# Pesticide Exposure and Female Breast Cancer Risk in Canada:

# A Case Control Study

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## ABSTRACT

Breast cancer is one of the most common types of cancer among females in Canada. The importance of personal characteristics such as obesity, diet, age of menarche, age of menopause, parity, and family history have been implicated. However, there is only a 30% attributable risk for breast cancer from these factors.

Environmental exposures are being more closely scrutinized and studies have shown that occupational and residential exposure to pesticides may be associated with increased risk for breast cancer. This thesis describes a case control study that investigated the relationship between pesticide exposure and breast cancer using data from the National Enhanced Cancer Surveillance System. All cases of female breast cancer and corresponding controls available from the data (2,360 cases and 2,488 controls) were used in the analysis. Potential pesticide exposure was assessed through self-reported lifetime occupational histories and lifetime residential histories. Known or suspected covariates were controlled for in the multiple logistic regression models. Manitoba, Saskatchewan and Alberta, the three provinces that have the highest reported usage of pesticides, were analyzed as a sub-group.

Results of this study did not find any association between exposure to pesticides and an increased risk in breast cancer. However, there was a significantly negative association between women who had lived all their lives in a rural setting and breast cancer risk [odds ratio (OR) 0.70, 95% confidence interval (CI) 0.474, 0.780].

The strengths and limitations of the study are discussed. While women living in a rural setting may experience increased exposure to pesticides, women living in urban settings may be exposed to more sources of environmental toxins. Furthermore, self reported environmental exposures are difficult to measure, analyze and generalize to the larger population. Implications for future research are also included.

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This project uses data collected through the National Enhanced Cancer Surveillance System, a collaboration of the Cancer Bureau, Laboratory Centre of Disease Control, Health Canada and the Canadian Cancer Registries Epidemiology Research Group.

To my children, Jerilyn and John Alderman.

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# DISCLAIMER

This study is based in part by the data collected through the National Enhanced Cancer Surveillance System, a collaboration of the Cancer Bureau, Laboratory Centre of Disease Control, Health Canada and the Canadian Cancer Registries Epidemiology Research Group. The interpretation and conclusions contained herein do not necessarily represent those of Health Canada or the Canadian Cancer Registries Epidemiology Research Group.

# 1. INTRODUCTION

Questions regarding the risk pesticides pose to humans and wildlife have been more frequently raised as the rates of pesticide use have also been increasing in the past several decades.[1] Evidence has arisen regarding the hormone like effects of environmental chemicals such as pesticides and industrial chemicals. Some of these chemicals have been shown to mimic the effect of endogenous hormones such as estrogen.[2] For example, cell culture studies have shown certain pesticides could initiate cell division only with cells that had positive estrogen receptors compared to those with negative estrogen receptors.[3] It has been reported that most breast cancer cases are initially estrogen receptor positive, therefore, xenoestrogenic chemicals could have a strong negative role in stimulating breast cancer cells.[3] Therefore, the xenoestrogenic properties of these chemicals embedding themselves in the tissue and possibly increasing the rate of cell growth and therefore breast cancer have been postulated.[4] There has also been evidence shown that xenoestrogens including certain pesticides become embedded in adipose tissue and through repeated exposure over a period of time, the concentration in the tissues would be expected to increase and possibly have a cumulative effect on cell proliferation.[2]

Breast cancer is one of the most common types of cancer diagnosed among females in Canada. Statistics Canada reports that a woman has a 10.7 % chance of developing breast cancer in her lifetime, the highest probability of all cancers.[5] In relation to mortality, only lung cancer has a higher death rate at 4.5 %, only slightly higher than breast cancer at 4.0 %. There is increasing public interest in this disease and

women are demanding to know why their risk is greater than that of their grandmothers and great grandmothers.

Known risk factors such as: obesity, alcohol consumption, age of menarche, age of menopause, parity, genetics and family history have already been identified. However, these only account for about one third of the cases.[6] In the search for other causes, occupational and environmental risk factors such as pesticides are being explored to see whether they also play a role in the high incidence of this disease.

## 2. REVIEW OF THE LITERATURE

### 2.1 Identification of the Literature

A search through Medline from 1990 to 2000 was performed. The following search words used in various combinations were: *pesticides, herbicides, farmer, case control, breast cancer, breast cancer risk, genetics and occupation.* Articles were also obtained from personal contacts and from references in other articles. In total, 106 articles were reviewed.

### 2.2 Definitions

Pesticide is the general term for a synthetic chemical, which is used to control and eradicate undesirable plants and animals. Insecticides, herbicides, nematicides, fungicides, insect and plant growth regulators, fumigants, attractants and repellants are all included under this broad category.[7] The specific mechanism for each pesticide depends on the pest for which it is developed to combat. The mechanisms can range from interference with nerve impulses in the central nervous system in insects to interference with cell respiration or acting as a synthetic growth hormone in plants.[8]

In the Saskatchewan Agriculture and Food Pesticide Safety Handbook, there are 460 pesticides listed which are available for use in the province of Saskatchewan.[9] Pesticides vary in their toxicity to humans. Health Canada maintains an updated registry of pesticides. A rough estimate of currently registered pesticides is 7,500, using approximately 550 active ingredients.

## 2.3 History of Pesticide Use

Use of synthetic pesticides in North America began in the 1930's but widespread use really became more common after World War II.[10] The first group of synthetic insecticides that were widely used are commonly referred to as the organochlorines and were used from about 1945 to 1965. Discovery of the organophosphates, which were less persistent insecticides, led to the eventual replacement of the organochlorines.[10] In fact many of the organochlorines are now banned in Canada due not only to toxicity to humans and animals but also to bioaccumulation and persistence in the environment. Each chemical group discovered after that became more and more selective for specific pests.

The carbamate insecticides are less commonly used and starting in the 1950's were mostly used in the forest industry, in potato and in grain farming. In the early 1970's the pyrethroid group of insecticides was introduced to the market and are now used by the fruit, vegetable and corn farmers. Two of the best known pesticides, 2,4-dichlorophenoxyacetic acid (2,4-D) and trichlorophenoxyacetic acid (2,4,5-T) are phenoxy herbicides and large scale distribution started in 1946. After 50 years of use, 2,4-D still accounts for one-quarter of all pesticides used in Canada.[10] Other common chemical groupings are the amides, benzimidazoles, benzonitrate, dinitroaniline, phthalates, thiocarbamates, triazines, and triazoles.[8]

According to Statistics Canada, the percentage of farms using herbicides has risen from 39.6% in 1971 to 49.1% in 1981 to 59.0% in 1986 to 49.4% in 1991, which translates to a 24.9% increase over a 20 year period.[11] The 1996 census reported that herbicide use had increased only slightly to 49.6% of farms reporting.[12] Insecticide and

fungicide use went from 9.9% in 1971, 13.7% in 1981, 21.2% in 1986 to 14.4% in 1991; a 45.9% increase over a 20 year period.[11] From 1991 to 1996, the percentage of farms applying insecticides and fungicides decreased to 14.1%.[12] From the above figures, it's evident that the highest use of pesticides occurred in the mid-80s. After a fairly dramatic drop between 1986 and 1991, they have stabilized at the present levels.

## 2.4 Epidemiology of Pesticides and Humans

### 2.4.1 Pesticide toxicity

Undesirable side effects are widespread for nontarget organisms, both immediate and long term effects are slowly being compiled in the scientific literature. There are generally four categories of exposure:

(1) acute toxicity, in which the organism is exposed to the chemical only once, and the toxic symptoms appear immediately or within a few hours of exposure;

(2) subchronic toxicity, in which the organism is exposed a few times, and the toxic symptoms appear after about 1 week;

(3) chronic toxicity, in which the organism is exposed to the chemical several times, but the toxic symptoms appear after 1 yr; and

(4) delayed toxicity, in which the organism is exposed once or many times to the chemical, but the toxic symptoms appear after several years.[7]

The delayed toxicity and accumulation of pesticides in the human body is the area of interest in breast cancer.

Carcinogenic pesticides may increase the risk of breast cancer through several mechanisms, including genotoxicity, tumor promotion, hormonal action and

immunotoxicity.[1] Some better known pesticides that have been identified as being xenoestrogenic include, atrazine, chlordane, dichlorodiphenyltrichloroethane (DDT), endosulfan, kepone, and methoxychlor.[6] These chemicals mimic the action of the hormone estrogen, and in cell studies have been shown to initiate cell division that is inappropriate and may lead to the development of tumours in the breast.[3]

### 2.4.2 Ecological Studies

A study in Kentucky, USA found a modest increase in breast cancer incidence rates in counties that had medium to high levels of triazine herbicide exposure (ORs = 1.10 and 1.18 respectively).[13] The exposure was measured by water contamination data, corn crop production and pesticide use data from several sources of previously collected data. The water contamination data was gathered from a Kentucky Geological Survey, corn crop production data was compiled from Kentucky Agricultural Statistics and pesticide use was assessed using the corn crop production data and from another survey which measured the amount of pesticide used by applicators. The breast cancer incidence data came from the state tumor registry.[13] Another study in Costa Rica using similar data sources found increased cancer rates of various sites including breast.[14]

In 1990, Westin & Richter postulated that the 30% drop in age specific breast cancer mortality rates among young women (44 years old or less) in Israel during the years 1976-1986 was due to the banning of hexachlorocyclohexane (α-BHC) and lindane (γ-BHC) in 1978. Up until that time, milk and dairy products were contaminated by extraordinarily high levels of 3 pesticides; α-BHC ,γ-BHC and DDT. Cows' milk measured for pesticide levels in 1976, found concentrations to be 500% greater than

those measured in the United States of 1,1-Dichloro-2,2-bis(p-chlorophenyl)ethylene (DDE), a derivative of DDT. The Israeli population had continually been shown to have elevated levels of pesticides in body fat in general and breast milk in particular. By 1980, there was a 90% drop in γ-BHC concentration in breast milk, 43% in DDT and 98% in α-BHC.[15]

When Kogevinas et al compared cancer incidence and mortality of an international cohort of women occupationally exposed to chlorophenoxy herbicides, chlorophenols and dioxins, there was no association found between breast cancer and these exposures even though breast cancer was the most common cancer in this group. The number of women identified with cancer was 29 out of 701. There was no increased rate of cancer overall compared to cause specific national death rates, however, there was a significant increase in cancer incidence among workers exposed to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).[16] A recent study out of North Carolina did not find any association between pesticide exposure based on farming as an occupation and breast cancer, in fact there was an inverse association between increasing duration of farming and breast cancer.[17] Duell et al (2000) measured pesticide exposure through personal interviews among 862 cases and 790 controls. Potential pesticide exposure was assessed by questions regarding contact with crops and livestock and presence in fields during or after pesticide application, and laundering of farm workers' clothing. Women who washed laundry for pesticide users for 11 years or longer were at a slight increased risk of breast cancer even after adjustment for duration of residence and several covariates.[17] The study concludes that indirect exposure to pesticides may be as important as direct sources of exposure.

### 2.4.3 Case Control Studies Measuring Pesticides in Human Tissues

The evidence of long-term exposure in humans has become an increasingly popular area of study as breast cancer can have a long latency period. Specific pesticides such as organochlorines and DDT and polychlorinated biphenyls (PCBs) which were once used as electrical insulators, have been the most often studied. Blood serum and breast tissue have been the most common substrates used to identify levels of these chemicals in the human body. The following findings are all from case control study designs. Falck et al found that there were approximately 50% higher levels of DDE, DDT, and higher chlorinated PCBs in breast adipose tissue among 20 breast cancer cases, compared with 20 controls.[18] Wolff et al found significantly elevated levels of DDE in 58 breast cancer cases, compared to 171 controls. There was an approximate 9% increased risk for each ppb increase of DDE in blood serum.[19] A Finnish study found elevated levels of ß-hexachlorocyclohexane (ß-HCH) in 44 women with breast cancer compared to 33 controls.[20] Dewailly et al found higher levels of DDE in 18 breast cancer cases that had estrogen receptor-positive status compared to 17 controls. This study used both breast adipose tissue and blood serum to measure the level of organochlorines.[21] A study in Denmark, that measured blood levels of 240 women with breast cancer and 477 controls found that the concentration of dieldrin was associated with a significantly increased dose-related risk of breast cancer (OR-2.25, 95% CI 1.32-3.84). There was also a slight increase in risk with increasing concentrations of ß-HCH. All other pesticides showed no association.[22]

A European study measured organochlorine concentrations in adipose tissue obtained from the buttocks of 265 women with breast cancer and 341 controls. This study did not find any significant association between breast cancer and DDE levels.[23] Schecter et al studied blood serum levels of DDT in Vietnamese women in 1994. There were 21 cases of invasive breast cancer and 21 controls with benign breast disease. The study found that the controls had higher levels of DDT, which does not support the theory of association between DDT and breast cancer risk.[24] A similar study in Brazil also found no association between breast cancer risk and plasma levels of exposure to organochlorine pesticides. The number of cases was 177 compared to 350 controls.[25] In a 1994 study of San Francisco Bay area women, there was no association found between organochlorine serum levels and breast cancer. The study had 150 cases and 150 controls. This study separated the participants according to race; white, black and Asian and overall there were no differences in organochlorine levels. Subgroup analysis did however find that there was a positive association between DDE blood levels in black women compared to white and Asian. There was a negative association between PCB levels and breast cancer in white women. None of the other studies attempted to make such a distinction between races.[26] A prospective study using the study population from the Nurses' Health Study measured plasma levels of DDE and PCB from 240 cases and 240 controls. The levels of both DDE and PCB were found to be lower in cases than controls.[27] A nested case control study in Columbia, Missouri found no association between 45 organochlorines and PCBs with the exception of hexachlorobenzene and breast cancer. Women in the upper three quartiles had twice the risk of those in the lowest quartile. This study measured serum levels in donated blood,

which was collected between 1977-87 with up to 9.5 years of follow up. The median time from serum collection to measurement of pesticides was 16.7 years. The highest levels of hexachlorobenzene were found in those women who were diagnosed on average 2.7 years after they donated their blood.[28]

One of the problems in trying to compare these studies is that very few of them were analyzing the same tissue; some studies analyzed blood serum, others analyzed adipose tissue taken from either the breast or the buttocks. Although the majority of studies measured serum levels, these were also taken at different times ranging from the day of surgery to 16.7 years prior to diagnosis. Articles that critiqued the findings of the positive association between organochlorines and breast cancer most commonly used the argument that the numbers of cases in the studies were too small. However, the most recent of these positive findings, the Denmark study, has the highest number of cases and controls and no opinion articles were found that attempted to refute the findings. The literature was inconclusive when it came to trying to support the hypothesis that exposure to pesticides as assessed by measuring various types of pesticides in blood or adipose tissue increased the risk for breast cancer.

## 2.5 Epidemiology of Breast Cancer

### 2.5.1 Introduction

Breast cancer, like other malignancies, arises when a cell escapes the usual restraints on replication and multiplies out of control. The incidence rates have increased within the past two decades while at the same time the mortality rates have

decreased in some populations. However, it is the leading cause of cancer death in women throughout the industrialized world and in many developing countries.[29] A combination of earlier diagnosis and adjuvant therapy could be a cause for the decrease in mortality rates.[30] The epidemiological literature of breast cancer identifies that the established risk factors are linked to total lifetime exposure to bioavailable estrogens.

### 2.5.2 Reproductive Risk Factors

Epidemiological studies have shown that risk of breast cancer is increased for those women who menstruate for more than 30 years, due to an early age of menarche or late menopause or a combination of both.[30] Menopause at age 45 years old or older carries a 40% increased risk, compared with women who experience menopause before the age of 45 years.[30] The increase in risk is suspected to be due to prolonged exposure to estradiol, the biologically active form of estrogen. Estradiol induces the epithelial cells in mammary tissue to multiply.[6] Approximately 75% of breast cancers are diagnosed among postmenopausal women.[30] Hankey et al found that 93% of the breast cancer cases in the Surveillance, Epidemiology and End Results (SEER) database from the United States were postmenopausal women.[31]

Women who have their first pregnancy after the age of 30 and nulliparous women are also at increased risk for breast cancer. In the United States, this translates into an estimated 30% increased risk.[30] Henderson reported that when a woman has her first baby before the age of 19, her risk of getting breast cancer is approximately half that of a nulliparous woman.[32] It is now thought that full term pregnancy at an early age

causes breast tissue to develop in ways that resist estrogen's growth promoting signals.[6]

### 2.5.3. Socioeconomic Status

The risk for breast cancer follows a clear socioeconomic trend, with a steep gradient towards high risk in high social strata found in at least 14 populations on four continents.[33] The attributable risk for breast cancer associated with high socioeconomic status (SES) has been estimated to be 19%.[33] The higher incidence among women in high SES strata may mask potentially work-induced exposures among women in the lower strata who encounter chemical exposures at work more frequently.[30] In fact, when Cantor et al adjusted for SES, they found an increased risk for breast cancer among women with occupations in the lower end of the SES scale. They hypothesized that those with lower SES would more likely be exposed to carcinogenic substances thus accounting for the observed increase.[34] There was an excess risk identified for black women under the age of 40 in higher SES groups whereas white women over the age of 40 had excess risk in the lower SES groups.[35] There is a definite connection between high socioeconomic status and increased risk in breast cancer. One usually assumes that higher education is equivalent to higher socioeconomic status. Habel et al did find that breast cancer cases were more likely to be higher educated than the controls.[36]

### 2.5.4. Diet and Body Size

High fat diets have been touted as a major lifestyle cause of chronic illnesses such as atherosclerosis, diabetes and certain cancers in the western society. Although a

diet high in fruits and vegetables has been found to decrease the risk of developing lung and stomach cancer, there is no evidence that it has any effect for breast cancer.[30] There is however, an increased risk associated with greater body mass, specifically with postmenopausal obesity. The increased risk is suspected to be due to the fact that endogenous and exogenous hormones deposit and build up in adipose tissue.[30] A study of Singaporean Chinese women with breast cancer found that those with a larger waist to hip ratio were associated with the highest risk (OR 9.18, 95% CI 4.8-17.5).[37] However, the Body Mass Index (BMI), which is a standard measure derived from the height and weight[38] was not a significant predictor for breast cancer. This suggests that women that carry the majority of their excess weight around their waist have an increased risk for breast cancer. Studies have shown that increased fat consumption is not a risk factor for breast cancer. In fact, in one study fat consumption was found to have a protective effect.[39] Hunter & Willett (1993) published an extensive review of studies based on diet, body size and breast cancer. Those studies that had accounted for the three different types of fat; saturated, polyunsaturated and monounsaturated, found that diets high in polyunsaturated and monounsaturated fats had a protective effect.[40] So although there is limited evidence to suggest a direct link between fat consumption and breast cancer there is an indirect link between a high fat diet, obesity and breast cancer.

There is a consistent finding of a weak causal association between alcohol consumption and the risk of breast cancer.[39] Welp et al reported that a combined analysis of six dietary case-referent studies found an estimated 70% increased risk for women consuming over four alcoholic drinks a day.[30] How alcohol itself, its metabolites or a contaminant of alcoholic beverages might have a carcinogenic effect

has not been proven.[41] However, animal studies have shown that ethanol consumption can stimulate cell proliferation in mammary tissue.[39] Ethanol has also been shown to increase the permeability of cells to other potential carcinogens. It has also been reported that ethanol increases circulating plasma oestrone and estradiol levels in premenopausal women.[39] Therefore, alcohol may increase the exposure effect of bioavailable estrogens.

### 2.5.5. Genetics

Breast cancer in a mother or sister is associated with an approximately 50% increased risk compared to women without a family history of breast cancer. Furthermore, when two or more first degree relatives have breast cancer, the risk is higher.[32] In the fall of 1994, a region on chromosome 17 was shown to have a substantial role in early-onset familial breast and ovarian cancer, the BRCA1 gene was identified.[42] Among approximately 200 families, which had at least four closely related members diagnosed with breast cancer, about half of the cases were attributed to BRCA1 gene mutations.[42] A genomic search of 15 families at high risk for breast cancer in which linkage to BRCA1 had been excluded led to the identification of the BRCA2 gene, which is on chromosome 13.[43] One of the identifying characteristics for suspecting a gene mutation is a positive diagnosis at an early age. It is estimated that known gene mutations account for 5-10% of cases.[6,30] The prevalence of the mutated BRCA1 gene is estimated to be 0.1% in the general population. [44]

A higher frequency of gene mutations has been identified in a specific population; these are the descendents of Ashkenazi Jews in central Europe. A study of

over 5000 individuals of Ashkenazi Jewish decent observed a prevalence of 2.3 % the three gene mutations of BRCA1, BRCA2 and 185delAG, a specific mutation of BRCA1.[44] Specifically, the estimated contribution of the BRCA1 gene mutation to breast cancer cases is 16% before the age of 50 which compares to only 4.1% in the non-Ashkenazi population that have the gene mutation.[43] This shows that the genetic risk is definitely higher among the Ashkenazi Jewish population.

### 2.5.6. Occupation

Few studies have been conducted to evaluate the contribution of occupation and occupational exposures to breast cancer and those that have been done haven't been replicated or subsequent studies found no association. A study of women in the Portland-Vancouver area identified 18 occupational categories with significant elevations of breast cancer incidence rates, nine with significant elevations of breast cancer mortality rates and 20 with either incidence or mortality rate increases.[45] Professional and technical women as a group had elevated incidence and mortality rates, so did housewives, registered nurses, clinical laboratory technicians, schoolteachers, social workers, scientists, secretaries, typists, meat wrappers and cutters. Increased incidence rates but average mortality rates were seen among religious workers, authors, restaurant and bar managers, realtors, brokers, bank tellers, cashiers, telephone and telegraph operators, canning and bottling workers, chemical and gas handlers and papermill workers. Significant increases in mortality rates alone were observed among librarians and beauticians.[45] Cantor et al designed a study that estimated exposure to possible and known carcinogens. The findings indicate that

exposure to styrene, lead, cadmium, solder, acid mists and a combined grouping of chromium, arsenic, beryllium and nickel showed a significantly increased risk for breast cancer compared to women who were not exposed to such chemicals.[34] However, these findings were not translated into occupational titles. A study by Calle et al found an elevated risk of breast cancer among administrative and clerical workers. However, the authors go on to state that the findings should be viewed with caution since they are based on a small number of cancer deaths in a large cohort study of 563,395 women.[46]

A population based case control study in King County, Washington with 537 cases and 492 controls found no association with breast cancer and any occupation.[36] Petralia et al did not find any association between breast cancer risk and occupation among 840 cases and 810 controls in western New York State.[47] Despite the statistically significant association between administrative and clerical occupations with breast cancer risk, Calle et al state that their prospective cohort study did not find any association between occupation and breast cancer.[46] The evidence of association among occupations and breast cancer is inconclusive.

### 2.5.7. Race

There are some studies that evaluated ethnicity as a risk factor. Velentgas states that there is higher incidence of breast cancer in black women under the age of 40 than white women, whereas the opposite is true for women over 40. However, the elevated risk for young black women cannot be explained.[35] The San Francisco Bay area has a higher incidence rate of breast cancer than the rest of the United States and the rate also varies greatly according to ethnicity. In the time period of 1988-1993, the incidence per

100,000 was 128 for White, 102 for Blacks, 86 for Japanese, 83 for Hispanics, 76 for Filipinos and 69 for Chinese.[48] When the survival rate was assessed according to ethnicity in this population, White women and Japanese had the highest survival rate at 86%, followed by Chinese women at 85%, 82% for Hispanic, 77% for Filipino and 73% for Black women. Even after stratifying for tumor stage at time of diagnosis it was shown that Hispanics, Blacks and Filipinos had the lowest survival rates. Underlying reasons for these differences are not known although there are several hypotheses: later stage of diagnosis, increased body mass, misclassification by stage, histopathological differences and genetic differences are a few that have been mentioned.

### 2.5.8. Smoking

The association of smoking and breast cancer is unclear. Most epidemiological studies have found weak or no association between smoking and breast cancer.[35,49] The effects of smoking has been shown to have antiestrogenic effects and therefore thought to be protective for breast cancer, however more recent studies have shown that women who smoke have higher incidences of cervical, pancreatic and bladder cancer.[49] Furthermore, Wolff reports that cigarette smoking and heavy drinking during prepubertal time periods may be related to an increased risk of developing future breast cancers.[50] This suggests that there may be critical periods during breast development that are more highly susceptible to carcinogenic insults. Palmer & Rosenberg's epidemiological review of smoking and breast cancer did not report any inverse association between smoking and breast cancer. The review also did not report any overall positive association.[49]

Second hand smoke is an area that is getting increased attention, however, there is very little data available. Three studies have reported an increased risk in relation to passive smoking.[51,52,53] However, one study did not account for race, education, alcohol consumption or age. The two-fold increase in risk was largely confined to premenopausal women who were married to smokers.[51] A large cohort study of Japanese women whose husbands smoked found a relative risk of 1.26.[52] Johnson et al found a strong dose response trend for more than 35 years of residential or occupational second hand smoke (OR. 2.9, 95% CI 1.3-6.6).[53] It is apparent that smoking and breast cancer risk is going to need more research.

## 3. RATIONALE

Breast cancer rates continue to rise, not only in Canada but also worldwide. The search for a cause or causes is high on the public agenda. The known biological risk factors of age, family history, genetics, race, length of menstruation, and height cannot be changed. The lifestyle risk factors that can be decreased, not only for breast cancer but also other chronic illnesses are alcohol consumption, high body weight and smoking. Genetic counseling could be offered to individuals with high genetic risk but what are the prevention strategies; elective double mastectomy? High socioeconomic status and a high level of education are also positive risk factors. Does that mean you tell women to live in poverty and not get educated? The known risk factors only account for a third of breast cancer cases. What is the cause of the other two thirds of cases with no identifiable risks?

This leaves the environment and our day to day lives of work and play. Occupational studies have identified a higher risk of breast cancer in some occupations but subsequent studies have failed to verify the findings. In the environmental field, several pesticides have proven to be carcinogenic in cellular and animal studies. In terms of epidemiological evidence among humans, researchers continue to search for definitive answers. Therefore, further studies are required until there is unequivocal evidence of an association or not.

In 1995, Statistics Canada and Agriculture & Agri-Food Canada conducted a telephone survey of 6000 farms across Canada. The survey explored the issues of land management, specifically manure, commercial fertilizer and pesticide management. The

results were generalized to the entire farming population and estimated that there were 224,060 operating farms in Canada. Approximately 67% of farms applied herbicides, 31% applied pesticides and 19% applied fungicides.[54] One of the Prairie Provinces' major industries is farming. The survey reported that of those farms in the prairies ecozone, 83% applied herbicides, 36% applied insecticides and 20% applied fungicides. These figures were among the highest in the entire country, only the Mixedwood plains ecozone had a higher percentage of insecticides at 37% and fungicides at 24%.[54] From these figures it is obvious that pesticide exposure is prevalent in the farming community, both as an occupation and as a residential setting.

No evidence was found that a Canadian case control study exploring occupation and residential history as proxy measures for pesticide exposure had been done.

## 4. OBJECTIVE AND RESEARCH QUESTIONS

The objective of this thesis was to determine whether there is an association between pesticide exposure and breast cancer in females in Canada. Two proxy measures of pesticide exposure were residential locations and occupational history. The data also allowed for controlling of known and some of the suspected risk factors of breast cancer.

### 4.1 Primary Research Questions

Among females in Canada:

**4.1.1** Is there an increased risk for breast cancer in females who are exposed to pesticides in their occupation compared to females who are not exposed to pesticides in their occupation?

**4.1.2** Is there an increased risk for breast cancer in females who are exposed to pesticides in their residential setting compared to females who are not exposed to pesticides in their residential setting?

### 4.2 Secondary Research Question

Among females in Manitoba, Saskatchewan and Alberta:

**4.2.1.** Is there an increased risk for breast cancer in females from a farming background compared to females who are not from a farming background?

# 5. METHODOLOGY

## 5.1 Description of Research Design

This thesis used data that had been collected through the National Enhanced Cancer Surveillance System (NECSS), a collaboration of the Cancer Bureau, Laboratory Centre of Disease Control (LCDC), Health Canada and the Canadian Cancer Registries Epidemiology Research Group, during 1994 to 1997. The rationale for the project was to collect data to evaluate environmental cancer concerns and to strengthen cancer surveillance in Canada. [55] There were two other parts of the data collection project in addition to the case control portion. There was a national community level environmental quality database and a geographical surveillance network.[55]

The case-control study design is particularly well suited for diseases with long latency periods such as breast cancer. It also provides the opportunity to look retrospectively in time to assess for specific exposure such as pesticide exposure. The fact that pesticides have a long half-life in the human body is another reason why the case control study design is attractive. The cases have already been exposed and have been diagnosed with the illness so there is no further risk to them or the controls.

