	67	1.06	1.38	0.62	1.22	0.83
M1102	24	1.21	0.83	0.99	1.85	0.16	M1342	212	1.05	1.09	1.00	1.05	0.69
M1105	104	1.24	1.33	1.32	1.06	0.17	M1348	79	0.94	1.03	1.04	0.77	*0.44*
M1112	160	1.14	1.05	1.28	1.09	0.19	M1351	12	0.96	0.82	0.71	1.33	0.90
M1114	48	0.99	0.91	1.07	0.98	1.00	M1381	64	1.10	0.67	1.22	1.37	0.18
M1128	59	0.88	0.98	1.04	0.65	*0.20*	M1392	20	1.13	0.90	1.21	1.26	0.51
M1130	21	1.07	0.89	0.79	1.54	0.50	M1407	44	1.25	1.08	1.14	1.57	0.10
M1137	393	1.26**	1.30*	1.21	1.26*	<.01	M1410	12	1.36	1.55	1.14	1.46	0.39
M1142	24	1.51	1.34	1.93	1.37	0.10	M1419	19	1.28	1.40	0.84	1.58	0.33
M1145	93	1.14	1.05	1.24	1.12	0.28	M1422	20	1.03	0.67	0.44	1.93*	0.39
M1150	28	2.29**	2.31*	3.59**	1.03	<.01	M1423	93	0.98	1.08	0.72	1.14	*0.97*
M1152	53	0.90	0.95	1.05	0.75	*0.39*	M1428	9	1.61	2.82	1.39	0.61	0.59
M1155	23	1.12	1.55	0.68	1.14	0.88	M1429	49	1.23	1.36	1.07	1.26	0.28
M1164	43	0.92	1.05	0.79	0.92	*0.56*	M1431	54	1.36*	1.48	1.42	1.19	0.11
M1173	35	0.93	1.01	1.19	0.57	*0.45*	M1432	15	1.07	0.46	1.38	1.34	0.51
M1174	229	1.10	1.13	1.09	1.08	0.36	M1433	22	1.22	1.04	1.60	1.01	0.45
M1176	46	1.19	1.17	1.42	0.97	0.43	M1436	173	1.20*	1.35*	1.16	1.09	0.17
M1183	206	1.03	1.15	1.12	0.82	*0.65*	M1438	79	1.29	1.25	1.77**	0.89	0.16
M1184	214	1.18	1.15	1.35*	1.04	0.13	M1439	28	1.28	1.62	1.49	0.77	0.60
M1187	184	1.15	1.00	1.42**	1.05	0.12	M1441	9	1.08	1.52	0.69	1.08	0.97

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
M1444	17	0.84	1.62	0.33	0.55	*0.19*	M1650	60	1.37*	1.50	1.13	1.50	0.05
M1448	13	1.02	1.89	1.24	0.18	*0.40*	M1659	10	1.13	1.07	0.96	1.37	0.66
M1450	31	0.98	0.99	1.29	0.63	*0.71*	M1662	29	1.02	0.97	0.99	1.09	0.85
M1456	20	1.31	2.23*	0.83	1.00	0.70	M1673	10	1.22	1.36	1.44	0.59	0.78
M1462	11	0.83	0.35	1.18	1.18	*0.98*	M1677	18	0.80	0.98	0.96	0.48	*0.23*
M1463	560	1.20**	1.28**	1.12	1.20	0.04	M1687	58	1.24	1.59	1.25	0.92	0.47
M1467	19	1.13	0.76	1.14	1.44	0.41	M1702	52	1.14	1.30	1.14	0.99	0.62
M1469	16	0.63	0.49	0.84	0.54	*0.12*	M1710	27	1.20	0.83	1.35	1.40	0.25
M1475	79	1.03	0.82	1.23	1.04	0.61	M1711	207	1.04	1.13	0.92	1.09	0.69
M1485	9	1.09	1.14	0.62	1.65	0.68	M1717	34	1.01	0.89	1.37	0.78	*0.95*
M1492	36	0.84	0.89	0.53	1.11	*0.50*	M1720	83	1.04	1.01	0.93	1.16	0.64
M1495	26	0.93	1.13	0.69	0.92	*0.62*	M1721	10	1.51	1.55	1.51	1.47	0.30
M1515	119	1.06	0.85	1.13	1.17	0.34	M1726	61	1.30	1.86**	0.98	1.00	0.42
M1517	25	0.86	0.90	0.91	0.75	*0.44*	M1737	124	1.26*	1.17	0.96	1.64**	<.01
M1519	72	1.31*	1.49	1.25	1.18	0.13	M1743	18	1.03	1.14	0.48	1.48	0.75
M1525	470	1.22**	1.29**	1.12	1.24*	0.02	M1765	40	1.14	0.78	1.07	1.56	0.19
M1527	11	1.77	0.89	3.04*	1.51	0.08	M1766	83	1.16	1.16	1.13	1.19	0.26
M1528	133	0.99	0.89	1.08	0.97	0.99	M1772	127	1.15	1.10	1.37	0.99	0.28
M1529	182	1.19	1.38*	1.07	1.11	0.21	M1800	34	0.96	1.16	0.65	1.08	*0.79*
M1531	13	2.25*	2.78*	2.75	1.09	0.07	M1806	167	1.05	1.20	1.03	0.93	1.00
M1532	186	1.07	1.01	1.12	1.09	0.39	M1812	24	1.12	0.82	0.98	1.54	0.38
M1540	16	0.98	0.63	1.06	1.21	0.81	M1813	218	1.21*	1.28	1.02	1.35*	0.03
M1541	23	0.78	0.76	0.70	0.89	*0.38*	M1818	18	1.68	1.15	1.85	2.00	0.03
M1542	436	1.24**	1.35**	1.13	1.24*	0.01	M1821	63	1.02	0.78	1.23	1.01	0.72
M1545	23	1.20	1.31	0.98	1.30	0.48	M1832	11	0.70	0.79	0.56	0.75	*0.29*
M1548	9	1.01	0.66	0.93	1.51	0.70	M1833	30	1.24	1.27	1.21	1.24	0.35
M1566	22	1.04	0.79	1.25	1.14	0.70	M1839	43	0.96	0.99	0.64	1.26	0.95
M1569	249	1.17*	1.19	1.00	1.33*	0.04	M1842	18	0.80	0.98	0.96	0.48	*0.23*
M1577	270	1.13	1.16	1.02	1.20	0.13	M1844	42	1.40	2.03**	0.85	1.38	0.20
M1596	61	0.99	0.92	1.29	0.79	*0.84*	M1850	49	0.99	0.89	1.13	0.97	0.95
M1598	13	0.96	0.84	0.47	1.56	0.80	M1851	18	1.49	1.71	0.82	1.84	0.15
M1604	17	1.03	0.87	0.82	1.40	0.69	M1859	23	1.00	0.95	1.00	1.03	0.97
M1608	54	1.07	0.93	1.09	1.19	0.52	M1866	27	1.73*	1.26	1.26	2.68**	<.01
M1609	114	1.05	1.16	1.01	1.00	0.85	M1872	29	1.13	0.83	1.41	1.15	0.43
M1633	17	0.66	0.61	0.48	0.92	*0.23*	M1874	9	0.83	0.38	2.74	0.52	*0.77*
M1634	60	1.08	0.85	1.34	1.05	0.48	M1884	54	1.20	1.35	1.34	0.94	0.48
M1643	9	3.20**	1.08	3.48	5.20**	<.01	M1910	14	0.74	1.01	0.38	0.96	*0.34*

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
M1913	62	0.88	0.96	0.93	0.75	*0.28*	M2130	19	1.16	0.54	1.67	1.32	0.32
M1915	123	1.03	1.24	0.98	0.88	*0.76*	M2131	18	1.06	1.25	1.56	0.37	*0.75*
M1920	387	1.22**	1.18	1.33**	1.16	0.01	M2135	143	1.01	1.38*	0.84	0.84	*0.40*
M1922	84	1.27	1.54*	1.17	1.07	0.23	M2138	11	1.13	2.09	0.62	0.39	*0.63*
M1931	47	1.17	1.65*	0.69	1.10	0.75	M2140	12	1.35	0.68	2.02	1.20	0.29
M1936	83	1.26	1.27	1.61*	0.90	0.21	M2141	19	1.34	1.60	0.84	1.58	0.30
M1937	111	1.37**	1.41	1.08	1.65**	<.01	M2142	37	1.03	1.12	1.15	0.82	*0.89*
M1941	14	0.87	1.03	0.00	1.34	*0.81*	M2148	171	1.05	1.22	1.18	0.74	*0.62*
M1951	278	1.14	1.16	1.18	1.07	0.20	M2152	84	1.15	1.21	1.10	1.16	0.33
M1956	38	1.05	1.02	1.08	1.05	0.79	M2153	78	0.97	0.99	0.82	1.06	*0.87*
M1957	15	1.14	1.83	0.26	1.17	0.98	M2154	85	1.25	1.46	1.24	1.03	0.27
M1959	24	1.38	1.20	1.98	1.12	0.21	M2161	12	0.87	0.23	0.91	1.40	0.85
M1962	15	1.55	1.76	2.01	0.89	0.29	M2162	16	2.27**	4.18**	2.02	0.47	0.15
M1966	23	1.28	1.39	1.32	1.16	0.40	M2163	14	0.96	0.23	0.84	1.68	0.54
M1992	80	0.98	1.04	0.76	1.12	*0.98*	M2167	9	0.72	0.89	0.41	0.92	*0.38*
M1993	90	1.12	0.94	1.18	1.24	0.21	M2171	20	1.30	1.54	0.73	1.68	0.29
M2025	9	2.15*	2.60	3.50*	0.00	0.21	M2175	12	1.13	0.32	0.81	2.16	0.27
M2038	16	1.41	2.44*	0.60	1.02	0.68	M2181	78	1.11	0.99	1.05	1.29	0.26
M2040	12	1.13	0.51	0.71	2.16	0.26	M2187	19	0.86	0.50	0.69	1.43	0.93
M2073	13	0.75	0.72	0.56	0.95	*0.46*	M2193	9	0.85	0.55	0.76	1.32	*0.95*
M2074	48	0.96	1.22	0.75	0.92	*0.58*	M2194	128	1.26*	1.12	1.20	1.46*	0.01
M2075	11	0.99	0.54	0.57	1.81	0.58	M2196	33	0.74	0.84	0.96	0.44*	*0.06*
M2078	23	1.11	1.32	1.04	0.99	0.84	M2198	37	1.05	1.13	0.73	1.30	0.71
M2089	17	1.24	0.99	0.40	2.61**	0.14	M2201	28	1.12	0.62	0.81	1.93*	0.17
M2090	14	0.63	0.85	0.42	0.62	*0.10*	M2203	19	1.07	0.68	0.86	1.67	0.41
M2098	86	1.04	0.91	1.00	1.21	0.49	M2206	10	1.17	0.84	1.09	1.75	0.44
M2100	31	1.07	1.42	0.53	1.22	0.88	M2208	45	1.11	0.98	1.18	1.19	0.44
M2101	181	1.01	0.93	1.21	0.90	1.00	M2209	40	1.25	1.52	1.06	1.17	0.38
M2105	21	0.97	1.69	0.80	0.51	*0.37*	M2210	17	1.06	2.10*	0.39	0.69	*0.53*
M2109	104	0.99	0.95	1.04	0.97	*0.93*	M2211	14	0.92	1.58	0.42	0.61	*0.38*
M2111	22	1.39	1.67	1.21	1.34	0.27	M2212	11	1.08	0.74	0.94	1.54	0.59
M2113	39	1.26	1.16	1.40	1.22	0.21	M2216	12	1.13	0.51	0.71	2.16	0.26
M2125	14	1.32	1.34	1.15	1.46	0.37	M2218	15	0.90	1.06	1.88	0.00	*0.29*
M2126	20	1.20	1.29	0.73	1.56	0.42	M2221	55	1.06	1.17	1.03	0.98	0.88
M2127	15	1.30	1.76	1.06	0.94	0.68	M2223	114	1.06	1.01	0.92	1.23	0.40
M2128	30	1.00	1.20	0.61	1.16	*0.96*	M2225	13	0.88	0.68	1.02	0.92	*0.79*
M2129	71	1.13	1.27	1.25	0.86	0.71	M2226	15	1.05	0.79	1.57	0.84	0.85

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
M2227	14	1.13	0.76	1.66	0.94	0.65	M2553	100	1.11	1.38	1.19	0.77	0.98
M2233	25	1.07	1.23	0.78	1.20	0.79	M2566	112	1.09	1.00	1.07	1.19	0.32
M2235	130	1.01	1.19	0.92	0.91	*0.69*	M2571	123	1.20	1.53**	0.96	1.12	0.30
M2238	50	1.20	1.85**	0.93	0.86	0.86	M2576	13	1.24	1.67	1.03	1.10	0.67
M2241	12	0.97	0.29	0.75	1.72	0.56	M2589	17	1.23	0.57	1.24	2.09	0.14
M2244	11	1.10	1.20	0.98	1.10	0.83	M2606	12	0.58	0.56	0.77	0.42	*0.08*
M2248	13	0.85	0.67	0.98	0.89	*0.70*	M2609	134	1.32**	1.18	1.57**	1.17	0.01
M2255	152	1.14	1.39*	1.16	0.89	0.68	M2629	14	1.37	0.92	2.35*	0.88	0.35
M2259	29	1.33	1.43	0.80	1.80	0.14	M2632	10	0.78	0.85	0.71	0.78	*0.48*
M2263	145	1.10	0.95	1.18	1.16	0.23	M2634	10	0.92	0.70	1.67	0.55	*0.77*
M2266	18	1.04	1.40	0.96	0.70	*0.76*	M2637	265	1.09	1.30*	0.91	1.05	0.72
M2268	25	1.18	1.68	0.77	1.16	0.70	M2648	52	0.96	0.99	1.17	0.78	*0.61*
M2271	11	1.35	0.38	1.45	2.16	0.14	M2651	22	0.98	0.54	1.19	1.20	0.72
M2274	79	1.04	1.04	1.13	0.95	0.88	M2653	11	1.00	1.16	0.50	1.39	0.90
M2278	135	1.20	1.22	1.22	1.16	0.12	M2673	9	0.78	0.72	0.26	1.39	*0.76*
M2280	405	1.16*	1.15	1.26*	1.08	0.09	M2677	19	0.86	1.06	0.94	0.56	*0.37*
M2284	13	1.52	2.65*	0.34	1.65	0.38	M2690	24	1.06	1.07	1.53	0.62	*0.94*
M2286	58	1.16	1.13	1.24	1.11	0.37	M2698	11	1.55	1.93	1.30	1.37	0.33
M2287	43	1.17	1.40	0.84	1.26	0.48	M2703	18	0.70	0.72	0.59	0.78	*0.21*
M2301	90	1.26	1.00	1.35	1.43	0.03	M2704	15	1.39	0.93	1.87	1.85	0.13
M2307	12	1.05	1.59	0.28	1.16	*0.90*	M2709	135	1.17	1.00	1.35	1.14	0.11
M2309	154	1.15	0.96	1.24	1.24	0.07	M2710	176	1.22*	1.39*	1.07	1.21	0.09
M2310	16	1.04	1.16	0.39	1.58	0.73	M2716	116	1.02	1.06	0.81	1.16	0.76
M2325	79	0.98	0.95	0.91	1.06	*0.99*	M2725	36	1.15	0.85	1.26	1.33	0.29
M2326	11	1.31	0.35	2.27	1.21	0.28	M2761	22	1.01	1.22	0.72	1.08	*0.95*
M2327	113	1.04	1.15	0.90	1.06	0.87	M2766	40	1.37	1.54	1.49	1.06	0.20
M2347	12	0.98	1.23	1.22	0.50	*0.67*	M2776	31	0.93	1.56	0.67	0.56	*0.22*
M2379	46	1.25	1.00	1.46	1.34	0.13	M2779	60	1.15	0.89	1.34	1.23	0.23
M2386	29	1.16	0.64	1.33	1.50	0.22	M2848	14	0.87	0.62	0.69	1.33	*0.97*
M2395	27	1.00	0.89	1.38	0.82	*0.95*	M2878	74	1.03	0.92	0.83	1.33	0.49
M2398	13	1.01	1.13	0.86	1.04	*0.98*	M2880	251	1.09	1.04	1.11	1.12	0.25
M2441	10	0.70	0.67	1.00	0.42	*0.26*	M2891	20	1.35	2.15*	0.66	1.09	0.63
M2452	25	2.21**	2.37**	2.41	1.79	<.01	M2894	152	1.19	1.19	1.18	1.19	0.10
M2498	14	1.16	1.29	0.27	1.93	0.46	M2900	87	1.31*	1.61*	1.14	1.16	0.14
M2509	115	1.08	1.06	1.05	1.13	0.44	M2954	40	1.20	0.88	1.69*	0.99	0.29
M2524	11	1.22	1.43	0.99	1.22	0.65	M2955	92	1.09	1.14	1.12	1.00	0.65
M2544	15	0.96	0.57	1.43	1.15	0.79	M2958	27	1.14	1.58	0.49	1.39	0.65

