UNDERLYING CAUSES OF DEATH AMONG PATIENTS WITH CANCER IN NOVA SCOTIA, 1969-1989

by

Sharon Gushue

Faculty of Medicine and Dentistry
Graduate Program in Epidemiology & Biostatistics

Submitted in partial fulfilment
of the requirements for the degree of
Master of Science

Faculty of Graduate Studies
The University of Western Ontario
London, Ontario
August, 1999

0-612-42151-1

ABSTRACT

Objectives: To examine the underlying causes of death among patients with malignant neoplasms diagnosed in Nova Scotia between 1969 and 1988.

Methods: Mortality data were from 1969 to 1989 inclusive. Vital status was determined by record linkage to the Canadian Mortality Data Base. Proportions of cancer and non-cancer deaths were first examined by sex and age. The relative proportions of cancer and non-cancer deaths were also determined using cumulative five-year cause-specific mortality. Deaths from circulatory, respiratory and digestive diseases were compared to those of the general population of Nova Scotia using standardized mortality ratios (SMRs) and 95% CIs.

Results: Cancer was the main overall underlying cause of death (54.2%), followed by circulatory (7.8%) and respiratory (1.9%) diseases. Cumulative five-year cause-specific mortality showed the highest proportion of deaths to be caused by the cancer diagnosis; the highest proportion of non-cancer deaths were from circulatory diseases. SMRs ranged from 1.18 (95% CI 1.04 – 1.33) to 4.82 (95% CI 2.69 – 7.95) depending on cancer type and cause of death.

Conclusions: Most cancer patients will die from cancer. However, non-cancer causes of death become more prevalent with age. More studies are needed to confirm whether cancer patients are at an increased risk for mortality from diseases other than cancer as well as to investigate the relationship between cancer and comorbidity.

Keywords: Underlying causes of death, cancer, SMR, comorbidity

ACKNOWLEDGMENTS

Thanks to the Nova Scotia Cancer Registry and Statistics Canada for providing these data. Without their contribution, this project would not be possible.

Dr. Truls Østbye, my thesis advisor, thank-you for your unending support and guidance throughout the last three years. I have learned a great deal about myself as well how to look at situations through different perspectives.

To my advisor, Dr. John Koval and Dr. Yang Mao. Dr. Koval thank you for your criticisms and statistical support. Dr. Yang Mao, thank you for allowing me the opportunity to be a part of LCDC and to have been exposed to an important area of research that has affected my own life.

Many thanks to Ron Dewar at the Nova Scotia Cancer Registry. Thank you so much for your assistance. Your input and good sense of humour was much appreciated during my not-so-happy days.

To my friends Lorinda Simms, Cathy Mills, Karen Beingessner, Rick Fry and Patsy Hamilton-Diabo: Thank you for your unending support, encouragement and belief that I could accomplish this project.

Last but not least, to my fiancé Shawn: Thank you so much for believing in me and seeing me through this from start to finish.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

Chapter 1 - Introduction

1.1 Cancer Incidence and Mortality in Canada

Cancer is the leading cause of death among Canadian women and the second leading cause of death for men (Statistics Canada, 1997). With respect to cancer-specific mortality, lung cancer remains the leading cause of death for both sexes (National Cancer Institute of Canada [NCIC], 1998). Cancer incidence and mortality are increasing mainly because of the growth and ageing of the population, whereby older Canadians, particularly those 60 years of age and older, represent a majority of the cancer population (Steering Committee for Canadian Cancer Statistics, 1997; Yancik and Ries, 1994; Dodd, 1991).

In Canada, the risk of developing cancer has increased for most cancer sites since the 1970s. With the exception of lung cancer, cancer mortality rates among women have actually decreased by 15% since 1971. The overall cancer mortality rate for men has also decreased due to decreasing mortality rates for lung, colorectal and other specific malignancies (NCIC, 1998). This finding may be attributed to improved cancer survival rates over time from earlier detection of cancer and therefore more effective treatment (Mao, Robson, Semenciw, Morrison and Wigle, 1991). Although cancer-specific mortality is well documented and reported, there is a paucity of information regarding the underlying causes of death in patients with cancer and whether mortality from causes other than cancer is higher or lower compared to those of the general population.