Information was collected from 20,730 cases for 18 types of cancer along with 5,039 controls from across Canada. The method of data collection was a thirteen-page mail-in questionnaire with telephone follow up if required. The sample of controls was structured so that the 5,039 controls would have a similar age-sex distribution as the overall case group, so that there would be at least one control for every case within each sex and five year age group for any specific cancer site.[55] Obviously due to the much

smaller number of controls, they would be used repeatedly depending on the type of cancer an investigator was researching. All cases of female breast cancer from across Canada in the database were used in the analysis. The total number of breast cancer cases was 2,362 cases and there were 2,492 controls.

### 5.1.1 Sample Size Calculations

Determining the estimated Odds Ratio required to detect any statistically significant association between pesticide exposure and breast cancer was calculated as follows: assuming that 2% of the controls were exposed to pesticides and using the conventional alpha level of 0.05, beta level of 0.20 and the sample size of 2,362, an OR of 1.7 or higher would be statistically significant. The sub-group consisting of the prairie provinces was comprised of 504 cases and an OR of 2.7 would be required for a statistically significant association between pesticide exposure and breast cancer. The computer program used to determine the ORs was PSDos.[56]

## 5.2 Data Collection

The Provincial Cancer Registries collect cancer incidence data from their respective provinces and forward the data to the Canadian Cancer Registry.[55] This data collection system was enhanced through the collaboration of LCDC and the Registries in the formation of the National Enhanced Cancer Surveillance System (NECSS) that led to this case control study. The data was collected through a survey questionnaire (see Appendix IV). The questionnaire was designed to extract information regarding lifetime residential history, including exact addresses where the individual lived at least

1 year, drinking water source, type of home heating, and exposure to dust and odours from industry. The occupational history requested information on type of industry, business name, job titles, duties, full or part time or seasonal status, and exposure to dust and odours. There were detailed questions on smoking history such as amounts, types of tobacco, years since quit as well as exposure to second hand smoke in the home and at work. Dietary habits were assessed through a 70 item food frequency questionnaire and also a series of questions to assess a change in habits from 20 years before. Physical activity was assessed in terms of type of activity, time of year, number of times per week and duration in terms of minutes. Reproductive history of women included menstruation history, pregnancy history, surgical removal of ovaries, mammogram history and breastfeeding history.[55]

The case control study design was population based. The 18 types of cancer that were collected are: prostate, breast, colon, leukaemia, bladder, kidney, rectum, Non-hodgkin's lymphoma, liver, testes, pancreas, lung, brain, stomach, bone/cartilage, salivary, multiple myeloma and mesothelioma. The initial pilot study of the questionnaire took place in the spring of 1993, and was tested in 7 provinces. Data collection began in 1994 with the participation of seven provinces. An eighth province joined the surveillance in 1995. The participating provinces were British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Prince Edward Island, Nova Scotia and Newfoundland. The data collection phase was completed in the spring of 1997.[55]

### 5.2.1 Selection of Cases

Data collection occurred through the Provincial Cancer Registries. They identified the cases, obtained physician consent for approaching cases and distributed the questionnaires. The questionnaires were sent to the cases within one to four months of diagnosis.[55] The time between diagnosis of the patient and the time the questionnaire was mailed out varied by province. For those patients with a cancer diagnosis that had a poorer survival rate, a proxy questionnaire was sent to the next of kin if the patient was too ill or had died. The data was entered using a standardized data entry programme and sent to LCDC for national collating and data summarization. Surveys were completed from 20,730 cases for the 18 types of cancer.

Data for all cases of female breast cancer in the database, a total of 2,362 cases, were used for this study. The response rate for those women contacted was 77.4%.[53]

### 5.2.2 Selection of Controls

The 5,039 controls were randomly selected within age and sex constraints from the eight participating provinces. The data collection period was spread out over the 12 months of 1996 to accommodate seasonal variations in answers related to diet and physical activity.[55] The study design for control selection was set up to reflect a similar age-sex distribution as the overall case group such that there would be at least one control for each case within each sex and five-year age group for any specific cancer site.

Each province collected data on controls, the age and sex characteristics of the controls reflected the cases that originated from each particular province. The sampling

strategy for potential controls varied by province. British Columbia, Saskatchewan, Manitoba, Prince Edward Island and Nova Scotia used their respective provincial health insurance registration databases. Ontario used the Ontario Ministry of Finance Property Assessment Database. Alberta and Newfoundland accessed their controls through random digit dialling.[55]

The data used for this study included 2,492 controls for which there was a response rate of 71.3%.[53]

## 5.3. Data Analysis

### 5.3.1 Description of the Data

There were three separate sets of data; Breastres, which was the data for residential history; Breastocc, the data for the occupational history; Panpsy, which contained the variables specifically requested for this thesis.

The data was sent on 3 computer disks, formatted in SAS, the statistical program LCDC used to maintain the dataset. The data had to be converted from SAS to SPSS, which was the statistical program used for the analysis. The files were converted from SAS to EXCEL and then to SPSS.[1] Random visual checks between the two sets, including the first 10 and last 10 cases of each file, were done to verify that there was no corruption of data during the conversion process. With the exception of Breastocc there had been no corruption or loss of data. For Breastocc the number of cases was cut

[1] The direct conversion of SAS data files to SPSS is possible, negating the use of EXCEL. However this option was not available due to the file creation method used by LCDC.

off at 16,383. Therefore, the occupational history for part of the Alberta sample and all the British Columbia sample were not carried over initially. The file in SAS was split in two and merged together in SPSS. There was a further corruption for part of the British Columbia sample. Once again, splitting and merging files solved the problem.

The major dataset, Panpsy, had 204 variables and 4,854 observations. The variables included data on: ethnicity, age, education, income, marital status, smoking history, height, weight, BMI, alcohol consumption, pregnancy history, mammogram history, menstrual history, breastfeeding history, and all the variables related to exposure to known carcinogens including pesticides and herbicides.

The second dataset, Breastres, was the lifetime residential history. This was the complete residential history of each individual and was composed of 29 variables and 27,393 observations. The number of observations was greatly increased due to a potential of 12 responses for the residential location for each individual. The responses in this set included: water supply source, type of home heating, addresses of city, municipality, county and province, number of years living at each address and whether dust and odours from industry were noticed.

The third dataset, Breastocc, consisted of occupational history. This set also had the potential for 12 jobs for each individual and contained 22 variables and 27,085 observations. This dataset outlined the occupational history of each person, including, job titles, duties, location, years at the job, and whether it was full-time, part-time, or seasonal and if dust or odours were noticed. The jobs were coded according to the 1980 Standard Occupational Classification code (see Appendix VI). They were also coded to the 1980 Standard Industry Code.

### 5.3.2 Errors Found in the Data

The next step was generating frequency distributions and graphs to gain familiarity with the data. Errors found in the data were recorded and forwarded to Health Canada to see how they should be handled. Advice from Health Canada was to handle the obvious errors as missing values as it would not be possible to go back to the original data submissions to search for corrections.

### 5.3.3 Variables of Interest

Three sources of data for assessing pesticide exposure were considered; (1) responses to explicit questions on the survey, (2) occupation and (3) place of residence. The most direct measurement was from the set of questions in the survey regarding exposure to a list of known or suspected carcinogens. The leading question was '*Have you ever worked with any of the following for more than one year?*'[57] The possible answers were: never, don't know, at work, at home, and years in total. Pesticides and herbicides were two distinct categories even though herbicides generally fall under the broad category of pesticides in the literature. The responses to both sets of questions were analyzed separately and were also recoded into different summary combinations.

The next strongest measurement was potential exposure related to occupation. Each occupation had been coded according to the 1980 Standard Occupational Classification Code (SOC) (see Appendix VI). The numerical codes were printed out and matched with the written occupational categories. Then they were recoded according to several different exposure coding systems. The simplest reclassification

led to a dichotomous variable of *working on a farm or not*. All codes that had any type of farming as an occupation became *farm* and all the rest became *non-farm.*

A search of the literature did not identify a job coding based on female occupations for exposure to pesticides. Therefore, the job classification was recoded according to an occupation scheme based on likely exposure to pesticides for males formulated by Dr. Helen McDuffie and her colleagues. (Dr. Helen McDuffie, February 20, 2001. See Appendix VII) Four groups were identified:

Group 1. Potential exposure to pesticides

Group 2. Potential exposure to other chemicals (non-pesticides)

Group 3. White collar workers

Group 4. All others

These groups were analyzed as four distinct groups then also recoded into a dichotomous variable, where group 1 became one category and groups 2, 3 & 4 became another category.

An occupation and exposure linkage system for occupational carcinogenesis was found in the literature. This system invented by Hsieh et al (1983) created 29 occupational clusters based on the Alphabetical Index of Industries and Occupations from the United States 1970 Census of Population as well as an agent list of known and suspected carcinogens which included chemicals found in pesticides (see Appendix VIII).[58] The clusters listed occupations according to the expected level of exposure to carcinogens in relation to light, medium or heavy exposure. The higher the cluster number meant that those occupations had more opportunities for heavy exposure to known or suspected carcinogens. In this study a summary variable was created using

this linkage system. Each occupation an individual held was recoded into the appropriate occupational cluster and then multiplied by the number of years in that occupation. The lifetime exposure score was a summary of the products created from the clusters multiplied by the years. This process created a continuous variable, which reflected the lifetime exposure score to known or suspected carcinogens. The variable range was from 0 to 1,012 and highly skewed towards the score of 0. In response to the skewed distribution, a 4-group categorical variable was created by transforming the continuous variable into its quartile frequency distribution.

The third and most indirect measure of possible pesticide exposure was derived from the residential history. This measure was based on the assumption that if an individual lived in a rural area then he/she would likely be exposed to pesticides, either because of living in the proximity of pesticide application areas or from helping out on the farm. At best, this would be a proxy measure of pesticide exposure. Due to patient confidentiality, residential data was only available as an aggregate measure, which did not include the postal codes. However, LCDC had created a continuous variable showing the lifetime percentage living in an urban setting. Determining whether a location was urban was based on three identifiers: (1) municipal drinking water source, (2) no RR# in the address and (3) not having a '0' as the second character in the postal code. The urban/rural variable was analyzed as a categorical variable; the two categories were 100% rural and partial or 0% rural.

A composite variable was created in an effort to determine whether an individual's risk increased by having multiple sources of pesticide exposure. The level of exposure variable had a possible score of 3;

1 – exposure from at least one source i.e. questionnaire, occupation or residence

2 – exposure from at least two sources

3 – exposure from all three sources.

### 5.3.4 Breast Cancer Covariates

#### 5.3.4.1 Reproductive Risk Factors

Reproductive risk factors for breast cancer are the most widely known. The data was very rich in this area. Menstruation history was assessed by *age started menstruating* and *age stopped menstruating*, *regularity* and *how menstrual periods stopped*, whether naturally, as a result of a hysterectomy, radiation or other reason. *Surgical removal of ovaries* and at what age, *routine mammograms* and at what age the individual starting having them were also asked under the broad category of menstruation. Pregnancy history was assessed in terms of *ever being pregnant*, *age when first pregnant, number of pregnancies*, and *number of live births*. There was a question on breastfeeding under the pregnancy category. Whether a woman had ever breastfed and if so for how many months in total did she breastfeed was assessed. The literature indicates that breastfeeding is one way pesticides are removed from the body[59], therefore this variable was included in the analysis.

Two new variables were created to provide a concise summary measure based on the Gail model.[60] The Gail Model was developed by Gail and colleagues at the National Cancer Institute in the United States. The model provides a quantifiable risk assessment for breast cancer of an individual woman. The predictors used are: current

age, age at menarche, number of breast biopsies, age at first live birth and number of first degree relatives with breast cancer.[60] The earlier a woman starts her menstrual periods is a risk factor, therefore *Gailmenstruation* became a dichotomous variable; < 12 years old and > 13 years old. *Gailbirth* became a dichotomous variable to reflect the increased risk of breast cancer when a woman first becomes pregnant after the age of 30 (0-29 years old, ≥ 30 years old). The other three predictors of the Gail model were not appropriate for this study. Current age was not a suitable summary variable due to the fact that the mean age was 55 years old. Data was not available for *number of biopsies* and *first degree relatives with breast cancer.*

#### 5.3.4.2 Socioeconomic Factors

The literature reports an increased risk for breast cancer among women in higher socioeconomic strata and this may mask the work-induced exposure to pesticides among women in lower socioeconomic strata.[34] Therefore, adjusting for this covariate in the analysis was important. Socioeconomic status was measured by two variables: the approximate total income for all household members and the number of members in the household. The combination of these two variables was used to also determine a household income adequacy class. The *total income* and *income adequacy class* were categorical variables and the *number of members in the household* was a continuous variable.

The level of education is often used as a proxy measure for SES. The assumption is that higher education can be a proxy measure for higher socioeconomic status. Education was measured by the *highest grade reached in high school/elementary*

*school* and the *number of years of post secondary education* received. The *total number of years education* was another variable created in the dataset by LCDC.

#### 5.3.4.3 Body Size

The literature showed that there is an increased risk for breast cancer due to increased body mass. There was also some evidence suggesting that taller women have an increased risk for breast cancer. Therefore, both these factors were analyzed. Height, current weight and heaviest weight were asked. There was complete information on the entire sample for both imperial and metric measurements. The height and weight measurements were continuous variables. The Body Mass Index (BMI), which is a standard measure derived from the height and weight, was also a continuous variable. The BMI is regarded as a better indicator for risk to health associated with weight, either underweight or overweight.[38] The BMI was categorized into 3 groups: those with a BMI less than 20 which would be normal weight, those that had a BMI between 20 and 28 which would be overweight, and those that had a BMI greater than 28 which would be morbid obesity.[38]

#### 5.3.4.4 Lifestyle Choices

Consuming over 4 alcoholic drinks a day has been shown to put a woman at an approximate 70% excess risk for breast cancer.[30] Alcohol consumption was assessed through 2 sets of questions. A continuous variable measuring all alcohol served per week and a categorical variable measuring whether alcohol consumption habits had changed from 20 years ago.

Although smoking hasn't consistently been shown to be a risk factor, it is still biologically relevant and was included in the list of potential covariates. Smoking can be related to BMI, in that women who smoke will likely have a lower BMI as nicotine increases metabolism.[49] The data regarding smoking was very extensive. An individual's smoking history was assessed through a series of questions regarding age of onset of smoking, total number of years smoked, cigarettes smoked per day, age quit smoking, smoking pipes or cigars or chewing tobacco and the respective amounts and duration. From these data the continuous variables of *years since quit smoking, pack years of smoking, age quit smoking, total years smoked,* and *cigarette years* were formulated by LCDC. There were also two categorical variables; *type of smoker* (never, light, heavy) and *smoking status* (never smoked, ex-smoker, current smoker).

#### 5.3.4.5 Ethnicity

Race has been found to be a risk factor for breast cancer. However most of the research indicates that the greater risk is for Black women. The questionnaire assessed for ethnicity which was not necessarily equivalent to race. There were 15 categories plus an 'other' category for possible choices and the individual could check off as many as were applicable. This variable wasn't expected to be a confounder but more an area of interest, especially in the area of aboriginal ethnicity.

### 5.3.5 Analysis Testing for Comparability

The continuous variables were analyzed using the independent samples t-test in SPSS to compare the means between the cases and controls. A p-value of $<0.05$

indicated a statistically significant difference between the two means. Assessing variance homogeneity was through the Levene's test for equality of variance. A p-value of <0.05 indicated that the variances were not homogenous. SPSS gave output measures for both *equal variances assumed* and *equal variances not assumed.* If the variances were not homogenous, the output for *equal variances not assumed* could have been used however, analyses using the non-parametric test Mann Whitney U were also performed.

The categorical variables were tested for comparability through the use of the Pearson's chi-square test. A p-value of <0.05 was indicative of a statistically significant difference between the cases and controls. In situations where there were less than 5 values in a cell, the p-value from the Fisher's Exact Test was used.

### 5.3.6 Analysis of the Prairie Provinces

As each case and control had a provincial identifier, it was a fairly simple process to separate the prairie provinces subgroup from the larger dataset. The three provinces had 504 cases and 568 controls, a total sample size of 1,072. The same analyses for comparability of the large group were run for this subgroup.

### 5.3.7 The Logistic Regression Model

The search for an association between pesticide exposure and breast cancer may be confounded by covariates. Kleinbaum, Kupper and Muller (1988) state that confounding exists if meaningfully different interpretations of the relationship of interest result when an extraneous variable is ignored or included in the data analysis.[61]

One analytical procedure that controls for the effect of the covariates is the regression model. The dependent variable was breast cancer (Y), which was a categorical variable, either they have breast cancer or they don't. Multiple logistic regression analysis is the method used when the dependent variable is categorical. This method allows for analysis of continuous and categorical independent variables (X).

The logistic regression model allowed for the analysis of the primary interest of pesticide exposure and breast cancer while controlling for covariates. Determining which covariates were entered in the model was through examining the statistical significance values from the comparability tests and biological or sociological significance. The findings were expressed as odds ratios (OR's) with the required statistical significance (p-value) and confidence intervals (CI's) presented.

### 5.4 Ethical Considerations

There was an ethical protocol established by LCDC regarding the use of the dataset (see Appendix V). The researcher had to sign a confidentiality agreement before there was any release of data. The protocol stated that any data which could identify individuals would not be released and only aggregate data would be published. Furthermore, ethics approval was sought and granted from the University of Saskatchewan Advisory Committee On Ethics in Human Experimentation (see Appendix I).

## 5.5 Computer Software Used

Determining the power calculations for required sample sizes was performed using Winepiscope Version 2.0.[62] Conversion of the data from SAS[63] to SPSS, Version 10.05[64] used EXCEL Version 4.0[65] as the intermediate program. The lower version of EXCEL was used due to incompatibility between SAS and higher versions of EXCEL. The statistical analysis of the data was performed using SPSS Version 10.05.

# 6. RESULTS

The presentation of the results will follow the same format as the methods chapter starting from *5.3 Data Analysis*. The complete analysis of the entire sample will be presented, followed by the analysis of the Prairie Provinces subgroup.

## 6.1 Description of the Data

The three sets of data received were Panpsy, Breastocc, and Breastres. Data on the residential history was sent in an aggregate format, the city or county or rural municipality was the smallest area measure. No meaningful analysis on pesticide exposure could be performed with the residential history dataset. Instead the summary variable for *percent living in an urban setting* created by LCDC was used as the proxy measure for pesticide exposure according to residential history and this variable was part of the Panpsy data set. Panpsy and Breastocc were the two sets of data that were used in the analysis.

### 6.1.1 Demographics of the Sample

The data were collected from 8 provinces. Table 6.1 is a breakdown of the distribution of cases and controls from the participating provinces. Once the data were received it became apparent that there was not an exact one-to-one match for cases and controls therefore, a matched analysis was not necessary. The only province that had more cases then controls was British Columbia.

The other variables for describing the sample demographics are education, total number of household members, age, marital status, income and ethnicity. Very minor

differences of all the variables between the cases and controls were observed. Both cases and controls had an average of 12 years total education, slightly more than 2.5 members per household, and average age at time of the interview was 55. The majority of cases (70.4%) and controls (67.5%) were married. Nearly 40% of cases and controls had household incomes between $50,000 and $99,999. The number of women who preferred not to answer the question regarding their total household income was quite high (cases 24.5%, controls 27.8%). Missing data will affect the ability of the researcher to generalize the findings of a particular variable to the general population. Therefore, any findings in the area of income would have to be treated with caution since the missing data is so high. The highest percentage of both cases (47.2%) and controls (46.8%) chose English as their ethnic group. Irish and Scottish ethnicity were the other two most common groups for both cases and controls. Respondents were given the option of selecting as many ethnic groups as they felt they belonged to thus creating difficulty in analyzing distinct ethnic groups.

**Table 6.1 Breakdown of Sample by Province**

| Reporting Province | Cases (%) | Controls (%) |
|---|---|---|
| Newfoundland | 66 (2.8) | 117 (4.7) |
| Prince Edward Island | 133 (5.6) | 138 (5.5) |
| Nova Scotia | 107 (4.5) | 236 (9.5) |
| Ontario | 754 (31.9) | 1027 (41.3) |
| Manitoba | 115 (4.9) | 153 (6.1) |
| Saskatchewan | 117 (5.0) | 124 (5.0) |
| Alberta | 272 (11.5) | 291 (11.7) |
| British Columbia | 796 (33.7) | 402 (16.2) |
| **Total** | **2360 (100)** | **2488 (100)** |

**Table 6.2 Demographic Description of Continuous Variables**

| Variables | Cases (n) | Mean | Std. Dev. | Range | Controls (n) | Mean | Std. Dev. | Range |
|---|---|---|---|---|---|---|---|---|
| Total education | 2331 | 12.5 | 3.2 | 2-27 | 2459 | 12.2 | 3.4 | 1-37 |
| Total # of household members | 2265 | 2.6 | 1.3 | 1-10 | 2377 | 2.6 | 1.4 | 1-12 |
| Age at interview | 2361 | 55.7 | 11.4 | 25-76 | 2490 | 55.8 | 12.4 | 20-76 |

**Table 6.3 Demographic Description of Categorical Variables**

| Variables | | Cases n (%) | Controls n (%) |
|---|---|---|---|
| Marital Status | Married | 1662 (70.4) | 1683 (67.5) |
| | Common-law | 70 (3.0) | 78 (3.1) |
| | Single | 146 (6.2) | 134 (5.4) |
| | Divorced | 211 (8.9) | 226 (9.1) |
| | Widowed | 264 (11.2) | 360 (14.4) |
| | Other | 9 (0.4) | 11 (0.4) |
| **TOTAL** | | **2362 (100)** | **2492 (100)** |
| Household Income | < $10,000 | 97 (4.1) | 84 (3.4) |
| | $10,000-19,999 | 241 (10.2) | 291 (11.7) |
| | $20,000-29,999 | 311 (13.2) | 349 (14.0) |
| | $30,000-49,999 | 514 (21.8) | 545 (21.9) |
| | $50,000-99,999 | 528 (22.4) | 435 (17.5) |
| | >$ 100,000 | 92 (3.9) | 96 (3.9) |
| | Prefer not to answer | 579 (24.5) | 692 (27.8) |
| **TOTAL** | | **2362 (100)** | **2492 (100)** |
| Ethnicity | French | 269 (11.4) | 361 (14.5) |
| | English | 1115 (47.2) | 1167 (46.8) |
| | German | 341 (14.4) | 346 (13.9) |
| | Scottish | 645 (27.3) | 585 (23.5) |
| | Italian | 65 (2.8) | 103 (4.1) |
| | Irish | 510 (21.6) | 471 (18.9) |
| | Ukranian | 98 (4.1) | 128 (5.1) |
| | Chinese | 65 (2.8) | 50 (2.0) |
| | Dutch | 116 (4.9) | 123 (4.9) |
| | Jewish | 51 (2.2) | 23 (0.9) |
| | Polish | 64 (2.7) | 66 (2.6) |
| | Black | 20 (0.8) | 16 (0.6) |
| | Aboriginal | 29 (1.2) | 34 (1.4) |
| | Metis | 20 (0.8) | 17 (0.7) |
| | Inuit | 1 (<0.1) | 1 (<0.1) |

## 6.2 Errors Found in the Data

Running frequency checks and generating graphs of all the variables was the initial step in gaining familiarity with the data. Health Canada was notified of errors found and following the advice given, they were deleted and therefore became missing values. In the Panpsy data, 664 errors were found in 47 of the 204 variables. The three major contributors to the total was 178 errors in *Total Household Gross Income,* 273 errors in *Have Menstruated* and 109 errors in *Regularity in Menstrual Periods.* SPSS indicated that these values were valid but did not fit any of the variable categories.

There were obvious entry errors such as being 10 cm tall or having –37 incomplete pregnancies or having mammograms at the age of 2. With the addition of the 664 errors to the 15,660 missing values, the total number of missing values was now 16,324 out of 990,216 cells, 16.5% of the sample. There were no errors found in Breastocc, however there were 12,751 missing values out of 299,989 cells. Some of the missing values were for those individuals that had never been employed (52.9% of the missing values) and the rest were due to incomplete data.

## 6.3 Variables of Interest

### 6.3.1 Pesticide Exposure According to Questionnaire

The primary research question asked if there was an increased risk for breast cancer in females who were exposed to pesticides in their occupation and/or their residential setting. There were three sources of information to consider in answering this question. The most direct measurement of pesticide exposure was derived from the answers on the survey questionnaire regarding working with pesticides and/or herbicides. Table 6.4 illustrates the comparability between the cases and controls according to the total number of years handling pesticides and herbicides. The average time for handling pesticides was 10.7 months for cases and 9.2 months for controls. It is even less for handling herbicides; 7.8 months for cases and 7.0 for controls. The p-values indicate that there are no significant differences between the cases and controls in these two continuous variables.

**Table 6.4 Continuous Variables Relating to Pesticide Exposure**

| Variable | Cases (n) | Mean | Std. Dev. | Controls (n) | Mean | Std. Dev. | Independent samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Total number of years handling pesticides | 2341 | 0.89 | 4.52 | 2478 | 0.77 | 4.30 | 0.38 |
| Total number of years handling herbicides | 2350 | 0.65 | 4.01 | 2480 | 0.58 | 3.60 | 0.51 |

The categorical variables are presented in Table 6.5, it is the summary of those individuals that responded to having been exposed to pesticides and/or herbicides. Pearson's Chi-square p-value was calculated individually for each variable based on the number of responses for *yes* and the number of non-responses, which indicated a *no* response. Multiple responses from one individual were possible, for example, one could check off *never* and *don't know* when asked if she had ever handled pesticides. As well, a woman could check off both *at work* and *at home* in response to the question *have you ever worked with any of the following for more than one year?*

Three new variables, *handled pesticides at work or at home, handled herbicides at work or at home* and *handled herbicides or pesticides* were created to combine the pesticide exposures without regard to where and what type of exposure occurred.

**Table 6.5 Categorical Variables Relating to Pesticide Exposure**

| Variable | Cases n (%) | Controls n (%) | Pearson's Chi-Square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Handled pesticides at work only | 58 (2.5) | 62 (2.5) | 0.94 | 1.0 (.69, 1.4) |
| Handled pesticides at home only | 149 (6.3) | 123 (4.9) | 0.04* | 1.3 (1.0,1.6) |
| Handled pesticides at home or work | 202 (8.6) | 173 (6.9) | 0.04* | 1.2 (1.0,1.5) |
| Don't know if handled pesticides | 114 (5.0) | 117 (4.9) | 0.83 | |
| Never handled pesticides | 1962 (86.1) | 2114 (87.9) | 0.10 | |
| | | | | |
| Handled herbicides at work only | 42 (1.8) | 42 (1.7) | 0.80 | 1.0 (.69, 1.6) |
| Handled herbicides at home only | 93 (3.9) | 100 (4.0) | 0.90 | 1.0 (.98, 1.3) |
| Handled herbicides at work or home | 134 (5.7) | 134 (5.4) | 0.65 | 1.0 (.84, 1.3) |
| Don't know if handled herbicides | 127 (5.6) | 120 (5.0) | 0.37 | |
| Never handled herbicides | 2012 (88.5) | 2138 (89.4) | 0.57 | |
| | | | | |
| Handled pesticides or herbicides | 208 (8.8) | 187 (7.5) | 0.10 | 1.2 (.97, 1.5) |

* p-value <0.05 denoting statistical significance

Two variables were found to have p-values of <0.05 indicating a statistically significant difference; *handled pesticides at home* and *handled pesticides at home or at work,* more cases had been exposed to pesticides than controls. Generally, an OR = 1.0 indicates that there is no difference between the cases and the controls. The crude ORs for *handling pesticides at home* and *handling pesticides at home or at work* were both greater than 1.0, indicating that exposure to pesticides at home or at work is a risk factor for breast cancer.

An analysis of the subgroup of women (n=394) who had responded yes to being exposed to pesticides and/or herbicides was performed to see if increased length of exposure showed an increased risk for breast cancer. Table 6.6 shows that the average number of years cases and controls were exposed to pesticides, 11.1 and 11.1 respectively, were identical. The average number of years exposed to herbicides (cases 7.8, controls 8.2) was also not statistically significant and it was also in the wrong direction then what would be expected.

**Table 6.6 Sub-group of Women Reporting Exposure to Pesticides**

| Variable | Cases (n) | Mean | Std. Dev. | Controls (n) | Mean | Std. Dev. | Independent Samples T-test p-value |
|---|---|---|---|---|---|---|---|
| Total number of years handling pesticides | 187 | 11.1 | 12.0 | 173 | 11.1 | 12.3 | 0.996 |
| Total number of years handling herbicides | 196 | 7.8 | 11.7 | 175 | 8.2 | 11.0 | 0.732 |

### 6.3.2 Pesticide Exposure According to Occupation

The occupations were categorized according to the 1980 SOC code. The first step was to create a dichotomous variable where a surrogate for potential pesticide exposure would be the occupation of farming according to the SOC code. Table 6.7

shows the comparability analysis between *farming as an occupation* and *all other occupations* according to the SOC coding system. The p-value (0.35) indicated that there was no significant association between farming as an occupation and breast cancer.