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
M2972	143	0.94	1.01	0.86	0.96	*0.52*	M3288	25	1.28	1.42	0.57	1.94*	0.18
M2975	14	1.05	1.51	1.14	0.47	*0.70*	M3289	39	1.36	1.03	1.80*	1.28	0.09
M2989	80	1.04	0.98	1.18	0.98	0.78	M3295	56	1.26	1.46	1.55	0.79	0.44
M2994	69	0.98	1.16	0.80	0.92	*0.63*	M3297	35	1.17	1.00	1.14	1.37	0.29
M2997	29	0.88	0.81	1.14	0.67	*0.47*	M3299	18	1.03	1.13	1.41	0.60	*0.80*
M3004	14	1.12	0.46	1.13	1.88	0.30	M3304	194	1.19	1.48**	1.09	0.99	0.38
M3019	12	0.97	0.65	1.00	1.33	0.79	M3305	25	1.16	0.70	1.49	1.28	0.33
M3032	22	1.25	1.65	1.31	0.65	0.75	M3308	16	0.89	0.83	0.35	1.45	*0.98*
M3033	77	1.09	0.84	1.28	1.16	0.32	M3309	22	1.02	0.70	1.76	0.58	1.00
M3050	12	1.16	1.12	1.29	1.09	0.68	M3374	27	0.99	1.10	1.01	0.85	*0.81*
M3057	73	1.19	1.70**	0.91	1.00	0.64	M3389	19	1.05	0.89	0.85	1.46	0.62
M3058	49	1.08	0.96	1.23	1.05	0.60	M3390	86	1.27	1.26	1.25	1.30	0.07
M3091	44	1.22	1.42	0.93	1.37	0.29	M3397	52	0.96	0.99	1.17	0.78	*0.61*
M3095	76	1.10	0.96	1.34	1.00	0.48	M3405	20	1.19	0.51	1.66	1.46	0.24
M3098	14	0.85	1.51	0.72	0.35	*0.23*	M3417	78	0.87	1.12	0.99	0.51*	*0.06*
M3107	54	0.89	1.00	0.93	0.73	*0.29*	M3821	250	1.19*	1.23	1.15	1.20	0.05
M3114	10	1.18	1.46	1.51	0.42	0.99	M3823	64	1.02	0.99	1.03	1.05	0.84
M3116	11	1.51	0.86	1.42	2.31	0.11	M3829	48	1.21	1.49	1.18	0.93	0.59
M3118	219	1.10	0.90	1.37*	1.05	0.17	M3832	82	1.33*	1.13	1.34	1.51*	0.01
M3125	31	1.03	0.96	1.62	0.46	*0.84*	M3835	68	1.19	1.56*	0.93	1.00	0.61
M3135	9	1.06	0.34	1.59	1.25	0.60	M3841	118	1.08	1.35	0.75	1.14	0.72
M3162	12	1.13	0.51	0.71	2.16	0.26	M3846	144	1.07	1.47**	1.03	0.74	*0.52*
M3187	140	1.12	0.95	1.19	1.22	0.13	M3847	18	0.72	1.45	0.47	0.32	*0.04*
M3190	64	1.30	1.52	1.39	0.97	0.26	M3848	12	1.17	0.65	2.70*	0.36	0.64
M3191	507	1.25**	1.22*	1.28*	1.25*	<.01	M3849	27	0.99	1.14	0.68	1.12	*0.94*
M3192	139	1.15	1.38*	1.03	1.03	0.51	M3850	26	1.06	1.20	0.94	1.06	0.87
M3195	12	1.05	1.59	0.28	1.16	*0.90*	M3855	60	1.08	1.09	0.95	1.20	0.55
M3207	10	0.53	0.71	0.42	0.49	*0.06*	M3856	57	1.22	1.53	1.01	1.11	0.42
M3210	17	1.13	1.71	1.12	0.59	*0.87*	M3860	34	1.29	0.69	1.34	1.82*	0.05
M3213	21	0.90	0.95	0.72	1.04	*0.72*	M3862	16	1.41	1.41	0.86	1.72	0.21
M3220	158	1.14	1.11	0.96	1.34*	0.10	M3864	46	1.04	1.09	0.93	1.09	0.82
M3225	46	1.03	0.61	1.11	1.42	0.33	M3866	31	1.04	1.07	0.76	1.29	0.73
M3232	12	0.88	0.76	0.43	1.44	*0.98*	M3873	189	1.16	1.13	1.04	1.29	0.07
M3249	58	1.20	1.64*	0.83	1.17	0.49	M3881	210	1.18*	1.24	1.05	1.27	0.06
M3252	63	0.91	0.99	0.96	0.80	*0.40*	M3886	102	1.16	0.96	1.59**	0.95	0.24
M3258	17	0.86	0.80	1.09	0.69	*0.53*	M3891	15	1.30	2.62*	1.07	0.24	*0.75*
M3275	19	1.09	0.82	1.42	1.18	0.57	M3895	164	1.23*	1.29	1.16	1.23	0.06

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
M3898	217	1.16	1.05	1.18	1.24	0.05	M4242	152	1.02	1.22	0.98	0.89	*0.70*
M3899	184	1.25*	1.45**	1.19	1.13	0.08	M4250	95	1.17	1.55*	0.92	1.03	0.59
M3901	34	0.99	0.97	1.67	0.46	*0.60*	M4258	9	1.27	2.48	1.15	0.00	*0.76*
M3914	9	0.84	0.97	1.19	0.46	*0.47*	M4279	31	1.33	1.72	1.06	1.16	0.37
M3939	18	1.05	2.01	0.81	0.52	*0.48*	M4292	130	1.17	0.99	1.33	1.17	0.10
M3981	333	1.11	1.18	1.12	1.03	0.40	M4308	67	0.99	1.16	0.79	0.93	*0.66*
M3983	9	1.31	2.62	1.16	0.38	*0.94*	M4318	342	1.19*	1.13	1.25*	1.20	0.02
M3984	17	1.08	1.27	0.84	1.14	0.87	M4320	16	1.14	1.46	0.84	1.11	0.81
M3985	17	1.10	1.71	0.65	1.04	*0.98*	M4331	266	1.22*	1.26	1.23	1.18	0.03
M3986	17	1.06	1.32	0.38	1.50	0.78	M4338	17	1.08	0.75	1.22	1.29	0.58
M4011	33	0.75	0.92	0.70	0.63	*0.09*	M4353	42	1.12	0.70	1.20	1.47	0.21
M4016	379	1.19*	1.25*	1.22	1.12	0.06	M4358	16	1.30	0.95	0.86	2.22	0.16
M4022	90	1.06	0.97	1.01	1.20	0.45	M4370	14	0.87	1.03	0.00	1.34	*0.81*
M4037	15	1.06	1.45	0.77	0.99	*0.96*	M4376	254	1.09	1.01	0.97	1.27*	0.12
M4039	105	1.23	1.16	1.41	1.13	0.10	M4385	20	1.00	1.28	0.86	0.89	*0.81*
M4051	9	1.50	2.50	1.45	0.52	0.72	M4392	95	0.96	1.13	0.89	0.86	*0.46*
M4052	11	2.72**	2.57	3.49*	2.09	0.02	M4401	68	0.89	0.98	1.07	0.64	*0.21*
M4056	66	1.13	0.97	1.15	1.28	0.25	M4404	186	1.05	1.11	0.96	1.08	0.66
M4058	146	1.22*	1.21	1.11	1.32	0.05	M4408	12	1.13	0.51	0.71	2.16	0.26
M4063	200	1.06	1.14	1.10	0.95	0.82	M4410	11	0.80	0.85	1.17	0.42	*0.38*
M4077	9	0.83	0.59	1.45	0.50	*0.58*	M4438	29	1.55*	2.79**	0.98	1.09	0.30
M4088	16	1.03	0.52	1.38	1.26	0.59	M4444	9	1.62	2.58	1.54	0.62	0.56
M4090	22	1.18	0.94	0.95	1.60	0.31	M4448	58	1.14	1.48	0.86	1.10	0.66
M4097	34	1.11	0.87	1.19	1.28	0.40	M4487	14	1.32	1.57	1.38	0.95	0.56
M4102	12	0.88	0.74	1.09	0.81	*0.75*	M4491	12	0.95	0.81	1.00	1.03	*0.96*
M4115	15	1.08	0.90	0.82	1.61	0.55	M4513	11	1.14	0.95	1.33	1.15	0.66
M4117	30	1.04	0.65	1.01	1.46	0.43	M4514	19	1.26	0.39	1.53	1.96	0.11
M4132	27	1.11	1.08	1.68	0.53	0.93	M4517	14	1.00	1.27	0.72	1.04	*0.90*
M4134	10	0.73	0.70	0.22	1.24	*0.58*	M4554	23	1.03	0.82	1.53	0.75	0.97
M4188	83	1.12	0.97	1.10	1.30	0.22	M4558	16	0.99	1.23	0.76	0.96	*0.83*
M4210	9	0.52	0.54	0.92	0.15	*0.05*	M4575	16	1.10	2.01	0.83	0.55	*0.64*
M4214	57	1.06	1.35	0.85	0.95	*0.92*	M4598	22	1.73*	3.19**	0.49	1.62	0.15
M4215	11	1.17	0.90	1.02	1.63	0.45	M4618	9	0.80	0.35	2.74	0.52	*0.72*
M4219	17	0.98	0.73	1.06	1.22	0.79	M4624	46	1.06	0.79	1.49	0.95	0.63
M4220	14	0.96	0.65	0.93	1.32	0.82	M4636	11	0.83	0.90	0.69	0.90	*0.60*
M4232	10	0.84	0.83	0.41	1.46	*0.85*	M4649	42	1.45*	1.58	1.77*	1.03	0.13
M4235	20	1.24	0.94	1.80	0.94	0.42	M4663	9	0.72	0.31	2.61	0.47	*0.55*

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
M4673	18	1.14	0.57	1.51	1.36	0.37	P2001	641	1.24**	1.21*	1.24*	1.27*	<.01
M4692	29	1.28	0.78	0.84	2.17**	0.05	P2002	700	1.19*	1.14	1.20	1.23*	0.02
M4718	22	1.18	1.25	0.45	1.91	0.32	P2003	727	1.20*	1.13	1.10	1.37**	<.01
M4719	173	1.30**	1.00	1.40*	1.48**	<.01	P2004	693	1.17*	1.15	1.13	1.22*	0.04
M4743	38	1.03	1.23	1.15	0.75	*0.79*	P2005	735	1.19*	1.15	1.19	1.24*	0.02
M4755	53	1.27	1.50	1.25	1.07	0.29	P2006	643	1.15*	1.18	1.21*	1.07	0.22
M4756	12	1.58	2.26	1.86	0.72	0.45	P2007	332	1.04	1.02	1.03	1.07	0.52
M4839	106	1.05	0.96	1.10	1.07	0.60	P2008	420	1.07	1.22*	0.94	1.04	0.81
M4884	40	1.19	1.05	1.81*	0.84	0.49	P2009	223	1.03	0.95	1.10	1.03	0.64
M4891	11	1.47	1.51	1.16	1.77	0.26	P2011	100	0.96	1.34	0.77	0.81	*0.27*
M4896	11	0.52*	1.04	0.30	0.25	*0.01*	P2013	56	0.94	1.01	1.07	0.78	*0.52*
M4897	222	1.06	1.11	0.96	1.12	0.49	S0001	150	1.17	1.41*	0.86	1.23	0.23
M4905	39	1.10	0.71	1.28	1.29	0.34	S0002	35	1.28	1.21	1.71	0.94	0.30
M4946	11	0.98	1.05	1.35	0.54	*0.77*	S0005	102	1.11	1.00	0.98	1.34	0.19
M4982	177	1.06	1.22	0.97	0.97	0.95	S0006	9	0.82	1.21	0.26	1.05	*0.57*
M4987	24	1.23	0.80	1.29	1.62	0.19	S0008	86	1.20	1.09	1.38	1.14	0.15
M4999	52	0.96	0.99	1.17	0.78	*0.61*	S0009	40	1.41	1.58	1.06	1.58	0.08
M5090	64	0.95	1.00	0.96	0.90	*0.66*	S0012	46	1.28	1.63	1.29	0.93	0.45
M5222	282	1.16	1.20	1.11	1.16	0.11	S0019	136	1.19	1.09	1.20	1.27	0.06
P0120	14	0.81	0.32	0.89	1.25	*0.92*	S0020	44	1.28	1.13	1.57	1.14	0.17
P0310	148	1.10	1.12	1.19	0.99	0.49	S0022	68	1.02	0.94	0.92	1.19	0.68
P0410	102	1.11	0.91	1.27	1.15	0.25	S0024	66	1.33*	1.70*	1.38	0.95	0.26
P0412	18	0.57*	0.49	0.98	0.27*	*0.02*	S0026	37	1.21	1.46	1.10	1.05	0.53
P0418	36	1.17	0.69	1.29	1.55	0.16	S0028	81	1.08	0.95	1.06	1.25	0.34
P0420	25	0.83	1.04	0.76	0.69	*0.27*	S0030	71	1.35*	1.70*	1.31	1.05	0.17
P0430	141	1.04	1.04	1.01	1.07	0.68	S0037	66	1.01	0.97	0.98	1.07	0.85
P0431	79	1.01	1.04	0.93	1.04	0.98	S0042	13	1.14	1.69	1.36	0.48	*0.86*
P0432	16	0.75	0.12*	0.74	1.54	1.00	S0045	13	1.14	1.69	1.36	0.48	*0.86*
P0450	56	0.83	0.68	1.13	0.65	*0.23*	S0049	22	1.05	1.39	0.43	1.28	0.96
P0610	705	1.18*	1.19	1.07	1.28**	0.02	S0050	239	1.27**	1.21	1.42**	1.19	<.01
P0620	545	1.30**	1.18	1.36**	1.34**	<.01	S0051	136	1.11	1.19	0.99	1.13	0.40
P0640	81	1.11	1.54*	0.59	1.21	0.76	S0056	14	1.14	1.30	0.79	1.28	0.68
P0651	630	1.15*	1.12	1.13	1.21*	0.03	S0057	31	1.27	1.66	1.06	1.04	0.52
P0652	601	1.18*	1.16	1.14	1.24*	0.02	S0058	12	0.98	1.26	1.03	0.68	*0.72*
P0710	493	1.12	1.14	1.01	1.19	0.11	S1030	16	1.33	0.95	1.33	1.81	0.19
P0720	163	1.05	0.86	1.20	1.07	0.40	S1031	10	1.38	0.90	2.01	1.53	0.26
P2000	718	1.19*	1.24*	1.18	1.15	0.11	S2002	111	1.18	1.22	1.19	1.11	0.23

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
S2003	229	1.19*	1.00	1.42**	1.14	0.03	S2124	29	1.17	1.81	1.11	0.67	*0.93*
S2004	153	1.13	1.02	0.98	1.39*	0.07	S2126	15	1.29	0.73	1.38	1.85	0.20
S2009	22	0.89	1.04	0.56	1.02	*0.64*	S2129	9	0.86	1.17	0.57	0.84	*0.58*
S2010	97	0.99	0.92	1.03	1.02	0.94	S2133	32	1.31	1.38	1.11	1.48	0.19
S2031	25	1.39	0.83	1.81	1.69	0.07	S2134	146	1.07	0.94	1.27	0.98	0.52
S2035	17	1.22	1.07	1.13	1.53	0.37	S2139	92	1.21	1.43	1.18	1.02	0.35
S2042	42	1.28	1.94**	0.94	0.88	0.68	S2140	19	1.18	1.20	0.68	1.58	0.43
S2044	90	1.22	1.17	1.33	1.16	0.13	S2156	39	1.12	0.85	1.32	1.28	0.33
S2045	107	1.12	1.09	0.90	1.34	0.21	S2167	28	1.23	1.73	0.65	1.32	0.54
S2046	9	1.81	2.90*	0.00	1.86	0.30	S2184	58	1.18	1.37	1.05	1.11	0.44
S2049	18	1.29	1.38	1.54	0.92	0.50	S2186	44	1.21	1.17	1.40	1.04	0.36
S2059	9	1.13	0.85	2.01	0.79	0.76	S2199	58	0.98	0.93	1.12	0.90	*0.87*
S2063	31	1.33	1.72	1.06	1.16	0.37	S2205	58	1.30	1.66*	1.06	1.18	0.24
S2065	60	1.11	0.81	1.37	1.15	0.32	S2206	88	1.21	1.48*	1.03	1.08	0.36
S2068	270	1.20*	1.10	1.24	1.27*	0.01	S2207	67	1.22	1.29	1.39	0.96	0.33
S2069	78	1.21	1.28	1.19	1.16	0.22	S2209	214	1.20*	1.18	1.26	1.17	0.05
S2075	9	1.26	2.07	0.35	1.68	0.62	S2210	81	1.32*	1.46	1.46	1.03	0.12
S2077	204	1.13	1.15	1.16	1.09	0.24	S2213	12	1.34	1.34	0.85	2.20	0.28
S2080	19	1.21	1.07	1.00	1.58	0.34	S2215	35	1.26	1.64	0.77	1.34	0.38
S2084	58	1.04	1.53	0.61	0.99	*0.75*	S2226	12	1.34	1.34	0.85	2.20	0.28
S2085	21	0.89	1.06	0.76	0.86	*0.56*	S2227	12	1.19	1.26	0.72	1.99	0.47
S2088	18	1.12	1.74	1.10	0.62	*0.80*	S2228	12	1.34	1.34	0.85	2.20	0.28
S2090	24	1.00	0.78	1.13	1.12	0.81	S2257	119	1.04	1.14	0.91	1.06	0.85
S2091	14	0.85	0.92	0.95	0.70	*0.52*	S2258	29	1.45	1.50	1.37	1.51	0.10
S2092	218	1.11	1.11	1.10	1.11	0.27	S2259	86	1.00	0.67	1.25	1.07	0.58
S2093	17	1.05	1.03	0.91	1.19	0.81	S2260	135	1.11	0.94	1.17	1.20	0.18
S2094	58	1.24	1.30	1.33	1.06	0.28	S2261	35	1.10	1.33	1.04	0.91	0.92
S2095	426	1.21**	1.26*	1.14	1.24*	0.01	S2262	12	1.34	1.34	0.85	2.20	0.28
S2099	78	1.25	1.15	1.15	1.46	0.06	S2263	83	0.94	0.88	0.98	0.97	*0.75*
S2100	14	0.70	1.28	0.14	0.77	*0.14*	S2265	32	0.99	0.82	1.05	1.10	0.86
S2101	269	1.16	1.14	1.14	1.20	0.06	S2269	16	1.34	1.01	1.23	2.01	0.16
S2105	29	1.26	1.73	0.89	1.10	0.58	S2271	15	1.22	0.99	1.38	1.40	0.39
S2106	32	1.24	1.70	0.90	1.08	0.60	S2312	64	1.03	1.29	1.00	0.79	*0.69*
S2113	64	0.93	0.96	1.01	0.81	*0.49*	S2315	17	1.07	1.09	1.43	0.65	0.99
S2114	56	0.98	0.97	1.24	0.82	*0.74*	S2316	25	1.07	1.01	1.29	0.85	0.86
S2120	93	1.18	1.53*	0.82	1.20	0.40	S2317	14	1.38	2.09	0.64	1.70	0.44
S2123	55	1.23	1.29	1.15	1.24	0.23	S2318	17	1.12	1.99	0.45	0.89	*0.83*