1.2 Investigating Underlying Causes of Death

Studies that have examined the underlying causes of death to help understand the natural history of a disease or determine whether there is an increased risk for a specific cause of death compared to a standard population, exist for a variety of other diseases but there are few relevant studies relating to cancer. Diseases such as congestive heart failure, schizophrenia, Down's syndrome, rheumatoid arthritis, Alzheimer's disease, systemic lupus erythematosus (SLE) and multiple sclerosis provide information on this topic (Ackman et al., 1996; Newman and Bland, 1991; Baird and Sadovnick, 1988; Mitchell et al., 1986; Beard et al., 1996; Ward, Pyun and Studenski, 1995; Sadovnick, Eisen, Ebers and Paty, 1991; Koch-Henriksen, Brønnum-Hansen and Stenager, 1998). To date, there is only one Canadian study that has investigated the underlying causes of death using a population of breast cancer patients in Northern Alberta (Koch, Hanson, Gaedke and Wilson, 1987). Extending this information using available Canadian data for men and women, as well as to several types of cancer, would be worthwhile, provided a linked cancer incidence and mortality database were available.

1.3 Potential for Examining Underlying Causes of Death in Cancer

With such a database, when examining the underlying causes of death, it is first important to define what the underlying cause of death means, since the death certificate contains immediate, contributory and underlying causes of death. Using the World Health Organization (W.H.O.) definition, the underlying cause of death defined in Part I of the death certificate is "(a) the disease or injury which initiated the train of morbid events leading directly to death", or "(b) the circumstances of the accident or violence which produced the fatal injury" (World Health Organization, 1977). Secondly, it is helpful to consider that what a patient with cancer dies from is likely to be related to the probability of dying from the cancer itself or another competing cause. To begin with, the lifetime probability of developing cancer in general is higher than the lifetime probability of dying from it and the relative extent to which the probability of developing cancer exceeds the probability of dying from it is defined as cancer prognosis (National Cancer Institute of Canada, 1998). An example is lung cancer, which typically has a very poor prognosis (poor survival) as indicated by its case-fatality rate being greater than 90% (Beckett, 1993), hence the probabilities of developing it and dying from it are very similar.

For cancers with available screening programmes and potential detection at an earlier stage, the proportions of non-cancer underlying causes of death might be higher or at least more varied due to longer survival offered by treatment modalities which make it more likely that competing causes of death enter the picture. The second consideration is that with increasing age, individuals are more likely to have other co-existing conditions, such as cardiovascular disease, in which case the underlying cause of death may be attributed to this existing disease (Phillips, Glendon and Knight, 1999). To examine these ideas and further understand the nature of some cancer diagnoses using mortality data, underlying causes of death (both cancer and non-cancer causes) should be examined.

Measures such as cancer-specific mortality or relative survival, although useful, may be considered narrow in scope since the focus is either cancer-specific causes of death or mortality compared to that of the general population irrespective of cause. In other words, all specific underlying causes of death are not examined. Such indices may be important in the context of the perceived risk of mortality for an individual diagnosed with cancer. This is not to disregard the seriousness of the cancer diagnosis itself, but to also emphasize that cancer does not necessarily have to be a lethal disease and that there exist other possible risks of mortality from preventable causes that should not be ignored (Phillips et al., 1999).

1.4 Probabilities of Developing and Dying from Cancer

In Canada, 1998 estimates reported the lifetime probability of developing cancer in males to be one in 2.4, and for women, one in 2.9. The lifetime probability of dying from cancer for Canadian men is one in 3.7 and for women one in 4.5 (NCIC, 1998). These lifetime probabilities of dying from cancer were based on a cohort subjected to the prevailing mortality conditions in the Canadian population at large in 1995. Since the probability of developing cancer is greater than the probability of dying from it, many cancer patients will die from other causes.

Noting the probabilities of developing and dying from cancer, an observed decrease in cancer mortality over time (when lung cancer is excluded) and improved survival in cancer patients, investigating the underlying causes of death among cancer patients would be of interest. Subsequently, the underlying causes of death should not only consist of cancer-specific deaths but other causes, perhaps varying according to the specific cancer diagnosis, sex, age group and calendar period.

This project therefore examined the underlying causes of death as defined by W.H.O., in deceased cancer patients using incident cancer cases from the Nova Scotia Cancer Registry which were linked to the Canadian Mortality Data Base.

1.5 Research Objectives

Using the Nova Scotia linked incidence and mortality database that covered the diagnosis years of 1969 to 1988 and mortality years from 1969 to 1989, the objectives of this study were:

1. To describe the causes of death among the cancer patient cohort by identifying the proportion of cancer and non-cancer causes of death for all cancer patients who died.

2. To compare the overall cumulative 5-year cause-specific mortality experience

of subgroups of patients with different cancer types and to examine the relative proportions dying from different causes within 5 years.

3. To compare cause-specific mortality of the patient cohort with that of the general population of Nova Scotia. The specific underlying causes of death were circulatory, respiratory and digestive diseases.