**Table 6.7 Farming as an Occupation as Surrogate for Pesticide Exposure**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Farming as an occupation | 51 (2.2) | 64 (2.6) | 0.35 | 0.84 (.58, 1.2) |
| All other occupations | 2311 (97.8) | 2428 (97.4) | | ref |
| **Total** | **2362 (100)** | **2492 (100)** | | |

One of the difficulties in assessing occupation of women in a traditionally male oriented field such as farming, is accurate reporting. Would women who were farm wives report farming as their occupation or would they report themselves as never having been employed? In an effort to see if women living in a rural location were more likely to have never been employed, these women were selected and analyzed as a subgroup. Comparability analysis between *never been employed* with an *urban/rural* dichotomous variable showed no significant difference ($p = 0.80$) between cases and controls. Less than 20% of both cases and controls had lived all their lives in a rural location. The mean percent for *living in an urban location* was 66% for cases and 65% for controls (p-value 0.78), once again signifying that there was no appreciable difference but also indicating that those women who had never been employed were not necessarily farm wives. Two cases and two controls were missing due to their residential location not being available.

**Table 6.8 Being a Farmers' Wife as a Surrogate for Occupation related to Pesticide Exposure**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value |
|---|---|---|---|
| Lived in rural location all their lives | 30 (18.5) | 43 (17.6) | 0.80 |
| Lived in rural location for part/ none of their lives | 132 (81.5) | 202 (82.4) | |
| **TOTAL** | **162 (100)** | **245 (100)** | |

The next coding system used was by McDuffie et al (Dr. Helen McDuffie, February 20, 2001. See Appendix VII). The summary of occupations was based on 4 groups:

Group 1 – occupations that potentially involve handling or being exposed to pesticides;

Group 2 – occupations that potentially involve exposure to other known or suspected carcinogenic chemicals (non-pesticides);

Group 3 – white collar occupations and

Group 4 – all other occupations.

Table 6.9 shows the breakdown of the sample according to the four groups. No significant differences were found between the cases and controls in the distribution of the four groups.

**Table 6.9 Pesticide Exposure According to McDuffie et al Occupational Code**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value |
|---|---|---|---|
| Group 1 | 77 (3.6) | 68 (3.1) | 0.33 |
| Group 2 | 90 (4.2) | 111 (5.1) | |
| Group 3 | 1498 (70.2) | 1488 (68.7) | |
| Group 4 | 470 (22.0) | 498 (23.0) | |
| **Total** | **2135 (100)** | **2165 (100)** | |

The remaining coding scheme was the one derived from Hsieh et al's Linkage System[58], which was designed to assess the exposure of all known or suspected

explained in Section 5.3.3., for each individual according to all the occupations reported in the survey. The minimum summary score was 0 and the maximum score was 1,012. However, the distribution was very skewed; the mean was 55.18 but the median was 4.00 and the mode was 0. The Mann Whitney – U test, the non-parametric equivalent to the independent samples t-test, was used to analyze the comparability between the cases and controls. No statistically significant difference was found between the cases and controls according to the Hseih et al coding system for carcinogenic exposure.

**Table 6.10 Total Carcinogenic Exposure According to Hsieh et al Linkage System**

| Variable | Mean Cases (n) Rank | Mean Controls (n) Rank | Mann Whitney-U test p-value |
|---|---|---|---|
| Carcinogenic Exposure Summary Score | 2204.37 (2175) | 2186.79 (2215) | 0.63 |

The data was categorized according to the quartile distribution produced by SPSS and analyzed by the Pearson's Chi-square test. Table 6.11 shows the distribution of the data. The first two quartiles were collapsed into one automatically by SPSS because the first 25th percentile had a score of 0. The p-value of 0.77 was not significant.

**Table 6.11 Categorical Distribution of Carcinogenic Exposure According to Hsieh et al Linkage System**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value |
|---|---|---|---|
| 0-50$^{th}$ percentile (scores 0.00-4.00) | 1114 (51.2) | 1157 (52.2) | 0.77 |
| 50-75$^{th}$ percentile (scores 4.01-32.25) | 515 (23.7) | 507 (22.9) | |
| 75$^{th}$-100$^{th}$ percentile (scores 32.36-1012) | 546 (25.1) | 551 (24.9) | |
| **Total** | 2175 (100) | 2215 (100) | |

### 6.3.3 Pesticide Exposure According to Residential History

As previously mentioned, the residential history of each individual was summarized into total percent living in an urban area according to three criteria:

municipal drinking water source, RR# not being in the address and 0 not being the second character in the postal code. The assumption regarding pesticide exposure and residential history is that women who have lived all their lives in a rural location would have a greater probability of being exposed to pesticides. Therefore, since the residential variable was measured on a continuous scale, it was recoded into two groups; (1) women who had lived 100% of their lives in a rural area and (2) all the others.

The results of the Chi-square analysis are shown in Table 6.12. There was a significant difference between cases and controls. However, the Crude Odds Ratio of 0.61 indicated that living in a rural location resulted in lower risk of breast cancer. The results were contrary to the proposed hypothesis.

**Table 6.12 Distribution of Residence Based on Urban/Rural Location as a Proxy Measure for Pesticide Exposure**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Odds Ratio (95% CI) |
|---|---|---|---|---|
| Lived in rural area all their lives | 104 (4.4) | 176 (7.1) | <0.001* | 0.61 (.47, .78) |
| Lived in urban area all or part of their lives | 2248 (95.6) | 2313 (92.9) | | |
| **Total** | 2352 (100) | 2489 (100) | | |

* p-value <0.05 denoting statistical significance

### 6.3.4 Assessing Increased Risk from Increased Opportunities of Exposure

A new variable was created to assess whether an individual's risk was increased if she had had multiple sources of exposure to pesticides. For example, would a woman who had reported that she had been exposed to pesticides from the survey and worked in a pesticide exposure related occupation and lived in a rural environment have an increased risk as compared to a woman who reported that she had been exposed to pesticides in the survey but did not work in a pesticide exposure related occupation or

live in a rural setting? The lowest score of the new variable *Level of Exposure* was 0, no pesticide exposure and the highest score was 3, exposure from the survey, occupation and residence therefore there were 4 mutually exclusive categories. However, due to only 2 cases having a score of 3, the last two categories were collapsed into one. There was no significant difference ($p = 0.86$) between cases and controls based on multiple sources of exposure.

**Table 6.13 Pesticide Level of Exposure Summary According to All Sources**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value |
|---|---|---|---|
| No pesticide exposure | 1198 (84.5) | 1843 (85.1) | 0.86 |
| Pesticide exposure from one source | 193 (13.6) | 284 (13.1) | |
| Pesticide exposure from more than one source | 27 (1.9) | 38 (1.8) | |
| **Total** | **1418 (100)** | **2165 (100)** | |

## 6.4 Breast Cancer Covariates

The medically accepted indicators for increased risk for breast cancer are: (1) menstruation starting before the age of 12, (2) remaining childless or becoming pregnant after the age of 30, (3) being over the age of 35 and (4) having one or more first degree relative that has had breast cancer and (5) a history of benign breast disease.[60] Some but not all of the indicators were available from the data. Age was controlled for through the case control study design. Menstruation history and childbirth history was available. However, family history and benign breast disease was not available.

### 6.4.1 Reproductive Risk Factors

The reproductive histories of the women were expected to be the most likely confounders in the analysis, particularly those that related to menstruation history and pregnancy history.

The comparability analyses of the continuous variables are presented in Table 6.14. All the variables were statistically significant in the expected direction as risk factors for breast cancer. The large sample size increases the power of the statistical tests. For example, even though *age when first menstruated* was statistically significant there was likely no biological or sociological significant difference between the cases and controls based on the 2 month difference.

**Table 6.14 Reproductive Risk Factors for Breast Cancer (continuous)**

| Variable | Cases (n) | Mean | Std Dev | Controls (n) | Mean | Std Dev | Independent Samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Age when first menstruated | 2232 | 12.76 | 1.51 | 2296 | 12.93 | 1.66 | <0.001* |
| Age at end of first pregnancy | 2027 | 24.23 | 5.06 | 2170 | 23.68 | 4.62 | <0.001* |
| Total number of pregnancies | 2354 | 2.90 | 2.19 | 2483 | 3.15 | 2.30 | <0.001* |
| Lifetime months of breastfeeding | 2351 | 5.28 | 9.41 | 2480 | 6.03 | 11.09 | 0.01* |
| Age when ovaries removed | 226 | 47.86 | 9.56 | 232 | 45.59 | 10.09 | 0.01* |
| Total years being in menopause | 2281 | 10.10 | 10.21 | 2371 | 10.85 | 10.60 | 0.02* |
| Total years menstruated | 2189 | 32.74 | 6.95 | 2234 | 31.73 | 7.72 | <0.001* |

* p-value <0.05 denoting statistical significance

The categorical variables are presented in Table 6.15. The percentages shown in brackets indicated the ratio comparing the whole sample on each specific variable. More cases have had routine mammograms and more cases had never been pregnant

then controls. Although *has never breastfed* was significant, more controls than cases have never breastfed.

**Table 6.15 Reproductive Risk Factors for Breast Cancer (categorical)**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Is in post menopause | 1448 (61.4) | 1530 (61.5) | 0.92 | 1.0 (.95, 1.0) |
| Has had routine mammograms | 1618 (69.2) | 1224 (50.0) | <0.001* | 1.3 (1.3, 1.5) |
| Has never been pregnant | 308 (13.1) | 267 (10.8) | 0.02* | 1.2 (1.0, 1.4) |
| Has never breastfed | 737 (31.2) | 850 (34.2) | 0.03* | 0.9 (.84, .99) |

* p-value <0.05 denoting statistical significance

### 6.4.2 Socioeconomic Risk Factors

The two most common indicators of socioeconomic status are income and education level. Although marital status is not usually considered to be an SES indicator, single women have an increased risk for breast cancer.[66] Tables 6.16, 6.17 and 6.18 show the comparability between the cases and controls of these three indicators. The total number of years of education between cases and controls was statistically significant, however, a 3 month difference was not likely to be of any sociological significance. The income status, which was a categorical variable, showed a statistically significant difference in the distribution among the 4 categories. There was also no income information for 24.5 % of cases and 27.8 % of controls. A large difference, such as approximately 25% of the sample being missing, would decrease the ability to generalize this variable to the population. The variables for marital status were collapsed into 3 categories: married, single, divorced/widowed/other. There is a significant difference among the 3 groups, more controls are married and divorced/widowed/other than cases, whereas more cases are single than controls.

**Table 6.16 Education Level and Risk of Breast Cancer**

| Variable | Cases (n) | Mean | Std Dev | Controls (n) | Mean | Std Dev | Independent Samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Total years of education | 2331 | 12.5 | 3.2 | 2459 | 12.2 | 3.4 | 0.004* |

* p-value <0.05 denoting statistical significance

**Table 6.17 Income Level and Risk of Breast Cancer**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Yearly Income < $19,999 | 338 (14.3) | 375 (15.0) | <0.001* | ref. |
| Yearly Income $20,000-49,999 | 825 (34.9) | 894 (35.9) | | 1.0 (.86, 1.2) |
| Yearly Income > $50,000 | 620 (26.2) | 531 (21.3) | | 1.3 (1.1, 1.6) |
| Income unknown | 579 (24.5) | 692 (27.8) | | |
| **Total** | **2362 (100)** | **2492 (100)** | | |

* p-value <0.05 denoting statistical significance

**Table 6.18 Marital Status and Risk of Breast Cancer**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Married | 1732 (73.3) | 1761 (70.7) | 0.01* | ref. |
| Single | 146 (6.2) | 134 (5.4) | | 1.1 (.87, 1.4) |
| Divorced/Widowed/Other | 484 (20.5) | 597 (24.0) | | 0.8 (.72, .95) |
| **Total** | **2362 (100)** | **2492 (100)** | | |

* p-value <0.05 denoting statistical significance

### 6.4.3 Body Size as a Risk Factor

Looking at Tables 6.19 and 6.20, it was apparent that all measurements were statistically significant but once again, the differences were not likely to be biologically significant. Cases were, in general slightly taller and heavier than controls, both factors which would increase the risk for breast cancer.

**Table 6.19 Body Size and Risk of Breast Cancer (continuous)**

| Variable | Cases (n) | Mean | Std Dev | Controls (n) | Mean | Std Dev | Independent samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Height (cm) | 2356 | 162.5 | 7.12 | 2487 | 161.8 | 7.05 | 0.002* |
| Current weight (kg) | 2352 | 67.76 | 16.1 | 2484 | 66.04 | 13.2 | <0.001* |
| Maximum weight (kg) | 2352 | 73.77 | 17.2 | 2473 | 71.94 | 14.7 | <0.001* |
| Body Mass Index (BMI) | 2351 | 25.6 | 5.2 | 2481 | 25.3 | 5.3 | 0.02* |

* p-value <0.05 denoting statistical significance

**Table 6.20 Body Size and Risk of Breast Cancer (categorical)**

| Variables | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| BMI less than 20 | 205 (8.7) | 239 (9.6) | 0.003* | ref. |
| BMI between 20 and 28 | 1526 (64.6) | 1692 (67.9) | | 1.0 (.86, 1.3) |
| BMI greater than28 | 631 (26.7) | 561 (22.5) | | 1.3 (1.1, 1.6) |
| **Total** | **2362 (100)** | **2492 (100)** | | |

* p-value <0.05 denoting statistical significance

### 6.4.4 Lifestyle Choices as Risk Factors

Although smoking has not been proven to be a risk factor according to the literature, it was still considered to be biologically significant. Increased alcohol consumption has been associated with increased risk for breast cancer. Both continuous and categorical variables shown in Tables 6.21 and 6.22 have significant p-values. There were a lot of variables measuring smoking but the summary variable chosen was *pack years of smoking.* The p-value (0.01) indicated a significant difference between cases and controls even though the difference was approximately 1pack year. This was probably due to the large sample size. The same could be said for *all alcohol, serving per week,* where less than 1 drink per week was the difference between cases and controls. Roughly 1000 values were missing for both cases and controls for *all alcohol, serving per week*, meaning the women had not answered the question.

**Table 6.21 Smoking and Alcohol and Risk of Breast Cancer (continuous)**

| Variables | Cases (n) | Mean | Std Dev | Controls (n) | Mean | Std Dev | Independent samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Pack yrs of smoking | 2320 | 8.7 | 13.3 | 2449 | 7.7 | 12.7 | 0.01* |
| All alcohol, serving/wk | 1460 | 1.6 | 3.9 | 1549 | 1.3 | 3.7 | 0.03* |

* p-value <0.05 denoting statistical significance

The categorical variables in Table 6.22 show that approximately 50% of both cases and controls had never smoked. When the non-smokers were compared to the smokers and ex-smokers, there was statistical significance, however the Crude OR was

only 1.2, a value that was not considered to be large enough to indicate a positive association. The comparison of alcohol consumption between 2 years ago and 20 years ago was significantly different among the 3 groups however, there was difficulty calculating an odds ratio due to the lack of an appropriate reference group. The change in drinking habits from 20 years ago is a difference that was difficult to compare and analyze. For example one individual may report drinking less than 20 years ago but perhaps the amount is 1 drink a week which is not much of a difference, whereas for another individual it could be 5 drinks a day.

**Table 6.22 Smoking and Alcohol and Risk of Breast Cancer (categorical)**

| Variables | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Never smoked | 1098 (49.2) | 1253 (51.7) | 0.02* | Ref. |
| Ex-smoker | 755 (33.9) | 729 (30.1) | | 1.2 (1.0,1.3) |
| Current smoker | 377 (16.9) | 443 (18.3) | | 1.0 (.82, 1.1) |
| **Total** | **2230 (100)** | **2425 (100)** | | |
| Drinking much less alcohol compared to 20 years ago | 692 (31.1) | 842 (36.1) | <0.001* | Ref. |
| Drinking same amount as 20 years ago | 958 (43.0) | 972 (41.7) | | 1.2 (1.0, 1.4) |
| Drinking more than 20 years ago | 576 (25.9) | 516 (22.1) | | 1.4 (1.2, 1.6) |
| **Total** | **2226 (100)** | **2330 (100)** | | |

* p-value <0.05 denoting statistical significance

### 6.4.5 Ethnicity as a Risk Factor

These variables were included in the dataset more as an area of interest, specifically in regards to aboriginal ancestry. Table 6.23 shows the breakdown of the sample, keeping in mind that an individual could choose as many ethnic categories as were applicable. Those women who had French, Scottish, Italian, Irish and Jewish ancestry were found to be statistically significantly different in the distribution of the cases and controls. Jewish ancestry was highly significant ($p<0.001$), which was

interesting since that was one ethnic group in which genetic heredity for breast cancer had been identified among certain sub-populations. The other population that has been found to have an increased risk for breast cancer is the black ethnic group. This group was not significant in the sample. The ethnic groups of primary interest in this study were the Aboriginal, Metis and Inuit populations, the numbers of cases and controls are very low and statistically insignificant.

Respondents were given the option of selecting as many ethnic groups as they felt they belonged to thus creating difficulty in analyzing distinct ethnic groups or regrouping of ethnic groups. No further analysis was done for ethnicity.

**Table 6.23 Ethnicity and Risk of Breast Cancer**

| Variables | Cases (%) | Controls (%) | Pearson's Chi-square p-value |
|---|---|---|---|
| French ethnic origin | 269 (11.4) | 361 (14.5) | 0.001* |
| English ethnic origin | 1115 (47.2) | 1167 (46.8) | 0.79 |
| German ethnic origin | 341 (14.4) | 346 (13.9) | 0.58 |
| Scottish ethnic origin | 645 (27.3) | 585 (23.5) | 0.002* |
| Italian ethnic origin | 65 (2.8) | 103 (4.1) | 0.01* |
| Irish ethnic origin | 510 (21.6) | 471 (18.9) | 0.02* |
| Ukranian ethnic origin | 98 (4.1) | 128 (5.1) | 0.10 |
| Chinese ethnic origin | 65 (2.8) | 50 (2.0) | 0.09 |
| Dutch ethnic origin | 116 (4.9) | 123 (4.9) | 0.97 |
| Jewish ethnic origin | 51 (2.2) | 23 (0.9) | <0.001* |
| Polish ethnic origin | 64 (2.7) | 66 (2.6) | 0.90 |
| Black ethnic origin | 20 (0.8) | 16 (0.6) | 0.41 |
| Aboriginal ethnic origin | 29 (1.2) | 34 (1.4) | 0.67 |
| Metis ethnic origin | 20 (0.8) | 17 (0.7) | 0.51 |
| Inuit ethnic origin | 1 (<0.1) | 1 (<0.1) | 0.97 |

* p-value <0.05 denoting statistical significance

## 6.5 The Logistic Regression Models

The purpose of the logistic regression models was to determine whether the variables concerning pesticide exposure continued to remain significant when the covariate variables were controlled for. The rule of parsimony was applied when the

models were built, namely the fewer number of variables in the model the more stable it became. One measure of pesticide exposure from each of the 3 sources of questionnaire, occupation and residence was chosen. The statistical significance based on the p-value and variables which were the most comprehensive in terms of pesticide exposure were included, therefore *handling pesticides at home or work, occupation according to McDuffie et al* and *rural residence* were chosen. For the covariates, generally one measure for each of the known risk factors was chosen. The p-value, crude OR and biological or sociological significance were the inclusion criteria. The following variables were selected: *gailmenstruation, gailbirth, BMI, income,* and *smoking.* There were three models, one model for each measure of pesticide exposure along with the mentioned covariates bringing the total number of variables entered in each model to 6.

Variables that were re-categorized specifically for the regression model are shown in Table 6.24. The reproductive risk factors were according to the Gail model, which is one of the most common indicators used to assess breast cancer risk among women. The referent group for *first menses* was those that started their menstruation after the age of 12 and for *age of first pregnancy*, the referent group was those that had children before the age of 30. Pack years smoking was categorized into smoker and non-smoker so that the numbers of non-smokers would not dilute the effect of the smoking variable. Non-smokers were the referent group for *pack years smoking.*

**Table 6.24 Recategorized Variables for Inclusion in Regression Model**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| First menses before 12 yrs old | 996 (42.2) | 952 (38.2) | 0.01* | 1.1 (1.0, 1.2) |
| First pregnancy after 30 yrs of age | 635 (26.9) | 557 (22.4) | <0.001* | 1.2 (1.1, 1.3) |
| Pack years smoking | 1222 (52.7) | 1098 (47.3) | 0.01* | 1.1 (1.0, 1.1) |

* p-value <0.05 denoting statistical significance

The results from the regression analyses are shown in Tables 6.25, 6.26 and 6.27. Generally, an odds ratio of 2.0 or greater will not be biased to the null in well controlled studies and therefore will be considered to be a stable predictor.[67] The ORs for reproductive risk factors of menstruation before the age of 12 and not having a first child until after the age of 30 remain significant predictors and support the literature regarding known risk factors. Smoking was also a significant predictor in all three models. The measurement of income was significant but only for one category where a negative association was found between breast cancer and having a yearly income of greater than $50,000. This result was contradictory to the literature but there was also missing data for 25% of the sample, which decreases the ability to generalize this finding. Having a BMI greater than 28 was significant in two of the models but it was also a negative association which is contrary to the literature and to the crude OR which was 1.3 (1.1, 1.6).

**Table 6.25 Results from the Logistic Regression Analysis for Pesticide Exposure According to Direct Self Reporting**

| Variables | Adjusted Odds Ratio | 95% Confidence Interval Lower | Upper | p-value |
|---|---|---|---|---|
| Beginning menses 12 years old or younger | 1.2 | 1.0 | 1.3 | 0.01* |
| Having first baby after the age of 30 | 1.3 | 1.1 | 1.5 | <0.001* |
| Body Mass Index greater than 28 | 0.76 | 0.61 | 0.96 | 0.02* |
| Income greater than $50,000 | 0.74 | 0.61 | 0.89 | 0.002* |
| Smoking | 1.2 | 1.1 | 1.3 | 0.004* |
| **Handling pesticides at home or work** | **1.2** | **0.98** | **1.5** | **0.07** |

**Table 6.26 Results from the Logistic Regression Analysis for Pesticide Exposure According to Occupation**

| Variables | Adjusted Odds Ratio | 95% Confidence Interval Lower | Upper | p-value |
|---|---|---|---|---|
| Beginning menses 12 years old or younger | 1.2 | 1.0 | 1.3 | 0.04* |
| Having first baby after the age of 30 | 1.3 | 1.1 | 1.5 | 0.001* |
| Body Mass Index greater than 28 | 0.76 | 0.58 | 1.0 | 0.05 |
| Income greater than $50,000 | 0.73 | 0.58 | 0.93 | 0.01* |
| Smoking | 1.2 | 1.0 | 1.3 | 0.02* |
| **Occupation according to McDuffie et al coding system** | **1.3** | **0.9** | **1.9** | **0.13** |

**Table 6.27 Results from the Logistic Regression Analysis for Pesticide Exposure According to Rural Residence**

| Variables | Adjusted Odds Ratio | 95% Confidence Interval Lower | Upper | p-value |
|---|---|---|---|---|
| Beginning menses 12 years old or younger | 1.2 | 1.0 | 1.3 | 0.01* |
| Having first baby after the age of 30 | 1.3 | 1.1 | 1.5 | <0.001* |
| Body Mass Index greater than 28 | 0.75 | 0.60 | 0.94 | 0.01* |
| Income greater than $50,000 | 0.76 | 0.63 | 0.93 | 0.01* |
| Smoking | 1.2 | 1.0 | 1.3 | 0.01* |
| **Living 100% in rural setting** | **0.67** | **0.52** | **0.87** | **0.003*** |

Table 6.25 shows that the pesticide exposure in response to the questionnaire had an OR of 1.2, but the p-value falls just above $\alpha$ <0.05 indicating that the results are not statistically significant. Pesticide exposure measured by occupation had an OR of 1.3 but once again it was not statistically significant. The variable concerning pesticide exposure based on rural residence remains significant. The adjusted OR was 0.67 (95% CI - 0.52, 0.87), slightly higher when compared to the crude OR of 0.61 (95% CI - 0.47, 0.78). Therefore, women who had lived in a rural environment 100% of their lives had a significantly decreased risk of getting breast cancer compared to women who had lived part or none of their lives in a rural setting.

The residential location was the weakest link in identifying an association between pesticide exposure and breast cancer risk but perhaps the findings indicate that living in a rural environment is actually better for your health. Perhaps there is more opportunity for exposure to pesticides but at the same time there is less opportunity for exposure to other toxic chemicals than women in urban locations.

In response to the primary research question *Is there an increased risk for breast cancer in females who are exposed to pesticides in their occupation,* there was no association identified. In response to the second research question *Is there an increased*

*risk for breast cancer in females who are exposed to pesticides in their residential setting,* there was a negative association identified.

## 6.6 Analysis of the Prairie Provinces

The secondary research question was *Is there an increased risk for breast cancer in females from a farming background?* Women resident in the provinces of Manitoba, Saskatchewan and Alberta were selected, as these three provinces are primarily agricultural based and according to the 1995 Stats Canada survey, they have the highest use of pesticides in the country.[54] The same analysis protocol was followed for this sub-group as for the Canada-wide sample.

### 6.6.1 Demographics of the Prairie Provinces Sample

The sample distribution of the three provinces showed that Alberta made up over 50% of both cases and controls. Manitoba and Saskatchewan were fairly equal in the remaining numbers of samples. The total years of education, number of members per household and age at time of interview were very similar between cases and controls with just slightly over 12 years of education, 2.5 household members and 56 years of age respectively. There were slightly more cases that were single and widowed than controls but otherwise the other marital status categories were similar. Nearly 25% of both cases and controls preferred not to answer the question regarding total family income. The greatest number of individuals' income fell between $30,000 and $99,999/yr, 41.6% of cases and 43.3 % of controls. English, German and Scottish were

the three most common ethnic groups chosen. The demographics of the sub-group were very similar to those of the larger group.

**Table 6.28 Breakdown of Sample by the 3 Provinces**

| Reporting Province | Cases (%) | Controls (%) |
|---|---|---|
| Manitoba | 115 (22.8) | 153 (26.9) |
| Saskatchewan | 117 (23.2) | 124 (21.8) |
| Alberta | 272 (54.0) | 291 (51.2) |
| **Total** | **504 (100)** | **568 (100)** |

**Table 6.29 Demographic Description of Continuous Variables for Prairie Provinces**

| Variables | Cases (n) | Mean | Std Dev | Range | Controls (n) | Mean | Std Dev | Range |
|---|---|---|---|---|---|---|---|---|
| Total education | 497 | 12.1 | 2.9 | 3-20 | 564 | 12.26 | 3.1 | 2-37 |
| Total # of household members | 485 | 2.5 | 1.1 | 1-8 | 548 | 2.5 | 1.2 | 1-8 |
| Age at interview | 504 | 55.8 | 11.1 | 25-75 | 566 | 55.9 | 12.0 | 21-76 |

**Table 6.30 Demographic Description of Categorical Variables for Prairie Provinces**

| Variables | | Cases n (%) | Controls n (%) |
|---|---|---|---|
| Marital Status | Married | 364 (72.2) | 419 (73.8) |
| | Common Law | 12 (2.4) | 19 (3.3) |
| | Single | 27 (5.4) | 20 (3.5) |
| | Divorced | 36 (7.1) | 46 (8.1) |
| | Widowed | 62 (12.3) | 62 (10.9) |
| | Other | 3 (0.6) | 2 (0.4) |
| **Total** | | **504 (100)** | **568 (100)** |
| Household Income | <$10,000 | 23 (4.6) | 14 (2.5) |
| | $10,000-19,999 | 67 (13.3) | 71 (12.5) |
| | $20,000-29,999 | 69 (13.7) | 83 (14.6) |
| | $30,000-49,999 | 102 (20.2) | 140 (24.6) |
| | $50,000-99,999 | 108 (21.4) | 106 (18.7) |
| | >$100,000 | 14 (2.8) | 13 (2.3) |
| | Prefer not to answer | 121 (24.0) | 141 (24.8) |
| **Total** | | **504 (100)** | **568 (100)** |
| Ethnicity | French | 58 (11.5) | 68 (12.0) |
| | English | 186 (36.9) | 222 (39.1) |
| | German | 130 (25.8) | 112 (19.7) |
| | Scottish | 119 (23.6) | 129 (22.7) |
| | Italian | 7 (1.4) | 13 (2.3) |
| | Irish | 93 (18.5) | 106 (18.7) |
| | Ukranian | 40 (7.9) | 80 (14.1) |
| | Chinese | 11 (2.2) | 1 (0.2) |
| | Dutch | 30 (6.0) | 31 (5.5) |
| | Jewish | 10 (2.0) | 2 (0.4) |
| | Polish | 17 (3.4) | 29 (5.1) |
| | Black | 3 (0.6) | 1 (0.2) |
| | Aboriginal | 3 (0.6) | 11 (1.9) |
| | Metis | 14 (2.8) | 12 (2.1) |
| | Inuit | 0 | 0 |

### 6.6.2 Variables of Interest

#### 6.6.2.1 Pesticide Exposure According to Questionnaire

The mean number of years exposed to pesticides was higher in the sub group populations compared to the large group but the p-value (0.61) indicated that there were no statistically significant differences between the cases and controls. The direction of difference for exposure to herbicides was opposite to the large group. Whereas the cases

had a higher mean in the large group, the controls have a higher mean in the sub-group but once again, the differences were not of statistical significance.