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
S2323	15	1.10	1.21	0.64	1.31	0.75	S2475	45	1.29	1.67*	1.24	0.95	0.44
S2325	22	1.25	0.67	1.57	1.49	0.18	S2479	12	1.05	2.01	0.53	0.71	*0.65*
S2326	106	1.14	1.03	1.09	1.31	0.14	S2482	68	0.99	0.95	0.75	1.25	0.77
S2393	169	1.13	1.09	1.16	1.12	0.22	S2483	37	1.03	1.31	0.68	1.08	*0.95*
S2394	54	1.33	1.46	1.25	1.26	0.13	S2484	58	1.39*	1.23	1.55	1.41	0.03
S2395	209	1.20*	1.03	1.33*	1.24	0.02	S2487	52	1.28	1.69*	1.22	0.90	0.47
S2396	131	1.09	0.98	0.97	1.32	0.20	S2489	234	1.12	1.12	1.19	1.06	0.25
S2397	50	1.25	1.51	1.07	1.16	0.34	S2490	45	1.43*	1.54	1.74*	1.00	0.12
S2399	31	1.18	1.60	0.87	1.04	0.75	S2494	9	1.70	1.28	0.48	3.61*	0.06
S2400	12	0.90	0.91	1.08	0.70	*0.68*	S2499	9	1.70	1.28	0.48	3.61*	0.06
S2401	21	0.79	1.03	0.63	0.72	*0.25*	S2501	29	1.19	1.73	0.83	1.00	0.79
S2404	163	1.10	1.15	1.11	1.04	0.46	S2503	17	1.12	1.15	0.69	1.76	0.52
S2405	31	1.33	1.72	1.06	1.16	0.37	S2507	114	1.01	1.02	0.99	1.01	0.97
S2410	12	0.69	0.75	0.94	0.44	*0.19*	S2511	56	0.98	1.29	0.95	0.72	*0.46*
S2414	86	1.08	0.94	0.95	1.35	0.27	S2515	14	0.86	0.48	0.76	1.46	0.92
S2421	57	1.15	1.40	1.14	0.87	0.76	S2517	9	0.84	0.56	1.01	0.97	*0.81*
S2425	12	0.89	1.04	0.58	1.10	*0.73*	S2524	63	1.23	1.43	1.05	1.20	0.28
S2427	35	1.00	1.49	0.98	0.57	*0.44*	S2531	38	1.15	1.58	1.00	0.83	0.92
S2430	24	1.16	1.30	1.41	0.74	0.79	S2532	17	1.32	1.61	1.27	1.12	0.47
S2431	322	1.15	1.19	1.01	1.25*	0.06	S2540	115	1.02	0.94	1.13	0.99	0.80
S2434	9	1.70	1.28	0.48	3.61*	0.06	S2541	12	1.28	1.63	0.64	2.20	0.41
S2436	33	1.27	1.71	0.98	1.08	0.51	S2544	66	1.01	0.97	0.98	1.07	0.85
S2437	45	1.43*	1.54	1.74*	1.00	0.12	S2545	109	1.15	1.19	0.96	1.30	0.19
S2438	75	1.06	1.16	1.02	0.99	0.85	S2547	19	0.91	0.63	0.84	1.23	0.97
S2439	113	0.98	0.92	1.10	0.91	*0.82*	S2552	31	1.33	1.72	1.06	1.16	0.37
S2442	16	1.50	0.62	1.36	2.38*	0.04	S2555	42	1.00	0.63	1.04	1.31	0.53
S2443	9	1.70	1.28	0.48	3.61*	0.06	S2558	224	1.11	0.97	1.32*	1.06	0.18
S2447	14	1.06	1.10	0.65	1.44	0.74	S2561	33	1.27	1.71	0.98	1.08	0.51
S2453	112	1.27*	1.47*	0.94	1.40	0.05	S2569	31	1.32	1.70	1.10	1.10	0.40
S2459	69	1.15	1.22	1.20	1.00	0.49	S2581	120	1.28*	1.24	1.36	1.24	0.04
S2460	95	0.96	0.93	0.97	0.97	*0.78*	S2582	18	0.91	0.65	0.92	1.11	*0.94*
S2465	59	1.16	1.33	1.38	0.72	0.76	S2583	116	1.28*	1.31	1.52*	1.00	0.10
S2467	71	1.16	1.52*	1.12	0.84	0.81	S2584	62	1.59**	1.75*	1.52	1.50	<.01
S2471	339	1.19*	1.22	1.18	1.17	0.04	S2586	44	1.32	1.07	1.60	1.40	0.08
S2472	14	1.80	1.54	1.26	2.51*	0.04	S2591	12	1.34	1.34	0.85	2.20	0.28
S2473	33	1.27	1.71	0.98	1.08	0.51	S2594	249	1.17*	1.09	1.31*	1.12	0.06
S2474	45	1.43*	1.54	1.74*	1.00	0.12	S2596	12	1.34	1.34	0.85	2.20	0.28

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
S2597	99	1.07	1.13	1.00	1.06	0.69	T0481	42	1.39	1.07	1.43	1.69	0.03
S2598	278	1.19*	1.11	1.27*	1.18	0.03	T0482	10	0.86	0.83	0.57	1.14	*0.82*
S2599	221	1.37**	1.45**	1.37*	1.28	<.01	T0508	92	1.37**	1.70**	1.21	1.16	0.08
S2601	13	1.29	1.26	0.77	2.14	0.29	T0532	12	1.50	0.85	1.37	2.22	0.11
S2603	41	1.02	0.85	1.38	0.83	0.95	T0535	89	1.04	1.10	1.03	1.01	0.84
S2604	13	0.75	0.61	0.66	0.96	*0.50*	T0550	104	1.17	1.59**	0.88	1.03	0.63
S2627	257	1.14	1.20	1.14	1.09	0.20	T0624	147	1.22*	1.53**	0.97	1.17	0.19
S2630	56	0.98	0.99	1.17	0.86	*0.79*	T0641	16	0.81	0.82	0.93	0.65	*0.42*
T0016	31	1.08	0.90	1.42	0.95	0.70	T0670	30	0.80	0.98	0.76	0.66	*0.18*
T0021	50	1.14	1.05	1.51	0.88	0.55	T0763	18	1.95*	1.42	2.58*	1.90	0.02
T0027	56	1.22	1.16	1.24	1.26	0.19	T0795	23	1.36	2.53**	0.81	0.75	0.84
T0038	70	1.33*	1.31	1.36	1.32	0.06	T0798	10	0.91	0.62	2.19	0.51	*0.79*
T0052	11	1.87	0.48	3.50**	1.67	0.04	T0819	19	1.20	1.34	1.35	0.93	0.64
T0055	9	1.45	1.67	1.22	1.49	0.39	T0837	11	0.81	1.03	0.54	0.79	*0.46*
T0059	32	1.20	1.77*	0.82	1.04	0.74	T0861	18	1.49	1.89	1.78	0.98	0.35
T0062	46	1.31	1.39	1.20	1.35	0.15	T0890	9	1.03	1.50	0.00	1.48	*0.99*
T0084	91	1.30*	1.17	1.50*	1.24	0.04	T0892	276	1.01	0.90	1.15	0.99	0.71
T0118	142	1.09	0.97	1.11	1.20	0.23	T0902	12	0.56	0.14	1.18	0.40	*0.12*
T0166	23	1.14	0.69	1.20	1.47	0.33	T0962	225	1.16	1.30*	1.09	1.11	0.19
T0176	299	1.12	1.18	1.15	1.03	0.34	T0981	69	1.27	1.47	0.98	1.31	0.16
T0180	590	1.25**	1.32**	1.25*	1.17	0.02	T0995	9	0.94	0.25	2.13	0.88	0.85
T0183	16	1.23	1.39	1.40	0.91	0.66	T1017	16	1.03	1.47	0.70	0.94	*0.86*
T0189	17	1.09	1.36	0.91	1.01	0.91	T1055	14	1.07	0.54	1.34	1.24	0.60
T0202	9	0.94	0.25	2.13	0.88	0.85	T1063	130	1.17	0.89	1.51**	1.11	0.09
T0204	61	1.23	1.23	1.43	1.05	0.26	T1074	12	1.05	1.26	0.25	1.68	0.75
T0245	34	1.27	1.62	1.04	1.11	0.45	T1076	130	1.14	1.08	1.29	1.04	0.27
T0262	148	1.30**	1.29	1.29	1.31	0.02	T1120	12	0.80	1.86	0.34	0.41	*0.16*
T0263	18	0.94	0.66	1.38	0.69	*0.84*	T1124	27	1.05	1.11	0.69	1.32	0.72
T0265	17	1.24	1.41	1.09	1.16	0.56	T1150	25	1.12	0.69	1.15	1.52	0.32
T0269	240	1.18*	1.24	1.05	1.25	0.06	T1153	269	1.20*	1.15	1.08	1.35*	0.01
T0345	125	1.09	0.90	1.40*	1.00	0.35	T1155	191	1.13	1.32*	1.12	0.96	0.55
T0362	45	0.96	0.53	1.34	0.98	0.84	T1185	364	1.28**	1.29*	1.25*	1.30*	<.01
T0375	10	1.06	0.93	1.12	1.13	0.82	T1186	209	1.14	1.29*	1.32*	0.82	0.64
T0379	34	1.25	0.81	1.57	1.33	0.16	T1187	641	1.22**	1.26*	1.13	1.27**	0.01
T0420	47	1.29	1.13	1.39	1.37	0.10	T1188	569	1.23**	1.16	1.21	1.32**	<.01
T0430	21	0.95	0.43	1.39	1.00	0.86	T1192	19	1.07	1.06	0.68	1.63	0.60
T0453	13	1.02	1.04	1.51	0.50	*0.83*	T1194	190	1.13	1.09	1.11	1.17	0.17

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
T1214	43	1.24	1.26	1.29	1.18	0.27	T1624	66	1.04	1.38	0.86	0.86	*0.72*
T1269	503	1.18*	1.38**	1.00	1.16	0.16	T1628	290	1.12	1.18	1.04	1.13	0.23
T1270	482	1.22**	1.27*	1.16	1.22*	0.02	T1649	10	1.02	0.00	1.61	1.56	0.46
T1271	411	1.13	1.21	1.12	1.06	0.29	T1650	257	1.09	1.19	1.16	0.93	0.68
T1272	430	1.16*	1.15	1.14	1.19	0.04	T1651	247	1.10	1.03	1.15	1.12	0.20
T1274	12	1.07	0.83	1.36	1.03	0.77	T1652	30	1.41	0.66	1.99*	1.67	0.03
T1293	10	0.73	0.42	1.27	0.48	*0.41*	T1676	97	1.06	1.06	1.10	1.01	0.71
T1307	29	0.88	0.80	1.07	0.76	*0.55*	T1706	14	1.22	1.33	1.16	1.18	0.58
T1341	125	1.10	1.37	1.03	0.90	0.93	T1720	44	1.09	1.00	1.19	1.09	0.58
T1364	9	1.40	0.82	2.98*	0.51	0.43	T1722	34	0.86	1.21	0.44	0.98	*0.36*
T1366	27	1.11	1.57	1.14	0.64	*0.86*	T1734	37	1.11	0.98	1.07	1.26	0.46
T1378	81	1.14	1.25	1.18	1.00	0.50	T1764	408	1.19*	1.23*	1.19	1.15	0.04
T1379	10	0.90	1.42	0.00	1.21	*0.72*	T1768	552	1.17*	1.21*	1.13	1.17	0.06
T1460	141	1.11	1.12	0.92	1.28	0.23	T1792	15	1.22	0.75	1.68	1.28	0.37
T1473	9	0.73	0.71	0.84	0.65	*0.39*	T1799	194	1.09	1.01	1.13	1.13	0.25
T1474	165	0.97	0.90	1.17	0.85	*0.68*	T1816	11	1.62	1.91	0.46	2.50	0.15
T1475	535	1.24**	1.18	1.09	1.45**	<.01	T1833	216	1.13	1.22	1.10	1.06	0.32
T1486	42	1.25	1.18	1.28	1.29	0.21	T1854	151	1.18	1.42*	1.25	0.85	0.55
T1488	21	1.21	1.03	1.66	0.92	0.49	T1857	183	1.09	0.99	0.95	1.34*	0.13
T1492	65	1.32*	1.37	1.49	1.12	0.11	T1867	102	0.94	1.03	1.03	0.77	*0.35*
T1493	65	1.30	1.27	1.53	1.11	0.12	T1870	227	1.14	1.05	1.30*	1.07	0.14
T1500	73	1.11	0.90	1.52*	0.92	0.46	T1872	104	1.07	1.01	1.13	1.09	0.49
T1505	9	1.27	0.83	0.87	2.09	0.30	T1873	14	1.08	1.61	1.01	0.64	*0.78*
T1516	11	2.38*	2.42	3.25*	1.43	0.04	T1876	134	1.01	0.97	0.87	1.21	0.59
T1523	69	0.89	1.07	0.85	0.74	*0.20*	T1880	230	1.13	1.12	1.06	1.21	0.11
T1525	36	1.03	0.81	1.34	0.94	0.79	T1887	295	1.06	0.97	1.14	1.07	0.32
T1531	73	1.32*	1.32	1.45	1.18	0.08	T1890	21	0.86	1.47	0.39	0.86	*0.32*
T1542	495	1.13	1.16	1.10	1.12	0.15	T1891	21	0.84	1.22	0.45	0.87	*0.35*
T1554	170	0.99	0.92	1.32*	0.75	*0.68*	T1892	10	0.72	0.69	1.07	0.41	*0.29*
T1557	423	1.10	1.12	1.13	1.04	0.37	T1909	80	1.63**	1.17	1.76**	2.01**	<.01
T1558	171	1.21*	1.46**	1.17	1.01	0.26	T1912	229	1.22*	1.24	1.23	1.18	0.04
T1575	253	1.18*	1.21	1.08	1.24	0.05	T1941	23	0.98	1.31	0.67	1.02	*0.79*
T1577	47	1.10	1.03	1.28	0.97	0.63	T1947	13	1.18	0.61	0.87	1.92	0.29
T1583	73	1.35*	1.47	1.06	1.50	0.04	T1949	17	0.76	0.87	0.15	1.18	*0.47*
T1585	101	1.01	1.02	1.02	0.99	0.99	T1956	304	1.00	1.05	1.01	0.94	*0.73*
T1587	30	1.10	1.19	0.72	1.40	0.56	T1966	16	0.92	0.77	1.19	0.78	*0.76*
T1595	23	0.89	0.71	0.68	1.29	*0.96*	T1998	16	1.30	0.53	1.14	2.26*	0.10

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
T2003	16	1.03	2.49**	0.19	0.52	*0.32*	X1080	177	1.19	0.97	1.51**	1.08	0.06
T2051	65	1.06	0.96	0.79	1.40	0.39	X1100	12	1.40	0.35	2.02	1.83	0.13
T2060	18	1.04	0.57	1.08	1.41	0.54	X1102	12	1.44	0.35	1.30	2.77*	0.06
T2072	18	1.03	0.99	0.84	1.23	0.81	X1103	18	1.19	0.69	1.30	1.70	0.24
T2076	109	1.10	0.97	0.99	1.34	0.19	X1105	56	1.32	1.13	1.52	1.28	0.08
T2080	50	1.20	1.03	1.32	1.31	0.19	X1106	20	0.99	0.65	1.62	0.74	*0.98*
T2086	25	1.02	0.75	1.46	0.84	0.89	X1107	14	0.82	0.00	0.98	1.40	0.88
T2096	13	0.87	0.77	1.24	0.60	*0.59*	X1108	266	1.19*	1.20	1.24	1.14	0.06
T2097	19	1.01	0.34	1.34	1.29	0.56	X1109	20	1.26	2.09*	1.29	0.34	*0.85*
T2099	9	0.93	1.26	0.00	1.40	*0.86*	X1112	67	0.91	0.97	0.97	0.81	*0.41*
X0001	61	0.98	0.94	0.99	1.02	*0.99*	X1114	9	0.86	0.47	1.55	0.66	*0.81*
X0029	55	1.05	1.20	0.99	0.98	0.93	X1118	183	1.10	1.19	0.89	1.22	0.28
X0063	57	1.15	1.71*	0.90	0.82	*0.96*	X1120	9	0.82	0.89	1.09	0.50	*0.49*
X0074	192	1.04	0.87	1.49**	0.77	0.86	X1121	12	1.13	0.51	0.71	2.16	0.26
X0089	46	1.04	1.03	1.18	0.90	0.94	X1133	43	1.25	0.90	1.82*	1.27	0.11
X0093	78	1.14	1.25	1.19	0.98	0.53	X1134	28	1.25	0.79	1.70	1.27	0.19
X0105	9	1.66	1.13	2.42	1.51	0.18	X1135	14	0.73	0.75	0.17	1.24	*0.49*
X0108	22	0.99	0.81	1.43	0.88	0.97	X1139	10	0.67	0.59	0.38	1.07	*0.41*
X0145	64	0.92	0.97	0.96	0.84	*0.47*	X1140	47	1.08	1.22	0.86	1.15	0.71
X0150	11	0.89	0.51	1.35	0.75	*0.82*	X1141	25	1.22	0.83	1.08	1.72	0.17
X0158	91	1.25	1.34	1.00	1.40	0.08	X1146	131	0.99	1.01	0.83	1.13	0.91
X0167	14	0.76	0.91	1.03	0.41	*0.21*	X1156	33	1.22	1.96*	0.71	1.04	0.76
X0182	45	1.09	0.93	1.17	1.18	0.49	X1162	15	1.27	1.64	0.25	1.94	0.39
X1009	53	1.38*	1.25	1.34	1.54	0.03	X1165	149	1.14	1.29	0.92	1.20	0.30
X1017	23	1.12	1.35	1.15	0.90	0.86	X1166	18	1.49	1.89	1.78	0.98	0.35
X1021	103	1.07	0.87	1.15	1.15	0.36	X1167	45	1.27	1.41	1.09	1.30	0.24
X1028	31	1.32	1.71	1.05	1.14	0.39	X1170	45	1.07	0.69	1.28	1.26	0.37
X1031	427	1.15*	1.08	1.20	1.17	0.04	X1172	28	1.22	0.75	1.38	1.58	0.16
X1036	117	1.10	1.03	0.92	1.33	0.22	X1173	111	1.08	1.00	1.07	1.16	0.38
X1038	440	1.25**	1.17	1.29*	1.27*	<.01	X1174	18	1.25	0.99	1.27	1.52	0.28
X1041	16	1.78*	1.75	1.39	2.17	0.04	X1175	39	1.29	1.50	1.48	0.89	0.42
X1049	17	1.03	1.59	1.37	0.28	*0.53*	X1184	51	1.18	1.16	1.42	1.01	0.42
X1056	28	1.05	0.82	0.94	1.39	0.52	X1185	156	1.15	1.10	1.15	1.21	0.12
X1067	16	1.11	1.58	0.40	1.36	0.83	X1187	85	0.96	1.08	0.78	0.96	*0.60*
X1068	257	1.25**	1.34*	1.16	1.26	0.02	X1197	63	0.90	0.98	0.87	0.84	*0.37*
X1075	161	1.42**	1.22	1.59**	1.44*	<.01	X1209	11	0.67	0.88	0.86	0.20	*0.12*
X1079	321	1.20*	1.10	1.21	1.29*	<.01	X1217	42	1.23	1.13	1.78*	0.80	0.40