The results of these objectives may be of value to patients and their families as well as medical practitioners for selecting and monitoring patients with potentially higher risks for specific causes of death. Examining the underlying causes of death among males and females with the most frequently diagnosed cancers will also allow one to investigate how the proportions of deaths vary according to cancer lethality, sex and age thus providing us with some information about the nature of the disease.

Chapter 2 - Literature Overview: Cancer in Canada and Nova Scotia, the Province of Nova Scotia and Underlying Causes of Death Among Cancer Patients and Other Diseases

2.1 Cancer in Canada

Since 1969, the yearly number of cancer cases has more than doubled, with 49,629 cases occurring in 1969 and 117,016 cases occurring in 1993. Incidence rates between 1984 and 1993 were relatively stable for women with an average annual percent change (AAPC) of 0.3%; whereas for men, it was higher (0.8%) due to an increase in the number of cases of prostate cancer. For the same time period, cancer mortality rates were stable for women (AAPC = 0.0%) and men (0.3%) (Gaudette, 1997). Currently, the most frequently diagnosed cancers in men (in decreasing order) are prostate, lung and colorectal cancer. In women, the most frequently diagnosed cancers are breast, lung and colorectal cancers. Lung cancer is the leading cause of cancer mortality in both men and women and accounts for approximately one-third of cancer deaths in men and over one-fifth of cancer deaths in women (NCIC, 1998).

2.2 Cancer (All Sites) in Nova Scotia 1971-1990

An interim report describing the cancer burden and cancer data quality improvements for Nova Scotia was produced by the Nova Scotia Cancer Registry and the Cancer Treatment and Research Foundation of Nova Scotia in 1994 (Croteau, Johnston, Starratt and Hum, 1994). A brief summary of cancer incidence, which was examined from 1971 to 1990, and mortality (examined from 1984 to 1990) for Nova Scotia are presented here. Age-and sex-standardized cancer incidence rates which excluded non-melanotic skin cancer and in-situ cases, increased by 47.9 per cent (211.8 to 313.3 per 100,000). Nova Scotia rates were consistently lower compared to the overall Canadian incidence rates up until 1986. It was suggested that this might have been attributed to an underreporting of cases. Nova Scotia age-standardized incidence rates were also consistently higher each year among men compared to women and may have been partly due to a greater absolute increase in the number of lung cancer cases. Persons aged 65 or older had consistently higher age-specific incidence rates, compared to those less than 65, which may be explained by the ageing of that population group.

Age-standardized mortality rates were also presented in the interim report and were calculated for the years 1984 to 1990. Men had consistently higher mortality rates than did women with an increased mortality rate from 173.1 to 183.3 per 100,000 in comparison to 120.8 to 128.1 per 100,000 for women.

2.3 Historical Background of the Causes of Death In Cancer Patients

From the wealth of literature that exists for cancer, cancer mortality and survival, there is limited current information discussing the causes of death in cancer patients. Research into the causes of death among cancer patients can be traced to at least the early nineteen sixties and seventies in which bacterial infection and cancer causes of death were the focus for mortality. At that time, some of the information obtained from these studies provided feedback regarding the effectiveness of cancer therapies and treatment, especially when new antibiotic therapies were being introduced.

Throughout the nineteen eighties and early nineteen nineties the focus for the causes of death shifted from infectious diseases to diseases more chronic in nature such as cardiovascular or respiratory causes. Comparisons of specific underlying causes of death were also made to reference populations, to determine whether cancer patients experienced higher or lower risks of mortality. The following overview provides information from these studies in which causes of death were investigated among various cancer populations.

2.3.1 Ederer, Cutler, Goldenberg and Eisenberg (1963)

Ederer et al. (1963) examined the underlying causes of death among 4,100 breast cancer patients in Connecticut who were known to have survived at least five years since diagnosis. Follow-up ranged from 5 to 20 years after diagnosis. Life table methods were used to calculate mortality rates. To account for competing causes of death, net mortality rates for breast cancer and net mortality rates for all other causes were calculated. Specific causes of death were calculated using partial crude mortality rates. Breast cancer mortality was increased (40:1) for patients who died five to ten years after diagnosis and gradually decreased ten to twenty years after the cancer diagnosis. Deaths from other cancers such as endometrial and ovarian cancer were also greater than expected (2.97:1 for ovarian and 2.57:1 for endometrial cancers). Non-cancer causes of death which included arteriosclerotic heart disease, other cardiovascular-renal diseases and all other causes (undefined) were all lower than expected.