**Table 6.31 Continuous Variables Relating to Pesticide Exposure for Prairie Provinces**

| Variable | Cases (n) | Mean | Std Dev | Controls (n) | Mean | Std Dev | Independent Samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Total number of years handling pesticides | 497 | 1.3 | 5.1 | 563 | 1.1 | 5.4 | 0.61 |
| Total number of years handling herbicides | 499 | 1.1 | 4.9 | 564 | 1.2 | 5.6 | 0.81 |

The categorical variables are presented in Table 6.32. None of the variables were significant at $\alpha<0.05$. The distribution followed the same pattern as the large sample except the ORs were slightly larger in the Prairie Provinces and whereas the Canada-wide sample had ORs of 1.0 for *handling pesticides at work only* and *handling herbicides at work only,* the Prairie Provinces show an inverse association although the results are not statistically significant.

**Table 6.32 Categorical Variables Relating to Pesticide Exposure for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Handled pesticides at work only | 14 (2.8) | 17 (3.0) | 0.83 | 0.9 (.46, 1.9) |
| Handled pesticides at home only | 47 (9.6) | 40 (7.0) | 0.17 | 1.3 (.88, 2.0) |
| Handled pesticides at work or home | 61 (12.1) | 54 (9.5) | 0.17 | 1.3 (.90, 1.8) |
| Don't know if handled pesticides | 24 (4.8) | 31 (5.6) | 0.61 | |
| Never handled pesticides | 406 (82.7) | 471 (84.7) | 0.32 | |
| | | | | |
| Handled herbicides at work only | 9 (1.8) | 11 (1.9) | 0.86 | 0.9 (.39, 2.2) |
| Handled herbicides at home only | 39 (7.7) | 39 (6.9) | 0.58 | 1.1 (.74, 1.7) |
| Handled herbicides at work or home | 48 (9.5) | 47 (8.3) | 0.47 | 1.2 (.78, 1.7) |
| Don't know if handled herbicides | 29 (5.9) | 32 (5.7) | 0.93 | |
| Never handled herbicides | 414 (84.3) | 478 (85.8) | 0.38 | |
| | | | | |
| Handled pesticides or herbicides | 63 (12.5) | 60 (10.6) | 0.32 | 1.2 (.85, 1.7) |

### 6.6.2.2 Pesticide Exposure According to Occupation

The first analysis was on farming as an occupation compared to all other occupations. Table 6.33 shows that there were slightly more cases than controls that were in a farming occupation and the crude OR of 1.6 is higher than the Canada-wide sample of 0.8, which was actually a negative association. Whereas, a higher number of controls had *farming as an occupation* in the Canada-wide sample, the sub-group had more cases that listed *farming as an occupation.* However, the p-value of 0.13 is statistically insignificant.

**Table 6.33 Farming as an Occupation as Surrogate for Pesticide Exposure for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Farming as an occupation | 23 (4.6) | 16 (2.8) | 0.127 | 1.6 (.86, 3.1) |
| All other occupations | 439 (87.1) | 503 (88.6) | | ref |
| **Total** | **504 (100)** | **568 (100)** | | |

In following with the analysis protocol for the Canada-wide sample, assessing whether women who had never been employed might be farm wives was accomplished through a comparison of this sub-group based on residential location. The breakdown of the categorized residential variable is shown in Table 6.34. The crude OR indicates that women who have never been employed are 2.6 times more likely to have lived all their lives in a rural location. Although the Canada-wide sample did not show any significant differences between cases and controls, the Prairie Provinces sample did. Considering the predominantly agricultural economy base of the Prairie Provinces, the result was to be expected.

**Table 6.34 Being a Farmer's Wife as a Surrogate for Occupation related to Pesticide Exposure**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Lived in rural location all their lives | 14 (33.3) | 8 (16.3) | 0.06 | 2.6 (0.95, 6.9) |
| Lived in rural location for part/none of their lives | 28 (66.7) | 41 (83.7) | | |
| **Total** | **42 (100)** | **49 (100)** | | |

The breakdown of the sample according to McDuffie et al's four groups (Appendix VII) is summarized in Table 6.35. A higher percentage of cases are in group 1- occupations with potential pesticide exposure - than controls, which is opposite to the findings from the Canada-wide sample, where more controls were in Group 1. The distribution between the 4 groups and cases and controls was not statistically significant (p=0.33).

**Table 6.35 Pesticide Exposure According to McDuffie et al Occupational Code for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value |
|---|---|---|---|
| Group 1- potential pesticide exposure occupations | 25 (5.5) | 16 (3.2) | 0.33 |
| Group 2 – potential carcinogenic exposure occupations (non-pesticide) | 18 (4.0) | 20 (4.0) | |
| Group 3 – white collar occupations | 305 (67.0) | 351 (70.5) | |
| Group 4 – all other occupations | 107 (23.5) | 111 (22.3) | |
| **Total** | **455 (100)** | **498 (100)** | |

The next coding scheme that had been used was the one derived from the Hseih et al Linkage System.[58] The summary score reflected the total lifetime exposure to known and suspected carcinogens. Table 6.36 shows that the distribution between cases and controls of total carcinogenic exposure was not statistically significant.

**Table 6.36 Total Carcinogenic Exposure According to Hsieh et al Linkage System for Prairie Provinces**

| Variable | Mean Rank | Cases (n) | Mean Rank | Controls (n) | Mann Whitney-U test p-value |
|---|---|---|---|---|---|
| Carcinogenic Exposure Summary Score | 501.63 | (461) | 478.68 | (517) | 0.19 |

The categorization of the continuous variable is shown in Table 6.37. The categorical variable of total carcinogenic exposure was not significant (p-value 0.26).

**Table 6.37 Categorical Distribution of Carcinogenic Exposure According to Hsieh et al Linkage System for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value |
|---|---|---|---|
| 0-50$^{th}$ percentile (scores 0.00-4.00) | 227 (49.2) | 267 (51.6) | 0.26 |
| 50-75$^{th}$ percentile (scores 4.01-32.00) | 109 (23.6) | 133 (25.7) | |
| 75-100$^{th}$ percentile (scores 32.01-1012) | 125 (27.1) | 117 (22.6) | |
| **Total** | **461 (100)** | **517 (100)** | |

### 6.6.2.3 Pesticide Exposure According to Residential History

The lifetime percentage spent in a rural location was used as a proxy measure for pesticide exposure as previously mentioned in the Methods chapter. The categorization of the continuous variable and the subsequent chi-square analysis is shown in Table 6.38. Once again, no statistical significance at the $\alpha<0.05$ level was found.

**Table 6.38 Distribution of Residence Based on Urban/Rural Location for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Lived in rural area all their lives | 27 (5.4) | 19 (3.3) | 0.10 | 1.6 (.90,3.0) |
| Lived in urban all or part of their lives | 476 (94.6) | 549 (96.7) | | Ref. |
| **Total** | **503 (100)** | **568 (100)** | | |

Calculation of the crude odds ratios was performed in order to compare the Canada-wide sample with the Prairie Provinces sample; 0.6 and 1.6 respectively. The direction of risk in the Prairie Provinces, although not statistically significant, had switched over from being protective to being at increased risk. A province by province analysis was done to see what the risk was for each province in an effort to find out why the direction had changed. The results are shown in Table 6.39. Manitoba, Saskatchewan and Nova Scotia were the three provinces that had an OR > 1.0 indicating increased risk, this clearly showed that the change-over that occurred in the subgroup was due to Manitoba and Saskatchewan. The large sample size from Ontario and the protective direction of the other 5 provinces likely caused the protective factor result in the Canada-wide sample.

**Table 6.39 Distribution of Residence Based on Rural Location by Province**

| Variable | Cases (%) | Controls (%) | Crude OR (95% CI) | Pearson's Chi-square p-value |
|---|---|---|---|---|
| Newfoundland | 7 (10.8) | 15 (12.8) | 0.8 (.32, 2.1) | 0.68 |
| Prince Edward Island | 20 (15.0) | 36 (26.1) | 0.5 (.27, .92) | 0.03* |
| Nova Scotia | 19 (17.8) | 41 (17.4) | 1.0 (.56, 1.9) | 0.94 |
| Ontario | 25 (3.3) | 60 (5.8) | 0.6 (.34, .89) | 0.01* |
| Manitoba | 11 (9.6) | 3 (2.0) | 5.3 (1.5, 19.6) | 0.01* |
| Saskatchewan | 9 (7.7) | 4 (3.2) | 2.5 (.75, 8.4) | 0.13 |
| Alberta | 7 (2.6) | 12 (4.1) | 0.6 (.24, 1.6) | 0.31 |
| British Columbia | 6 (0.8) | 5 (1.2) | 0.6 (.18, 2.0) | 0.41 |

* p-value <0.05 denoting statistical significance

### 6.6.2.4. Assessing Increased Risk from Increased Opportunities of Exposure

The new variable, *Level of Exposure,* which measured the combined effect of multiple sources of pesticide exposure did not show any statistically significant differences between the cases and controls in the 3 groups at $\alpha < 0.05$.

**Table 6.40 Pesticide Level of Exposure Summary According to All Sources for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| No pesticide exposure | 371 (81.5) | 423 (84.9) | 0.08 | ref |
| Pesticide exposure from one source | 71 (15.6) | 70 (14.1) | | 1.1 (.81, 1.7) |
| Pesticide exposure from more than one source | 13 (2.9) | 5 (1.0) | | 2.9 (1.1, 8.0) |
| **Total** | **455 (100)** | **498 (100)** | | |

### 6.6.3. Breast Cancer Covariates

#### 6.6.3.1. Reproductive Risk Factors

The variables representing the reproductive risk factors in Tables 6.41 and 6.42 follow the same distribution as the Canada-wide sample. Whereas, nearly all the variables in the large sample had statistically significant differences, the sub group did not exhibit any significant p-values. However the differences between the cases and controls are in the expected directions, i.e. controls started menstruating at a later age than cases.

**Table 6.41 Reproductive Risk Factors (continuous) for Breast Cancer for Prairie Provinces**

| Variable | Cases (n) | Mean | Std Dev | Controls (n) | Mean | Std Dev | Independent Samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Age when first menstruated | 480 | 12.7 | 1.5 | 533 | 12.9 | 1.6 | 0.07 |
| Age at end of first pregnancy | 450 | 23.8 | 5.0 | 504 | 23.4 | 4.4 | 0.18 |
| Total number of pregnancies | 504 | 3.2 | 2.1 | 568 | 3.3 | 2.3 | 0.58 |
| Lifetime months of breastfeeding | 504 | 6.0 | 10.1 | 564 | 6.5 | 11.8 | 0.46 |
| Age when ovaries removed | 57 | 49.3 | 8.3 | 54 | 47.2 | 10.6 | 0.25 |
| Total years being in menopause | 495 | 9.9 | 9.8 | 547 | 10.6 | 10.1 | 0.27 |
| Total years menstruated | 475 | 33.1 | 6.8 | 520 | 32.4 | 7.7 | 0.11 |

**Table 6.42 Reproductive Risk Factors (categorical) for Breast Cancer for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Is post-menopausal | 321 (63.7) | 368 (64.8) | 0.71 | 0.98 (.90, 1.1) |
| Has had routine mammograms | 288 (57.6) | 286 (50.6) | 0.02* | 1.1 (1.0, 1.3) |
| Has never been pregnant | 51 (10.2) | 57 (10.1) | 0.98 | 1.0 (.70, 1.4) |
| Has never breastfed | 148 (29.4) | 179 (31.5) | 0.45 | 0.93 (.78, 1.1) |

* p-value <0.05 denoting statistical significance

### 6.6.3.2. Socioeconomic Risk Factors

The two socioeconomic indicators of education and income were not significantly different between the cases and controls at the $\alpha$ <0.05 level. However, the ORs for income now show a negative association compared to the Canada-wide sample, which showed no association for the middle income group and increased risk for the high income group. This is another indication that the Prairie Provinces are different from the rest of Canada in some measures.

Table 6.45 shows the distribution of marital status. Although statistically insignificant, it is interesting to note that the expected association between being single and breast cancer is more pronounced in the sub-group where the OR is 1.6, compared to the Canada-wide sample of 1.0, which indicated no association.

**Table 6.43 Education Level and Risk of Breast Cancer for Prairie Provinces**

| Variable | Cases (n) | Mean | Std Dev | Controls (n) | Mean | Std Dev | Independent Samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Total years of education | 497 | 12.1 | 2.9 | 564 | 12.3 | 3.1 | 0.37 |

**Table 6.44 Income Level and Risk of Breast Cancer for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Yearly Income less than $19,999 | 90 (17.9) | 85 (15.0) | 0.19 | ref |
| Yearly Income between $20,000-49,999 | 171 (33.9) | 223 (39.3) | | 0.72 (.51,1.0) |
| Yearly Income over $50,000 | 122 (24.2) | 119 (21.0) | | 0.97 (.66, 1.4) |
| Income unknown | 121 (24.0) | 141 (24.8) | | N/A |
| **Total** | **504 (100)** | **568 (100)** | | |

**Table 6.45 Marital Status and Risk of Breast Cancer for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Married | 376 (74.6) | 438 (77.1) | 0.31 | ref |
| Single | 27 (5.4) | 20 (3.5) | | 1.6 (.87, 2.8) |
| Divorced/Widowed/Other | 101 (20.0) | 110 (19.4) | | 1.1 (.79, 1.4) |
| **Total** | **504 (100)** | **568 (100)** | | |

### 6.6.3.3. Body Size as a Risk Factor in the Prairie Provinces

The height between cases and controls was not significantly different and neither was the BMI measurement. Current weight and maximum weight were statistically significantly different, it appeared that cases were and had been heavier than controls.

**Table 6.46 Body Size and Risk of Breast Cancer for Prairie Provinces (continuous)**

| Variable | Cases (n) | Mean | Std Dev | Controls (n) | Mean | Std Dev | Independent samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Height (cm) | 503 | 162.5 | 7.0 | 568 | 162.1 | 6.8 | 0.34 |
| Current weight (kg) | 501 | 68.4 | 13.6 | 567 | 66.5 | 13.2 | 0.02* |
| Maximum weight (kg) | 503 | 74.3 | 14.7 | 564 | 72.4 | 14.8 | 0.04* |
| Body Mass Index (BMI) | 501 | 25.9 | 4.9 | 567 | 25.3 | 5.0 | 0.07 |

* p-value <0.05 denoting statistical significance

The categorization of the BMI also had a significantly different distribution as seen in Table 6.47. There were a higher number of cases that had a BMI > 28 and the crude OR was 1.4, indicating that women who had BMIs >28 had an increased risk of getting breast cancer when compared to women who had BMIs <20. Whereas, having a BMI between 20 and 28 had a slightly negative association indicating that there was negligible difference between having a BMI of < 20 and having a BMI between 20 and 28. The distribution of the body size variables followed the same pattern as the larger sample.

**Table 6.47 Body Size and Risk of Breast Cancer for Prairie Provinces (categorical)**

| Variables | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR |
|---|---|---|---|---|
| BMI less than 20 | 42 (8.3) | 49 (8.6) | 0.007* | ref |
| BMI between 20 and 28 | 316 (62.7) | 401 (70.6) | | 0.92 (.593, 1.425) |
| BMI greater than 28 | 146 (29.0) | 118 (20.8) | | 1.4 (.895, 2.328) |
| **Total** | **504 (100)** | **568 (100)** | | |

* p-value <0.05 denoting statistical significance

### 6.6.3.4 Lifestyle Choices as Risk Factors in the Prairie Provinces

Smoking and alcohol consumption were not statistically significantly different between the cases and controls at the $\alpha$ <0.05 level for both the continuous and categorical variables.

**Table 6.48 Smoking and Alcohol and Risk of Breast Cancer for Prairie Provinces (continuous)**

| Variables | Cases (n) | Mean | Std Dev | Controls (n) | Mean | Std Dev | Independent samples t-test p-value |
|---|---|---|---|---|---|---|---|
| Pack yrs of smoking | 490 | 8.8 | 12.7 | 558 | 7.5 | 12.0 | 0.08 |
| All alcohol, serving/wk | 327 | 1.3 | 3.2 | 349 | 1.4 | 3.9 | 0.67 |

**Table 6.49 Smoking and Alcohol and Risk of Breast Cancer for Prairie Provinces (categorical)**

| Variables | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Never smoked | 234 (49.5) | 285 (51.1) | 0.76 | ref |
| Ex-smoker | 149 (31.5) | 164 (29.4) | | 1.0 (.91, 1.2) |
| Current smoker | 90 (19.0) | 109 (19.5) | | 1.0 (.72, 1.4) |
| **Total** | **473 (100)** | **558 (100)** | | |
| Drinking much less alcohol compared to 20 years ago | 142 (30.7) | 190 (35.3) | 0.31 | |
| Drinking same amount as 20 years ago | 200 (43.2) | 216 (40.1) | | |
| Drinking more than 20 years ago | 121 (26.1) | 133 (24.7) | | |
| **Total** | **463 (100)** | **539 (100)** | | |

### 6.6.3.5 Ethnicity as a Risk Factor in the Prairie Provinces

In following the same analysis protocol as the Canada-wide sample, ethnicity was compared between cases and controls. Whereas, the large sample had significant differences between those of French, Scottish, Irish, and Jewish ancestry, the sub-group showed that those of German, Ukranian, Chinese and Jewish ancestry were significantly different. It's interesting that the only ethnic group that is significantly different between both groups is the Jewish group. Although the Prairie Provinces have a higher aboriginal population, this was not evident in the sample representation and there were no significant differences between the cases and controls. No further analyses were carried out for ethnicity.

**Table 6.50 Ethnicity and Risk of Breast Cancer for Prairie Provinces**

| Variables | Cases (%) | Controls (%) | Pearson's Chi-square p-value |
|---|---|---|---|
| French ethnic origin | 58 (11.5) | 68 (12.0) | 0.81 |
| English ethnic origin | 186 (36.9) | 222 (39.1) | 0.46 |
| German ethnic origin | 130 (25.8) | 112 (19.7) | 0.02* |
| Scottish ethnic origin | 119 (23.6) | 129 (22.7) | 0.73 |
| Italian ethnic origin | 7 (1.4) | 13 (2.3) | 0.28 |
| Irish ethnic origin | 93 (18.5) | 106 (18.7) | 0.93 |
| Ukranian ethnic origin | 40 (7.9) | 80 (14.1) | 0.001* |
| Chinese ethnic origin | 11 (2.2) | 1 (0.2) | 0.002* |
| Dutch ethnic origin | 30 (6.0) | 31 (5.5) | 0.73 |
| Jewish ethnic origin | 10 (2.0) | 2 (0.4) | 0.02* |
| Polish ethnic origin | 17 (3.4) | 29 (5.1) | 0.16 |
| Black ethnic origin | 3 (0.6) | 1 (0.2) | 0.35 |
| Aboriginal ethnic origin | 3 (0.6) | 11 (1.9) | 0.06 |
| Metis ethnic origin | 14 (2.8) | 12 (2.1) | 0.48 |
| Inuit ethnic origin | 0 | 0 | N/A |

* p-value <0.05 denoting statistical significance

### 6.6.4 The Logistic Regression Model of the Prairie Provinces

Due to the smaller sample size, the risk of every variable being statistically significant was no longer an issue, in fact it was now the opposite, hardly any variables were statistically significant. Therefore, the inclusion criteria into the three models for the Prairie Provinces were based on following the same protocol as the Canada-wide sample. The pesticide measures *handling pesticides at home or work, occupation according to McDuffie et al* and *rural residence* were selected, along with *age50, gailmenstruation, gailbirth, income, smoking,* and *BMI.*

Table 6.51 shows the variables that were recoded to facilitate the regression modeling.

**Table 6.51 Recategorized Variables for Inclusion in Regression Model for Prairie Provinces**

| Variable | Cases (%) | Controls (%) | Pearson's Chi-square p-value | Crude OR (95% CI) |
|---|---|---|---|---|
| Age 50 or older | 341 (67.7) | 399 (70.5) | 0.32 | 0.96 (.89, 1.0) |
| First menses before 12 yrs old | 304 (60.3) | 332 (58.5) | 0.54 | 1.0 (.93, 1.1) |
| First pregnancy after 30 yrs of age | 112 (22.2) | 106 (18.7) | 0.15 | 1.2 (.94, 1.5) |
| Pack years smoking | 256 (52.2) | 273 (48.9) | 0.28 | 1.1 (.95, 1.2) |

The results from the regression analyses are shown in Tables 6.52, 6.53 and 6.54. Although none of the results were statistically significant, the adjusted ORs for measuring pesticide exposure according to the questionnaire and occupation were a bit larger than those from the Canada-wide sample. Pesticide exposure according to rural residence now became a risk factor, opposite to the Canada-wide sample. This could be an indication that women from the three Prairie Provinces do in fact have increased pesticide exposures through their occupations and their place of residence.

**Table 6.52 Results from the Logistic Regression Analysis for Pesticide Exposure According to Questionnaire for Prairie Provinces**

| Variables | Adjusted Odds Ratio | 95% Confidence Interval Lower | Upper | p-value |
|---|---|---|---|---|
| Beginning menses 12 years old or younger | 1.1 | 0.86 | 1.4 | 0.41 |
| Having first baby after the age of 30 | 1.2 | 0.90 | 1.7 | 0.20 |
| Body Mass Index greater than 28 | 0.64 | 0.39 | 1.1 | 0.08 |
| Income greater than $50,000 | 1.0 | 0.70 | 1.6 | 0.88 |
| Smoking | 1.1 | 0.89 | 1.5 | 0.31 |
| **Handling pesticides at home or work** | **1.3** | **0.90** | **2.0** | **0.15** |

**Table 6.53 Results from the Logistic Regression Analysis for Pesticide Exposure According to Occupation for Prairie Provinces**

| Variables | Adjusted Odds Ratio | 95% Confidence Interval Lower | Upper | p-value |
|---|---|---|---|---|
| Beginning menses 12 years old or younger | 1.1 | 0.82 | 1.4 | 0.62 |
| Having first baby after the age of 30 | 1.3 | 0.92 | 1.8 | 0.15 |
| Body Mass Index greater than 28 | 0.72 | 0.42 | 1.2 | 0.24 |
| Income greater than $50,000 | 1.0 | 0.68 | 1.6 | 0.83 |
| Smoking | 1.1 | 0.88 | 1.5 | 0.32 |
| **Occupation according to McDuffie et al coding system** | **1.8** | **0.93** | **3.4** | **0.08** |

**Table 6.54 Results from the Logistic Regression Analysis for Pesticide Exposure According to Rural Residence for Prairie Provinces**

| Variables | Adjusted Odds Ratio | 95% Confidence Interval Lower | Upper | p-value |
|---|---|---|---|---|
| Beginning menses 12 years old or younger | 1.1 | 0.84 | 1.4 | 0.54 |
| Having first baby after the age of 30 | 1.2 | 0.90 | 1.7 | 0.19 |
| Body Mass Index greater than 28 | 0.63 | 0.38 | 1.0 | 0.07 |
| Income greater than $50,000 | 1.0 | 0.70 | 1.6 | 0.80 |
| Smoking | 1.2 | 0.92 | 1.5 | 0.18 |
| **Living 100% in rural setting** | **1.8** | **0.95** | **3.4** | **0.07** |

In answering the secondary research question of - *Is there an increased risk for breast cancer in females from a farming background?* – the analyses showed that although the adjusted ORs supported the hypothesis, the findings were not statistically significant.

# 7. Discussion

## 7.1 Interpretation of the Findings

The rationale for this study was to explore the possibility of an association between pesticide exposure and breast cancer in females in Canada based on two factors; occupation and residence. For the Canada-wide sample there was no significant association between pesticide exposure and breast cancer when occupation was used as a proxy measure for pesticide exposure. When residing in a rural location was used as a proxy measure for pesticide exposure, a significant negative association was identified. The sub group analysis of Manitoba, Saskatchewan and Alberta was more conducive to the hypothesis that exposure to pesticides increases the risk for breast cancer however the findings were not statistically significant, either by occupation or residence. The findings are inconclusive but this seems to follow the contradictory pattern found in the literature.

### 7.1.1. Occupational Exposure

The difficulty in attempting to measure pesticide exposure based on occupation has been identified in other studies. It is logical that the strongest correlation between cancer and pesticide exposure based on occupation would be through individuals that work with pesticides on a regular basis. A study by Kogevinas et al (1993) examined cancer incidence and mortality of women working in the production of chlorophenoxy herbicides, chlorophenols and dioxins.[16] There was no association between breast cancer and occupational exposure to the three chemicals. Two studies which investigated cancer incidence and cancer mortality in pesticide applicators found

decreased rates of cancers and cardiovascular diseases overall when compared to the general population.[68,69] The pesticide applicators included anyone that needed a state/provincial license to work with large quantities and highly toxic pesticides, which included farmers. The healthy-worker theory was offered as an explanation for the decreased disease rates in both studies. With relation to females and this thesis, Figa-Talamance et al (1993) excluded female pesticide applicators while Fleming et al (1999) found significantly decreased rates of breast cancer in female pesticide applicators while rates for all genital and cervical cancers were significantly elevated. [69]

A broader measure of possible pesticide exposure used in this thesis and found in the literature was farming as an occupation. Very few females were found in the farming occupational categories in previous studies and this observation was also supported by this thesis where only 7% of the rural sample population reported farming as an occupation. Several studies[36,70] did not include the job classification at all and several had such low numbers that meaningful results were not possible.[45,46] Cantor et al (1995) found a negative association between exposure to insecticides and breast cancer.[34] Furthermore, a review of international studies by Goldberg & Labreche identified 5 studies that also showed significant negative associations between farming as an occupation and breast cancer.[71] A recently published study also found a significant negative association between female farmers and breast cancer.[17]

### 7.1.2. Residential Exposure

Measuring environmental agents that could be detrimental to health has specific challenges that have not been overcome yet and establishing a causal relationship based

on environmental exposure is even more difficult. One study design that attempts to measure the effect of the environment on human health is the ecological study. However, one inherent weakness within that design is the difficulty in generalizing the findings at the individual level.

An ecological study in Kentucky[13] and one in Costa Rica[14] found significant increases in breast cancer incidence based on increased levels of pesticides in the environment. Although the thesis findings, which were based on individual residential measures did not support the above studies, the option for an ecological type study may be possible. Aggregate data, where the smallest area measurement was county or rural municipality was available and perhaps this would have been a more logical use of the data. However, the number of breast cancer cases may be too small to measure in an ecological study.

### 7.2 Strengths of The Study

The case control design is particularly well suited to studying diseases that are rare or have long latency periods such as breast cancer. When a disease takes a long time to manifest itself, it becomes more difficult to establish a cause-effect relationship. In rare diseases such as certain types of cancer, it takes a long time to get sufficient numbers in other designs such as cohort or cross-sectional. In this case, data from 2,362 individuals that had breast cancer was collected over a three-year period. The high number of cases would provide sufficient statistical power for analyses.

Decreasing the amount of risk to study subjects is also a major consideration in research. Retrospectively assessing possible risk factors did not impose further risk to

the subjects as they would have already been exposed and the cases had already been diagnosed with breast cancer. The self-administered questionnaire was the only intervention imposed on the subjects and with the exception of the 10% random sample verification by telephone, it was a one-time only measure.

Data on known or suspected covariates were collected and adjusted, making the possibility of finding a cause-effect relationship stronger. Having access to three different sources of information for assessing pesticide exposure increased the possibility of finding significant results. As well, being able to account for known risk factors such as age, socioeconomic status, and reproductive factors made the study design and analysis stronger.

As a general rule, case control study designs are quick and relatively inexpensive.[67] In this case, data collection occurred over a three-year period and resulted in data from over 25,000 individuals. The data available provides ample information for a multitude of research studies for various cancers and various risk factors. Since this thesis used data that had previously been collected and collated, the analysis was quick and there was no cost involved in accessing and using the data.

### 7.3 Study Limitations

There were limitations in this study, some due to the case control study design in general and others due to the specific study. In general, case-control studies are quick and inexpensive compared to cohort studies, two highly attractive characteristics which make this design increasingly popular.[72] However, it is also highly susceptible to bias. Of particular relevance to this study were: recall bias, non-respondent or volunteer bias,

diagnostic suspicion bias, and wrong sample size or significance bias. These are discussed in greater detail further on.

Another inherent weakness in the case control design is that weak associations (OR<1.5) may not be stable in this design. As a rule of thumb, OR>2.0 are considered to be stable and will not be biased to the null.[67] All the variables were less than 1.5 and were not considered to be strong predictors with the exception of those that were less than 1.0, which indicated a negative association.