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X1219	250	1.19*	1.24	1.08	1.25	0.05	X1355	9	1.06	1.64	0.36	1.16	*0.94*
X1222	50	0.96	0.97	0.96	0.93	*0.76*	X1357	15	0.85	0.66	0.67	1.27	*0.87*
X1224	26	1.23	0.71	1.43	1.55	0.17	X1367	199	1.09	1.18	1.02	1.06	0.51
X1226	11	1.71	2.41	2.57	0.00	0.49	X1376	27	1.25	0.73	1.57	1.43	0.17
X1228	121	1.07	1.05	0.95	1.21	0.39	X1379	157	1.25*	1.36*	1.08	1.32	0.04
X1230	10	1.05	0.67	1.82	1.01	0.73	X1380	92	1.01	0.91	1.19	0.94	0.93
X1231	352	1.22**	1.09	1.36**	1.21	<.01	X1394	127	1.36**	1.38	1.60**	1.11	0.02
X1239	15	1.34	0.77	1.48	1.85	0.16	X1395	221	1.23*	0.94	1.51**	1.23	<.01
X1240	31	0.73	0.86	0.63	0.68	*0.09*	X1396	177	1.35**	1.50**	1.49**	1.07	0.02
X1255	35	0.94	0.85	0.72	1.23	0.96	X1401	35	2.18**	1.62	2.68**	2.25*	<.01
X1256	12	1.00	0.53	0.97	1.45	0.67	X1402	67	1.00	1.19	0.81	0.93	*0.70*
X1257	15	1.18	1.48	0.62	1.55	0.57	X1411	56	1.19	1.16	1.04	1.36	0.22
X1258	10	0.73	0.26	0.54	1.39	*0.76*	X1424	9	2.83*	1.10	4.48*	2.70	<.01
X1266	9	1.32	0.43	1.31	2.65	0.18	X1425	218	1.21*	1.26	1.19	1.18	0.06
X1267	19	1.13	0.58	1.26	1.50	0.35	X1442	127	1.09	1.13	1.11	1.04	0.52
X1268	61	1.21	0.89	1.56*	1.20	0.12	X1447	151	1.01	0.98	1.20	0.84	*0.84*
X1280	37	1.08	1.21	0.78	1.23	0.67	X1448	14	1.82	2.00	1.46	2.04	0.07
X1281	18	1.07	0.61	1.16	1.56	0.40	X1449	102	1.03	0.87	1.04	1.16	0.52
X1302	14	1.60	0.66	1.42	2.77*	0.03	X1450	15	1.33	2.45*	1.40	0.27	*0.98*
X1303	52	0.95	1.00	1.17	0.76	*0.56*	X1454	24	1.38	1.81	1.09	1.24	0.33
X1304	12	1.07	1.37	0.00	1.96	0.70	X1456	170	1.10	1.25	1.04	1.03	0.56
X1306	23	0.94	1.08	1.03	0.69	*0.61*	X1457	94	1.29*	1.41	1.26	1.22	0.08
X1308	14	1.08	1.16	1.75	0.48	*0.89*	X1458	41	1.12	0.87	1.00	1.55	0.25
X1312	285	1.18*	1.10	1.30*	1.13	0.04	X1459	17	1.04	1.13	0.41	1.52	0.73
X1314	15	1.26	1.38	1.42	0.99	0.60	X1460	87	1.26	1.50*	1.07	1.19	0.18
X1322	176	1.13	1.00	1.24	1.14	0.15	X1463	50	1.19	1.17	1.26	1.16	0.32
X1329	61	1.24	1.40	1.29	1.01	0.34	X1464	18	1.14	0.43	2.04*	0.88	0.49
X1333	24	1.10	0.45	1.40	1.38	0.35	X1468	25	1.51	1.36	1.51	1.68	0.07
X1334	15	1.38	1.50	0.88	1.75	0.26	X1471	39	1.13	0.70	0.96	1.76*	0.13
X1335	104	1.12	1.09	1.27	1.00	0.44	X1475	10	1.12	1.68	0.58	1.12	0.96
X1336	14	1.13	0.55	1.53	1.24	0.48	X1484	17	1.37	2.48*	0.60	1.14	0.66
X1340	13	1.15	0.54	1.57	1.35	0.43	X1485	90	1.14	1.22	1.12	1.07	0.43
X1342	10	0.91	0.62	2.19	0.51	*0.79*	X1486	101	1.17	1.04	1.13	1.32	0.11
X1343	15	0.95	0.36	1.03	1.47	0.64	X1488	15	1.01	0.45	1.59	0.86	0.81
X1350	19	0.94	1.57	0.45	0.84	*0.50*	X1490	10	1.38	2.89*	0.80	0.41	*0.92*
X1351	12	1.10	0.51	0.69	2.04	0.31	X1496	83	1.39*	1.61*	1.43	1.13	0.06
X1354	18	1.03	0.50	1.67	0.84	0.74	X1497	34	1.20	0.70	1.27	1.63	0.13

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X1500	105	1.31*	1.33	1.23	1.38	0.03	X1653	28	1.27	1.36	1.22	1.24	0.34
X1503	108	1.26*	1.49*	1.13	1.15	0.15	X1654	166	1.16	1.25	1.24	1.00	0.32
X1505	115	1.03	0.98	1.18	0.93	0.86	X1655	26	1.20	0.90	1.28	1.39	0.28
X1506	86	1.06	0.95	0.89	1.31	0.38	X1656	170	1.34**	1.52**	1.48**	1.04	0.03
X1507	10	0.95	1.28	0.34	1.11	*0.81*	X1657	343	1.12	1.19	0.99	1.20	0.14
X1508	297	1.24**	1.05	1.26	1.41**	<.01	X1658	34	1.22	0.86	1.58	1.27	0.21
X1509	370	1.25**	1.19	1.26*	1.31*	<.01	X1667	9	0.99	0.88	0.00	2.10	0.63
X1511	34	0.97	1.23	1.15	0.53	*0.47*	X1673	12	1.13	0.51	0.71	2.16	0.26
X1512	287	1.13	1.28*	1.16	0.96	0.51	X1674	18	1.26	1.51	0.94	1.28	0.50
X1513	117	1.03	1.31	0.78	1.02	*0.88*	X1680	14	1.65	0.88	1.67	2.78*	0.03
X1516	41	1.15	0.67	1.79*	0.89	0.34	X1688	13	1.86*	4.50**	0.38	1.23	0.40
X1550	101	1.26*	1.53*	0.98	1.29	0.12	X1696	13	0.97	0.46	1.23	1.20	0.79
X1551	111	1.15	0.99	1.23	1.23	0.14	X1698	131	1.11	1.24	1.12	0.99	0.57
X1569	59	1.21	0.97	1.39	1.28	0.14	X1699	12	1.05	1.03	0.77	1.40	0.76
X1573	242	1.16	1.24	1.01	1.23	0.10	X1700	32	1.15	1.03	1.52	0.89	0.57
X1576	186	1.15	0.90	1.19	1.36*	0.02	X1712	15	1.19	0.70	1.60	1.30	0.39
X1579	249	1.10	1.12	1.10	1.08	0.33	X1718	87	1.29*	1.29	1.18	1.39	0.05
X1580	151	1.12	0.93	1.18	1.24	0.12	X1752	128	1.26*	1.23	1.20	1.37	0.02
X1585	83	1.29*	1.56*	1.20	1.10	0.18	X1783	13	0.58	0.43	0.62	0.67	*0.12*
X1586	106	1.30*	1.55*	1.28	1.09	0.12	X1791	9	1.17	0.90	1.63	1.04	0.62
X1588	19	1.20	0.44	1.98	1.12	0.33	X1794	15	0.65	0.65	0.25	1.10	*0.28*
X1590	24	1.34	1.10	1.37	1.54	0.16	X1808	176	1.18	1.43**	0.99	1.13	0.25
X1594	15	0.78	0.45	0.89	1.03	*0.67*	X1814	10	0.76	1.24	0.50	0.56	*0.27*
X1595	14	1.02	0.43	0.88	1.88	0.43	X1827	63	0.93	0.91	1.14	0.81	*0.54*
X1597	9	2.08	2.80	0.57	3.32	0.08	X1829	14	1.06	1.52	0.98	0.67	*0.78*
X1598	89	1.00	1.01	0.75	1.23	0.74	X1830	13	1.08	1.57	0.91	0.78	*0.89*
X1613	19	0.95	0.51	0.95	1.34	0.78	X1833	13	0.66	1.21	0.41	0.44	*0.07*
X1636	11	0.83	0.76	1.04	0.69	*0.58*	X1835	24	1.05	1.34	1.39	0.47	*0.70*
X1638	23	1.27	0.70	1.03	2.02*	0.10	X1836	116	1.23	1.33	1.03	1.33	0.08
X1639	326	1.10	1.12	1.16	1.03	0.36	X1837	203	1.18	1.28	0.98	1.27	0.08
X1641	17	1.23	0.56	1.46	1.88	0.17	X1841	129	1.16	0.96	1.44*	1.07	0.15
X1642	26	1.08	1.12	0.93	1.22	0.69	X1842	46	1.30	1.67*	1.09	1.12	0.32
X1643	12	1.29	0.32	1.25	2.34	0.13	X1850	45	1.29	1.67*	1.24	0.95	0.44
X1646	74	1.12	0.98	1.46	0.91	0.51	X1867	21	1.34	0.73	1.66	1.71	0.11
X1650	23	1.35	0.68	1.49	1.90	0.07	X1868	10	1.02	2.53*	0.62	0.24	*0.35*
X1651	118	1.11	0.83	1.37	1.13	0.18	X1869	34	0.95	1.25	0.60	0.98	*0.62*
X1652	166	1.17	1.26	1.25	1.01	0.28	X1872	410	1.25**	1.22	1.23*	1.30*	<.01

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X1877	250	1.14	1.15	1.11	1.16	0.13	X2014	131	1.19	1.18	1.11	1.28	0.09
X1893	44	1.06	0.95	1.24	0.96	0.77	X2015	12	0.91	0.49	1.15	1.06	1.00
X1894	48	1.86**	1.63	1.73	2.20**	<.01	X2016	226	1.06	1.18	0.93	1.08	0.67
X1895	13	1.06	2.10	0.62	0.69	*0.66*	X2017	9	1.16	0.90	1.91	0.54	0.75
X1897	356	1.26**	1.18	1.18	1.41**	<.01	X2019	49	1.07	0.92	1.22	1.07	0.61
X1899	60	1.14	1.43	0.98	1.02	0.67	X2020	153	1.06	1.00	1.26	0.92	0.66
X1902	24	1.72*	2.45*	1.48	1.27	0.12	X2022	90	1.01	0.90	1.10	1.03	0.80
X1906	11	1.00	0.62	1.03	1.29	0.77	X2023	20	1.60	1.84	1.94	1.16	0.17
X1909	122	1.13	1.44*	0.86	1.08	0.61	X2027	50	1.22	0.98	1.35	1.29	0.16
X1910	13	0.90	0.56	0.22	1.93	0.68	X2028	10	1.72	1.39	1.11	2.75	0.07
X1918	24	1.72*	2.81**	1.03	1.27	0.17	X2029	127	1.30*	1.35	1.19	1.37	0.02
X1922	11	1.04	1.91	0.71	0.59	*0.64*	X2031	38	1.44*	1.61	0.97	1.71	0.06
X1923	17	0.96	1.00	1.69	0.32	*0.57*	X2035	18	1.49	1.89	1.78	0.98	0.35
X1925	55	1.25	1.17	1.50	1.16	0.19	X2062	103	1.06	0.79	1.40	1.00	0.44
X1930	20	1.60	2.03	2.05	0.95	0.24	X2063	27	1.08	0.88	1.39	0.95	0.71
X1936	16	0.85	0.71	0.50	1.53	*0.92*	X2065	76	1.22	1.33	1.30	1.03	0.29
X1948	21	1.25	1.57	1.13	1.09	0.55	X2066	105	1.08	0.99	1.10	1.16	0.37
X1957	17	1.23	0.57	1.46	1.88	0.17	X2083	10	1.52	1.11	2.51	1.30	0.24
X1966	17	1.13	1.82	1.02	0.43	*0.70*	X2143	80	1.26	1.04	1.57*	1.24	0.06
X1970	18	1.15	1.05	0.96	1.40	0.50	X2145	40	1.42	1.04	1.80*	1.45	0.04
X1977	9	1.19	0.90	2.31	0.48	0.72	X2180	27	1.27	0.95	1.06	1.77	0.12
X1980	38	1.35	1.03	1.80*	1.27	0.09	X2192	32	1.22	1.01	1.30	1.35	0.25
X1981	12	1.14	1.36	1.75	0.29	*0.91*	X2202	12	1.11	1.04	0.75	1.61	0.59
X1984	25	1.37	0.71	1.96*	1.36	0.10	X2204	94	1.28*	1.59*	1.08	1.16	0.18
X1986	32	1.25	1.02	1.76	0.97	0.33	X2283	11	1.08	0.79	1.78	0.66	0.86
X1988	12	1.42	1.83	1.89	0.63	0.58	X2293	375	1.30**	1.26*	1.34**	1.30*	<.01
X1992	29	1.30	0.97	1.20	1.74	0.11	X2295	450	1.30**	1.25*	1.35**	1.31**	<.01
X1994	22	1.05	1.10	0.60	1.41	0.71	X2297	262	1.25**	1.14	1.25	1.37**	<.01
X1995	13	1.60	1.60	1.90	1.26	0.21	X2298	390	1.34**	1.33**	1.41**	1.27*	<.01
X1998	22	1.21	0.95	1.00	1.61	0.26	X2303	361	1.39**	1.42**	1.42**	1.33*	<.01
X1999	19	1.01	0.74	1.05	1.19	0.78	X2305	206	1.38**	1.22	1.32	1.62**	<.01
X2001	23	1.21	0.54	1.12	1.92	0.14	X2306	335	1.38**	1.40**	1.41**	1.34*	<.01
X2003	9	1.70	1.28	0.48	3.61*	0.06	X2307	301	1.38**	1.40**	1.39**	1.36*	<.01
X2006	65	1.06	1.05	0.98	1.16	0.59	X2308	208	1.40**	1.25	1.34*	1.61**	<.01
X2007	59	1.29	1.45	1.55	0.90	0.29	X2309	31	1.23	1.06	1.46	1.17	0.30
X2011	33	0.77	0.80	1.11	0.37*	*0.10*	X2310	154	1.04	1.01	0.92	1.18	0.50
X2013	14	1.34	1.28	1.44	1.29	0.37	X2311	155	1.08	1.12	1.05	1.08	0.49

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X2312	18	0.96	0.38	1.08	1.30	0.71	X2396	12	0.84	1.14	0.46	0.91	*0.54*
X2314	24	0.92	0.86	0.95	0.95	*0.77*	X2398	98	1.31*	1.54*	1.31	1.08	0.12
X2315	9	1.88	2.19	3.34*	0.00	0.33	X2400	10	1.02	2.15	0.93	0.24	*0.42*
X2316	14	0.94	0.45	1.04	1.28	0.80	X2401	20	1.06	0.46	1.30	1.49	0.39
X2317	33	1.19	1.01	1.34	1.21	0.34	X2403	68	1.02	0.97	0.96	1.13	0.73
X2318	23	1.02	0.73	1.12	1.18	0.71	X2404	10	1.02	2.15	0.93	0.24	*0.42*
X2319	23	1.20	0.73	1.30	1.48	0.26	X2405	48	1.07	1.65*	1.09	0.52	*0.42*
X2320	33	0.95	0.92	1.20	0.72	*0.68*	X2417	77	1.32*	1.06	1.67*	1.31	0.03
X2325	18	1.06	0.93	0.73	1.63	0.57	X2418	18	1.03	0.39	1.13	1.49	0.49
X2327	10	0.67	0.63	0.83	0.55	*0.25*	X2423	64	1.06	0.88	0.96	1.30	0.40
X2328	20	1.09	0.52	1.16	1.55	0.36	X2424	31	1.21	0.67	1.58	1.45	0.15
X2329	15	1.20	1.08	0.46	2.22	0.27	X2436	13	0.77	1.91	0.16	0.46	*0.11*
X2330	15	1.20	1.08	0.46	2.22	0.27	X2441	11	0.88	0.48	1.61	0.51	*0.72*
X2331	15	1.20	1.08	0.46	2.22	0.27	X2449	179	1.05	1.17	1.11	0.90	*0.98*
X2332	15	1.20	1.08	0.46	2.22	0.27	X2463	18	1.06	1.57	0.98	0.64	*0.71*
X2333	15	1.20	1.08	0.46	2.22	0.27	X2467	13	1.02	0.90	1.12	1.05	0.88
X2335	86	0.99	1.07	0.73	1.16	0.97	X2468	10	1.02	2.15	0.93	0.24	*0.42*
X2336	48	1.06	0.96	1.37	0.82	0.82	X2470	96	1.31*	1.46	1.25	1.23	0.06
X2342	12	0.80	1.32	0.63	0.40	*0.23*	X2475	111	1.06	1.00	0.76	1.42*	0.27
X2346	15	0.93	0.60	1.02	1.16	0.95	X2480	118	1.11	1.06	1.26	1.03	0.38
X2351	16	1.13	0.98	0.60	1.94	0.39	X2482	14	1.32	1.57	1.38	0.95	0.56
X2352	16	1.19	0.89	1.33	1.35	0.42	X2496	53	0.91	1.00	1.00	0.72	*0.34*
X2354	12	0.81	1.29	0.78	0.39	*0.25*	X2501	24	1.37	0.94	1.43	1.80	0.09
X2361	100	1.22	1.28	1.11	1.29	0.11	X2513	118	1.11	1.28	1.07	0.98	0.66
X2363	98	1.29*	1.48*	1.16	1.24	0.09	X2514	118	1.11	1.28	1.07	0.98	0.66
X2365	23	1.27	1.73	0.34	1.72	0.39	X2517	56	1.30	1.54	1.13	1.24	0.19
X2373	18	1.01	0.38	1.11	1.49	0.52	X2518	218	1.23*	1.16	1.27	1.26	0.01
X2377	64	1.11	1.07	1.09	1.15	0.46	X2521	9	1.05	1.24	0.78	1.08	0.96
X2378	9	0.91	0.55	0.85	1.41	0.89	X2522	9	1.04	1.13	0.85	1.18	0.91
X2379	12	1.17	1.72	0.30	1.39	0.81	X2523	136	1.15	1.25	1.29	0.89	0.46
X2380	85	1.29*	1.56*	1.23	1.08	0.19	X2529	46	0.97	0.88	1.24	0.79	*0.79*
X2381	30	1.07	1.02	1.35	0.86	0.84	X2532	10	0.94	0.58	0.52	1.76	0.71
X2384	175	1.14	1.23	1.04	1.13	0.28	X2533	13	1.55	2.96*	1.78	0.31	0.69
X2386	11	0.83	0.84	0.63	1.05	*0.66*	X2534	97	1.24	1.08	1.34	1.33	0.05
X2393	55	1.26	1.53	1.00	1.25	0.25	X2537	21	0.86	1.01	0.85	0.76	*0.46*
X2394	21	1.06	0.87	1.17	1.11	0.73	X2538	62	1.24	1.31	0.97	1.47	0.13
X2395	11	1.11	0.31	1.52	1.50	0.42	X2541	22	1.18	0.70	1.56	1.24	0.34