2.3.2 Klastersky, Daneau and Verhest (1972)

Klastersky et al. (1972) examined the causes of death in 157 cancer patients admitted to a Belgian cancer therapy centre where there was "...modern and aggressive treatment" (p. 149) over an 18-month period. Each patient had histological evidence of cancer plus a complete post-mortem examination. The researchers used clinical and pathological information to determine the specific cause of death for each patient. Minor degrees of infection, haemorrhage or other morbid conditions were excluded. Over sixty per cent of the causes of death were due to infection (31.8%), severe haemorrhage (11.4%) and cancer metastases (19.7%). Other notable causes were cardiac failure and infarction (4.46% combined), pulmonary embolus (3.1%) and thrombosis of the carotid and cerebral vessels (3.8%). Death due to infection was more common among patients with leukemia, upper respiratory and digestive tract neoplasms, gastro-intestinal and genito-urinary tract tumours. There was no clear indication of whether cancer therapy had any association with the cause of death although infection was found more commonly among patients treated with cytostatic agents or radical surgery. Although statistical tests were not calculated, the authors had stated that age, sex, duration of the cancer diagnosis and the length of hospital stay did not significantly influence the cause of death in their study sample.

2.3.3 Inagaki, Rodriguez and Bodey (1974)

Causes of death were examined in 816 cancer patients over the period of January 1st, 1968 to December 31st, 1970. Cause of death was determined using data from the last hospitalization that included clinical, laboratory, x-ray findings, therapy and post-mortem examination results. Patients who were excluded were those with haematologic malignancies (e.g. leukemias, lymphomas and myelomas), patients with an incomplete post-mortem examination and any patient dead on arrival at hospital. Patient data were reviewed independently by two of the authors and each of their findings was compared. Differences between the two authors were reviewed and resolved by the third author. Causes of death that were investigated included infection, organ failure, infarction, haemorrhage and carcinomatosis. The proportions for the causes of death were infection (47%), organ failure (25%), infarction (11%), carcinomatosis (10%) and haemorrhage (7%). Patients who died from infection were those who had tumours that compressed or obstructed urinary, alimentary or respiratory tracts, patients with neutropenia (abnormally small neutrophil count in the blood) as a result of cancer treatment, patients who had been diagnosed with head and neck cancers, and genitourinary tract and gastrointestinal cancers. Organ failure (201 cases), appeared as a direct result of tumour invasion. Death from haemorrhage (62 cases) was more common among patients with gastrointestinal or brain cancers in which bleeding was mainly due to the underlying tumour. Among patients who had died from carcinomatosis, post-mortem examination revealed extensive dissemination of the tumour to vital organs such as the pituitary gland, adrenals, heart and brain. Death due to carcinomatosis was common in breast cancer patients and persons diagnosed with melanotic cancers.

2.3.4 Ambrus, Ambrus Mink and Pickren (1975)

In 1975, Ambrus and colleagues reviewed the causes of death in 486 patients who died in 1970 at a cancer hospital and research centre in Buffalo, New York. All patients had autopsy and histopathologic data. Causes of death were sub-classified as either a major mechanism or a contributory factor. Over seventy per cent of the major mechanisms of death included infection (36%), respiratory failure (19%), haemorrhage (11%) and pulmonary embolism and myocardial infarction/cardiac failure (7%). Some of the major mechanisms that caused death overlapped as being a contributory cause of death. These included infection (13%), haemorrhage (25%) and thrombosis and/or embolism of any type (18%). Unfortunately, this study did not provide basic descriptive patient information such as age at diagnosis, sex, cancer diagnosis nor any description of the cause of death classification system. No comparisons were made among cancer types to see whether a particular cancer showed an increased mortality for a particular cause of death. Definitions of what constituted a *major mechanism* as well as *contributory causes* of death were not provided.

2.3.5 Hakulinen and Teppo (1977)

Cause-specific mortality in women diagnosed with breast cancer between 1953 to 1970 was calculated and compared to the expected mortality in the general Finnish population. Women with colon cancer and cancer of the small intestine were used as a comparison group, representing a cancer in which excess mortality (compared to the general population) disappeared almost entirely after five years of follow-up. The study population consisted of 17,181 breast and colon/small intestinal cancer patients. Cases derived from death certificate only or autopsy were excluded, as well as patients who had been diagnosed with multiple primaries that did not have breast cancer or cancer of the intestines as the first primary tumour. Cause-specific mortality was examined by stratifying by the extent of the disease (localized or non-localized), age at diagnosis and length of follow-up time (categorized as 0 to 4 years or 5 years or greater). Cause of death was defined using the W.H.O. definition from ICD-7.