There were also certain limitations due to the data content. The literature states that increased exposure to xeno-estrogens earlier in a woman's life may increase the risk for breast cancer.[2] This theory could not be investigated due to the limitations of the use of their residential history caused by patient confidentiality. Although the summary variable of *percent living in an urban area* was a continuous variable, it was impossible to separate into individual age. Therefore, analyzing if a woman grew up on a farm and therefore had potential exposure to pesticides during puberty was not possible.

As previously mentioned, there are over 7,500 pesticides available on the market, of which many are not carcinogenic. The inability to differentiate between types of pesticides was a limitation. If an association had been found, there would be no way to determine which pesticides may have had the greatest effect.

### 7.3.1. Recall Bias

The recall of cases and controls can vary in both the amount of information that is remembered and the accuracy.[72] Cases may be more likely to provide greater detail and to recall exposures to known or suspected carcinogens because they are looking for

possible causes as to why they got breast cancer, thus causing false positive associations. However, this did not appear to be the case with regards to pesticide exposure in this study. Controls, on the other hand may be less likely to provide explicit, informative detail because they may not have the same interest level and commitment. There may have been under-reporting of lifestyle behaviours which are seen negatively by society, such as alcohol and smoking. Since the questionnaire asked for lifetime histories of occupation and residence, full detailed descriptions may not have been complete. Under-reporting of exposure to pesticides and herbicides is a definite possibility, individuals probably don't consider using ant-killer or garden weed-killer as pesticide exposure.

### 7.3.2. Misclassification Bias

Coding the occupations of the women could be a source of bias. The lack of a linkage system for occupation that was based strictly on pesticide exposure and female occupations was an important limitation. Three separate coding schemes were used in the analysis, however none were entirely appropriate for the purpose of this thesis.

Another possible misclassification could have occurred with women who were unemployed. The analysis of the Prairie Provinces showed that women who stated they had never been employed were more likely to have lived all their lives in a rural area, although this result was not evident in the Canada-wide sample. Women who reported that they had never been employed did not fill out any of the questions on occupation and possibly additional numbers of women exposed to pesticides were lost.

Misclassification according to residential history was also a potential source of bias. The summary variable of *percent living in an urban area* was based on three distinct inclusion criteria: municipal drinking water, no RR# in the postal code and no zero as the second character in the postal code. If a woman lived in a small rural town and her husband farmed just outside of the town, the local post office would have a 0 as the second character for the postal code but the water might be supplied by the town indicating a municipal water source, therefore she would be categorized as being urban. The proxy measure of pesticide exposure according to residence would therefore be lost.

### 7.3.3. Non-respondent or Volunteer Bias

Non-respondent bias can be a problem if the individuals who refuse to take part in the study exhibit different characteristics from those that responded.[72] Schlesselman states that non-respondent bias is likely if the response rates are less than 80%.[67] The response rate for cases was 77.4% and 71.3% for controls. Lifestyle factors such as smoking and drinking alcohol that the non-respondents may have thought would be viewed negatively may have prevented them from taking part in the study. Healthier individuals may be more likely to volunteer to participate, which could bias the results in favour of the controls. There may have been different levels of exposures and/or other exposures from either the non-respondent cases or controls. Ideally, the non-respondents should have been interviewed to see if they differed from the respondents. However, this was not possible in this study likely due to time and financial constraints.

### 7.3.4. Diagnostic Suspicion Bias

Diagnostic suspicion bias usually refers to prior knowledge of patient exposure to suspect causes, which then leads to more intense diagnostic procedures.[72] A slightly different version of this bias was evident in this study. Women who are over the age of 50 are encouraged to have routine mammograms and the results showed that having routine mammograms was associated with breast cancer. Receiving mammograms was not necessarily a risk factor, it indicated that because of screening protocols, women who had routine mammograms were more likely to be diagnosed.

### 7.3.5. Wrong Sample Size or Significance Bias

Although most statistics textbooks show how to calculate the minimum sample size required to increase the odds of finding statistically significant results, having too large a sample size can also be a hindrance. Sackett (1979) states that samples which are too small can prove nothing, samples which are too big can prove anything.[72] When there is a large sample size, the 95% Confidence Interval becomes narrower and therefore even a relatively small difference will become statistically significant. According to the power calculations in part 5.1.2 of the methods section, assuming that 2% of the controls were exposed to pesticides and using the conventional alpha level of 0.05, beta level of 0.20 and the sample size of 2,362, an OR of 1.7 or higher would be statistically significant. The comparability results of the Canada wide sample showed that nearly every variable was statistically significant, however the ORs did not reach the required significance level of 1.7. Therefore, only certain summary variables were included in the regression analysis. When the sample size is too large and everything is

statistically significant, the importance of clinical significance plays a larger part in the interpretation of the results.

### 7.4. Future Research

The contradictory and inconclusive results of this thesis as well as from previous studies, indicates the obvious need for further research. More research with the data that was used for this thesis is recommended. An ecological type study could be initiated to make better use of the aggregate data of the residential history. This might be a better indication of possible pesticide exposure since only 9% of those who had lived all of their lives in a rural area had self reported exposure to pesticides. In addition, studies that focus specifically on pesticides and on known or suspected carcinogenic pesticides might get better self-reported exposure rather then trying to collect information on every possible environmental exposure.

Other questions to think about include; if breastmilk is one of the only ways certain pesticides are expelled from a woman's body, does the cancer risk for her baby increase? Could there be a cumulative effect of pesticides passed on through the generations of mothers and daughters through breastmilk? When a woman grows up on a farm during her pubertal years, does her exposure to pesticides increase her risk at this crucial developmental stage of her life? Which pesticides exhibit the most deleterious effect on breast tissue? Do the 7,500 registered pesticides have a cumulative effect or do they act independently?

In light of these type of unanswered questions and contradictory findings from previous studies, the Canadian Breast Cancer Network (CBCN), a national network of

breast cancer survivors in Canada, issued a position statement in 1997 supporting further research in the area of xeno-estrogens.[73] Recommendations include determining how foreign estrogens might contribute to breast cancer, whether different life stages of breast development include periods of high vulnerability to foreign hormones and whether hormone disrupting chemicals expressed through breast milk increases the risk of breast cancer for the infants.

There is an interesting study that shows great promise in helping to determine health risks of women and children who live on farms. The Agricultural Health Study[74] is a prospective cohort study based out of Iowa and North Carolina that started data collection in 1994 with an expected follow-up time of 10 years or more. Exposure to pesticides is an important part of this study and although some results have already been published, none relate specifically to pesticides and breast cancer.

### 7.5 Conclusion

As the incidence rates of breast cancer continue to increase, so do the demands of women for answers, however only 33% are attributable to known risk factors. Breast cancer prevention is high on the public agenda and environmental and occupational factors are becoming more suspect. This thesis examined the controversial environmental and occupational issue of pesticide exposure. The findings did not produce any definitive results based on occupation, however there were very low numbers of women who reported working in an occupation where pesticide exposure was possible. Place of residence, where living in a rural area was hypothesized to have greater opportunities for pesticide exposure, resulted in a significant negative

association. The data was reliable because the known risk factors were identified in the analysis. The difficulty in measuring environmental and occupational exposures such as pesticides will continue to challenge researchers. Perhaps a combination of objective measures such as serum levels coupled with subjective measures of personal interviews would provide more reliable data. More precise methods of data collection and measurement relating not only to pesticides but to all potentially carcinogenic environmental exposures will be necessary. The role pesticides play in the etiology of breast cancer remains indefinite and the search for irrefutable answers must continue.

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Appendix I

Ethics Application Form

**UNIVERSITY OF SASKATCHEWAN ADVISORY COMMITTEE ON ETHICS IN HUMAN EXPERIMENTATION**

**(BIOMEDICAL SCIENCES)**

ORS USE ONLY
File Number:

Date Received:

PROJECT TITLE:
**Pesticide Exposure and Female Breast Cancer Risk in Canada: A Case Control Study**

SUBMITTED BY: Dr. Anne Leis DEPARTMENT: Community Health & Epidemiology
(Faculty Member)

CO-INVESTIGATOR(S): Rose Alderman DEPARTMENT: Community Health & Epidemiology

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT: University of Saskatchewan

1. Hypothesis (state briefly the proposition the research is seeking to uphold):
There is an increased risk for breast cancer among women who have been exposed to pesticides either through occupational exposure or residential exposure in Canada.

2. Academic Validity (provide your own comments and those resulting from peer review. Indicate if any committee or other body has assessed the project's scientific validity.)
The project will use data collected through the National Enhanced Cancer Surveillance System, a collaboration of the Cancer Bureau, Laboratory Centre of Disease Control, Health Canada and Canadian Cancer Registries Epidemiology Research Group. The methodology for the data collection has been published in Environmetrics, 9, 495-504 (1998). Data collection was carried out from 1994 to Spring 1997. All researchers accessing this database are required to sign a

confidentiality release form and to follow a protocol for maintaining the confidentiality of the participants.

3. Funding (indicate the source of funds supporting the research. If externally funded, state whether the grant or contract is in application or has been awarded).

   Not Applicable

4. Subjects (classify by requirements of research initiative and by other subject categories, if appropriate):

   All cases of female breast cancer from across Canada will be used in the analysis. The questionnaire was completed within 6 months after diagnosis. The controls were randomly selected from across Canada so that there was an approximate one-to-one match for each case in terms of sex and age, within 5 years. There is a total of 2,360 cases and 2,488 controls in the database.

5. Procedures (clearly identify the medical and other procedures to be followed in obtaining research data):

   The data will be accessed through Ken Johnson, Environmental Risk Assessment and Case Surveillance Division, Cancer Bureau, Laboratory Centre for Disease Control, Health Protection Branch, Health Canada. The data has already been collected and coded, therefore the researcher will not have any means of identifying individual persons that participated in the study.

6. Time Period (indicate the dates when the research project is expected to begin and to be completed. A copy of the final report should be filed with the Office of Research Services. If this is not feasible, ORS should be notified when the research is completed.)

   The analysis of the data is expected to begin in July 2000, or as soon as the data has been received, with a completion date of April 2001.

7. Consent Form (include a copy of the consent form or give reasons if one is not being used):

   No consent form is included in this ethics submission as this data has already been collected by another agency and this is a secondary analysis.

8. Other Comments (include further information or details which might assist the Ethics Committee in understanding the nature and purpose of the research):

---

The Research Proposal has been reviewed and is recommended for approval.

_____

Department Head

***NOTE:*** *Researcher's Summary and consent form to be supplied in 15 copies along with 2 copies of the complete protocol or grant application.* ***Please submit to: The Office of Research Services, Kirk Hall Room 207, University of Saskatchewan, 117 Science***

***Place, Saskatoon, SK S7N 5C8.*** *If the research involves patients, clients, residents, staff, or resources of Saskatoon District Health agencies and/or facilities (SDH agencies/facilities include: Royal University Hospital, Saskatoon City Hospital, St. Paul's Hospital, Parkridge Centre, Public Health Services, Home Care Services, Mental Health Services, Delisle & District Community Health Centre, Borden Community Health Centre and Addiction Services), 1 complete copy of the Researcher's Summary and consent form must also be submitted to the Office of Research Services, Saskatoon District Health, c/o Box 16, Royal University Hospital, along with Saskatoon District Health's "Application for Approval to Conduct Research".*

**Abstract**

Breast cancer is the most common type of cancer among females in Canada. The importance of personal characteristics such as obesity, diet, age of menarche, age of menopause, parity, and family history have been implicated. However, these only explain a small percentage of the cases. Studies have shown that occupational and environmental risk factors could also play an important role in the high incidence of this disease. There have been few population studies done in Canada to explore the role of pesticides as possible risk factors. The use of pesticides has steadily been increasing in our society and the data that is available provides an excellent opportunity to see if there is a causal relationship.

This research is going to look at the following questions: Is there an increased risk for breast cancer in females who are exposed to pesticides in their occupation?
Is there an increased risk for breast cancer in females who are exposed to pesticides in their residential setting?
Is there an increased risk for breast cancer in females from a farming background?

This will be a case control study to make the best use of the data available, which was collected using a case-control study design. The cases will be matched with controls on an approximate one-to-one basis in terms of sex and age – within 5 years. All cases of female breast cancer across Canada will be used in the analysis. There is a total of 2,360 cases and 2,488 controls.

The variables of interest are occupational history and residential history. Potential confounding variables are: household income, level of education, alcohol consumption, height, weight, menstruation history, pregnancy history, breastfeeding history, smoking, age, and ethnicity. The data will be analyzed using the SPSS statistical program. In order to control for confounding and interaction, multiple logistic regression analysis will be used. The findings will be expressed as odds ratios with the required statistical significance and confidence intervals presented.

University of Saskatchewan
Advisory Committee on Ethics in Human Experimentation

June 5, 2000

# Certificate of Approval

| 'AL INVESTIGATOR | DEPARTMENT | BMC# |
|---|---|---|
| | Community Health & Epidemiology | 2000-124 |

TION(S) WHERE RESEARCH WILL BE CARRIED OUT

ity of Saskatchewan

)RING AGENCIES

e Exposure and Female Breast Cancer Risk in Canada: A Case Control Study

| 'AL DATE | EXPIRY DATE |
|---|---|
| 2000 | July 1, 2001 |

**ICATION**

iversity Advisory Committee on Ethics in Human Experimentation (UACEHE) has reviewed the above-esearch project including the protocol and consent form, if applicable. The proposal was found to be le on ethical grounds. The principal investigator has the responsibility of ensuring that the authorized is carried out according to governing law. This Certificate of Approval is valid for the above time period l there is no change in experimental procedures.

**IG REVIEW REQUIREMENT(S)**

CEHE will require the submission of an annual status report prior to the expiry date of July 1, 2001.

)VED.

dest, Chair
ity Advisory Committee on
n Human Experimentation



d all correspondence to:
Office of Research Services
University of Saskatchewan
Room 207 Kirk Hall, 117 Science Place
Saskatoon, SK S7N 5C8
Phone: (306) 966-4053 Fax: (306) 966-8597

# Appendix II

## Letter of Intent

May 31, 2000

Ken Johnson, DAAC secretary
Environmental Risk Assessment and Case Surveillance Division
Laboratory Centre for Disease Control

Dear Mr. Johnson,

Please find attached a copy of the abstract for my proposed thesis and this as my Letter of Intent. I am in the process of writing up my final proposal and expect to be done by the end of June. My thesis committee members will be meeting on July 7th to discuss my final proposal. I have submitted a request for approval from the University of Saskatchewan Advisory Committee on Ethics in Human Experimentation and their next meeting is scheduled for June 5th, 2000.

I look forward to hearing from you.

Sincerely,
Rose Alderman
University of Saskatchewan Master's Candidate

Pesticide Exposure and Female Breast Cancer Risk in Canada
A Case Control Study

**Abstract**

Breast cancer is the most common type of cancer among females in Canada. The importance of personal characteristics such as obesity, diet, age of menarche, age of menopause, parity, and family history have been implicated. However, these only explain a small percentage of the cases. Studies have shown that occupational and environmental risk factors could also play an important role in the high incidence of this disease. There have been few population studies done in Canada to explore the role of pesticides as possible risk factors. The use of pesticides has steadily been increasing in our society and the data that is available provides an excellent opportunity to see if there is association.

This research is going to look at the following questions: Is there an increased risk for breast cancer in females who are exposed to pesticides in their occupation?
Is there an increased risk for breast cancer in females who are exposed to pesticides in their residential setting?
Is there an increased risk for breast cancer in females from a farming background?

This will be a case control study to make the best use of the data available, which was collected using a case-control study design. The cases will be matched with controls on an approximate one-to-one basis in terms of sex and age – within 5 years. All cases of female breast cancer across Canada will be used in the analysis. There is a total of 2,360 cases and 2,488 controls.

The variables of interest are occupational history and residential history. Potential confounding variables are: household income, level of education, alcohol consumption, height, weight, menstruation history, pregnancy history, breastfeeding history, smoking, age, and ethnicity. The data will be analyzed using the SPSS statistical program. In order to control for confounding and interaction, multiple logistic regression

analysis will be used. The findings will be expressed as odds ratios with the required statistical significance and confidence intervals presented.

The research is expected to be completed by Spring 2001.

Appendix III

Letter of Support from Saskatchewan Cancer Agency

Date: Tue, 20 Jun 2000 16:12:19 -0500
To: Ken_lcdc_Johnson@hc-sc.gc.ca
From: Diane Robson <drobson@scf.sk.ca>
Subject: Rose Alderman

Ms. Alderman is a masters student in epidemiology who is currently working on her thesis project. Her thesis will explore risk factors for breast cancer with a particular interest in farming as an occupation or residence and the relationship to pesticides.

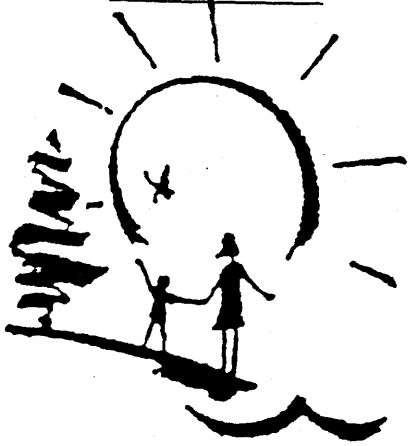
Ms. Alderman has written to you requesting access to data within the NECSP for use in her project.

The Saskatchewan Cancer Agency is supportive of this release of data to Ms. Alderman for the purposes of this thesis work.

Sincerely,

D. Robson
Director of Cancer Registry
Saskatchewan Cancer Agency
ph: 306-766-7516
Fx: 306-766-2179 email: drobson@scf.sk.ca

APPENDIX IV



# Environmental Health Survey

(Confidential when completed)

This form asks a variety of questions about you and your environment, which may affect or be related to your health. The information you provide will help Canadians to understand more about preventing disease.

Please complete each question as best you can even if you are not sure of your answer.

You do not need to fill in the entire questionnaire all at once. You may wish to take a brief rest in the middle.

If you have any questions about the survey or would like help filling it out, please call

_____

at _____

**Please return this questionnaire by**

_____ ____. Thank you for your time.

**ide to filling in this Questionnaire:**

ase choose answers by
rking a circle O — ●

printing in the boxes. ☐ — ☐

☐ — *April*

☐ **Si vous préférez répondre en français, veuillez cocher la case et renvoyer le questionnaire dans l'enveloppe adressée ci-jointe.**



Canada

## GENERAL INFORMATION

Today's date — *Month* ____ *Day* ____ *Year* 19____

**Is anyone helping you** (the person whose name appears on the front of the questionnaire) to complete this questionnaire?

o No o Yes →o Spouse
o Other -- Please specify: ____

When were you born?

*Month* ____ *Day* ____ *Year* 19____

Are you

o Female o Male

To which **ethnic or cultural group(s)** did **your ancestors** belong?

Mark or specify as many as applicable.

o French
o English
o German
o Scottish
o Italian
o Irish
o Ukrainian
o Chinese
o Dutch
o Jewish
o Polish
o Black
o Aboriginal
o Métis
o Inuit
o Other ethnic or cultural group(s) -- Please specify: ____

*Examples of other ethnic or cultural groups are: Portuguese, Greek, Indian, Pakistani, Vietnamese, Japanese, Lebanese, Haitian, etc.*

What is your **marital status**?

o Single
o Married
o Common law
o Widowed
o Divorced/Separated
o Other

What is the **highest grade** (or year) of high school or elementary school that you have completed?

Grade ____ o Never attended school

How many **years of post-secondary** school have you completed?

____ years o none

9. Have you smoked **at least 100 cigarettes** in your entire life?
   o No → Go to 10
   o Yes
   About how old were you when you **first started** smoking cigarettes? ____ years old

   About **how many years** in total did you smoke? ____ years

   Of the entire time you smoked, how many **cigarettes**, on the average, **did you smoke per day**? ____ per day

   **Do you smoke cigarettes now?**

   o No → How old were you when you **stopped** smoking? ____ years old

   o Yes → On the average, about how many **cigarettes a day** do you smoke now? ____ per day

10. Have you ever smoked a **pipe or cigars** regularly?
    o No → Go to 11
    o Yes
    For how many years? ____ years
    About how many pipes or cigars? ____ per day or ____ per week

11. Have you ever used **chewing tobacco** regularly?
    o No → Go to 12
    o Yes
    For how many years? ____ years
    About how many plugs? ____ per day or ____ per week

12. How **tall** are you?
    ____ feet ____ inches or ____ centimetres

13. How much did you **weigh** about 2 years ago?
    ____ pounds or ____ kilograms

14. What is the **most you have ever weighed?** (Women should not include pregnancy.)
    ____ pounds or ____ kilograms

## RESIDENTIAL HISTORY

**15.** Please list each of the places **in Canada** you have lived for at least **1 year**. Start with the most recent residence and follow back to your childhood. (If you cannot remember exact details, provide your best recollection, for example, nearest cross-street or intersection.)

| TIME PERIOD | ADDRESS | | | |
|---|---|---|---|---|
| *First Year* — *Last Year* | Street and Number or Lot, Concession and Township **(If you don't remember the exact address, give the nearest cross-street or intersection.)** | City, Town, or Municipality | County or District, if rural | Province |
| Example: 19 8 9 to 19 9 3 | *97 Greargate Rd.* | *Brandon* | | *Manitoba* |
| 19 to 19 | | | | |
| 19 to 19 | | | | |
| 19 to 19 | | | | |
| 19 to 19 | | | | |
| 19 to 19 | | | | |
| 19 to 19 | | | | |
| | | | | |
| 19 to 19 | | | | |
| 19 to 19 | | | | |
| 19 to 19 | | | | |
| 19 to 19 | | | | |
| 19 to 19 | | | | |
| 19 to 19 | | | | |

| RESS | Main source of **drinking water** | Primary types of **home heating** (Mark those which apply.) | Were you aware of **dusts or odours from industry** while living at this residence? | How many **regular smokers** usually lived in this home with you? | |
|---|---|---|---|---|---|
| | *Townlcity water* *Dug well* *Drilled well* *Bottled* *Other* *Don't know* | *Oil* *Natural gas/propane* *Electric* *Wood* *Coal* *Other* *Don't know* | *Never or rarely* *At least once a month* *At least once a week* *At least once a day* | *None* *1* *2* *3 or more* *Don't know* | |
| 47 | ✓ ○ ○ ○ ○ ○ | ○ ✓ ○ ✓ ○ ○ ○ | ○ ✓ ○ ○ | ✓ ○ ○ ○ ○ | |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 1 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 2 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 3 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 4 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 5 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 6 |
| | | | | | |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 7 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 8 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 9 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 10 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 11 |
| | ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 12 |

## EMPLOYMENT HISTORY

**16.** Please tell us about **each job or occupation you had for at least 12 months in Canada or elsewhere.** Include seasonal work, part-time, etc., if you worked the equivalent of 12 months or more. Begin with your most recent job and continue back to your first job. Please estimate the time period if you cannot remember exact years. (Even if you have retired, we still require the information.) **If you have never been employed, check here** ☐ and continue to Question 17.

| TIME PERIOD *First Year* *Last Year* | Type of Industry, Business, or Service and Company Name | Main Job Duties |
|---|---|---|
| Example: 19 89 to 19 94 | *Oil industry, Bluestar Oil Company* | *Process powerhouse and sulphur plant operations.* |
| 19 ☐☐ to 19 ☐☐ | | |
| 19 ☐☐ to 19 ☐☐ | | |
| 19 ☐☐ to 19 ☐☐ | | |
| 19 ☐☐ to 19 ☐☐ | | |
| 19 ☐☐ to 19 ☐☐ | | |
| | | |
| 19 ☐☐ to 19 ☐☐ | | |
| 19 ☐☐ to 19 ☐☐ | | |
| 19 ☐☐ to 19 ☐☐ | | |
| 19 ☐☐ to 19 ☐☐ | | |
| 19 ☐☐ to 19 ☐☐ | | |

| ocation(s)<br>own and province | Job Title | Status<br>Full time / Part time / Seasonal / Other | At this work-place, were you aware of **dusts or odours** from industry?<br>Never or rarely / At least once a month / At least once a week / At least once a day | About how many people **smoked regularly** in your **immediate work area?**<br>None / 1 or 2 / 3 to 5 / 6 or more / Don't know | |
|---|---|---|---|---|---|
| *Mountain House, a* | *Gas plant operator* | ✓ ○ ○ ○ | ○ ○ ○ ✓ | ○ ○ ✓ ○ ○ | |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 1 |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 2 |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 3 |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 4 |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 5 |
| | | | | | |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 6 |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 7 |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 8 |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 9 |
| | | ○ ○ ○ ○ | ○ ○ ○ ○ | ○ ○ ○ ○ ○ | 10 |

7. Have you ever worked with any of the following **for more than one year**?

| | Never | Don't know | At work | At home | How many years in total? |
|---|---|---|---|---|---|
| .sbestos | o | o | o | o | |
| .rsenic salts | o | o | o | o | |
| hromium salts | o | o | o | o | |
| admium salts | o | o | o | o | |
| oal tar, soot, pitch, reosote, asphalt | o | o | o | o | |
| lineral, cutting or ibricating oil | o | o | o | o | |
| enzidine | o | o | o | o | |
| enzene | o | o | o | o | |
| opropyl oil | o | o | o | o | |
| yestuffs | o | o | o | o | |
| inyl chloride | o | o | o | o | |
| esticides | o | o | o | o | |
| erbicides | o | o | o | o | |
| lustard gas | o | o | o | o | |
| adiation sources | o | o | o | o | |
| 'elding | o | o | o | o | |
| 'ood dust | o | o | o | o | |

*You are more than halfway through the questionnaire. This is a good place to take a short break, if you wish.*

## ET INFORMATION

**During the past 20 years** have you ever taken any of the following vitamin or mineral supplements?

| *'itamin and Mineral type* | How often? | | | For how many years in total? | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No | Yes, but not regularly | Yes, fairly regularly | Less than 1 year | 1 to 2 years | 3 to 5 years | 6 to 9 years | 10 to 19 years | 20 + years |
| ltiple vitamins | o | o | o | o | o | o | o | o | o |
| amin A | o | o | o | o | o | o | o | o | o |
| a-carotene | o | o | o | o | o | o | o | o | o |
| omplex vitamins | o | o | o | o | o | o | o | o | o |
| amin C | o | o | o | o | o | o | o | o | o |
| amin E | o | o | o | o | o | o | o | o | o |
| | | | | | | | | | |
| cium | o | o | o | o | o | o | o | o | o |
| 1 | o | o | o | o | o | o | o | o | o |
| c | o | o | o | o | o | o | o | o | o |
| enium | o | o | o | o | o | o | o | o | o |

This section asks about your eating habits **about two years ago.** Thinking back to that time, we ask you to mark the column that best describes how often, on average, you ate or drank the amount specified of each of the following foods and beverages.

| | Never or less than 1 per month | 1-3 per month | 1 per week | 2-4 per week | 5-6 per week | 1 per day | 2-3 per day | 4-5 per day | 6+ per day |
|---|---|---|---|---|---|---|---|---|---|
| **BEVERAGES MADE WITH WATER** | | | | | | | | | |
| ee (1 cup) | o | o | o | o | o | o | o | o | o |
| (1 cup) | o | o | o | o | o | o | o | o | o |
| ge or grapefruit juice from frozen entrate (4 oz/115 ml glass) | o | o | o | o | o | o | o | o | o |
| r juices or drinks from frozen entrate (4 oz/115 ml glass) | o | o | o | o | o | o | o | o | o |
| ks from powdered drink crystals /115 ml glass) | o | o | o | o | o | o | o | o | o |
| water (8 oz/230 ml glass) | o | o | o | o | o | o | o | o | o |
| ed water (8 oz/230 ml glass) | o | o | o | o | o | o | o | o | o |
| **OTHER BEVERAGES** | | | | | | | | | |
| le milk (8 oz/230 ml glass) | o | o | o | o | o | o | o | o | o |
| nilk (8 oz/230 ml glass) | o | o | o | o | o | o | o | o | o |
| nilk (8 oz/230 ml glass) | o | o | o | o | o | o | o | o | o |
| milk (8 oz/230 ml glass) | o | o | o | o | o | o | o | o | o |
| ge or grapefruit juice, fresh, bottled nned (4 oz/115 ml glass) | o | o | o | o | o | o | o | o | o |
| r juices or drinks, fresh, bottled or ed (4 oz/115 ml glass) | o | o | o | o | o | o | o | o | o |
| ato or vegetable juices /115 ml glass) | o | o | o | o | o | o | o | o | o |
| | | | | | | | | | |
| drinks (1 glass/bottle/can) | o | o | o | o | o | o | o | o | o |
| (1 bottle/can) | o | o | o | o | o | o | o | o | o |
| (1 glass) | o | o | o | o | o | o | o | o | o |
| or (1 drink or shot) | o | o | o | o | o | o | o | o | o |