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X2548	71	1.18	1.31	1.06	1.15	0.35	X2812	62	1.05	0.99	1.06	1.10	0.67
X2549	54	0.92	0.98	1.07	0.73	*0.39*	X2821	68	1.36*	0.95	1.49	1.62*	<.01
X2555	52	0.94	1.00	0.93	0.87	*0.60*	X2822	68	1.00	0.96	0.86	1.17	0.79
X2560	31	1.30	1.66	1.02	1.16	0.41	X2823	14	0.94	0.62	0.83	1.36	0.83
X2562	23	1.08	0.67	2.19*	0.45	0.83	X2826	12	1.13	0.51	0.71	2.16	0.26
X2570	21	1.15	0.68	1.62	1.12	0.44	X2836	9	1.39	0.00	1.71	3.27*	0.07
X2572	19	1.31	0.57	1.52	1.98	0.09	X2838	91	1.37**	1.63*	0.98	1.51*	0.02
X2582	9	1.05	0.97	1.04	1.16	0.84	X2839	28	1.28	1.32	1.30	1.22	0.32
X2598	45	1.20	1.54	1.09	0.96	0.61	X2842	25	1.40	0.68	1.97	1.57	0.06
X2604	26	1.08	1.45	1.41	0.37	*0.65*	X2844	11	1.67	3.08*	0.81	1.30	0.40
X2608	17	1.15	0.56	1.10	1.76	0.25	X2847	9	1.16	0.90	1.91	0.54	0.75
X2629	65	1.24	1.32	1.19	1.23	0.18	X2851	9	0.85	0.81	0.33	1.33	*0.87*
X2644	9	1.07	0.85	1.11	1.35	0.70	X2852	173	1.27**	1.55**	1.01	1.23	0.07
X2652	44	1.10	1.02	0.90	1.38	0.42	X2861	23	1.19	0.83	1.30	1.40	0.31
X2656	123	1.17	1.04	1.39*	1.08	0.16	X2862	18	1.08	1.59	0.81	0.72	*0.78*
X2657	25	1.45	1.59	2.02*	0.83	0.28	X2863	177	1.26*	1.50**	1.11	1.15	0.09
X2661	84	1.11	0.86	1.26	1.21	0.23	X2864	56	1.25	1.44	1.55	0.79	0.45
X2672	18	1.39	1.28	0.91	1.89	0.15	X2865	59	0.99	0.98	0.97	1.02	1.00
X2674	50	1.17	1.00	1.30	1.20	0.28	X2866	64	1.10	1.07	1.08	1.15	0.49
X2676	146	1.13	1.16	0.99	1.23	0.21	X2867	39	1.31	1.16	1.76	1.10	0.19
X2686	45	1.23	1.59	1.21	0.90	0.59	X2869	21	1.12	0.67	1.58	1.10	0.50
X2689	25	2.89**	1.93	2.95**	4.00**	<.01	X2871	131	1.10	1.18	1.04	1.09	0.46
X2701	37	1.29	1.10	1.47	1.29	0.16	X2873	9	0.95	0.83	1.14	0.85	*0.92*
X2703	14	1.17	0.65	1.04	2.07	0.27	X2874	9	0.89	0.57	0.98	1.14	*0.98*
X2712	23	1.37	1.44	1.27	1.43	0.21	X2876	18	1.61	1.92	0.87	1.99	0.10
X2730	68	1.20	1.41	1.18	1.01	0.44	X2878	25	1.28	1.39	0.91	1.56	0.26
X2732	45	1.29	1.67*	1.24	0.95	0.44	X2881	56	1.19	1.16	1.04	1.36	0.22
X2744	67	1.00	1.19	0.81	0.93	*0.70*	X2887	85	1.27	1.63*	1.14	1.03	0.29
X2754	14	1.04	0.96	0.95	1.24	0.79	X2897	11	1.12	0.50	1.54	1.46	0.45
X2769	15	1.10	1.28	1.58	0.49	*0.89*	X2900	15	0.95	0.69	0.66	1.54	0.78
X2777	106	1.03	0.93	0.80	1.33	0.41	X2905	12	1.13	0.51	0.71	2.16	0.26
X2789	32	1.22	1.01	1.30	1.35	0.25	X2925	64	1.31	1.50	1.29	1.10	0.18
X2793	364	1.20*	1.06	1.36**	1.18	<.01	X2938	91	1.23	1.28	1.37	1.01	0.21
X2797	47	1.30	1.14	1.72*	1.04	0.16	X2951	23	1.08	1.70	0.72	0.81	*0.77*
X2803	19	1.13	1.03	1.45	1.02	0.66	X2954	103	1.39**	1.60**	1.54*	1.02	0.06
X2805	21	0.91	0.80	1.13	0.82	*0.72*	X2955	53	0.96	0.96	1.22	0.78	*0.64*
X2807	9	0.85	0.57	0.88	1.08	*0.85*	X2963	39	1.00	0.67	1.21	1.15	0.65

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X2965	11	0.80	0.42	1.13	0.86	*0.69*	X3100	39	1.71**	1.52	1.86	1.78	<.01
X2966	10	1.03	0.36	1.07	1.63	0.57	X3103	180	1.02	0.96	1.18	0.92	0.93
X2973	57	0.97	0.99	1.08	0.87	*0.74*	X3104	45	1.26	1.38	0.74	1.70*	0.13
X2974	89	1.32*	1.55*	1.21	1.17	0.11	X3105	130	1.08	0.98	1.17	1.12	0.34
X2981	61	0.96	1.00	0.93	0.94	*0.72*	X3106	10	0.99	1.84	0.63	0.33	*0.44*
X2982	80	1.25	1.44	1.34	0.98	0.27	X3108	57	1.12	1.45	0.63	1.27	0.63
X2984	68	1.37*	1.25	1.85**	0.96	0.07	X3111	11	1.04	1.49	1.25	0.48	*0.69*
X2986	9	2.02	4.34**	1.78	0.00	0.57	X3117	47	1.00	0.92	1.02	1.06	0.90
X2987	16	0.90	0.53	1.32	0.84	*0.87*	X3120	69	1.03	1.00	0.99	1.10	0.74
X2988	13	1.84	2.34	2.77*	0.38	0.25	X3130	28	0.99	1.60	0.64	0.77	*0.50*
X3000	61	1.16	0.90	1.44	1.16	0.23	X3142	41	1.14	1.07	1.39	0.96	0.55
X3003	124	1.12	0.93	1.30	1.13	0.19	X3148	11	1.91	1.99	3.03*	0.58	0.17
X3007	125	0.99	0.98	1.01	0.97	*0.89*	X3152	14	0.87	1.30	0.88	0.38	*0.33*
X3008	12	1.13	0.56	0.60	2.16	0.29	X3160	20	1.05	1.26	0.98	0.91	*0.97*
X3009	140	1.10	1.20	1.04	1.05	0.53	X3167	64	1.24	1.17	1.33	1.21	0.16
X3012	52	0.96	0.99	1.17	0.78	*0.61*	X3204	28	1.67*	2.30*	1.76	1.04	0.13
X3014	539	1.16*	1.14	1.15	1.20*	0.03	X3205	16	0.96	1.06	1.62	0.49	*0.59*
X3017	296	1.25**	1.27*	1.37**	1.11	0.02	X3211	140	1.34**	1.68**	1.26	1.12	0.06
X3019	252	1.18*	1.26	1.23	1.07	0.13	X3220	20	1.01	1.47	0.82	0.77	*0.69*
X3020	169	1.09	1.29	0.87	1.10	0.61	X3231	184	1.17	0.85	1.53**	1.12	0.04
X3025	53	0.96	0.99	1.17	0.80	*0.65*	X3232	15	1.06	1.22	1.39	0.48	*0.85*
X3027	262	1.04	1.03	1.10	1.01	0.66	X3235	64	1.03	0.72	1.37	0.99	0.64
X3032	186	1.16	0.99	1.24	1.25	0.05	X3239	16	1.17	1.04	2.26	0.83	0.68
X3033	45	0.98	0.85	0.90	1.18	0.84	X3241	100	1.06	0.85	0.87	1.44*	0.21
X3038	230	1.20*	1.32*	1.10	1.19	0.07	X3243	11	0.99	1.00	0.94	1.01	*0.97*
X3039	39	1.07	1.49	0.45	1.28	0.92	X3256	96	1.05	1.09	1.21	0.85	0.96
X3045	81	1.19	1.27	0.98	1.35	0.18	X3262	104	1.14	1.18	1.03	1.21	0.26
X3048	21	0.99	0.75	1.17	1.04	0.89	X3264	21	1.07	0.94	0.97	1.31	0.64
X3051	20	1.04	0.98	1.40	0.82	0.96	X3265	290	1.21*	1.24	1.10	1.28*	0.02
X3054	42	0.97	1.01	0.78	1.14	*0.98*	X3269	12	1.38	1.31	1.26	1.54	0.31
X3064	304	1.27**	1.19	1.31*	1.32*	<.01	X3272	14	0.85	1.02	0.53	1.01	*0.61*
X3069	103	1.18	1.56**	0.84	1.12	0.46	X3275	38	1.35	1.13	1.72	1.23	0.11
X3077	13	1.00	0.71	1.25	1.06	0.86	X3278	15	0.94	1.12	0.76	0.95	*0.77*
X3082	178	1.08	1.24	0.85	1.11	0.62	X3286	167	1.19	1.13	1.15	1.28	0.05
X3088	37	1.19	1.13	1.26	1.17	0.37	X3287	14	1.18	0.96	0.46	2.30*	0.27
X3089	53	1.12	1.46	0.96	0.94	0.88	X3289	18	0.86	0.81	0.64	1.12	*0.75*
X3093	13	0.63	1.09	0.16	0.59	*0.08*	X3290	11	1.07	0.80	0.91	1.56	0.59

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X3373	11	1.55	0.90	1.60	2.16	0.11	X3989	29	1.35	1.16	1.44	1.44	0.14
X3396	15	0.73	1.02	0.76	0.43	*0.15*	X3991	18	1.07	1.69	1.39	0.30	*0.54*
X3401	21	1.08	1.13	0.94	1.15	0.77	X3992	33	1.06	1.37	0.81	1.01	1.00
X3542	20	0.63	1.21	0.42	0.37	*0.02*	X4004	31	0.93	0.87	0.72	1.22	*0.95*
X3558	12	0.87	0.45	1.80	0.42	*0.66*	X4016	23	1.12	0.41	1.42	1.59	0.23
X3559	64	0.91	0.91	1.22	0.63	*0.33*	X4021	32	0.94	1.61	0.79	0.36*	*0.15*
X3569	12	1.68	0.36	2.15	2.82*	0.02	X4025	21	1.18	1.39	1.27	0.95	0.72
X3570	11	1.51	0.36	1.61	2.81*	0.05	X4033	11	1.99*	0.49	3.50**	2.01	0.02
X3635	104	1.33*	1.57*	1.22	1.18	0.08	X4041	17	1.14	1.36	0.94	1.10	0.77
X3644	46	1.46*	1.63	1.55	1.21	0.08	X4042	111	1.25*	1.38	1.34	1.03	0.17
X3647	11	2.00*	1.79	1.20	2.82*	0.03	X4045	64	1.43*	1.45	1.62*	1.22	0.04
X3672	373	1.21**	1.11	1.21	1.31**	<.01	X4046	18	0.79	0.14	0.92	1.25	*0.90*
X3691	245	1.12	1.12	1.06	1.18	0.16	X4057	34	1.37	1.12	2.14**	0.89	0.17
X3693	25	1.55	0.57	1.84	2.25*	0.01	X4063	18	1.33	1.82	1.18	0.92	0.60
X3695	42	1.39	1.76*	1.06	1.32	0.17	X4067	15	1.37	2.05	0.45	1.79	0.38
X3700	10	0.61	0.80	0.59	0.39	*0.10*	X4073	11	1.12	0.35	1.82	1.11	0.55
X3712	251	1.15	1.18	1.12	1.15	0.13	X4096	30	1.08	0.81	1.01	1.43	0.43
X3716	11	0.89	1.36	1.27	0.00	*0.30*	X4097	75	1.05	1.07	1.16	0.92	0.88
X3720	20	1.04	0.78	1.00	1.34	0.62	X4101	96	0.99	1.03	1.23	0.73	*0.60*
X3722	10	0.88	0.95	1.09	0.58	*0.60*	X4103	13	1.72	1.73	1.60	1.81	0.11
X3743	16	1.14	1.78	0.00	1.92	0.58	X4104	16	1.50	1.54	1.24	1.77	0.15
X3755	11	1.50	2.03	1.45	0.88	0.51	X4107	9	0.62	0.47	0.61	0.75	*0.27*
X3761	245	1.22*	1.14	1.12	1.40**	<.01	X4113	54	0.93	0.98	1.06	0.77	*0.49*
X3764	18	0.82	0.57	1.48	0.48	*0.41*	X4119	13	0.99	0.64	2.19*	0.23	*0.81*
X3765	9	1.19	1.60	1.12	0.85	0.88	X4131	68	1.31	1.25	1.62*	1.06	0.11
X3767	191	1.19*	1.19	1.28	1.11	0.10	X4134	9	1.07	0.55	2.22	0.47	0.80
X3782	357	1.09	1.19	1.27*	0.81	*0.92*	X4140	9	1.96	3.19*	1.64	1.25	0.25
X3812	40	1.11	1.01	0.90	1.41	0.39	X4178	15	1.08	1.43	0.82	0.99	0.99
X3835	16	1.10	1.11	0.82	1.35	0.66	X4207	16	1.67	1.09	0.97	3.09**	0.02
X3842	176	1.09	1.05	1.07	1.16	0.27	X4230	12	3.52**	2.71	4.22**	3.50	<.01
X3845	9	1.50	1.40	2.35	0.60	0.44	X4231	30	0.96	1.00	1.05	0.83	*0.73*
X3870	142	1.10	1.32	0.98	0.94	0.89	X4233	9	0.75	0.85	0.79	0.65	*0.40*
X3881	109	1.20	1.42*	1.08	1.11	0.27	X4237	79	0.99	1.06	0.92	0.98	*0.84*
X3912	12	1.59	1.63	1.58	1.57	0.20	X4242	158	1.00	0.89	0.92	1.19	0.55
X3941	145	1.08	1.26	0.93	1.04	0.73	X4255	31	0.97	0.85	1.30	0.72	*0.83*
X3950	16	0.80	0.17	1.14	1.02	*0.81*	X4263	27	1.10	1.24	1.24	0.78	0.92
X3955	36	0.86	1.09	0.96	0.54	*0.19*	X4267	32	1.96**	1.19	2.40*	2.56**	<.01

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X4268	10	1.88	0.53	3.24*	1.56	0.05	X5075	9	0.94	0.61	0.97	1.24	0.91
X4282	29	1.40	1.88*	1.17	0.98	0.42	X5085	11	1.99	1.12	2.37	2.50	0.03
X4297	11	1.45	0.86	1.25	2.16	0.14	X5093	12	2.97**	3.00*	4.35*	1.67	0.01
X4330	11	1.81	1.13	3.21*	0.96	0.13	X5094	16	1.21	1.08	1.13	1.42	0.43
X4393	91	1.01	1.05	1.03	0.95	*0.95*	X5115	38	1.28	0.89	1.70	1.22	0.15
X4425	9	1.58	0.69	3.74*	1.28	0.15	X5131	25	1.06	1.00	1.01	1.18	0.72
X4471	14	0.99	0.44	2.15*	0.41	*0.96*	X5135	12	1.43	2.39	0.69	1.34	0.50
X4521	11	0.92	1.54	0.97	0.27	*0.41*	X5145	46	1.18	1.26	1.50	0.84	0.58
X4540	24	1.11	1.32	0.60	1.49	0.58	X5161	49	1.30	1.66*	1.18	1.03	0.36
X4542	83	0.98	0.97	0.94	1.01	*0.89*	X5184	10	3.00**	5.62**	0.90	2.86	0.03
X4548	35	1.25	1.56	1.67	0.52	0.79	X5185	90	1.07	1.32	1.07	0.76	*0.80*
X4599	17	1.02	1.43	0.51	1.15	*0.90*	X5189	9	1.67	0.53	2.66	1.83	0.10
X4622	9	1.27	0.91	1.99	0.85	0.57	X5192	13	0.85	0.58	1.03	0.93	*0.75*
X4668	35	1.27	1.66	0.76	1.37	0.36	X5206	9	0.93	0.64	1.31	0.85	*0.91*
X4697	67	0.99	1.05	1.14	0.82	*0.71*	X5213	28	1.16	0.63	2.32**	0.65	0.53
X4699	9	3.02**	2.53	2.91	3.66	<.01	X5235	11	1.07	2.06	0.71	0.59	*0.66*
X4731	78	1.09	1.15	1.18	0.95	0.75	X5258	11	0.97	1.77	0.51	0.60	*0.51*
X4753	20	1.41	0.70	1.34	2.13*	0.06	X5262	631	1.21**	1.15	1.11	1.36**	<.01
X4779	109	1.18	1.40	1.21	0.91	0.52	X5263	557	1.28**	1.24*	1.24*	1.37**	<.01
X4785	36	1.25	1.65	0.70	1.41	0.37	X5299	255	0.97	0.90	1.06	0.95	*0.81*
X4794	9	2.65*	3.29	2.39	2.39	0.04	X5311	58	1.20	1.46	1.06	1.08	0.44
X4849	16	1.34	2.19*	0.52	1.26	0.61	X5318	11	1.26	1.80	1.75	0.00	*0.96*
X4891	9	1.52	0.48	3.14*	0.64	0.25	X5404	149	1.24*	1.12	1.32	1.27	0.03
X4906	10	1.08	1.02	1.61	0.63	0.97	X5408	31	1.11	1.16	1.15	1.04	0.69
X4918	95	1.09	0.94	1.10	1.23	0.30	X5417	397	1.14	1.07	1.30**	1.07	0.08
X4922	12	1.08	2.06	0.66	0.78	*0.77*	X5421	9	0.96	1.38	1.11	0.35	*0.59*
X4987	75	1.05	0.87	0.90	1.40	0.32	X5427	9	1.19	1.29	0.82	1.42	0.63
X5001	9	1.65	1.20	1.84	1.83	0.16	X5447	164	1.18	1.14	1.28	1.11	0.12
X5029	289	1.14	1.27*	1.02	1.09	0.30	X5459	22	1.08	0.71	1.32	1.25	0.51
X5034	21	1.01	1.19	0.53	1.32	0.91	X5467	29	1.04	0.72	1.00	1.40	0.51
X5037	21	0.92	1.27	0.55	0.96	*0.61*	X5495	34	1.40	1.63	1.40	1.18	0.21
X5044	36	0.95	1.06	0.70	1.08	*0.80*	X5502	182	1.24*	1.21	1.22	1.30	0.02
X5054	33	1.23	1.13	1.08	1.45	0.23	X5503	250	1.07	1.10	1.09	1.02	0.58
X5065	9	1.82	2.16	1.03	2.47	0.14	X5504	20	1.03	0.58	0.90	1.60	0.44
X5067	62	1.38*	1.36	1.66*	1.13	0.06	X5505	32	0.84	0.81	0.96	0.75	*0.36*
X5068	10	1.60	1.93	1.52	1.44	0.27	X5507	10	1.03	0.67	1.46	0.91	0.86
X5071	54	1.37*	1.27	1.67*	1.15	0.07	X5509	52	1.27	1.19	1.45	1.16	0.18

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X5515	89	1.21	1.30	1.21	1.12	0.23	X5892	9	0.97	0.24	1.41	1.63	0.56
X5516	171	1.24*	1.32	1.16	1.23	0.05	X5898	16	0.85	0.97	0.47	1.12	*0.64*
X5518	12	1.72	2.09	1.79	1.15	0.21	X5899	11	1.76	1.70	2.94*	0.55	0.24
X5520	137	1.10	1.44*	1.14	0.76	*0.81*	X5906	233	1.20*	1.16	1.22	1.22	0.03
X5521	21	0.92	0.83	0.45	1.60	0.86	X5907	21	1.10	0.87	1.29	1.17	0.58
X5582	9	1.00	0.74	2.60	0.00	*0.80*	X5911	158	1.07	1.07	0.99	1.15	0.44
X5629	11	1.01	1.65	1.17	0.27	*0.55*	X5915	25	1.29	1.04	1.85	0.89	0.32
X5638	98	1.12	0.99	1.15	1.22	0.23	X5918	30	1.33	1.35	1.39	1.22	0.24
X5654	14	0.87	0.38	0.85	1.44	0.88	X5928	30	1.11	1.35	0.84	1.19	0.73
X5658	24	1.06	0.76	1.10	1.27	0.59	X5930	25	1.33	1.09	1.63	1.17	0.23
X5673	38	1.13	0.80	0.95	1.63	0.20	X5935	16	1.10	0.65	0.95	1.76	0.39
X5683	60	0.99	1.00	1.52*	0.44*	*0.47*	X5940	13	0.92	0.40	1.07	1.33	0.81
X5686	501	1.12	1.21*	1.01	1.15	0.20	X5941	55	0.90	0.98	1.09	0.67	*0.30*
X5689	19	0.96	1.29	0.59	0.98	*0.72*	X5942	17	1.16	0.65	1.12	1.72	0.31
X5690	126	1.13	0.89	1.37	1.13	0.16	X5943	16	1.34	1.01	1.38	1.78	0.19
X5691	9	1.09	0.59	2.53	0.39	0.86	X5945	10	1.15	2.03	0.00	1.29	0.96
X5697	386	1.20**	1.12	1.31**	1.17	0.01	X5946	22	1.09	0.73	1.00	1.60	0.39
X5701	9	1.16	0.69	1.47	1.42	0.51	X5950	424	1.24**	1.34**	1.19	1.19	0.02
X5704	13	1.22	1.21	1.40	1.01	0.61	X5974	18	1.02	0.88	0.85	1.41	0.72
X5710	14	0.85	0.97	0.71	0.89	*0.58*	X5976	182	1.14	0.93	1.25	1.23	0.06
X5711	88	0.93	0.98	0.78	1.04	*0.66*	X5983	138	1.17	1.09	1.29	1.13	0.14
X5714	18	1.22	0.38	1.77	1.66	0.17	X5986	55	1.00	0.66	0.78	1.57*	0.32
X5752	12	1.53	0.36	3.12**	1.20	0.12	X5991	12	1.00	1.22	0.76	1.01	*0.92*
X5757	79	1.16	0.95	1.32	1.19	0.19	X5992	50	1.02	0.69	1.10	1.29	0.47
X5758	239	1.17	0.95	1.34*	1.21	0.02	X5997	39	1.03	1.40	0.99	0.72	*0.68*
X5808	17	1.11	1.28	0.53	1.60	0.62	X6034	14	1.08	0.26	1.32	1.61	0.38
X5811	12	1.07	1.85	0.49	0.84	*0.76*	X6115	83	1.29*	1.56*	1.20	1.10	0.18
X5822	80	1.31*	1.40	1.12	1.45	0.05	X6125	9	1.45	0.45	2.39	1.55	0.20
X5824	15	0.98	1.48	0.63	0.76	*0.61*	X6186	360	1.17*	1.15	1.17	1.18	0.04
X5825	12	1.07	1.77	0.95	0.54	*0.71*	X6191	139	1.10	1.20	1.04	1.06	0.53
X5849	470	1.17*	1.23*	1.16	1.13	0.08	X6205	34	0.85	0.78	0.94	0.82	*0.44*
X5864	83	1.12	1.01	0.87	1.47*	0.17	X6222	141	1.04	0.92	1.07	1.12	0.49
X5873	88	1.03	1.12	0.77	1.16	0.81	X6238	182	1.19	1.00	1.39*	1.17	0.04
X5876	288	1.18*	1.33*	1.11	1.12	0.12	X6246	133	1.10	1.39*	0.94	0.97	0.84
X5886	204	0.96	1.05	0.93	0.91	*0.46*	X6265	10	0.95	0.45	2.26	0.33	*0.91*
X5890	11	0.79	0.73	0.76	0.88	*0.55*	X6289	66	1.37*	1.61*	1.00	1.46	0.06
X5891	15	1.03	1.12	0.88	1.07	0.95	X6293	293	1.17*	1.12	1.23	1.16	0.05

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X6352	28	1.24	0.41	1.50	1.82	0.07	X6502	14	1.14	1.04	1.43	1.00	0.69
X6353	81	1.01	0.99	0.80	1.22	0.72	X6505	9	1.07	0.58	2.45	0.40	0.87
X6358	9	1.57	2.03	0.52	2.23	0.25	X6507	28	1.09	0.94	1.21	1.13	0.61
X6360	46	1.04	1.06	1.09	0.95	0.92	X6517	16	1.29	1.14	0.96	1.82	0.25
X6362	20	1.08	0.50	1.15	1.60	0.35	X6518	11	1.05	1.83	0.26	0.95	*0.74*
X6363	40	1.10	0.82	1.27	1.26	0.37	X6523	16	1.09	1.40	0.68	1.25	0.86
X6366	29	1.20	0.90	1.13	1.59	0.21	X6524	13	1.24	1.21	1.48	1.01	0.57
X6367	40	1.21	1.17	1.36	1.08	0.36	X6525	16	1.09	1.40	0.68	1.25	0.86
X6368	51	1.26	1.22	1.18	1.40	0.14	X6526	13	1.25	0.95	1.93	0.98	0.46
X6371	9	2.06	1.72	1.20	3.82*	0.03	X6527	9	1.09	0.68	1.00	1.74	0.53
X6372	17	1.05	0.79	1.74	0.65	0.89	X6528	18	1.12	1.54	0.48	1.45	0.74
X6373	15	1.11	0.65	0.85	1.96	0.35	X6529	24	1.11	1.22	1.08	0.99	0.79
X6374	14	1.03	0.65	0.85	1.71	0.54	X6536	13	1.14	0.79	1.46	1.16	0.56
X6376	24	1.19	0.85	1.45	1.19	0.37	X6537	17	1.25	0.58	1.62	1.71	0.17
X6377	19	1.19	0.59	1.31	1.66	0.24	X6538	11	1.39	0.76	1.10	2.37	0.14
X6379	9	1.81	2.04	0.75	2.43	0.13	X6539	25	0.81	1.08	1.15	0.27*	*0.11*
X6382	188	1.09	1.09	1.18	1.00	0.50	X6540	14	1.17	1.07	1.34	1.13	0.60
X6386	18	1.12	0.58	1.26	1.53	0.37	X6542	16	1.09	1.33	0.91	1.00	0.93
X6388	18	1.15	0.54	1.08	1.90	0.22	X6543	13	1.24	1.18	0.70	2.10	0.32
X6391	22	1.29	0.71	1.27	1.89	0.11	X6551	18	1.29	0.40	1.99	1.61	0.13
X6393	86	1.26	1.51*	1.14	1.11	0.21	X6557	15	1.30	1.05	1.69	1.20	0.36
X6396	22	1.19	0.68	1.11	1.81	0.20	X6559	9	1.07	0.53	2.55	0.42	0.81
X6407	60	0.95	0.98	0.90	0.94	*0.67*	X6564	14	1.21	0.85	1.76	1.15	0.44
X6423	17	0.67	0.88	0.52	0.63	*0.10*	X6567	12	1.09	1.11	1.46	0.73	0.95
X6430	399	1.25**	1.33**	1.22	1.19	0.02	X6569	11	1.45	0.86	1.25	2.16	0.14
X6432	44	1.22	1.11	1.19	1.36	0.20	X6572	68	1.27	1.24	1.32	1.25	0.11
X6434	13	1.03	1.58	0.25	1.22	*0.91*	X6582	14	1.18	0.93	1.26	1.40	0.45
X6449	16	1.22	1.78	0.58	1.42	0.62	X6583	9	1.49	1.28	3.37*	0.58	0.42
X6456	38	0.86	0.98	0.88	0.72	*0.30*	X6586	12	0.81	0.87	0.86	0.70	*0.46*
X6463	124	1.05	0.98	0.92	1.22	0.43	X6588	26	1.14	0.86	1.51	1.02	0.51
X6468	12	0.81	0.23	1.07	1.02	*0.81*	X6596	88	1.07	0.93	0.87	1.40	0.27
X6472	12	0.82	1.13	0.60	0.71	*0.41*	X6597	34	1.43	1.51	1.56	1.20	0.14
X6475	106	1.11	1.52**	0.96	0.80	*0.81*	X6599	45	1.12	1.38	1.45	0.56	*0.94*
X6492	12	1.13	0.77	1.78	0.90	0.66	X6602	45	1.12	1.28	0.92	1.19	0.57
X6493	448	1.20**	1.25*	1.20	1.15	0.04	X6603	353	1.16*	1.20	1.13	1.17	0.07
X6494	34	1.15	0.70	2.22**	0.61	0.53	X6619	388	1.10	1.06	1.14	1.10	0.19
X6499	623	1.21**	1.15	1.18	1.29**	<.01	X6620	235	1.11	1.10	1.05	1.17	0.19

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X6624	179	1.13	1.09	0.99	1.29	0.12	X6903	13	0.93	0.56	0.67	1.62	0.74
X6628	106	1.21	1.48*	1.11	1.03	0.34	X6904	9	1.33	1.78	1.34	0.87	0.70
X6629	470	1.11	1.11	1.06	1.14	0.15	X6905	14	1.03	0.59	1.12	1.45	0.57
X6648	41	1.30	1.06	1.77*	1.09	0.15	X6911	177	1.14	1.22	1.09	1.10	0.28
X6652	15	0.99	1.28	0.53	1.21	*0.95*	X6912	83	1.29*	1.56*	1.20	1.10	0.18
X6658	10	0.75	0.75	0.23	1.26	*0.62*	X6913	33	0.90	0.81	0.96	0.90	*0.64*
X6663	28	1.06	1.05	1.25	0.86	0.89	X6921	56	1.18	1.15	1.04	1.36	0.22
X6678	99	1.29*	1.23	1.29	1.35	0.03	X6953	25	1.19	1.76	0.46	1.32	0.66
X6693	551	1.21**	1.34**	1.19	1.10	0.12	X6966	19	1.29	0.82	2.51**	0.58	0.44
X6695	12	0.98	0.90	1.00	1.05	0.98	X6967	32	0.83	1.07	0.42	0.71	*0.19*
X6732	15	1.09	0.59	1.04	1.87	0.37	X6970	366	1.12	1.11	1.23	1.01	0.27
X6749	14	1.03	0.59	1.12	1.45	0.57	X6990	51	1.18	0.74	1.53	1.23	0.17
X6756	39	1.13	1.12	1.44	0.84	0.71	X6998	12	1.18	1.61	1.37	0.36	*0.99*
X6757	10	1.01	2.18	0.46	0.65	*0.55*	X7020	149	1.21	1.17	1.19	1.27	0.05
X6765	12	1.00	0.54	0.55	2.36	0.46	X7030	13	2.03*	2.86*	2.75*	0.48	0.18
X6766	17	0.94	1.54	0.55	0.61	*0.39*	X7040	13	0.76	1.13	0.58	0.52	*0.21*
X6767	14	1.26	1.40	0.98	1.45	0.46	X7044	9	2.02	1.35	3.46*	1.32	0.09
X6769	58	1.07	1.00	1.11	1.11	0.58	X7080	329	1.20*	1.35**	1.12	1.13	0.09
X6773	24	1.08	0.65	1.50	1.14	0.52	X7092	10	1.05	0.70	1.50	0.91	0.83
X6777	14	0.93	1.01	0.90	0.88	*0.76*	X7100	12	1.07	0.51	1.57	1.16	0.61
X6785	38	1.35	1.76	1.34	0.97	0.34	X7108	34	1.20	1.05	1.07	1.46	0.24
X6786	80	1.13	1.25	1.06	1.06	0.53	X7123	22	0.92	0.74	0.93	1.09	*0.93*
X6791	22	1.40	1.90	0.96	1.29	0.33	X7128	58	1.03	0.99	1.16	0.99	0.86
X6800	432	1.17*	1.14	1.07	1.31**	<.01	X7153	10	1.99	1.89	2.78	1.26	0.11
X6801	9	0.87	2.34	0.56	0.00	*0.15*	X7157	25	1.39	1.60	1.22	1.33	0.24
X6804	288	1.12	1.11	0.99	1.25*	0.09	X7161	9	1.25	2.46	0.75	0.75	*0.98*
X6806	13	1.30	1.40	1.02	1.58	0.40	X7163	12	1.08	1.72	0.60	0.79	*0.80*
X6819	52	1.34	1.13	1.27	1.62	0.03	X7203	316	1.21**	1.23	1.24	1.18	0.02
X6858	9	1.31	1.68	1.46	0.81	0.74	X7204	156	1.12	0.92	1.26	1.19	0.12
X6859	26	1.03	0.80	1.58	0.72	0.99	X7211	47	0.89	0.76	0.97	0.94	*0.64*
X6864	11	1.67	1.84	1.51	1.65	0.18	X7233	12	1.12	1.09	1.17	1.08	0.76
X6874	24	0.68	0.94	0.60	0.51	*0.05*	X7255	234	1.14	1.15	1.11	1.16	0.15
X6880	20	0.88	0.64	0.52	1.50	0.93	X7312	139	1.21	1.31	1.17	1.14	0.15
X6881	89	1.12	1.09	0.91	1.35	0.24	X7313	543	1.21**	1.18	1.20	1.24*	<.01
X6891	15	0.73	1.27	0.49	0.48	*0.12*	X7314	41	0.97	0.72	0.92	1.25	0.75
X6895	9	1.33	1.78	1.34	0.87	0.70	X7315	52	1.23	1.67*	1.08	0.96	0.54
X6898	52	0.96	0.99	1.17	0.78	*0.61*	X7316	179	1.10	1.17	1.08	1.04	0.50