*(continued)*

(continued) Please mark the column that best describes how often, on average, you ate the amount specified of these foods **about two years ago.**

| | Never or less than 1 per month | 1-3 per month | 1 per week | 2-4 per week | 5-6 per week | 1 per day | 2-3 per day | 4-5 per day | 6 + per day |
|---|---|---|---|---|---|---|---|---|---|
| **FRUIT** | | | | | | | | | |
| pies or pears (1) | o | o | o | o | o | o | o | o | o |
| anges (1) | o | o | o | o | o | o | o | o | o |
| nanas (1) | o | o | o | o | o | o | o | o | o |
| ntaloupe (¼ melon) | o | o | o | o | o | o | o | o | o |
| ier fruit, fresh or canned (1 piece or ½ cup) | o | o | o | o | o | o | o | o | o |
| **VEGETABLES** | | | | | | | | | |
| natoes (1 or ½ cup) | o | o | o | o | o | o | o | o | o |
| rots (1 whole or ½ cup) | o | o | o | o | o | o | o | o | o |
| ccoli (½ cup) | o | o | o | o | o | o | o | o | o |
| bage, cauliflower, brussels sprouts (½ cup) | o | o | o | o | o | o | o | o | o |
| nach or other greens (1 serving) | o | o | o | o | o | o | o | o | o |
| low (winter) squash (½ cup) | o | o | o | o | o | o | o | o | o |
| / other vegetable including green beans, n and peas (½ cup) | o | o | o | o | o | o | o | o | o |
| ps with vegetables (1 cup) | o | o | o | o | o | o | o | o | o |
| | | | | | | | | | |
| atoes: baked, boiled (1) or mashed (1 cup) | o | o | o | o | o | o | o | o | o |
| ich fries or fried potatoes (½ cup) | o | o | o | o | o | o | o | o | o |
| et potatoes (1 or ½ cup) | o | o | o | o | o | o | o | o | o |
| n or soybeans (3-4 oz/115 ml) | o | o | o | o | o | o | o | o | o |
| ed beans or lentils (½ cup) | o | o | o | o | o | o | o | o | o |
| **BREADS AND CEREALS** | | | | | | | | | |
| n or granola cereals, shredded wheat up) | o | o | o | o | o | o | o | o | o |
| er cold cereals (1 cup) | o | o | o | o | o | o | o | o | o |
| ked cereals (1 cup) | o | o | o | o | o | o | o | o | o |
| te bread (1 slice) or rolls (1) | o | o | o | o | o | o | o | o | o |
| c or whole grain bread (1 slice) or rolls (1) | o | o | o | o | o | o | o | o | o |
| (1 cup) | o | o | o | o | o | o | o | o | o |
| aroni, spaghetti or noodles (1 cup) | o | o | o | o | o | o | o | o | o |

*(continued)*

(continued) Please mark the column that best describes how often, on average, you ate the amount specified of these foods **about two years ago.**

| | Never or less than 1 per month | 1-3 per month | 1 per week | 2-4 per week | 5-6 per week | 1 per day | 2-3 per day | 4-5 per day | 6 + per day |
|---|---|---|---|---|---|---|---|---|---|
| **EAT, POULTRY, FISH, EGGS & CHEESE** | | | | | | | | | |
| hicken or turkey (4 oz/115 ml) | o | o | o | o | o | o | o | o | o |
| eef, pork or lamb as a main dish (steak, roast, am) (4 oz/115 ml) | o | o | o | o | o | o | o | o | o |
| eef, pork or lamb as a mixed dish (stew or asserole, pasta dish) (4 oz/115 ml) | o | o | o | o | o | o | o | o | o |
| amburger (1) | o | o | o | o | o | o | o | o | o |
| ot dogs (1) | o | o | o | o | o | o | o | o | o |
| uncheon meats (salami, bologna) piece or slice) | o | o | o | o | o | o | o | o | o |
| moked meat or corned beef (1 piece or slice) | o | o | o | o | o | o | o | o | o |
| acon (1 slice) | o | o | o | o | o | o | o | o | o |
| ausage (1) | o | o | o | o | o | o | o | o | o |
| iver (4 oz/115 ml) | o | o | o | o | o | o | o | o | o |
| | | | | | | | | | |
| ish, fresh, frozen or canned (4 oz/115 ml) | o | o | o | o | o | o | o | o | o |
| ish, smoked, salted or dried (4 oz/115 ml) | o | o | o | o | o | o | o | o | o |
| ggs (1) | o | o | o | o | o | o | o | o | o |
| heese other than cottage cheese slice or 1 oz) | o | o | o | o | o | o | o | o | o |
| **SWEETS** | | | | | | | | | |
| ake (1 slice) | o | o | o | o | o | o | o | o | o |
| ookies (1) | o | o | o | o | o | o | o | o | o |
| oughnuts, pastry (1) | o | o | o | o | o | o | o | o | o |
| es (1 slice) | o | o | o | o | o | o | o | o | o |
| e cream (½ cup) | o | o | o | o | o | o | o | o | o |
| nocolate (1 small bar or 1 oz) | o | o | o | o | o | o | o | o | o |
| **MISCELLANEOUS** | | | | | | | | | |
| tato chips (small bag or 45g) | o | o | o | o | o | o | o | o | o |
| anut butter (1 tbsp) | o | o | o | o | o | o | o | o | o |
| uts (1 oz/30g) | o | o | o | o | o | o | o | o | o |
| argarine on bread or vegetables pat or tsp) | o | o | o | o | o | o | o | o | o |
| utter on bread or vegetables (1 pat or tsp) | o | o | o | o | o | o | o | o | o |
| ayonnaise or salad dressing on bread r in salads (1 tbsp) | o | o | o | o | o | o | o | o | o |

**About two years ago:**

| | Seldom or Never | Sometimes | Often or Always |
|---|---|---|---|
| low often did you **add salt** to your food? | o | o | o |
| low often did you **add pepper** to your food? | o | o | o |
| low often did you have **onions or garlic** in your food? | o | o | o |
| low often did you **eat the skin on chicken**? | o | o | o |
| low often did you **eat the fat on meat?** | o | o | o |

What kinds of **fat** did **you usually use** in cooking about 2 years ago?
Mark only 1 or 2.

- o Block or stick margarine
- o Soft tub margarine
- o Low-calorie margarine
- o Shortening
- o Butter
- o Oil
- o Lard, baconfat, fatback
- o Non-stick spray or no fat
- o Don't know or don't cook

**22.** What kinds of **fat** did **you usually put** on bread, potatoes and vegetables about 2 years ago?
Mark only 1 or 2.

- o Block or stick margarine
- o Soft tub margarine
- o Low-calorie margarine
- o Butter
- o Cream cheese
- o Didn't add fat

Summary Questions

**About 2 years ago:**

| | Never or less than 1 per month | Less than 1 per week | 1 to 2 per week | 3 to 4 per week | 5 to 6 per week | 1 per day | 1½ per day | 2 per day | 3 per day | 4 + per day |
|---|---|---|---|---|---|---|---|---|---|---|
| ow often did you use **fat or oil in cooking?** | o | o | o | o | o | o | o | o | o | o |
| t counting salad or potatoes, **how many vings of vegetables** did you eat? | o | o | o | o | o | o | o | o | o | o |
| t counting juices, how many **servings of fruit** you eat? | o | o | o | o | o | o | o | o | o | o |
| ow often did you eat **fried food** from a **staurant or take-out?** (for example, french es, fried chicken, fried fish) | o | o | o | o | o | o | o | o | o | o |

24. We have a few questions about your **usual eating habits 20 years ago.** What you have just told us about the different places you have lived and worked might help in remembering back to your eating habits at that time.

For each of the following foods and beverages, please indicate **whether you usually ate or drank more or less 20 years ago** than you did about 2 years ago. Please mark the appropriate column for each food or beverage.

| *Compared to 2 years ago, 20 years ago I used to consume:* | Much less | Some-what less | About the same amount | Some-what more | Much more |
|---|---|---|---|---|---|
| Beef, pork or lamb | o | o | o | o | o |
| Chicken or fish | o | o | o | o | o |
| Milk | o | o | o | o | o |
| Vegetables | o | o | o | o | o |
| Fruit | o | o | o | o | o |
| | | | | | |
| Bread | o | o | o | o | o |
| Margarine | o | o | o | o | o |
| Butter | o | o | o | o | o |
| Fried foods | o | o | o | o | o |
| Sweets | o | o | o | o | o |
| | | | | | |
| Tea | o | o | o | o | o |
| Coffee | o | o | o | o | o |
| Soft Drinks | o | o | o | o | o |
| Alcohol | o | o | o | o | o |

25. About **how many times** have you gone on a **diet to lose weight** during your adult life?

- o Never
- o 1 to 2 times
- o 3 to 5 times
- o 6 to 8 times
- o 9 to 11 times
- o 12 or more times

## HYSICAL ACTIVITY

5. **About 2 years ago**, how often did you do the following activities, on average?

| | Never | Which Seasons? Spring | Summer | Fall | Winter | How often? Less than 1 per month | 1-3 per month | 1-2 per week | 3-6 per week | Every day | Time per session Less than 15 minutes | 15-30 minutes | 31-60 minutes | 60+ minutes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| alking for exercise | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| gging or running | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| ardening or yard work | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| me exercises or exercise class | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| lf | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| cquet sports (tennis, squash, etc.) | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| wling or curling | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| imming or water exercises | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| iing or skating | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| cycling | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| cial dancing | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| her strenuous exercise | O | O | O | O | O | O | O | O | O | O | O | O | O | O |

## 'HER GENERAL INFORMATION

What was the **approximate total income for all household members** from all sources, **before income taxes**, in an average year during the last 5 years?

- O less than $10,000
- O $10,000 - $19,999
- O $20,000 - $29,999
- O $30,000 - $49,999
- O $50,000 - $99,999
- O greater than $100,000
- O prefer not to answer

How many members (adults and children) are there in your household in total?

☐ persons

**WOMEN:**
**Please continue to the next page.**

***MEN:***
***You have now completed the questionnaire.***

***Please take a moment to fill in any questions you may have missed.***

**THANK YOU VERY MUCH for taking the time to fill out this questionnaire. Your participation is sincerely appreciated.**

***Please return this completed questionnaire in the self-addressed envelope.***

## UESTIONS FOR FEMALES ONLY

### ENSTRUATION

How old were you when you had your first menstrual period?
[ ] years old

o Don't remember
o Haven't menstruated → Go to 33

Between the ages of 10 and 30, did your menstrual periods tend to occur regularly or irregularly (menstrual cycles varied by more than 10 days in length)? Please exclude any time when you were pregnant or using birth control pills.
o Regularly o Irregularly

**How old** were you when you had your **last menstrual period?**
[ ] years old

o Still menstruate → Go to 33

How did your **menstrual periods stop?**
o Naturally--that is, as part of the change of life
o As a result of a hysterectomy (removal of womb)
o Following radiation
o Other -- Please specify:
[ ]

Have you had an operation to remove **BOTH your ovaries?**
o No
o Yes → At what age? If they were removed on two separate occasions, record when your second ovary was removed.
At age [ ] years

Do you have **mammograms** (x-rays of the breast) performed on a **routine** basis (every two years)?
o No
o Yes → First mammogram at age [ ] years

### PREGNANCIES

35. Have you ever been pregnant?
o No → Go to bottom of page.
o Yes

36. **How many times have you been pregnant?** Include live births, stillbirths, miscarriages, abortions and ectopic (tubal) pregnancies.
[ ] times

37. How old were you at the end of your first **pregnancy**?
[ ] years old

38. How many **of your pregnancies** were live births?
[ ] live births o none

39. How old were you at the end of your first pregnancy which lasted 5 months or more?
[ ] years old

40. For how many **months** in total did you **breastfeed**? (Add the number of months that you breastfed after each birth to give the total number of months.)
[ ] months o never breastfed

***Please take a moment to fill in any questions you may have missed.***

**THANK YOU VERY MUCH for taking the time to fill out this questionnaire. Your participation is sincerely appreciated.**

***Please return this completed questionnaire in the self-addressed envelope.***

# The National Enhanced Cancer Surveillance System

# Policy on Data Access, Publications and Confidentiality

**A Collaboration of**

**The Environmental Risk Assessment and Case Surveillance Division,**

**Cancer Bureau, Laboratory Centre for Disease Control, Health Canada**

**and**

**The Canadian Cancer Registries Epidemiology Research Group**

May, 1999

1. Context

The National Enhanced Cancer Surveillance System (NECSS[1]) is a collaboration between the Environmental Risk Assessment and Case Surveillance (ERACS) Division of the Cancer Bureau, Laboratory Centre for Disease Control (LCDC) and the Canadian Cancer Registries Epidemiology Research Group (CCREG). ERACS has taken the lead on epidemiologic and technical development of the system: coordination of system design; management of funding and contracts; development of the proposal, questionnaire, procedures manual and data entry software; consolidation of the data nationally, data quality evaluation, data reduction and data maintenance; development of the Environmental Quality Database; development of linkages of environmental and cancer data, exposure summarization and development of an analysis system. The participating Cancer Registries contributions include: collaboration on surveillance design and implementation; obtaining provincial ethics approvals; case ascertainment, physician consent, data collection and clarification follow up; control sampling, data collection and follow up; data entry and other activities such as response trials.

Recognizing the investment in time and effort and the collaborative roles of the participants in collecting the data and developing the system, the first priority for analysis lies with the ERACS Division and the Cancer Agency partners. At the same time access to the system by outside groups is important for making optimal use of the considerable potential of the system. Continuing government support is dependent upon evidence of significant information contribution in federally targeted areas, the most acceptable evidence being peer reviewed publications and presentations at national and international conferences.

**B. Objectives**

- To make optimal use of the NECSS for assessment of environment-cancer relationships in Canada.

- To encourage broad and creative use of the NECSS.

[1] The National Enhanced Cancer Surveillance System (NECSS) team includes the NECSS team in the Environmental Risk Assessment and Case Surveillance Division (ERACS) and the Canadian Cancer Registries Epidemiology Research Group (CCRERG).

3. NECSS Internal Analysis

1. The Design, Access and Analysis Committee[2] (DAAC), in consultation with all of the provincial investigators, will generate a list of ongoing projects. The provincial investigators and ERACS will submit their projects of interest (as a one-page letter of intent) to the ongoing project list, including provincial and regional ones (more than one province's data but not all). The project list will be updated continuously with new projects and progress on ongoing projects. Projects will be deleted from the list if no action is taken within a period of six months. The list will be kept at ERACS and updated versions of the list will be e-mailed to all provincial investigators.

2. In addition to specific projects listed in the ongoing project list, ERACS may have to conduct surveillance activities that are unanticipated but urgent because of departmental priority, using the NECSS database. Prior to initiating specific activity involving the NECSS database, ERACS will inform all provincial investigators of the plan and seek collaboration if necessary. The ongoing project list will then be updated accordingly. Draft general surveillance publications will be circulated to provincial investigators for suggestions and comments.

**Access to, and use of, the NECSS**

1. Access to the NECSS is assured for ERACS Division and the provincial investigators to conduct projects listed in the ongoing list described in C.1 and national surveillance activities as described in C.2. Individual provincial investigators have unlimited access and unrestricted rights to the data collected through their registry while participating in the NECSS Program.

2. Outside investigators may propose national or regional analyses. Applications for external use of the data must be approved by the Executive Committee[3]. Outside investigations will include the collaboration of NECSS investigator(s), unless NECSS investigators are not interested in collaboration on the specific work, in which case work can go ahead without NECSS involvement.

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[2] The Design, Access and Analysis Committee (DAAC) consists of the NECSS Scientific Coordinator from the ERACS Team, Laboratory Centre for Disease Control and four or five Principal Investigators from Provincial Cancer Registries with epidemiology or biostatistics expertise. The committee discusses and makes recommendations on analysis issues to the Executive Committee.

[3] The Executive Committee consists of the principal investigators from the eight cancer registries currently actively involved in the NECSS, and the national scientific coordinator and Division Chief of the ERACS Division.

## F. Processing External Requests

1. A one-page Letter of Intent should be sent to the DAAC secretary in the ERACS Division. ERACS Division will check the idea with the ongoing project list (see C.1) for originality. The DAAC will then discuss the general suitability of the proposed analysis and request a more detailed proposal as appropriate within 6 weeks of submission.

2. The full proposal will be reviewed by the DAAC within 6 weeks of the submission. The letter of intent, proposal and DAAC recommendations will be forwarded to the Executive Committee for written approval by a specified date.

3. If consensus of the Executive Committee cannot be reached, final approval by the Executive Committee will be by a simple majority if required.

4. The DAAC secretary will inform the researchers of the decision within 3 months of their submission and arrange for data provision as appropriate.

## G. Provision of Data To Researchers

1. A copy of the NECSS questionnaire, summary counts of collected cases by site and controls, and the data dictionary will be provided to researchers who can then chose variables they require for analysis.

2. Data for multi-province projects will be provided by LCDC; a request for data from one province may be provided by LCDC or the provincial Registry.

## K. Confidentiality

1. All data will be managed in strict confidence.

2. All individuals with access to data in the course of the daily work required to manage the data set will sign a "CONFIDENTIALITY PLEDGE" as a condition of their work with the surveillance system. (See Appendix 1.)

3. Data containing information from which individuals could be identified will not be released except:

   a) to the data collection centres from which the information came, upon receiving written request;

b) to Statistics Canada, Health Statistics Division, for the purposes of undertaking record linkage studies, e.g., using the Canadian Cancer Registry Cancer Incidence Data Base and the Canadian Mortality Data Base.

4. Only aggregate data will be published. Data defining individual institutions shall not be publicly released without the explicit consent of the institution.

**H. Manuscript Review**

1. Manuscripts involving data from more than one province must be submitted to the DAAC for review prior to submission for publication. The DAAC will examine the manuscript within two weeks of the submission to ensure that it is within the scope of the originally approved proposal and that the NECSS data has not been misconstrued. The DAAC will provide a written response to the principal investigator within three weeks of submission. Abstracts and presentations require a one week lead time for DAAC review and response to the author.

2. The contribution of Health Canada and the CCRERG must be acknowledged in all papers as follows:

"This project uses data collected thorough the National Enhanced Cancer Surveillance System, a collaboration of the Cancer Bureau, Laboratory Centre of Disease Control, Health Canada and the Canadian Cancer Registries Epidemiology Research Group."

3. When the author list includes the Canadian Cancer Registries Epidemiology Research Group (CCRERG), one member of CCRERG will be chosen by the DAAC to sign off for CCRERG, after review of the document by all CCRERG members. The following footnote concerning the CCRERG must be included:

" The Canadian Cancer Registries Epidemiology Research Group comprises a Principal Investigator from each of the Provincial Cancer Registries: Bertha Paulse, M.Sc., B.N., Newfoundland Cancer Foundation; Ron Dewar, M.Sc., Nova Scotia Cancer Registry; Dagny Dryer, M.D., Prince Edward Island Cancer Registry; Nancy Kreiger, Ph.D., Cancer Care Ontario; Erich Kliewer, Ph.D., Manitoba Cancer Treatment and Research Foundation; Diane Robson, B.A., Saskatchewan Cancer Foundation; Shirley Fincham, Ph.D., Division of Epidemiology, Prevention and Screening, Alberta Cancer Board; and Nhu Le, Ph.D., British Columbia Cancer Agency.".

4. The Data Analysis Committee should be informed of substantive changes that are made in response to referees' reports, as required.

5. Upon publication, a reprint should be sent to ERACS.

**Authorship**

6. Authorship of all project-wide papers must include the Canadian Cancer Registries and Epidemiology Research Group.

7. In addition someone from ERACS will be represented in the authorship list for national analyses.

Appendix 1

**Agreement Concerning the Release of the NECSS Data**

**I,** the undersigned, hereby acknowledge that I will be granted access to the NECSS data under the following terms and conditions:

1. I will not release the data to any other persons and will keep all information strictly confidential (see Appendix 2).

2. I will only use the data in connection with the objectives outlined in my research protocol (attached).

3. I agree to be held accountable for the quality of the database, and will therefore report any suspected errors or inconsistencies in the data (see Appendix 2).

4. Upon completion of the research goal delineated in my protocol, I will remove the information that was provided from all computer storage medium and hard drives and return to ERACS Division for retention for three years.

5. I agree to maintain the confidentiality of all information, and will not include information so detailed and explicit as to permit identification of individuals in any research reports or publications that I prepare. To facilitate this, I will not report any statistics calculated on less than five (5) cases.

6. I will note the contribution of the NECSS and will include an acknowledgment in all reports or publications resulting from my use of the NECSS data.

Standard Acknowledgment: "This project uses data collected through the National Enhanced Cancer Surveillance System, a collaboration of the Cancer Bureau, Laboratory Centre of Disease Control, Health Canada and Canadian Cancer Registries Epidemiology Research Group.

7. I will submit the final manuscript or report, prior to submission for publication, for review and approval to the NECSS Design, Access and Analysis Committee for verification that my protocol has not been exceeded, data has not been misconstrued and that confidentiality was maintained.

8. I will be using the NECSS data at the following location: Department of Community Health & Epidemiology University of Sask.

Signature

Date Sept 27/00

Name (printed)

**Appendix 2.**

**Keeping NECSS data confidential**

Even without names, many NECSS data items are potential identifiers, particularly residential and employment histories. Study cases and controls have been good enough to help us with our research by providing us with some very personal information. One of our obligations to them is to keep such information confidential. In addition to the data removal and publication stipulations in the agreement concerning the release of the NECSS data, you must adopt the following practices regarding study records or data derived from them, on either diskettes or paper.

- If files or papers contain potential identifiers, either work with them only on premises, or carry them only in a locked briefcase or a password-protected portable computer. Potential identifiers include residential and occupational history items, birth dates, sex, ancestral origins, and family history of cancer, especially when any of these are in combination.

- Keep diskettes or papers with identifiers in locked drawers (in desks or filing cabinets) when you are not using them or are away from your work area.

- If anyone else uses the same computer, remove files with identifiers from the hard disk at the end of every working session.

- Turn papers face down if you leave your desk or office for a short time.

- If someone comes to see you in your work area while the data are on your computer screen, use a screen saver or dim your screen.

- Collect data printouts promptly from printers.

- If you need to produce any printouts containing address or employment history information, they must be disposed of by shredding box when you have finished with them.

If you think you can identify an individual known or related to you, you have no right to divulge to that individual or any other person any information collected by the study, or even the fact that you know the person participated in the study or has a Cancer Registry record. This restriction includes discussion of individual records with coworkers, fellow students and others, beyond any need to communicate information that has a direct bearing on your work with the data, or theirs.

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# ɜBREVIATIONS

— and
ːess. — Accessories
ːom. — Accommodation
nin. — Administration
ːn. — Agencies
ˈic. — Agricultural
·condit. — Air-conditioning
use. — Amusement
ɔl. — Appliance
oc. — Associations
o. — Automobile
. — Beverage
d. — Bindery
g. — Building
adcast. — Broadcasting
. — Business
. — Canned
t. — Casting
m. — Chemical
t. — Coated
ɪb. — Combined
ɪm. — Commercial
ɪmun. — Communication
serv. — Conservation
st. — Construction
sum. — Consumer
tr. — Contracting
— Cutlery
pt. — Development
prs. — Developers
c. — Education
. — Electric
tron. — Electronic
Elev. — Elevator
Equip. — Equipment
Exc. — Except
Fab. — Fabricated
Fer. — Ferrous
Fil. — Filament
Fin. — Finance
Frat. — Fraternal
Furn. — Furniture
Govt. — Government
Hhld. — Household
High. — Highway
Impl. — Implement
Incid. — Incidental
Ind. — Industry
Insce. — Insurance
Intermed. — Intermediaries
Jewel. — Jewellery
Lab. — Laboratories
Mach. — Machinery
Main. — Maintenance
Mfg. — Manufactured
Min. — Mineral
Nat. — Natural
N.E.C. — Not Elsewhere Classified
Off. — Offices
Org. — Organizations
Pers. — Personal
Petrol. — Petroleum
Pharm. — Pharmaceutical
Pic. — Picture
Plan. — Planing
Platemakg. — Platemaking

## ABBREVIATIONS

Press. — Pressed
Presv. — Preserved
Print. — Printing
Process. — Processing
Prod. — Products, Production
Prof. — Professional
Pub. — Publishing
Rec. — Recreation
Refin. — Refining
Refrig. — Refrigeration
Rel. — Related
Sci. — Scientific
Sec. — Secondary
Serv. — Service
Smelt. — Smelting
Soc. — Social
Struct. — Structural
St. — Street
Supp. — Supplies
Syn. — Synthetic
Syst. — Systems
T.V. — Television
Tech. — Technical
Telecom. — Telecommunication
Trans. — Transportation
Type. — Typesetting
Univ. — University
Veg. — Vegetables
Veh. — Vehicle
Whlse. — Wholesale

# ASSIFICATION STRUCTURE

## OF MAJOR GROUPS, MINOR GROUPS AND UNIT GROUPS

### OR GROUP 11 — MANAGERIAL, ADMINISTRATIVE AND RELATED OCCUPATIONS

#### 11 — Officials and Administrators Unique to Government

Members of Legislative Bodies

Government Administrators

ost Office Management Occupations

ıspectors and Regulatory Officers, Government

fficials and Administrators Unique to Government, e.c.

#### 13/114 — Other Managers and Administrators

eneral Managers and Other Senior Officials

anagement Occupations, Natural Sciences and ıgineering

anagement Occupations, Social Sciences and Related elds

lministrators in Teaching and Related Fields

lministrators in Medicine and Health

ıancial Management Occupations

rsonnel and Industrial Relations Management cupations

les and Advertising Management Occupations

rchasing Management Occupations

vices Management Occupations

duction Management Occupations

nagement Occupations, Construction Operations

m Management Occupations

1147 Management Occupations, Transport and Communications Operations

1149 Other Managers and Administrators, n.e.c.

#### 117 — Occupations Related to Management and Administration

1171 Accountants, Auditors and Other Financial Officers

1173 Organization and Methods Analysts

1174 Personnel and Related Officers

1175 Purchasing Officers and Buyers, Except Wholesale and Retail Trade

1176 Inspectors and Regulatory Officers, n.e.c.

1179 Occupations Related to Management and Administration, n.e.c.

### MAJOR GROUP 21 — OCCUPATIONS IN NATURAL SCIENCES, ENGINEERING AND MATHEMATICS

#### 211 — Occupations in Physical Sciences

2111 Chemists

2112 Geologists

2113 Physicists

2114 Meteorologists

2117 Physical Sciences Technologists and Technicians

2119 Occupations in Physical Sciences, n.e.c.

#### 213 — Occupations in Life Sciences

2131 Agriculturists and Related Scientists

2133 Biologists and Related Scientists

2135 Life Sciences Technologists and Technicians

2139 Occupations in Life Sciences, n.e.c.

### 214/215 — Architects, Engineers and Community Planners

2141 Architects

2142 Chemical Engineers

2143 Civil Engineers

2144 Electrical Engineers

2145 Industrial Engineers

2146 Agricultural Engineers

2147 Mechanical Engineers

2151 Metallurgical Engineers

2153 Mining Engineers

2154 Petroleum Engineers

2155 Aerospace Engineers

2156 Nuclear Engineers

2157 Community Planners

2159 Professional Engineers, n.e.c.

### 216 — Other Occupations in Architecture and Engineering

2160 Supervisors: Other Occupations in Architecture and Engineering

2161 Surveyors

2163 Draughting Occupations

2164 Architectural Technologists and Technicians

2165 Engineering Technologists and Technicians

2169 Other Occupations in Architecture and Engineering, n.e.c.

### 218 — Occupations in Mathematics, Statistics, Systems Analysis and Related Fields

2181 Mathematicians, Statisticians and Actuaries

2183 Systems Analysts, Computer Programmers and Related Occupations

2189 Occupations in Mathematics, Statistics, Systems Analysis and Related Fields, n.e.c.

## MAJOR GROUP 23 — OCCUPATIONS IN SOCIAL SCIENCES AND RELATED FIELDS

### 231 — Occupations in Social Sciences

2311 Economists

2313 Sociologists, Anthropologists and Related Social Scientists

2315 Psychologists

2319 Occupations in Social Sciences, n.e.c.

### 233 — Occupations in Social Work and Related Fields

2331 Social Workers

2333 Occupations in Welfare and Community Services

2339 Occupations in Social Work and Related Fields, n.e.c.

### 234 — Occupations in Law and Jurisprudence

2341 Judges and Magistrates

2343 Lawyers and Notaries

2349 Occupations in Law and Jurisprudence, n.e.c.

### 235 — Occupations in Library, Museum and Archival Sciences

2350 Supervisors: Occupations in Library, Museum and Archival Sciences

2351 Librarians, Archivists and Conservators

2353 Technicians in Library, Museum and Archival Sciences

2359 Occupations in Library, Museum and Archival Sciences, n.e.c.

### 239 — Other Occupations in Social Sciences and Related Fields

2391 Educational and Vocational Counsellors

Other Occupations in Social Sciences and Related Fields, n.e.c.