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X7320	48	1.09	1.19	1.07	1.03	0.72	X7648	18	1.12	0.76	0.86	1.83	0.35
X7327	214	1.13	1.34*	1.17	0.89	0.66	X7651	50	1.23	1.31	0.99	1.40	0.20
X7328	147	1.22*	1.22	1.27	1.17	0.08	X7669	459	1.10	1.06	1.09	1.15	0.13
X7348	58	1.16	1.09	1.41	0.97	0.44	X7885	56	1.18	0.90	1.38	1.25	0.18
X7385	39	1.30	1.06	1.37	1.45	0.11	X7911	19	1.07	0.77	1.10	1.37	0.52
X7390	9	0.84	0.39	2.74	0.52	*0.78*	X7917	25	1.22	1.61	1.45	0.60	0.82
X7393	9	0.84	0.39	2.74	0.52	*0.78*	X7937	47	1.14	1.53	1.03	0.88	0.87
X7397	147	1.09	0.99	1.35*	0.94	0.50	X7942	181	1.15	1.20	1.14	1.11	0.21
X7407	19	1.07	1.97	0.83	0.57	*0.58*	X7949	16	1.31	0.78	1.45	1.66	0.20
X7411	11	2.34*	2.55	2.29	2.24	0.03	X7972	10	1.38	1.45	1.96	0.76	0.55
X7422	16	0.89	0.78	1.02	0.88	*0.74*	X7988	24	0.80	0.72	0.58	1.12	*0.54*
X7432	99	1.10	1.07	1.14	1.08	0.44	X7989	38	0.95	0.53	0.79	1.56	0.52
X7433	29	1.06	1.54	0.11*	1.46	0.88	X7990	11	1.07	1.01	0.35	1.78	0.60
X7440	9	0.87	0.77	1.34	0.56	*0.64*	X8158	127	1.07	1.26	0.89	1.06	0.76
X7442	318	1.16*	1.22	1.19	1.09	0.13	X8176	13	0.72	1.19	0.36	0.51	*0.13*
X7443	220	1.20*	1.17	1.35*	1.09	0.07	X8178	21	1.22	0.99	1.81	0.95	0.46
X7445	308	1.14	1.15	1.01	1.27*	0.05	X8187	10	1.01	2.18	0.46	0.65	*0.55*
X7456	13	0.74	0.55	1.04	0.62	*0.36*	X8191	21	0.85	1.34	0.60	0.54	*0.20*
X7465	230	1.04	1.16	0.99	0.96	*0.95*	X8193	19	1.15	1.50	0.72	1.17	0.77
X7480	37	1.33	0.84	1.71	1.37	0.08	X8195	13	0.91	1.73	0.66	0.44	*0.34*
X7486	52	0.96	0.99	1.17	0.78	*0.61*	X8196	13	0.92	1.85	0.64	0.45	*0.36*
X7507	411	1.23**	1.13	1.33**	1.22*	<.01	X8203	57	1.03	0.86	1.22	1.00	0.75
X7514	18	1.06	1.01	1.58	0.62	1.00	X8206	11	1.34	0.88	1.67	1.37	0.34
X7515	41	1.12	1.10	1.25	0.99	0.62	X8232	13	0.95	1.47	0.40	0.98	*0.66*
X7516	252	1.17	1.22	1.05	1.22	0.08	X8237	15	0.97	0.90	0.81	1.19	0.96
X7540	18	0.74	1.62	0.13*	0.47	*0.05*	X8241	62	1.06	1.33	0.86	0.98	*0.97*
X7544	14	1.00	0.95	1.23	0.85	*0.96*	X8247	26	0.78	1.11	0.81	0.40	*0.09*
X7556	16	0.95	0.91	0.49	1.48	0.88	X8248	21	0.85	0.60	1.07	0.88	*0.65*
X7578	11	1.41	2.32	0.78	1.14	0.62	X8251	14	1.12	1.94	0.80	0.72	*0.82*
X7579	15	1.38	1.02	2.54*	0.93	0.34	X8256	83	1.04	1.05	1.15	0.94	0.86
X7592	14	1.03	0.59	1.12	1.45	0.57	X8257	26	0.80	0.86	1.08	0.41	*0.18*
X7610	380	1.11	1.21	1.13	1.00	0.47	X8258	68	1.00	1.11	1.08	0.82	*0.70*
X7611	168	1.27*	1.67**	1.33	0.83	0.34	X8261	12	1.08	2.26	0.43	0.82	*0.71*
X7620	336	1.24**	1.12	1.34**	1.26*	<.01	X8264	35	0.95	1.42	0.71	0.73	*0.40*
X7621	172	1.03	0.96	1.09	1.02	0.72	X8267	13	1.02	1.89	0.46	0.69	*0.57*
X7639	85	1.24	1.49*	1.15	1.06	0.30	X8272	76	1.31*	1.14	1.30	1.52	0.02
X7643	361	1.22**	1.45**	1.08	1.14	0.08	X8286	201	1.13	1.25	1.00	1.13	0.31

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X8287	151	1.22*	1.50**	1.21	0.93	0.36	X8654	73	1.00	0.94	1.26	0.80	*0.84*
X8299	73	1.03	1.17	0.94	0.96	*0.95*	X8656	28	1.24	1.25	1.00	1.48	0.28
X8309	184	1.09	1.16	1.25	0.88	0.70	X8658	283	1.20*	1.06	1.41**	1.13	0.02
X8317	95	0.96	1.15	1.09	0.66	*0.30*	X8708	14	1.32	2.03	1.11	0.93	0.67
X8319	22	1.26	1.39	1.29	1.10	0.45	X8711	9	0.45*	0.67	0.40	0.19	*0.02*
X8321	9	1.25	0.76	1.74	1.34	0.43	X8712	59	0.99	0.98	1.11	0.92	*0.90*
X8322	10	0.76	0.26	0.60	1.43	*0.86*	X8713	60	0.95	0.96	0.96	0.91	*0.67*
X8335	75	1.37*	1.26	1.26	1.60*	0.01	X8716	11	1.31	1.16	1.15	1.70	0.35
X8345	134	1.08	1.02	1.03	1.20	0.32	X8741	11	1.10	1.20	0.98	1.10	0.83
X8350	81	1.04	0.93	1.12	1.06	0.65	X8742	90	1.22	1.30	1.49*	0.88	0.33
X8532	309	1.18*	1.13	1.24	1.18	0.03	X8745	12	1.13	0.51	0.71	2.16	0.26
X8533	388	1.09	1.17	1.12	1.00	0.55	X8749	82	1.00	0.99	1.05	0.96	*0.95*
X8536	164	1.11	1.19	0.88	1.26	0.25	X8750	15	1.59	1.51	2.13	1.20	0.18
X8545	9	1.35	1.89	0.95	1.23	0.60	X8752	11	1.05	1.20	0.85	1.11	0.92
X8553	397	1.11	1.12	0.96	1.23*	0.10	X8793	52	0.92	0.99	1.13	0.71	*0.40*
X8559	62	0.91	0.96	1.07	0.72	*0.34*	X8798	14	1.13	1.63	0.92	0.91	0.96
X8563	9	1.26	1.65	2.17	0.00	*0.96*	X8833	11	1.12	0.93	1.32	1.12	0.69
X8564	20	1.46	1.45	1.30	1.62	0.15	X8843	11	1.07	0.92	1.19	1.11	0.78
X8569	72	1.04	0.98	0.79	1.34	0.48	X8859	10	0.75	0.26	0.62	1.28	*0.77*
X8570	87	1.17	1.03	1.33	1.17	0.18	X8862	230	1.21*	1.31*	1.13	1.17	0.08
X8571	423	1.17*	1.05	1.32**	1.13	0.03	X8864	156	1.11	1.35*	0.95	1.02	0.69
X8573	89	1.17	1.16	1.35	0.98	0.32	X8865	41	1.13	1.19	1.03	1.16	0.55
X8574	146	1.13	1.02	1.32	1.06	0.23	X8866	24	0.84	0.71	0.93	0.90	*0.57*
X8577	9	1.10	1.26	0.73	1.36	0.80	X8867	149	1.29*	1.47*	1.10	1.30	0.03
X8582	44	0.79	1.03	0.81	0.56	*0.07*	X8868	372	1.25**	1.37**	1.10	1.28*	<.01
X8583	213	1.06	0.98	1.10	1.10	0.39	X8923	14	1.38	0.83	1.56	1.80	0.16
X8585	18	2.03**	3.59**	0.70	1.98	0.06	X8962	25	1.37	1.35	1.74	0.95	0.28
X8586	12	1.13	0.51	0.71	2.16	0.26	X8963	84	1.09	1.18	1.00	1.08	0.61
X8593	60	0.95	1.01	0.87	0.94	*0.65*	X8964	73	1.04	1.13	1.14	0.84	*0.88*
X8594	13	1.14	1.06	1.30	1.05	0.70	X8975	24	0.78	0.20*	1.04	1.09	*0.75*
X8596	14	1.12	1.00	1.40	0.93	0.76	X8978	93	0.97	0.90	0.89	1.10	0.98
X8645	173	1.17	1.39*	1.08	1.03	0.36	X8981	175	1.06	0.84	1.23	1.10	0.29
X8646	71	0.98	0.96	0.95	1.04	*0.98*	X8982	27	1.00	1.29	0.97	0.78	*0.72*
X8647	21	1.07	0.83	1.18	1.21	0.62	X8987	334	1.25**	1.20	1.20	1.35**	<.01
X8648	20	1.00	0.93	0.95	1.13	0.91	X8988	44	1.20	0.84	1.83*	0.90	0.31
X8651	50	1.13	0.81	1.18	1.44	0.19	X8993	15	1.63	0.89	2.75*	1.34	0.08
X8652	45	0.91	1.04	0.66	1.07	*0.63*	X8996	294	1.19*	1.25	1.08	1.23	0.04

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X9001	52	1.19	1.24	1.23	1.09	0.38	X9100	11	1.05	1.83	0.26	0.95	*0.74*
X9011	13	1.49	1.02	1.55	1.86	0.14	X9101	9	1.32	0.75	4.12**	0.00	0.68
X9012	24	1.22	1.52	0.69	1.54	0.40	X9102	12	1.07	1.80	0.22	1.30	*0.93*
X9014	13	0.99	0.87	1.02	1.04	0.98	X9106	11	1.05	1.83	0.26	0.95	*0.74*
X9015	20	1.28	0.63	1.91	1.26	0.22	X9107	12	1.07	1.87	0.91	0.54	*0.69*
X9018	224	0.94	1.10	0.97	0.76*	*0.12*	X9126	358	1.11	0.92	1.26*	1.15	0.05
X9019	16	1.20	0.71	2.15*	0.68	0.56	X9133	9	0.86	1.14	0.79	0.63	*0.53*
X9021	87	1.21	1.22	1.05	1.34	0.12	X9143	10	2.30*	2.11	3.91*	0.73	0.08
X9022	99	1.05	0.96	1.03	1.17	0.47	X9153	132	1.04	0.90	1.12	1.11	0.46
X9023	199	1.10	1.12	1.05	1.13	0.30	X9181	274	1.16	1.23	1.20	1.06	0.17
X9024	374	1.11	1.19	1.24*	0.92	0.58	X9182	12	1.17	1.08	1.62	0.72	0.73
X9025	61	0.93	1.06	1.00	0.71	*0.33*	X9188	153	1.11	1.01	1.17	1.13	0.24
X9027	72	0.98	1.05	1.01	0.86	*0.68*	X9191	9	2.96**	1.22	5.07**	1.33	0.01
X9028	152	1.11	1.33*	0.95	1.01	0.70	X9196	12	1.13	0.51	0.71	2.16	0.26
X9029	160	1.06	0.82	1.31	1.06	0.31	X9197	15	1.00	0.63	1.17	1.20	0.76
X9030	191	1.21*	1.23	1.17	1.22	0.05	X9199	15	1.13	0.47	1.32	1.58	0.35
X9031	50	1.36	0.90	1.95**	1.26	0.04	X9200	84	1.11	1.37	0.84	1.16	0.60
X9032	68	0.98	1.05	1.08	0.82	*0.65*	X9201	12	0.98	0.27	0.81	1.69	0.54
X9035	71	0.99	1.20	0.78	0.93	*0.64*	X9202	33	0.98	1.40	0.77	0.81	*0.56*
X9036	16	1.15	1.73	0.66	1.05	0.91	X9203	25	1.41	1.57	1.58	1.00	0.27
X9045	20	1.10	1.86	0.52	1.05	*0.97*	X9216	25	1.32	1.00	1.48	1.47	0.16
X9052	71	0.99	1.22	0.78	0.93	*0.65*	X9217	351	1.20**	1.30*	1.18	1.13	0.06
X9053	71	0.98	1.22	0.78	0.90	*0.58*	X9218	38	1.06	0.82	1.04	1.35	0.45
X9059	69	1.01	1.19	0.86	0.92	*0.74*	X9244	23	1.35	2.00	1.35	0.80	0.58
X9062	26	1.22	0.66	2.27**	0.92	0.31	X9248	132	1.21	1.37	1.25	1.02	0.25
X9071	38	1.15	1.05	1.26	1.13	0.44	X9249	276	1.15	1.33*	0.92	1.20	0.18
X9073	9	0.66	0.66	0.29	0.96	*0.36*	X9252	13	0.90	0.47	1.29	0.87	*0.91*
X9075	14	1.25	1.33	1.08	1.33	0.49	X9256	239	1.24**	1.20	1.16	1.34*	<.01
X9076	69	1.00	0.97	1.03	0.99	1.00	X9258	371	1.13	1.18	1.03	1.19	0.11
X9078	397	1.27**	1.11	1.30*	1.39**	<.01	X9259	158	1.13	1.09	1.01	1.28	0.14
X9079	291	1.22**	1.20	1.28*	1.17	0.02	X9260	249	1.02	1.10	0.98	0.99	*0.98*
X9081	43	1.07	1.16	1.06	0.99	0.85	X9266	18	1.03	1.64	1.28	0.29	*0.46*
X9082	31	1.43	0.75	1.67	1.84	0.03	X9270	39	1.07	1.00	1.03	1.20	0.59
X9085	9	1.06	1.69	1.00	0.61	*0.77*	X9271	153	1.15	1.19	1.23	1.03	0.29
X9088	148	1.02	0.92	1.11	1.04	0.67	X9273	137	1.13	1.22	1.14	1.05	0.39
X9092	235	1.14	1.27	1.03	1.12	0.25	X9275	118	1.11	1.04	1.29	1.02	0.37
X9093	34	1.11	0.83	1.21	1.29	0.40	X9277	9	1.70	1.28	0.48	3.61*	0.06

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X9279	9	1.70	1.28	0.48	3.61*	0.06	X9391	128	1.10	1.01	1.35	0.95	0.47
X9284	182	1.17	1.17	1.22	1.11	0.14	X9394	13	0.99	1.75	0.00	0.94	*0.58*
X9285	22	0.81	1.10	0.56	0.80	*0.30*	X9397	72	1.04	0.91	1.02	1.21	0.50
X9286	29	1.11	0.96	1.55	0.81	0.72	X9398	15	1.44	1.73	0.33	2.10	0.21
X9287	43	0.93	1.05	0.89	0.86	*0.58*	X9399	21	0.68	0.89	0.58	0.60	*0.08*
X9288	286	1.12	1.22	1.14	1.00	0.42	X9401	14	1.22	1.80	1.44	0.46	*0.95*
X9289	20	1.26	0.87	1.34	1.59	0.21	X9402	13	1.11	1.60	1.07	0.56	*0.83*
X9290	55	1.35	1.72*	1.30	1.02	0.23	X9403	50	1.20	0.96	1.34	1.27	0.18
X9291	21	1.06	1.29	0.98	0.86	*0.93*	X9407	9	1.26	1.65	2.17	0.00	*0.96*
X9293	164	1.13	0.96	1.34*	1.09	0.16	X9411	106	1.14	1.24	1.16	1.02	0.44
X9296	573	1.26**	1.25*	1.31**	1.21*	<.01	X9412	171	1.17	1.40*	1.18	0.95	0.42
X9298	20	0.77	0.89	0.85	0.61	*0.24*	X9414	18	1.23	0.75	1.34	1.68	0.23
X9300	122	1.16	1.26	1.05	1.17	0.25	X9417	44	1.31	1.36	1.14	1.44	0.13
X9305	146	1.23*	1.45*	1.11	1.15	0.14	X9423	63	0.88	0.99	0.95	0.71	*0.22*
X9316	248	1.09	1.01	1.21	1.06	0.25	X9424	12	1.13	0.51	0.71	2.16	0.26
X9321	64	1.02	1.12	0.90	1.04	0.98	X9435	13	1.12	0.52	1.57	1.23	0.50
X9322	9	0.94	0.90	1.20	0.68	*0.80*	X9437	388	1.21**	1.18	1.27*	1.17	0.02
X9323	72	0.99	0.85	1.25	0.86	*0.93*	X9444	20	1.28	0.81	1.46	1.70	0.16
X9326	72	0.99	0.85	1.25	0.86	*0.93*	X9446	48	1.17	0.86	1.66*	0.96	0.32
X9327	18	1.01	1.53	1.07	0.47	*0.52*	X9447	17	0.81	0.74	0.93	0.76	*0.46*
X9328	226	1.11	1.11	1.13	1.09	0.25	X9448	17	0.81	0.74	0.93	0.76	*0.46*
X9332	18	1.01	0.52	1.41	1.11	0.71	X9454	136	1.07	0.83	1.27	1.09	0.32
X9333	262	1.31**	1.19	1.50**	1.25	<.01	X9455	118	1.17	1.11	1.19	1.21	0.14
X9336	95	1.04	1.22	1.03	0.88	*0.86*	X9462	74	1.08	1.10	1.04	1.10	0.59
X9343	60	1.17	1.52	1.09	0.94	0.64	X9464	170	1.12	1.06	1.06	1.23	0.16
X9347	46	1.13	1.15	1.34	0.90	0.67	X9465	17	0.89	0.90	1.04	0.79	*0.65*
X9350	24	1.24	1.08	1.18	1.43	0.28	X9466	29	1.26	0.96	1.40	1.46	0.17
X9352	217	1.12	1.28	1.04	1.05	0.45	X9472	70	1.27	1.24	1.05	1.54*	0.06
X9363	53	1.15	1.00	1.36	1.07	0.37	X9474	18	0.66	0.60	1.04	0.27	*0.08*
X9364	157	1.08	0.93	1.26	1.03	0.39	X9475	12	1.10	0.29	1.14	2.00	0.34
X9365	110	1.11	1.28	0.97	1.07	0.60	X9481	15	1.24	1.55	1.32	0.95	0.68
X9374	11	1.37	0.90	1.64	1.74	0.23	X9489	14	1.15	0.49	0.93	2.11	0.23
X9375	179	1.10	0.96	1.19	1.14	0.19	X9502	23	1.06	0.96	0.93	1.33	0.63
X9380	45	1.38	1.18	1.36	1.64	0.04	X9503	9	1.17	0.88	2.23	0.48	0.75
X9383	33	1.22	1.01	1.28	1.37	0.23	X9504	60	1.27	1.52	1.50	0.80	0.40
X9385	24	1.41	1.46	1.12	1.57	0.16	X9515	68	1.20	1.41	1.18	1.01	0.44
X9390	9	0.75	0.52	0.68	1.09	*0.65*	X9516	50	1.23	1.50	1.23	0.95	0.50

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X9518	45	1.21	0.98	1.51	1.23	0.20	X9686	34	1.50*	2.11*	0.89	1.44	0.14
X9521	15	0.60	0.66	0.78	0.30	*0.05*	X9687	30	1.10	1.00	1.57	0.75	0.81
X9531	149	1.06	1.49**	1.02	0.67*	*0.36*	X9689	18	1.10	0.54	1.42	1.37	0.42
X9536	12	0.74	0.24	0.82	1.05	*0.63*	X9692	348	1.15	1.10	1.20	1.14	0.07
X9541	31	1.39	1.40	1.42	1.36	0.14	X9701	9	0.94	0.88	0.33	1.63	0.88
X9542	22	1.17	0.80	1.57	1.13	0.42	X9719	214	1.07	1.03	1.09	1.10	0.37
X9547	10	0.84	1.12	0.55	0.79	*0.50*	X9722	201	1.31**	1.35*	1.46**	1.14	0.01
X9564	10	1.33	0.00	1.78	2.64	0.11	X9730	28	0.97	0.94	1.34	0.65	*0.70*
X9566	38	1.08	1.11	1.15	0.97	0.80	X9731	10	1.01	2.18	0.46	0.65	*0.55*
X9571	12	1.33	1.06	1.44	1.49	0.33	X9773	12	1.13	0.51	0.71	2.16	0.26
X9572	14	1.16	1.03	1.24	1.21	0.57	X9777	12	1.13	0.51	0.71	2.16	0.26
X9574	14	1.11	0.25	0.71	2.39*	0.19	X9786	73	0.99	1.05	0.90	1.02	*0.91*
X9576	39	0.92	0.97	0.87	0.93	*0.63*	X9788	12	0.87	1.40	0.66	0.46	*0.34*
X9578	74	1.04	0.95	0.77	1.38	0.43	X9791	65	1.12	1.07	1.08	1.21	0.38
X9582	18	1.13	0.63	1.11	1.58	0.37	X9792	32	1.23	1.60	1.05	1.00	0.59
X9588	11	1.08	0.58	1.13	1.54	0.53	X9795	18	1.49	1.89	1.78	0.98	0.35
X9593	77	0.93	0.94	0.78	1.05	*0.69*	X9797	35	0.88	0.79	1.11	0.76	*0.51*
X9597	49	1.23	1.58	1.54	0.63	0.74	X9800	32	1.07	1.60	0.82	0.79	*0.76*
X9601	14	1.17	0.65	1.04	2.07	0.27	X9801	251	1.15	1.23	1.03	1.19	0.14
X9602	45	1.12	1.15	1.01	1.21	0.51	X9845	55	1.31	1.58	1.07	1.29	0.17
X9604	16	1.35	1.83	1.09	1.15	0.50	X9854	39	0.92	0.52	1.08	1.22	0.78
X9605	25	0.88	1.01	0.64	0.99	*0.58*	X9857	10	0.60	0.39	0.61	0.81	*0.24*
X9606	109	1.14	1.04	1.17	1.21	0.19	X9875	15	1.12	0.51	1.53	1.24	0.49
X9607	86	1.01	0.86	1.04	1.12	0.69	X9878	179	1.05	1.04	0.94	1.17	0.43
X9610	16	0.81	0.36	1.69	0.71	*0.67*	X9879	100	1.01	1.01	0.93	1.07	0.90
X9620	48	1.33	1.50	1.30	1.19	0.17	X9880	170	1.27*	1.08	1.59**	1.11	0.02
X9623	21	1.16	1.13	1.23	1.12	0.58	X9881	156	1.14	0.98	1.15	1.28	0.07
X9628	138	1.08	0.92	1.16	1.17	0.26	X9891	10	0.75	0.75	1.07	0.43	*0.34*
X9638	99	1.20	1.08	1.13	1.39	0.07	X9893	193	1.33**	1.29	1.58**	1.13	<.01
X9641	16	1.14	2.41*	0.44	0.72	*0.69*	X9894	175	1.38**	1.47**	1.62**	1.06	0.01
X9643	20	1.26	0.59	1.99	1.60	0.14	X9895	160	1.40**	1.42*	1.61**	1.18	<.01
X9646	60	1.32	1.41	1.62*	0.91	0.20	X9898	70	1.54**	1.97**	1.57*	1.09	0.03
X9649	9	0.97	0.69	0.65	1.51	0.79	X9902	73	1.13	1.28	0.85	1.27	0.41
X9652	81	1.17	0.86	1.63**	0.98	0.22	X9903	43	0.77	0.84	0.95	0.53	*0.07*
X9656	47	1.27	1.41	1.16	1.25	0.24	X9912	25	1.41	1.57	1.58	1.00	0.27
X9666	14	1.09	1.81	0.63	1.03	*0.97*	X9914	26	1.05	1.02	0.86	1.26	0.71
X9685	96	1.35*	1.48	1.19	1.39	0.03	X9916	146	1.14	1.07	1.27	1.10	0.19

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
X9918	93	1.10	1.26	1.04	1.02	0.65	Y1006	25	3.11**	2.70**	2.46	4.12**	<.01
X9920	173	1.31**	1.06	1.26	1.61**	<.01	Y1012	124	1.03	0.90	1.18	1.02	0.63
X9921	12	1.51	2.29	1.32	1.09	0.43	Y1013	236	1.27**	1.21	1.52**	1.09	0.01
X9922	78	1.24	1.19	1.23	1.30	0.10	Y1014	489	1.22**	1.20	1.24*	1.23*	<.01
X9923	11	2.41*	3.20*	0.73	3.04	0.03	Y1016	479	1.19*	1.37**	1.13	1.08	0.20
X9925	20	1.25	2.14*	1.06	0.69	0.95	Y1018	66	1.05	1.13	1.09	0.93	0.92
X9926	11	1.13	0.97	1.28	1.15	0.67	Y1019	237	1.26**	1.20	1.56**	1.05	0.02
X9927	14	1.13	1.01	1.34	1.00	0.71	Y1020	609	1.23**	1.20	1.21*	1.28**	<.01
X9928	12	1.07	1.36	0.84	1.00	0.99	Y1022	215	1.27**	1.12	1.12	1.58**	<.01
X9929	13	1.11	0.76	1.42	1.18	0.60	Y1023	63	0.94	0.96	1.07	0.82	*0.57*
X9930	11	1.14	0.95	1.33	1.15	0.66	Y1024	280	1.15	1.38**	1.01	1.05	0.42
X9933	10	1.11	0.36	1.74	1.12	0.56	Y1026	234	1.28**	1.31*	1.39**	1.15	0.01
X9934	84	1.07	1.22	1.11	0.89	0.93	Y1028	22	0.92	1.41	0.82	0.59	*0.38*
X9936	116	0.99	1.00	0.82	1.14	0.91	Y1030	317	1.23**	1.25	1.16	1.28*	0.01
X9937	43	1.04	0.56	0.85	1.76*	0.20	Y1032	72	0.98	1.19	0.79	0.92	*0.60*
X9940	17	0.64	0.72	0.54	0.68	*0.11*	Y1034	275	1.18*	1.25	1.18	1.11	0.10
X9941	157	1.08	1.02	1.22	1.00	0.48	Y1036	15	1.15	0.64	1.47	1.41	0.40
X9944	19	0.99	0.99	0.98	0.99	*0.96*	Y1037	300	1.17*	1.22	1.20	1.08	0.13
X9945	9	1.63	2.64	1.06	1.39	0.38	Y1038	191	1.16	1.23	1.22	1.04	0.23
X9946	26	0.88	1.19	0.64	0.84	*0.41*	Y1040	510	1.17*	1.05	1.15	1.32**	<.01
X9947	261	1.10	1.03	1.14	1.13	0.17	Y1041	29	1.37	0.70	1.79	1.63	0.05
X9948	99	1.02	1.04	0.98	1.04	0.87	Y1042	461	1.26**	1.33**	1.15	1.29*	<.01
X9949	203	1.07	1.01	1.02	1.18	0.28	Y1043	203	1.28**	1.66**	0.99	1.19	0.08
X9950	27	1.24	1.01	1.24	1.45	0.24	Y1044	157	1.12	1.12	1.24	1.00	0.39
X9952	36	1.29	1.11	1.83*	0.94	0.25	Y1045	26	1.01	1.45	1.02	0.58	*0.56*
X9953	23	1.04	0.65	1.23	1.28	0.56	Y1046	234	1.27**	1.19	1.12	1.51**	<.01
X9956	19	1.04	0.47	1.14	1.56	0.41	Y1047	260	1.21*	1.18	1.23	1.21	0.02
X9958	92	1.31*	1.29	1.11	1.52*	0.02	Y1049	17	1.01	0.53	1.07	1.47	0.57
X9962	9	0.97	1.37	1.52	0.00	*0.49*	Y1050	269	1.16	0.92	1.39**	1.17	0.02
X9971	49	1.26	1.62*	1.15	0.99	0.44	Y1051	444	1.21**	1.21	1.29**	1.14	0.02
X9975	135	1.09	1.23	1.04	0.98	0.74	Y1053	149	1.12	1.01	1.20	1.15	0.19
X9977	102	1.31*	1.48*	1.30	1.14	0.08	Y1054	179	1.09	0.90	1.04	1.34*	0.09
X9978	12	1.08	2.09	0.53	0.72	*0.70*	Y1055	52	0.96	0.99	1.17	0.78	*0.61*
X9984	74	1.01	1.24	0.83	0.97	*0.82*	Y1056	154	1.16	0.91	1.32	1.24	0.05
XXXXX	15	0.68	0.67	1.03	0.36	*0.13*	Y1057	27	1.45	0.80	1.70	1.89	0.03
Y0005	28	1.57*	2.53**	0.85	1.39	0.18	Y1058	26	1.06	0.91	1.44	0.81	0.88
Y1000	407	1.15*	1.12	1.27*	1.08	0.09	Y1059	475	1.18*	1.26*	1.11	1.17	0.06

Table A.1: *Continued*

NIOSH	Cases	Ever	Low	Medium	High	Ordinal	NIOSH	Cases	Ever	Low	Medium	High	Ordinal
Y1061	119	1.03	1.02	1.21	0.86	*0.97*	Z0267	11	0.69	0.38	0.66	1.08	*0.52*
Y1062	127	1.15	1.39*	1.08	0.97	0.57	Z0475	33	1.39	2.03*	1.02	1.06	0.39
Y1064	47	1.08	0.94	0.99	1.31	0.43	Z0477	26	1.68*	2.20*	1.71	1.05	0.12
Y1066	148	1.12	0.86	1.39*	1.10	0.15	Z0482	138	1.09	1.24	1.12	0.91	0.82
Y1067	146	1.09	1.09	1.22	0.95	0.57	Z0483	218	1.25**	1.37*	1.21	1.16	0.05
Y1068	11	1.47	0.36	1.53	2.74*	0.06	Z0495	183	1.15	1.20	1.00	1.25	0.12
Y1069	232	1.21*	1.15	1.25	1.21	0.03	Z0496	94	1.16	0.85	1.41	1.24	0.10
Y1070	195	1.32**	1.34*	1.28	1.36*	<.01	Z0547	42	1.01	1.09	0.81	1.20	0.87
Y1071	202	1.28**	1.36*	1.25	1.22	0.02	Z0583	60	1.03	1.14	1.07	0.88	*0.91*
Y1072	232	1.02	1.06	1.04	0.97	1.00	Z0599	16	1.11	1.37	0.80	1.16	0.82
Y1074	169	1.07	0.92	1.18	1.09	0.33	Z0660	13	0.71	1.41	0.50	0.17	*0.06*
Y1079	34	0.70	0.78	0.77	0.55	*0.04*	Z0673	12	0.60	0.89	0.39	0.58	*0.09*
Y1080	124	1.11	1.25	1.01	1.07	0.51	Z0701	53	0.95	0.99	1.17	0.78	*0.57*
Y1081	171	1.17	1.26	1.02	1.24	0.12	Z0920	19	1.19	0.59	1.31	1.66	0.24
Y1083	96	1.34*	1.53*	1.23	1.26	0.05	Z0927	424	1.21**	1.16	1.28*	1.19	0.01
Y1085	62	1.00	1.22	1.13	0.68	*0.55*	Z0947	53	0.91	0.99	1.04	0.71	*0.34*
Y1086	75	1.21	1.45	1.12	1.04	0.39	Z1037	14	0.90	0.52	1.01	1.23	0.90
Y1087	193	1.16	1.24	1.06	1.17	0.16	Z1043	13	1.05	1.26	0.49	1.40	0.82
Y1090	12	1.32	1.65	2.29	0.28	0.87	Z1061	16	1.22	0.65	1.06	2.17	0.18
Y1092	9	1.05	1.30	0.67	1.20	0.95	Z1121	24	1.30	1.99*	0.86	0.92	0.73
Y1096	15	1.39	1.54	1.20	1.39	0.33	Z1122	17	1.23	0.57	1.46	1.88	0.17
Y1098	118	1.17	0.99	1.46*	1.14	0.11	Z3004	23	1.39	0.83	1.79	1.66	0.08
Z0000	30	1.07	1.40	1.25	0.61	*0.78*	Z3140	9	0.85	0.83	0.97	0.77	*0.66*

[a] Column Headings: NIOSH = NIOSH agent code. See NIOSH NOES website www.cdc.gov/noes/srch-noes.html to search for NIOSH agent names and NIOSH agent codes. Cases = number of bladder cancer cases exposed. Ever = odds ratio for ever exposure. Low/Medium/High = odds ratio for low/medium/high cumulative exposure relative to the non-exposed where groups are divided by tertiles of the controls. Ordinal = p-value for fitting a line through the non-exposed, low, medium, and high exposure groups by assigning scores of 0, 1, 2, and 3 respectively. Odds Ratios in *italics* represent a decreasing linear fit.

* Significant at a 5% alpha level

** Significant at a 1% alpha level

Appendix B

Table B.1: NIOSH Agent Name Abbreviations

Agent Name Abbreviation	NIOSH Agent Name
1, 2-ETHANEDIAMINE, RP W C IB HP	1, 2-ETHANEDIAMINE, REACTION PRODUCTS WITH CHLORINATED ISOBUTYLENE HOMOPOLYMER
2,5-PYRROLIDINEDIONE, 12AE MPIB D RP	2,5-PYRROLIDINEDIONE, 1-(2-((2-((2-((2-AMINOETHYL)AMINO)ETHYL)AMINO) ETHYL)AMINO)ETHYL)-, MONOPOLYISOBUTENYL DERIVS., REACTION PR
2,5-PYRROLIDINEDIONE, 12AE MPIB D	2,5-PYRROLIDINEDIONE, 1-(2-((2-((2-((2-AMINOETHYL)AMINO)ETHYL)AMINO) ETHYL)AMINO)ETHYL)-, MONOPOLYISOBUTENYL DERIVS.
2-BUTENEDIOIC ACID (E)-, PW 1,3-B EB	2-BUTENEDIOIC ACID (E)-, POLYMER WITH 1,3-BUTADIENE AND ETHENYLBENZENE
2-PROPENOIC ACID, 2M CEPWC2	2-PROPENOIC ACID, 2-ME-, C12 ESTER, POLY W/ C16 2ME2PROPENOATE, ISO-C10 2ME2PROPENOATE, ME 2ME2PROPENOATE, C18 2ME2PROPENOATE, C14 2ME2PROPENOATE
ALANINE, 3-(P-(BIS(2-CE)A)P-, L-	ALANINE, 3-(P-(BIS(2-CHLOROETHYL)AMINO)PHENYL-, L-
ALKENES, C15-18 ALPHA-, RPW SDP CS S	ALKENES, C15-18 ALPHA-, REACTION PRODUCTS WITH SULFURIZED DODECYLPHENOL CALCIUM SALT, SULFURIZED
BUTYRIC ACID, 4-(P-(B(2-CE)A)P)-	BUTYRIC ACID, 4-(P-(BIS(2-CHLOROETHYL)AMINO)PHENYL)-
ETHANOL, 2-(2-(2-BE)E)-	ETHANOL, 2-(2-(2-BUTOXYETHOXY) ETHOXY)-
ETHYLAMINE, 2-(P-(1, 2-D-1-B)P)-N,N-D-,(Z)-	ETHYLAMINE, 2-(P-(1, 2-DIPHENYL-1-BUTENYL)PHENOXY)-N,N-DIMETHYL-,(Z)-
NICKEL CHLORIDE (NICL2) , HH	NICKEL CHLORIDE (NICL2) , HEXAHYDRATE
N,N-BIS(2-CE)-2-NL (CHLORNAPHAZINE)	N,N-BIS(2-CHLOROETHYL)-2-NAPTHYLAMINE (CHLORNAPHAZINE)
NONYLPHENOL ETHYLENE OA	NONYLPHENOL ETHYLENE OXIDE ADDUCT
PHENOL, DODECYL-, SULFURIZED, CCSO	PHENOL, DODECYL-, SULFURIZED, CARBONATES, CALCIUM SALTS, OVERBASED
PHOSPHORODITHIOIC ACID, MOOB E ZS	PHOSPHORODITHIOIC ACID, MIXED O, O-BIS(SEC-BU AND 1,3-DIMETHYLBUTYL) ESTERS, ZINC SALTS
PHOSPHORODITHIOIC ACID, OOB(2E)E ZS	PHOSPHORODITHIOIC ACID, O, O-BIS(2-ETHYLHEXYL) ESTER, ZINC SALT
PHOSPHORODITHIOIC ACID, OOZS	PHOSPHORODITHIOIC ACID, O-(2-ETHYLHEXYL) O-ISOBUTYL ESTER, ZINC SALT
PLUTONIUM, RADIOACTIVE E (NO)	PLUTONIUM, RADIOACTIVE ELEMENT (NATURALLY OCCURING)
POC - GASOLINE (LEADED)	PRODUCTS OF COMBUSTION - GASOLINE (LEADED)
POC - JET FUEL & GASOLINE, ULD	PRODUCTS OF COMBUSTION - JET FUEL AND GASOLINE, UNLEADED
PURINE, 6-((1-M-4-N-5-YL)THIO)-	PURINE, 6-((1-METHYL-4-NITROIMIDAZOL-5-YL)THIO)-
SOLVENT RD HVY PF DIST (PETROLEUM)	SOLVENT REFINED HEAVY PARAFFINIC DISTILLATE (PETROLEUM)
SULFONIC ACIDS, PETROLEUM, CSO	SULFONIC ACIDS, PETROLEUM, CALCIUM SALTS, OVERBASED
SULFONIC ACIDS, PETROLEUM, MS	SULFONIC ACIDS, PETROLEUM, MAGNESIUM SALTS
SULFURIC ACID, AMMONIUM N(2+) S(2:2:1)	SULFURIC ACID, AMMONIUM NICKEL(2+) SALT (2:2:1)
SULFURIC ACID, NICKEL(2+) SALT(1:1) , HH	SULFURIC ACID, NICKEL(2+) SALT (1:1) , HEXAHYDRATE
UREA, N-(2-CE)-N'-(4-MC)-N-NITROSO-	UREA, N-(2-CHLOROETHYL)-N'-(4-METHYLCYCLOHEXYL)-N-NITROSO-