## OR GROUP 25 — OCCUPATIONS IN RELIGION

### 251 — Occupations in Religion

Ministers of Religion

Nuns and Brothers

Occupations in Religion, n.e.c.

## OR GROUP 27 — TEACHING AND RELATED OCCUPATIONS

### 271 — University Teaching and Related Occupations

University Teachers

University Teaching and Related Occupations, n.e.c.

### 273 — Elementary and Secondary School Teaching and Related Occupations

lementary and Kindergarten Teachers

econdary School Teachers

lementary and Secondary School Teaching and elated Occupations, n.e.c.

### 279 — Other Teaching and Related Occupations

ommunity College and Vocational School Teachers

ine Arts Teachers, n.e.c.

ost-secondary School Teachers, n.e.c.

eachers of Exceptional Students, n.e.c.

structors and Training Officers, n.e.c.

ther Teaching and Related Occupations, n.e.c.

## MAJOR GROUP 31 — OCCUPATIONS IN MEDICINE AND HEALTH

### 311 — Health Diagnosing and Treating Occupations

3111 Physicians and Surgeons

3113 Dentists

3115 Veterinarians

3117 Osteopaths and Chiropractors

3119 Health Diagnosing and Treating Occupations, n.e.c.

### 313 — Nursing, Therapy and Related Assisting Occupations

3130 Supervisors: Nursing, Therapy and Related Assisting Occupations

3131 Nurses, Registered, Graduate and Nurses-in-Training

3132 Orderlies

3134 Registered Nursing Assistants

3135 Nursing Attendants

3136 Audio and Speech Therapists

3137 Physiotherapists

3138 Occupational Therapists

3139 Nursing, Therapy and Related Assisting Occupations, n.e.c.

### 315/316 — Other Occupations in Medicine and Health

3151 Pharmacists

3152 Dietitians and Nutritionists

3153 Optometrists

3154 Dispensing Opticians

3155 Radiological Technologists and Technicians

3156 Medical Laboratory Technologists and Technicians

3157 Denturists

3158 Dental Hygienists and Dental Assistants

3161 Dental Laboratory Technicians

3162 Respiratory Technicians

3169 Other Occupations in Medicine and Health, n.e.c.

## MAJOR GROUP 33 — ARTISTIC, LITERARY, RECREATIONAL AND RELATED OCCUPATIONS

### 331 — Occupations in Fine and Commercial Art, Photography and Related Fields

3311 Painters, Sculptors and Related Artists

3313 Product and Interior Designers

3314 Advertising and Illustrating Artists

3315 Photographers and Camera Operators

3319 Occupations in Fine and Commercial Art, Photography and Related Fields, n.e.c.

### 333 — Occupations in Performing and Audio-visual Arts

3330 Producers and Directors, Performing and Audio-visual Arts

3331 Conductors, Composers and Arrangers

3332 Musicians and Singers

3333 Occupations Related to Music and Musical Entertainment, n.e.c.

3334 Dancers and Choreographers

3335 Actors/Actresses

3337 Radio and Television Announcers

3339 Occupations in Performing and Audio-visual Arts, n.e.c.

### 335 — Occupations in Writing

3351 Writers and Editors

3355 Translators and Interpreters

3359 Occupations in Writing, n.e.c.

### 336/337 — Occupations in Sports and Recreation

3360 Supervisors: Occupations in Sports and Recreation

3370 Coaches, Trainers and Instructors, Sports and Recreation

3371 Referees and Related Officials

3373 Athletes

3375 Attendants, Sports and Recreation

3379 Occupations in Sports and Recreation, n.e.c.

## MAJOR GROUP 41 — CLERICAL AND RELATED OCCUPATIONS

### 411 — Stenographic and Typing Occupations

4110 Supervisors: Stenographic and Typing Occupations

4111 Secretaries and Stenographers

4113 Typists and Clerk-typists

### 413 — Bookkeeping, Account-recording and Related Occupations

4130 Supervisors: Bookkeeping, Account-recording and Related Occupations

4131 Bookkeepers and Accounting Clerks

4133 Cashiers and Tellers

4135 Insurance, Bank and Other Finance Clerks

4137 Statistical Clerks

4139 Bookkeeping, Account-recording and Related Occupations, n.e.c.

### 414 — Office Machine and Electronic Data-processing Equipment Operators

4140 Supervisors: Office Machine and Electronic Data-processing Equipment Operators

4141 Office Machine Operators

4143 Electronic Data-processing Equipment Operators

### 415 — Material Recording, Scheduling and Distributing Occupations

0 Supervisors: Material Recording, Scheduling and Distributing Occupations

1 Production Clerks

3 Shipping and Receiving Clerks

5 Stock Clerks and Related Occupations

7 Weighers

9 Material Recording, Scheduling and Distributing Occupations, n.e.c.

### 416 — Library, File and Correspondence Clerks and Related Occupations

Supervisors: Library, File and Correspondence Clerks and Related Occupations

Library and File Clerks

Library, File and Correspondence Clerks and Related Occupations, n.e.c.

### 417 — Reception, Information, Mail and Message Distribution Occupations

Supervisors: Reception, Information, Mail and Message Distribution Occupations

Receptionists and Information Clerks

Mail Carriers

Mail and Postal Clerks

Telephone Operators

Messengers

Reception, Information, Mail and Message Distribution Occupations, n.e.c.

### 419 — Other Clerical and Related Occupations

Supervisors: Other Clerical and Related Occupations, n.e.c.

Collectors

Claim Adjusters

4193 Travel Clerks, Ticket, Station and Freight Agents

4194 Hotel Clerks

4195 Personnel Clerks

4197 General Office Clerks

4199 Other Clerical and Related Occupations, n.e.c.

## MAJOR GROUP 51 — SALES OCCUPATIONS

### 513/514 — Sales Occupations, Commodities

5130 Supervisors: Sales Occupations, Commodities

5131 Technical Sales Occupations and Related Advisers

5133 Commercial Travellers

5135 Sales Clerks and Salespersons, Commodities, n.e.c.

5141 Street Vendors and Door-to-door Sales Occupations

5143 Newspaper Carriers and Vendors

5145 Service Station Attendants

5149 Sales Occupations: Commodities, n.e.c.

### 517 — Sales Occupations, Services

5170 Supervisors: Sales Occupations, Services

5171 Insurance Sales Occupations

5172 Real Estate Sales Occupations

5173 Sales Agents and Traders, Securities

5174 Advertising Sales Occupations

5177 Business Services Sales Occupations

5179 Sales Occupations: Services, n.e.c.

### 519 — Other Sales Occupations

5190 Supervisors: Other Sales Occupations

5191 Buyers, Wholesale and Retail Trade

5193 Route Drivers

5199 Other Sales Occupations, n.e.c.

## MAJOR GROUP 61 — SERVICE OCCUPATIONS

### 611 — Protective Service Occupations

6111 Fire-fighting Occupations

6112 Police Officers and Detectives, Government

6113 Police Agents and Investigators, Private

6115 Guards and Related Security Occupations

6116 Commissioned Officers, Armed Forces

6117 Other Ranks, Armed Forces

6119 Protective Service Occupations, n.e.c.

### 612 — Food and Beverage Preparation and Related Service Occupations

6120 Supervisors: Food and Beverage Preparation and Related Service Occupations

6121 Chefs and Cooks

6123 Bartenders

6125 Food and Beverage Serving Occupations

6129 Food and Beverage Preparation and Related Service Occupations, n.e.c.

### 613 — Occupations in Lodging and Other Accommodation

6130 Supervisors: Occupations in Lodging and Other Accommodation

6133 Lodging Cleaners, Except Private Household

6135 Sleeping-car and Baggage Porters

6139 Occupations in Lodging and Other Accommodation, n.e.c.

### 614 — Personal Service Occupations

6141 Funeral Directors, Embalmers and Related Occupations

6142 Housekeepers, Servants and Related Occupations

6143 Barbers, Hairdressers and Related Occupations

6144 Guides

6145 Travel and Related Attendants, Except Food and Beverage

6147 Child-care Occupations

6149 Personal Service Occupations, n.e.c.

### 616 — Apparel and Furnishings Service Occupations

6160 Supervisors: Apparel and Furnishings Service Occupations

6162 Laundering and Dry Cleaning Occupations

6165 Pressing Occupations

6169 Apparel and Furnishings Service Occupations, n.e.c.

### 619 — Other Service Occupations

6190 Supervisors: Other Service Occupations

6191 Janitors, Charworkers and Cleaners

6193 Elevator-operating Occupations

6198 Occupations in Labouring and Other Elemental Work: Other Services

6199 Other Service Occupations, n.e.c.

## MAJOR GROUP 71 — FARMING, HORTICULTURAL AND ANIMAL HUSBANDRY OCCUPATIONS

### 711 — Farmers

7113 Livestock Farmers

7115 Crop Farmers

7119 Farmers, n.e.c.

### 718/719 — Other Farming, Horticultural and Animal Husbandry Occupations

7180 Foremen/women: Other Farming, Horticultural and Animal Husbandry Occupations

7183 Livestock Farm Workers

7185 Crop Farm Workers

7195 Nursery and Related Workers

7196 Inspecting, Testing, Grading and Sampling Occupations: Other Farming, Horticultural and Animal Husbandry

7197 Farm Machinery Operators

7199 Other Farming, Horticultural and Animal Husbandry Occupations, n.e.c.

## MAJOR GROUP 73 — FISHING, TRAPPING AND RELATED OCCUPATIONS

### 731 — Fishing, Trapping and Related Occupations

7311 Captains and Other Officers, Fishing Vessels

7313 Net, Trap and Line Fishing Occupations

7315 Trapping and Related Occupations

7319 Fishing, Trapping and Related Occupations, n.e.c.

## MAJOR GROUP 75 — FORESTRY AND LOGGING OCCUPATIONS

### 751 — Forestry and Logging Occupations

7510 Foremen/women: Forestry and Logging Occupations

7511 Forestry Conservation Occupations

7513 Timber Cutting and Related Occupations

7516 Log Inspecting, Grading, Scaling and Related Occupations

7517 Log Hoisting, Sorting, Moving and Related Occupations

7518 Occupations in Labouring and Other Elemental Work: Forestry and Logging

7519 Forestry and Logging Occupations, n.e.c.

## MAJOR GROUP 77 — MINING AND QUARRYING INCLUDING OIL AND GAS FIELD OCCUPATIONS

### 771 — Mining and Quarrying Including Oil and Gas Field Occupations

7710 Foremen/women: Mining and Quarrying Including Oil and Gas Field Occupations

7711 Rotary Well-drilling and Related Occupations

7713 Rock and Soil Drilling Occupations

7715 Blasting Occupations

7717 Mining and Quarrying: Cutting, Handling and Loading Occupations

7718 Occupations in Labouring and Other Elemental Work: Mining and Quarrying Including Oil and Gas Fields

7719 Mining and Quarrying Including Oil and Gas Field Occupations, n.e.c.

## MAJOR GROUP 81/82 — PROCESSING OCCUPATIONS

### 811 — Mineral Ore Treating Occupations

8110 Foremen/women: Mineral Ore Treating Occupations

8111 Crushing and Grinding Occupations, Mineral Ores

8113 Mixing, Separating, Filtering and Related Occupations, Mineral Ores

8115 Melting and Roasting Occupations, Mineral Ores

8116 Inspecting, Testing, Grading and Sampling Occupations: Mineral Ore Treating

8118 Occupations in Labouring and Other Elemental Work: Mineral Ore Treating

8119 Mineral Ore Treating Occupations, n.e.c.

### 813/814 — Metal Processing and Related Occupations

8130 Foremen/women: Metal Processing and Related Occupations

8131 Metal Smelting, Converting and Refining Occupations

8133 Metal Heat-treating Occupations

8135 Metal Rolling Occupations

8137 Moulding, Coremaking and Metal Casting Occupations

8141 Metal Extruding and Drawing Occupations

8143 Plating, Metal Spraying and Related Occupations

8146 Inspecting, Testing, Grading and Sampling Occupations: Metal Processing

8148 Occupations in Labouring and Other Elemental Work: Metal Processing

8149 Metal Processing and Related Occupations, n.e.c.

### 815 — Clay, Glass and Stone Processing, Forming and Related Occupations

8150 Foremen/women: Clay, Glass and Stone Processing, Forming and Related Occupations

8151 Furnace and Kiln Workers: Clay, Glass and Stone

8153 Separating, Grinding, Crushing and Mixing Occupations: Clay, Glass and Stone

8155 Forming Occupations, Clay, Glass and Stone

8156 Inspecting, Testing, Grading and Sampling Occupations: Clay, Glass and Stone Processing and Forming

8158 Occupations in Labouring and Other Elemental Work: Clay, Glass and Stone Processing and Forming

8159 Clay, Glass and Stone Processing, Forming and Related Occupations, n.e.c.

### 816/817 — Chemicals, Petroleum, Rubber, Plastic and Related Materials Processing Occupations

8160 Foremen/women: Chemicals, Petroleum, Rubber, Plastic and Related Materials Processing Occupations

8161 Mixing and Blending Occupations, Chemicals and Related Materials

8163 Filtering, Straining and Separating Occupations, Chemicals and Related Materials

8165 Distilling, Subliming and Carbonizing Occupations, Chemicals and Related Materials

8167 Roasting, Cooking and Drying Occupations, Chemicals and Related Materials

8171 Crushing and Grinding Occupations, Chemicals and Related Materials

8173 Coating and Calendering Occupations, Chemicals and Related Materials

8176 Inspecting, Testing, Grading and Sampling Occupations: Chemicals, Petroleum, Rubber, Plastic and Related Materials Processing

8178 Occupations in Labouring and Other Elemental Work: Chemicals, Petroleum, Rubber, Plastic and Related Materials Processing

8179 Chemicals, Petroleum, Rubber, Plastic and Related Materials Processing Occupations, n.e.c.

### 821/822 — Food, Beverage and Related Processing Occupations

8210 Foremen/women: Food, Beverage and Related Processing Occupations

8211 Flour and Grain Milling Occupations

8213 Baking, Confectionery Making and Related Occupations

8215 Slaughtering and Meat Cutting, Canning, Curing and Packing Occupations

8217 Fish Canning, Curing and Packing Occupations

8221 Fruit and Vegetable Canning, Preserving and Packing Occupations

8223 Milk Processing and Related Occupations

8225 Sugar Processing and Related Occupations

8226 Inspecting, Testing, Grading and Sampling Occupations: Food, Beverage and Related Processing

8227 Beverage Processing and Related Occupations

8228 Occupations in Labouring and Other Elemental Work: Food, Beverage and Related Processing

8229 Food, Beverage and Related Processing Occupations, n.e.c.

### 823 — Wood Processing Occupations, Except Pulp and Papermaking

230 Foremen/women: Wood Processing Occupations, Except Pulp and Papermaking

231 Sawmill Sawyers and Related Occupations

233 Plywood Making and Related Occupations

235 Wood Treating Occupations

236 Inspecting, Testing, Grading and Sampling Occupations: Wood Processing, Except Pulp and Papermaking

238 Occupations in Labouring and Other Elemental Work: Wood Processing, Except Pulp and Papermaking

239 Wood Processing Occupations, Except Pulp and Papermaking, n.e.c.

### 825 — Pulp and Papermaking and Related Occupations

250 Foremen/women: Pulp and Papermaking and Related Occupations

251 Cellulose Pulp Preparing Occupations

253 Papermaking and Finishing Occupations

256 Inspecting, Testing, Grading and Sampling Occupations: Pulp and Papermaking.

258 Occupations in Labouring and Other Elemental Work: Pulp and Papermaking.

259 Pulp and Papermaking and Related Occupations, n.e.c.

### 826/827 — Textile Processing Occupations

270 Foremen/women: Textile Processing Occupations

271 Textile Fibre Preparing Occupations

273 Textile Spinning and Twisting Occupations

275 Textile Winding and Reeling Occupations

277 Textile Weaving Occupations

281 Knitting Occupations

283 Textile Bleaching and Dyeing Occupations

285 Textile Finishing and Calendering Occupations

8276 Inspecting, Testing, Grading and Sampling Occupations: Textile Processing

8278 Occupations in Labouring and Other Elemental Work: Textile Processing

8279 Textile Processing Occupations, n.e.c.

### 829 — Other Processing Occupations

8290 Foremen/women: Other Processing Occupations

8293 Tobacco Processing Occupations

8295 Hide and Pelt Processing Occupations

8296 Inspecting, Testing, Grading and Sampling Occupations: Other Processing

8298 Occupations in Labouring and Other Elemental Work: Other Processing

8299 Other Processing Occupations, n.e.c.

## MAJOR GROUP 83 — MACHINING AND RELATED OCCUPATIONS

### 831 — Metal Machining Occupations

8310 Foremen/women: Metal Machining Occupations

8311 Tool and Die Making Occupations

8313 Machinist and Machine Tool Setting-up Occupations

8315 Machine Tool Operating Occupations

8316 Inspecting, Testing, Grading and Sampling Occupations: Metal Machining

8319 Metal Machining Occupations, n.e.c.

### 833 — Metal Shaping and Forming Occupations, Except Machining

8330 Foremen/women: Metal Shaping and Forming Occupations, Except Machining

8331 Forging Occupations

8333 Sheet Metal Workers

8334 Metalworking-machine Operators, n.e.c.

8335 Welding and Flame Cutting Occupations

8336 Inspecting, Testing, Grading and Sampling Occupations: Metal Shaping and Forming, Except Machining

8337 Boilermakers, Platers and Structural Metal Workers

8339 Metal Shaping and Forming Occupations, Except Machining, n.e.c.

### 835 — Wood Machining Occupations

8350 Foremen/women: Wood Machining Occupations

8351 Wood Patternmaking Occupations

8353 Wood Sawing and Related Occupations, n.e.c.

8355 Planing, Turning, Shaping and Related Wood Machining Occupations

8356 Inspecting, Testing, Grading and Sampling Occupations: Wood Machining

8357 Wood Sanding Occupations

8359 Wood Machining Occupations, n.e.c.

### 837 — Clay, Glass, Stone and Related Materials Machining Occupations

8370 Foremen/women: Clay, Glass, Stone and Related Materials Machining Occupations

8371 Cutting and Shaping Occupations: Clay, Glass, Stone and Related Materials.

8373 Abrading and Polishing Occupations: Clay, Glass, Stone and Related Materials

8376 Inspecting, Testing, Grading and Sampling Occupations: Clay, Glass, Stone and Related Materials Machining

8379 Clay, Glass, Stone and Related Materials Machining Occupations, n.e.c.

### 839 — Other Machining and Related Occupations, n.e.c.

8390 Foremen/women: Other Machining and Related Occupations, n.e.c.

8391 Engravers, Etchers and Related Occupations, n.e.c.

8393 Filing, Grinding, Buffing, Cleaning and Polishing Occupations, n.e.c.

8395 Patternmakers and Mouldmakers, n.e.c.

8396 Inspecting, Testing, Grading and Sampling Occupations: Other Machining and Related Occupations, n.e.c.

8399 Other Machining and Related Occupations, n.e.c.

## MAJOR GROUP 85 — PRODUCT FABRICATING, ASSEMBLING AND REPAIRING OCCUPATIONS

### 851/852 — Fabricating and Assembling Occupations: Metal Products, N.E.C.

8510 Foremen/women: Fabricating and Assembling Occupations: Metal Products, n.e.c.

8511 Engine and Related Equipment Fabricating and Assembling Occupations, n.e.c.

8513 Motor Vehicle Fabricating and Assembling Occupations, n.e.c.

8515 Aircraft Fabricating and Assembling Occupations, n.e.c.

8523 Industrial, Farm, Construction and Other Mechanized Equipment and Machinery Fabricating and Assembling Occupations, n.e.c.

8525 Business and Commercial Machines Fabricating and Assembling Occupations, n.e.c.

8526 Inspecting, Testing, Grading and Sampling Occupations: Fabricating and Assembling Metal Products, n.e.c.

8527 Precision Instruments and Related Equipment Fabricating and Assembling Occupations, n.e.c.

8528 Occupations in Labouring and Other Elemental Work: Fabricating and Assembling Metal Products, n.e.c.

8529 Other Fabricating and Assembling Occupations: Metal Products, n.e.c.

### 853 — Fabricating, Assembling, Installing and Repairing Occupations: Electrical, Electronic and Related Equipment

8530 Foremen/women: Fabricating, Assembling, Installing and Repairing Occupations; Electrical, Electronic and Related Equipment

8531 Electrical and Related Equipment Fabricating and Assembling Occupations

8533 Electrical and Related Equipment Installing and Repairing Occupations, n.e.c.

8534 Electronic and Related Equipment Fabricating and Assembling Occupations

8535 Electronic and Related Equipment Installing and Repairing Occupations, n.e.c.

8536 Inspecting, Testing, Grading and Sampling Occupations: Fabricating, Assembling, Installing and Repairing Electrical, Electronic and Related Equipment

8537 Radio and Television Repairers

8538 Occupations in Labouring and Other Elemental Work: Fabricating, Assembling, Installing and Repairing Electrical, Electronic and Related Equipment

8539 Fabricating, Assembling, Installing and Repairing Occupations: Electrical, Electronic and Related Equipment, n.e.c.

### 854 — Fabricating, Assembling and Repairing Occupations: Wood Products

8540 Foremen/women: Fabricating, Assembling and Repairing Occupations: Wood Products

8541 Cabinet and Wood Furniture Makers

8546 Inspecting, Testing, Grading and Sampling Occupations: Fabricating, Assembling and Repairing Wood Products

8548 Occupations in Labouring and Other Elemental Work: Fabricating, Assembling and Repairing Wood Products

8549 Fabricating, Assembling and Repairing Occupations: Wood Products, n.e.c.

### 855/856 — Fabricating, Assembling and Repairing Occupations: Textile, Fur and Leather Products

8550 Foremen/women: Fabricating, Assembling and Repairing Occupations: Textile, Fur and Leather Products

8551 Patternmaking, Marking and Cutting Occupations: Textile, Fur and Leather Products

8553 Tailors and Dressmakers

8555 Furriers

8557 Milliners, Hat and Cap Makers

8561 Shoemaking and Repairing Occupations

8562 Upholsterers

8563 Sewing Machine Operators, Textile and Similar Materials

8566 Inspecting, Testing, Grading and Sampling Occupations: Fabricating, Assembling and Repairing Textile, Fur and Leather Products

8568 Occupations in Labouring and Other Elemental Work: Fabricating, Assembling and Repairing Textile, Fur and Leather Products

8569 Fabricating, Assembling and Repairing Occupations: Textile, Fur and Leather Products, n.e.c.

### 857 — Fabricating, Assembling and Repairing Occupations: Rubber, Plastic and Related Products

8570 Foremen/women: Fabricating, Assembling and Repairing Occupations: Rubber, Plastic and Related Products

8571 Bonding and Cementing Occupations: Rubber, Plastic and Related Products

8573 Moulding Occupations: Rubber, Plastic and Related Products

8575 Cutting and Finishing Occupations: Rubber, Plastic and Related Products

8576 Inspecting, Testing, Grading and Sampling Occupations: Fabricating, Assembling and Repairing Rubber, Plastic and Related Products

8578 Occupations in Labouring and Other Elemental Work: Fabricating, Assembling and Repairing Rubber, Plastic and Related Products

8579 Fabricating, Assembling and Repairing Occupations: Rubber, Plastic and Related Products, n.e.c.

### 858 — Mechanics and Repairers, n.e.c.

8580 Foremen/women: Mechanics and Repairers, n.e.c.

8581 Motor Vehicle Mechanics and Repairers

8582 Aircraft Mechanics and Repairers

8583 Rail Transport Equipment Mechanics and Repairers

8584 Industrial, Farm and Construction Machinery Mechanics and Repairers

8585 Business and Commercial Machine Mechanics and Repairers

8586 Inspecting, Testing, Grading and Sampling Occupations: Equipment Repair, n.e.c.

8587 Watch and Clock Repairers

8588 Precision Instrument Mechanics and Repairers

8589 Other Mechanics and Repairers, n.e.c.

### 859 — Other Product Fabricating, Assembling and Repairing Occupations

8590 Foremen/women: Other Product Fabricating, Assembling and Repairing Occupations

8591 Jewellery and Silverware Fabricating, Assembling and Repairing Occupations

8592 Marine Craft Fabricating, Assembling and Repairing Occupations

8593 Paper Product Fabricating and Assembling Occupations

8595 Painting and Decorating Occupations, n.e.c.

8596 Inspecting, Testing, Grading and Sampling Occupations: Other Product Fabricating, Assembling and Repairing

8598 Occupations in Labouring and Other Elemental Work: Other Product Fabricating, Assembling and Repairing

8599 Other Product Fabricating, Assembling and Repairing Occupations, n.e.c.

## MAJOR GROUP 87 — CONSTRUCTION TRADES OCCUPATIONS

### 871 — Excavating, Grading, Paving and Related Occupations

8710 Foremen/women: Excavating, Grading, Paving and Related Occupations

8711 Excavating, Grading and Related Occupations

8713 Paving, Surfacing and Related Occupations

8715 Railway Section and Track Workers

8718 Occupations in Labouring and Other Elemental Work: Excavating, Grading, Paving and Related Activities

8719 Excavating, Grading, Paving and Related Occupations, n.e.c.

### 873 — Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occpations

8730 Foremen/women: Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations

8731 Electrical Power Line Workers and Related Occupations

8733 Construction Electricians and Repairers

8735 Wire Communications and Related Equipment Installing and Repairing Occupations

8736 Inspecting, Testing, Grading and Sampling Occupations: Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing

8738 Occupations in Labouring and Other Elemental Work: Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing

8739 Electrical Power, Lighting and Wire Communications Equipment Erecting, Installing and Repairing Occupations, n.e.c.

### 878/879 — Other Construction Trades Occupations

780 Foremen/women: Other Construction Trades Occupations

781 Carpenters and Related Occupations

782 Brick and Stone Masons and Tile Setters

783 Concrete Finishing and Related Occupations

784 Plasterers and Related Occupations

785 Painters, Paperhangers and Related Occupations

786 Insulating Occupations, Construction

787 Roofing, Waterproofing and Related Occupations

791 Pipefitting, Plumbing and Related Occupations

793 Structural Metal Erectors

795 Glaziers

796 Inspecting, Testing, Grading and Sampling Occupations: Other Construction Trades

798 Occupations in Labouring and Other Elemental Work: Other Construction Trades

799 Other Construction Trades Occupations, n.e.c.

## MAJOR GROUP 91 — TRANSPORT EQUIPMENT OPERATING OCCUPATIONS

### 911 — Air Transport Operating Occupations

10 Foremen/women: Air Transport Operating Occupations

11 Air Pilots, Navigators and Flight Engineers

13 Air Transport Operating Support Occupations

19 Air Transport Operating Occupations, n.e.c.

### 913 — Railway Transport Operating Occupations

30 Foremen/women: Railway Transport Operating Occupations

31 Locomotive Operating Occupations

9133 Conductors and Brake Workers, Railway

9135 Railway Transport Operating Support Occupations

9139 Railway Transport Operating Occupations, n.e.c.

### 915 — Water Transport Operating Occupations

9151 Deck Officers

9153 Engineering Officers, Ship

9155 Deck Crew, Ship

9157 Engine and Boiler-room Crew, Ship

9159 Water Transport Operating Occupations, n.e.c.

### 917 — Motor Transport Operating Occupations

9170 Foremen/women: Motor Transport Operating Occupations

9171 Bus Drivers

9173 Taxi Drivers and Chauffeurs

9175 Truck Drivers

9179 Motor Transport Operating Occupations, n.e.c.

### 919 — Other Transport Equipment Operating Occupations

9190 Foremen/women: Other Transport Equipment Operating Occupations

9191 Subway and Street Railway Operating Occupations

9193 Rail Vehicle Operators, Except Rail Transport

9199 Other Transport Equipment Operating Occupations, n.e.c.

## MAJOR GROUP 93 — MATERIAL HANDLING AND RELATED OCCUPATIONS, N.E.C.

### 931 — Material Handling and Related Occupations, n.e.c.

9310 Foremen/women: Material Handling and Related Occupations, n.e.c.

9311 Hoisting Occupations, n.e.c.

9313 Longshore Workers, Stevedores and Freight Handlers

9314 Parcel Carriers, n.e.c.

9315 Material Handling Equipment Operators, n.e.c.

9317 Packaging Occupations, n.e.c.

9318 Occupations in Labouring and Other Elemental Work: Material Handling and Related Activities, n.e.c.

9319 Other Material Handling and Related Occupations, n.e.c.

## MAJOR GROUP 95 — OTHER CRAFTS AND EQUIPMENT OPERATING OCCUPATIONS

### 951 — Printing and Related Occupations

9510 Foremen/women: Printing and Related Occupations

9511 Typesetting and Composing Occupations

9512 Printing Press Occupations

9513 Stereotyping and Electrotyping Occupations

9514 Printing Engraving, Except Photoengraving, Occupations

9515 Photoengraving and Related Occupations

9517 Bookbinding and Related Occupations

9518 Occupations in Labouring and Other Elemental Work: Printing and Related Activities

9519 Printing and Related Occupations, n.e.c.

### 953 — Stationary Engine and Utilities Equipment Operating and Related Occupations

9530 Foremen/women: Stationary Engine and Utilities Equipment Operating and Related Occupations

9531 Power Station Operators

9539 Stationary Engine and Utilities Equipment Operating and Related Occupations, n.e.c.

### 955 — Electronic and Related Communications Equipment Operating Occupations, n.e.c.

9550 Foremen/women: Electronic and Related Communications Equipment Operating Occupations, n.e.c.

9551 Radio and Television Broadcasting Equipment Operators

9553 Telegraph Operators

9555 Sound and Video Recording and Reproduction Equipment Operators

9557 Motion Picture Projectionists

9559 Other Electronic and Related Communications Equipment Operating Occupations, n.e.c.

### 959 — Other Crafts and Equipment Operating Occupations, n.e.c.

9590 Foremen/women: Other Crafts and Equipment Operating Occupations, n.e.c.

9591 Photographic Processing Occupations

9599 Other Crafts and Equipment Operating Occupations, n.e.c.

## MAJOR GROUP 99 — OCCUPATIONS NOT ELSEWHERE CLASSIFIED

### 991 — Occupations not Elsewhere Classified

9910 Supervisors and Foremen/women: n.e.c.

9916 Inspecting, Testing, Grading and Sampling Occupations: n.e.c.

9918 Occupations in Labouring and Other Elemental Work: n.e.c.

9919 Other Occupations, n.e.c.

## MAJOR GROUP 00 — PERSONS NOT CLASSIFIABLE BY OCCUPATION

### 001 — Workers Reporting Unidentifiable or Inadequately Described Occupations (Not Codeable)

0011 Workers Reporting Unidentifiable or Inadequately Described Occupations (Not Codeable)

### 002 — Workers not Reporting any Occupation

0021 Workers Not Reporting Any Occupation

### 003 — Other Persons, n.e.c.

0031 Other persons, n.e.c.

APPENDIX VII

JOB CLASSIFICATION SCHEME FOR CROSS CANADA STUDY OF PESTICIDE AND HEALTH

## 1. Potential Pesticide Exposure

Farmers
Farm managers (farm foremen)
Farm labourers
Forestry workers
Grain handlers
Power lineman and servicemen (telegraph, telephone linemen)
Grain, flour and feed millers
Gardeners
Groundskeeper
Lumbermen, raftsmen and woodchoppers
Pesticide manufacturing
Pesticide applicators (a) commercial, (b) lawn and garden care, (c) highway maintenance, (d) railroad right of way maintenance
Water treatment
Hog breeder
Tree nurser
Marker for aerial spraying
Agriculturalist
Cattle industry
Dairyman, chicken & turkeys
Horse slaughter
Seed cleaning
Feed lot
Bee keeper
Weed inspector, sprayer
Landscaper
Animal feeder

## 2. Potential Chemical Exposure (non-pesticides)

Chemists
Funeral directors and embalmers
Artists
Medical and dental technicians
Laboratory personnel
Truckers
Miners
Veterinarians
Dyers

Bus drivers
Engineers: chemical, industrial, metallic & mining
Dry cleaning operatives
Natural scientists
Testing technicians
Technicians, not elsewhere classified
Welders
Bookbinders
Compositors & typesetters
Electrotypers and stereotypers
Furriers
Glaziers
Heat treaters, annealers and temperers
Metal job setters
Machinist
Airplane mechanics and repairmen
Automobile mechanics and repairmen
Railroad and car shop mechanics and repairmen
Mechanics and repairmen, not elsewhere classified
Millwrights
Metal moulders
Construction & maintenance painters
Photoengravers and lithographers
Printing pressmen and plate printers
Roofers and slaters
Shoemakers and repairers, except factory

**3A. White collar Professionals, Managers, Officials and Proprietors (non-farm)**

Accountants and auditors
Actors
Airplane pilots and navigators
Architects
Art teachers
Athletes
Authors
Chiropractors
Clergymen
College presidents, professors, and instructors
Dancers and dancing teachers
Dentists
Designers
Dieticians and nutritionists
Draftsmen
Editors and reporters
Aeronautical engineers

Civil engineers
Electrical engineers
Mechanical engineers
Entertainers, not elsewhere classified
Farm and more management advisors
Lawyers and judges
Librarians
Musicians and music teachers
Optometrists
Osteopaths
Personnel and labour relations workers
Pharmacists
Photographers
Physicians and surgeons
Radio operators
Recreation and group workers
Religious workers
Social and welfare workers, except group
Social scientists
Sports instructors and officials
Surveyors
Teachers, not elsewhere classified
Therapists and healers, not elsewhere classified
Professional, not elsewhere classified
Store buyers and department heads
Buyers and shippers, farm products
Railroad conductors
Credit men
Store floormen and floor manager
Public administration inspectors
Building manager and superintendents
Ship officers, pilots, pursers, and engineers
Public administration officials and administrators, not elsewhere classified
Officials, lodge, society, union, etc
Postmasters
Purchasing agents and buyers, not elsewhere classified
Managers, officials, and proprietors, not elsewhere classified

**3B. Clerical and Kindred Workers, Sales Workers**

Agents, not elsewhere classified
Library attendants and assistants
Physician and dentist attendants
Transportation baggagemen
Bank tellers bookkeepers
Cashiers

Bill and account collectors
Vehicle dispatchers and starters
Express messengers and railway mail clerks
Mail carriers
Messengers and office boys
Shipping and receiving clerks
Advertising agents and salesmen
Auctioneers
Hucksters and peddlers
Insurance agents and brokers
Newsboys
Real estate agents and brokers
Stock and bond salesmen
Salesmen and sales clerks, not elsewhere classified

**4A. Blue Collar (dirty ie, potentially exposed to dusts, fumes etc.)**

**Ai. Craftsmen, foremen, and kindred workers**

Bakers
Blacksmiths
Boilermakers
Brickmasons, stonemasons, and tilesetters
Cabinetmakers
Carpenters
Cement and concrete finishers
Cranemen, derrickmen, and hoistmen
Engravers, except photoengravers
Excavating, grading, and road machinery operators
Locomotive engineers
Locomotive firemen
Loom fixers
Plasterers
Plumbers and pipe fitters
Metal rollers and roll hands
Stone cutters and carvers
Structural metal workers
Tailors
Tinsmiths, coppersmiths, and sheet metal workers
Toolmaker, and diemakers and setters
Upholsterers
Craftsmen and kindred workers, not elsewhere classified
Members of the armed forces

**Aii. Operatives and Kindred Workers**

Asbestos and insulation workers
Auto service and parking attendants
Blasters and powdermen
Garage labourers and car washers and greasers
Longshoremen and stevedores
Teamsters
Labourers, not elsewhere classified
Surveying chainmen, rodmen, and axemen
Bus, street, and railway conductors
Deliverymen and routemen
Dressmakers and seamstresses, except factory
Metal filers, grinders and polishers
Furnacemen, smeltermen and pourers
Metal heaters
Mine operatives and labourers
Mine, factory, and logging camp motormen
Street, subway, and elevated railway motormen
Oilers and greasers, except auto
Painters, except construction or maintenance
Photographic process workers
Sawyers
Textile spinners
Stationary firemen
Taxicab drivers and chauffers
Truck and tractor drivers
Textile weavers
Welders and flamecutters
Operatives and kindred workers, not elsewhere classified
Firemen

**4B. Blue Collar (clean)**

Fishermen and oystermen
Decorators and window dressers
Electricians
Foremen, not elsewhere classified
Inspectors, not elsewhere classified
Office machine mechanics and repairmen
Radio and television mechanics and repairmen
Motion picture projectionists
Opticians and lens grinders and polishers
Paperhangers
Pattern and model makers, except paper
Piano and organ tuners and repairmen

Stationary engineers
Fruit, nut & vegetable packers
Laundry operatives
Meat cutters, except slaughter and packing house
Milliners
Power station operator
Sailors and deck hands
Railroad switchmen
Hospital and other institution attendants
Professional and personal service attendants, not elsewhere classified
Recreation and amusement attendants
Barbers, beauticians, and manicurists
Bartenders
Bootblacks
Boarding and lodging housekeepers
Cooks, except private household
Counter and fountain workers
Elevator operators
Guards, watchmen, and doorkeepers
Housekeepers and stewards, except private household
Janitors and sextons
Marshals and constables
Policemen and detectives
Porters
Sheriffs and bailiffs
Waiters
Watchmen (crossing) and bridge tenders
Service workers, except private household, not elsewhere classified

**5.** Retired without specifying previous jobs
Unemployed without specifying previous jobs

# APPENDIX VIII

## TABLE 1

*List of industries in the occupation and exposure linkage system**

| Code | Industry |
|---|---|
| 01 | Agriculture, forestry, fishing |
| 02 | Mining |
| 03 | Construction |
| | Processors, producers, and users of products made from: |
| 04 | Paper and wood |
| 05 | Glass, clay, and stone |
| 06 | Metal |
| 07 | Machinery (includes electronics) |
| 08 | Shipbuilding, motor vehicles, aircraft, and other transportation methods (includes goods transport) |
| 09 | Food and tobacco |
| 10 | Textiles |
| 11 | Chemicals, drugs, and paints |
| 12 | Rubber, plastics, and synthetics (includes electric cable) |
| 13 | Fuel |
| 14 | Leather |
| 15 | Medicine and science |
| 16 | Entertainment and recreation |
| 17 | Art |
| 99 | Occupations with few chemical exposures (business, law, sales, etc.) |

## TABLE 2

*List of agent groups in the abridged occupation and exposure linkage system*

| New code | Agent group | Original code |
|---|---|---|
| | Organic compounds | |
| | Aromatic hydrocarbons: | |
| 10 | aromatic amino compounds | 1000–1099 |
| 11 | aromatic nitro compounds | 1100–1199 |
| 12 | aromatic halogens | 1200–1299 |
| 13 | aromatic azo compounds | 1300–1399 |
| 14 | phenols | 1400–1499 |
| 15 | aromatic hydrocarbons, NOS* | 1500–1999 |
| | Alicyclic hydrocarbons: | |
| 20 | alicyclic halogens | 2000–2499 |
| 25 | alicyclic hydrocarbons, NOS | 2500–2999 |
| 30 | Alkylating agents | 3000–3999 |
| | Aliphatic hydrocarbons: | |
| 40 | aliphatic halogens | 4000–4199 |
| 42 | aliphatic nitro compounds | 4200–4299 |
| 43 | alcohols, glycols, acids & derivatives | 4300–4499 |
| 45 | aldehydes, ketones, ethers & derivatives | 4500–4599 |
| 46 | esters | 4600–4699 |
| 47 | aliphatic hydrocarbons, NOS | 4700–4799 |
| 50 | Other organic compounds, NOS | 5000–5999 |
| | Inorganic compounds | |
| 60 | Metals, metalloids & their compounds | 6000–6499 |
| 65 | Minerals | 6500–6599 |
| 66 | Inorganic halogens | 6600–6699 |
| 67 | Inorganic compounds, NOS | 6700–6999 |
| | Physical agents | |
| 80 | Nonionizing radiation | 8000–8499 |
| 85 | Ionizing radiation | 8500–8999 |
| 90 | Dusts | 9000–9499 |
| 99 | Other physical agents | 9500–9999 |

* Not otherwise specified.

*Description of the clusters*

| Cluster | Industry | Task within the industry* |
|---|---|---|
| 0 | 7 | Sales. |
| | 8 | Personal service (steward, stewardess, porter). |
| | 9 | Hostess, steward, waiter, waitress. |
| | 15 | Occupations in psychology. Service managers and officials.† Public administration managers and officials. Office work.‡ |
| | 16 | Dancing. Music. Managers and officials.§ Sound recording, transcribing, and reproduction. Office work. Production clerk.‖ Sales. Packaging and materials handling.¶ |
| | 99 | Architect, draftsman. Mathematical science. Astronomy. Meteorology. Psychology. Social science. Student. Education (including translator). Museum, library, and archives. Judge, lawyer. Clergy, religious occupation. Writer, journalist, newspaper writer. Accountant, auditor, and other administrative specialists (including underwriter). Managers and officials. Bookkeeper, cashier. Production clerk. Telephone operator. Clerk, NOS.** Sales. Amusement and recreational attendants. Retired, NOS. Occupation known, cannot classify. Occupation unknown. |
| Exposure: not exposed to any of the 24 agent groups. | | |
| 1 | 1 | Marine engineering. Hunting, trapping, and guide. Animal care and husbandry. Veterinarian. |
| | 2 | Mining engineer. Geology. Managers and officials. Office work. Production clerk. Sales. |
| | 3 | Civil engineer, architect. Vocational educator. Manager and officials. Office work. Production clerk. Sales. Packaging and materials handling. |
| | 4 | Industrial engineer. Managers and officials. Office work. Production clerk. Sales. Logging and lumbering. |
| | 5 | Sales. |
| | 6 | Industrial engineer. Managers and officials. Office work. Production clerk. Sales. Occupation known, cannot classify. Occupation unknown. |
| | 7 | Electrical engineer. Industrial engineer (including draftsman). Office work. Production clerk. Metal processing. Metal machining. Metal working. Polishing products, abrasives, and related materials fabrication and repair. Assembling, repair, and installation of large household appliances. |
| | 8 | Aeronautical engineer. Mechanical engineer. Radio operator, air traffic controller. Managers and officials. Office work. Production clerk. Metal processing. Metal machining. Metal working. |
| | 9 | Engineering and research. Wholesale and retail managers. Service managers. Office work. Production clerk. Sales. Bartender. Meat cutter. Occupation known, cannot classify. Occupation unknown. |
| | 10 | Industrial engineer. Managers and officials. Office work. Production clerk. Sales. |
| | 11 | Managers and officials. Office work. Sales. |

* For the occupation titles, refer to reference 3. Abbreviation: NOS, not otherwise specified.

† Includes accountant, buyer, manager of dental laboratories and health services, hospital administrator.

‡ Nonmanagerial, nonprofessional NOS, includes secretary, office and errand boys.

§ Includes accountant, buyer.

‖ Includes warehouseman and storekeeper mainly concerned with paperwork, timekeeping, etc., as opposed to handling stock.

¶ Includes warehouseman, storekeeper, loader, fork lifter.

** Office work, not saleswork, includes postal clerk, bank clerk, proofreader.

†† Includes heavy equipment operator, jackhammerman, demolition, shot firer, trench digger.

| Cluster | Industry | Task within the industry* |
|---|---|---|
| | 12 | Industrial engineer. Managers and officials. Office work. Sales. |
| | 13 | Industrial engineer. Geology. Managers and officials. Office work. Production clerk. Occupations in nuclear energy. Occupation known, cannot classify. Occupation unknown. |
| | 14 | Engineer. Managers and officials. Office work. Production clerk. Sales. |
| | 15 | Nuclear engineer. Mathematical and physical sciences. Life sciences, NOS. Osteopath. Dietician. Animal care, NOS. Nurse's aid. Service occupation, NOS. Sales. |
| | 16 | Occupations in athletics. Radio operator. Masseur and related occupations. Bath attendant. Occupation known, cannot classify. Occupation unknown. |
| | 17 | Art education. Designer. Managers and officials. Office work. Production clerk. Sales. Paper processing. Paper working. Electrotyper. Stenotyper. Occupation known, cannot classify. Occupation unknown. |
| | 99 | Professional, technical, and managerial, NOS. Secretary, stenographer, typist, and filing clerk. Messenger, mail carrier. Personal services, NOS. Building services occupations. |
| Exposure: moderately exposed to agent group 46. | | |
| 2 | 6 | Mechanic and maintenance. |
| | 7 | Mechanics, machinery repair, and maintenance. Occupation known, cannot classify. Occupation unknown. |
| | 10 | Mechanic and maintenance. |
| | 11 | Chemistry college and university educators and research assistants. Chemistry secondary school educator. |
| | 12 | Production clerk. Mechanic and maintenance. Occupation known, cannot classify. Occupation unknown. |
| | 16 | Mechanic and maintenance. |
| | 17 | Mechanic and maintenance. Bookbinder. |
| Exposure: moderately exposed to agent groups 40, 45, 46, and 67. | | |
| 3 | 1 | Agricultural engineering. Agricultural science. Managers and officials. Office work. Production clerk. Forestry. Logging and lumbering. Fishing and whaling. Fishery and related occupations, NOS. Occupation known, cannot classify. Occupation unknown. |
| | 3 | Surveyor. Roofer. Excavating, paving and grading.†† |
| | 8 | Driver, chauffeur, trucker, pilot, train conductor, taxi driver. |
| | 13 | Extraction. |
| | 15 | Production clerk. Packaging and materials handling. Occupation known, cannot classify. Occupation unknown. |
| | 16 | Barbering, cosmetology, and related service occupations. |
| Exposure: moderately exposed to agent groups 15, 47, and 80. | | |
| 4 | 1 | Packaging and materials handling. |
| | 3 | Plumber, gas and steam fitter, pipe fitter. |
| | 4 | Packaging and materials handling. |
| | 5 | Packaging and materials handling. |
| | 6 | Packaging and materials handling. |
| | 7 | Packaging and materials handling. |
| | 8 | Packaging and materials handling. Plumber. Boby worker, transportation equipment. |

| Cluster | Industry | Task within the industry* |
|---|---|---|
| | 14 | Packaging and materials handling. |
| | 17 | Packaging and materials handling. |
| Exposure: moderately exposed to agent groups 10, 12, 80, and 95. | | |
| 5 | 1 | Cotton ginning and compressing. |
| | 2 | Packaging and materials handling. Occupation known, cannot classify. Occupation unknown. |
| | 9 | Packaging and materials handling. |
| | 10 | Packaging and materials handling. |
| | 13 | Packaging and materials handling. |
| | 99 | Packaging and materials handling. |
| Exposure: moderately exposed to agent groups 20, 25, 80, and 95. | | |
| 6 | 1 | Sales. |
| | 3 | Metal fabrication (structural work). Welder, flame cutter. |
| | 4 | Paper processing. Paper working. |
| | 6 | Metal machining. Metal working. Structural work. Welder, flame cutter. |
| | 10 | Fur working. Hat, cap, and glove fabrication and repair. |
| | 11 | Sewage and water treaters. |
| | 12 | Metal machining. |
| | 17 | Metallurgy engineer. Rubber, plastics, synthetics product fabrication and repair. Photoengraver. Graphic art, NOS. |
| Exposure: moderately exposed to agent groups 15, 43, 47 [illegible] and 67. | | |
| 7 | 3 | Electrician. Asbestos and insulation workers. |
| | 7 | Metal products fabrication, assembly, and repair. Structural work assembling, installing and repairing electrical equipment. |
| | 8 | Sales. Electrician. Electrical equipment assembly and repair. Transportation equipment assembler and related occupations. |
| | 17 | Printing (including engraver). Lithographer. Hard compositor, typesetter. |
| Exposure: moderately exposed to agent groups 10, 15, 43, and 47. | | |
| 8 | 8 | Upholstering. |
| | 9 | Cook (domestic). Cook, chef (establishment). |
| | 10 | Upholstering, fabrication and repair of mattresses and bedspreads. Sewer, embroiderer, knitter, seamstress, tailor, mender, stitcher. |
| | 14 | Apparel service occupations, NOS. |
| | 17 | Rubber, plastics, synthetics, chemicals processing. |
| | 99 | Food preparation. Utilities production and distribution (including sewage refiner). |
| Exposure: moderately exposed to agent groups 10 and 15. | | |
| 9 | 12 | Chemical engineer. Occupations in chemistry. |
| | 13 | Chemical engineer. Chemistry. |
| | 14 | Boot black, shoe shine. |
| | 15 | Chemistry. Biology. Physician, surgeon. |
| | 16 | Dramatics. Theatrical make-up. |
| Exposure: moderately exposed to agent groups 15, 47, and 85. | | |

| Cluster | Industry | Task within the industry* |
|---|---|---|
| 10 | 3 | Sculptor (art work). Wood machining. Wood fabrication and repair. |
| | 5 | Industrial engineer. Managers and officials. Office work. Production clerk. Sculptor. Occupations in art, NOS. Glass setter, glazier. Occupation known, cannot classify. Occupation unknown. |
| | 10 | Model maker, patternmaker. |
| | 17 | Commercial artist. Sculptor. Wood processing. Wood machining. |
| Exposure: heavily exposed to agent group 90. | | |
| 11 | 3 | Glass, clay, and stone machining. Carpenter (including joiner, cabinet maker). Brick and stone masons (including tile setter). |
| | 4 | Wood machining. Carpenter (including joiner, cabinet maker). |
| | 5 | Brick and stone masons, tile setter. |
| | 8 | Carpenter. |
| Exposure: heavily exposed to agent group 90 and moderately to 14, 15, and 60. | | |
| 12 | 3 | Glass, clay, and stone fabrication and repair. |
| | 10 | Apparel and furnishing service, NOS. |
| | 17 | Ceramic engineer. |
| Exposure: heavily exposed to agent groups 60 and 90, and moderately to 43, 47, 65, and 66. | | |
| 13 | 1 | Grain farming. Cotton farming. Vegetable farming. Fruit and nut farming. Tobacco farming. Plant farming, NOS (e.g., gardener). Dairy farming. Poultry farming. Livestock farming. Animal farming, NOS. Miscellaneous farming and related occupations. |
| Exposure: heavily exposed to agent groups 60 and 80, and moderately to 14, 15, 20, 25, 43, and 47. | | |
| 14 | 1 | Blight and pest control. Agricultural services. |
| Exposure: heavily exposed to agent groups 20, 50, and 60, and moderately to 10, 15, 25, 30, 40, 43, and 47. | | |
| 15 | 2 | Mechanic and maintenance. |
| | 3 | Mechanic and machinery repair (millwright). Structural maintenance. Occupation known, cannot classify. Occupation unknown. |
| | 8 | Engine mechanics and repair. Garage services, gas station attendant. Maintenance, NOS. Occupation known, cannot classify. Occupation unknown. |
| | 11 | Packaging and materials handling. |
| | 12 | Packaging and materials handling. |
| | 13 | Mechanic and maintenance. |
| | 15 | Mechanic and maintenance. |
| Exposure: moderately exposed to agent groups 15, 47, 60, 65, 67, 80, and 95. | | |
| 16 | 2 | Boring, drilling, cutting (including hewing, digging, coal miner). Blasting. Loading and conveying (including banksman, wagoneer). Crushing. Screening and related occupations. |
| Exposure: heavily exposed to agent groups 60, 65, and 85, and moderately to 14, 47, and 80. | | |
| 17 | 99 | Protective services, NOS (e.g., police, fire, military, NOS). |
| Exposure: heavily exposed to agent groups 30 and 80, and moderately to 10, 12, 40, 60, 65, and 85. | | |

| Cluster | Industry | Task within the industry* |
|---|---|---|
| 18 | 1 | Sales. |
| | 4 | Paper processing: calendering, sizing, coating. |
| | 6 | Metal processing. |
| | 9 | Processing. Preparation and service, NOS. |
| | 10 | Processing. |
| | 13 | Sales. Processing. |
| | 15 | Veterinarian. Pharmacist. Registered nurse. Licensed practical nurse. |
| Exposure: moderately exposed to agent groups 12, 14, 15, 25, 40, 47, 50, 60, 66, and 67. | | |
| 19 | 4 | Wood processing. Occupation known, cannot classify. Occupation unknown. |
| | 9 | Processing. |
| | 10 | Laundering, domestic. Laundering, dry cleaning, pressing. |
| Exposure: heavily exposed to agent group 60 and moderately to 14, 15, 30, 40, 43, 45, 66, and 90. | | |
| 20 | 2 | Extraction of minerals, NOS. |
| | 6 | Metallurgist. Metal processing. Ore refining. Metal products fabrication, assembly, and repair. |
| | 8 | Boilermaker, boiler stoker, locomotive, fireman, engineer, switchman, crane operator, brakeman, yard conductor. |
| | 13 | Boilermaker, utilities production and distribution. |
| | 17 | Metal processing. Textile and leather machining. |
| Exposure: heavily exposed to agent groups 15, 47, and 60 and moderately to 14, 43, 67, and 85. | | |
| 21 | 15 | Embalmer. |
| | 17 | Photographic equipment and supplies fabrication and repair. |
| Exposure: moderately exposed to agent groups 14, 45, 47, 60 and 66. | | |
| 22 | 1 | Mechanic and maintenance. |
| | 3 | Painter (art work). Painter (benchwork, including sign writer). Painter, plasterer, waterproofer, cementer, housepainter. |
| | 7 | Electrical equipment assembly, and repair. Stripper, painter of electrical products. |
| | 8 | Painter. |
| | 11 | Painter. |
| | 12 | Processing. |
| | 15 | Dentist. Hospital housekeeping. Porter, cleaner, janitor. Hospital laundering. |
| | 17 | Museum curator. Painter (art). Painter (benchwork, including sign painter, billboard painter). |
| | 99 | Homemaker, domestic services (including housewife, companion). Lodging services (including chambermaid) |
| Exposure: heavily exposed to agent group 10, and moderately to 11, 12, 14, 15, 25, 30, 43, 45, 46, 47, 50, 60, 65, 67, and 85. | | |
| 23 | 10 | Processing. Occupation known, cannot classify. Occupation unknown. |
| | 11 | Processing. |
| Exposure: heavily exposed to agent groups 10, 15, 47, 60, 65, and 66, and moderately to 12, 13, 14, 20, 25, 30, 40, 43, 45, 46, 50, 67, and 85. | | |

| Cluster | Industry | Task within the industry* |
|---|---|---|
| 24 | 10 | Dyeing finished textile products. |
| | 14 | Dyeing service occupations. |
| | 15 | Medical and health occupations, NOS. |
| | 17 | Dyeing-art. Photography. Darkroom. |

Exposure: heavily exposed to agent groups 10, 43, 50, and 60, and moderately to 12, 13, 14, 15, 25, 40, 45, 46, 47, 66, 67, 85, and 95.

| | | |
|---|---|---|
| 25 | 4 | Mechanic and maintenance. |
| | 5 | Mechanic and maintenance. |
| | 9 | Mechanic and maintenance. |
| | 14 | Maintenance. Shoe, luggage, and other leather product fabrication and repair. |
| | 17 | Artwork, NOS. |

Exposure: moderately exposed to agent groups 10, 15, 40, 43, 46, 47, 65, 90, and 95.

| | | |
|---|---|---|
| 26 | 4 | Printing. Wood product fabrication and repair. |
| | 17 | Metal products fabrication and repair. Fabrication and repair of products of assorted materials (jewelry, sporting goods, etc.). Wood products fabrication and repair. Glass, clay, stone, and sand product fabrication and repair. Fabrication and repair, NOS. |

Exposure: heavily exposed to agent group 60, and moderately to 12, 15, 25, 40, 43, 47, 65, 66, 67, and 90.

| | | |
|---|---|---|
| 27 | 5 | Glass, clay, and stone products fabrication and repair. |
| | 11 | Chemical engineer. Chemistry. Production clerk. Mechanic and maintenance. Occupation known, cannot classify. Occupation unknown. |
| | 12 | Rubber, plastics, and synthetics machining. Tire, tube, and tread fabrication and repair benchwork. Laying out and cutting rubber, plastics, and synthetics. Fitting, shaping, cementing, finishing benchwork. Rubber and plastic footwear fabrication and repair. Rubber, plastic, and synthetic product fabrication and repair, NOS. |
| | 15 | Dental assistant, dental technician. |

Exposure: moderately exposed to agent groups 10, 15, 45, 47, 60, 66, and 67.

| | | |
|---|---|---|
| 28 | 5 | Ceramic engineer. Processing. Glass, clay, and stone machining. |
| | 11 | Occupations in fabrication of ammunition, fireworks, explosives and related products. |
| | 17 | Glass, clay, and stone processing. Glass, clay, and stone machining. |

Exposure: heavily exposed to agent groups 60, 65, and 90, and moderately to 15, 43, 45, 47, and 85.

| | | |
|---|---|---|
| 29 | 14 | Processing. Occupation known, cannot classify. Occupation unknown. |
| | 17 | Textile and leather processing. Textile and leather product fabrication and repair. |

Exposure: heavily exposed to agent groups 10, 65, and 90, and moderately to 14, 15, 43, 47, 50, and 67.

## Appendix IX

List of Abbreviations

DDT – dichlorodiphenyltrichloroethane

α-BHC – hexachlorocyclohexane

γ-BHC – lindane

DDE – 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene

TCDD – 2,3,7,8-tetrachlorodibenzo-p-dioxin

PCBs – polychlorinated biphenyls

β-HCH - β-hexachlorocyclohexane

SEER – Surveillance, Epidemiology and End Results

SES – Socioeconomic Status

BMI – Body Mass Index

NECSS – National Enhanced Cancer Surveillance System

LCDC – Laboratory Centre of Disease Control

SOC – Standard Occupational Classification code

RR# - Rural Route number

OR – odds ratio

CI – Confidence Interval