Breast cancer patients had an excess total mortality during the entire follow-up period with excess mortality decreasing both with increased follow-up time and age at diagnosis. The comparison group exhibited a marked excess mortality (follow-up 0-4 years) for all age groups. Patients with intestinal cancer had experienced a lower mortality than expected for deaths from cardiovascular diseases. Breast cancer patients with non-localized tumour had a higher risk of dying from accidents and other violent causes of death during the first 5 years of follow-up. Mortality from other forms of malignancy (other than the primary cancer) was lower than expected during the first 5 years of follow-up and eventually reached the expected level of mortality. Mortality from other cancers such as the stomach and cervix uteri was lower than expected. Patients with localized breast cancer showed an increased mortality from leukemia after 5 years of follow-up suggesting possible effects from radiation therapy.

2.3.6 Houten and Reilley (1980)

Houten and Reilley provided a continuation of the causes of death from the previously mentioned study by Ambrus et al. (1975), using 4,728 consecutive autopsies. Nine causes of death were investigated: respiratory failure, infection, toxic drug reaction, hepatic failure, renal failure, shock/heart failure, electrolyte imbalance and central nervous system (CNS) failure. Relationships between causes of death and patient information such as age at death, sex, duration of disease, primary tumour site and the presence or absence of metastases and tumour mass were also examined. The majority of deaths (44.3%) were due to respiratory failure with shock or heart failure and infections being the second and third causes of death respectively. No statistical tests were performed to examine the relationships between cause of death and patient information; instead, proportions for the causes of death were calculated. Respiratory failure was found more commonly in men, especially in those with lung, lymph node, tongue or testicular cancer. Respiratory failure was also more common among patients who had been diagnosed with breast, testicular or bone cancer and had shown metastases to the lung. Factors such as age or length of survival did not appear to be associated with respiratory failure.

2.3.7 Rutqvist (1984)

Rutqvist assessed whether breast cancer patients were at risk for other causes of death, besides breast cancer, compared to the Swedish general population using death certificate information which was linked to the Swedish Cancer Register by record linkage. A total of 1,732 breast cancer patients from 1961 to 1963 and 2,127 breast cancer patients from 1971 to 1973 were analyzed using the Swedish Cancer Register. In-situ cases and two cases lacking complete identification were excluded. Underlying causes of death as well as contributory causes, were based on medical death certificates coded using ICD-8. Follow-up periods ranged from 18 to 21 years in the 1961-1963 group and from 8 to 11 years in the 1971-1973 group. Observed and expected mortality were compared to that of the general population using life-table methods. Sixty-three per cent had breast cancer recorded as the underlying cause of death and 36.7% had died from other causes. Non-cancer causes of death included circulatory diseases (534 cases), other primary malignant sites (176 cases), respiratory diseases (48 cases), accidents, suicides and injuries (47 cases), gastro-intestinal diseases (32 cases), endocrine and metabolic diseases (15 cases) and infectious diseases (14 cases). Compared to the general population, this study population experienced a 21% excess mortality from other causes of death ($\underline{p} < 0.001$). A 29% increase in deaths was attributed to other tumours such as the ovary and endometrium ($\underline{p} < 0.001$) and a 19% increase in deaths was due to non-neoplastic diseases (mainly circulatory diseases).

2.3.8 Koch, Hanson, Gaedke and Wilson (1987)

Koch et al. (1987) examined competing causes of death among breast cancer patients in Northern Alberta, Canada between 1974 and 1983. Cause of death was divided into three groups: (1) the percentage who died of breast cancer; (2) the percentage who died of other causes; and (3) the percentage with cause of death unknown. A total of 2,053 deaths occurred among women with a diagnosis of breast cancer. The medical records of all patients recorded as having died of other causes (413 cases) were reviewed along with a five percent random sample of patients who were recorded as having died of breast cancer. Cause of death was ascertained using autopsy results (13%), hospital records and discharge summaries (62%) and death certificates (25%). The observed number of deaths were compared to the expected number of deaths by chi-square analysis. The proportion of patients dying of other causes increased progressively in the first 20 years after diagnosis and then decreased afterward. A statistically significant excess of deaths was due to cardiovascular disease ($p < 0.01$) and second malignancies ($p < 0.05$). Secondary malignancies revealed an excess of cancers of the digestive organs ($p < 0.05$), a non-statistically significant excess in the genital organs, and a decrease in bronchogenic carcinomas ($p < 0.05$). The proportion of patients dying from other causes of death stratified by 10-year age groups was similar to that of the general Alberta female population greater than 40 years of age.

2.3.9 Brown, Brauner and Minnotte (1993)

Non-cancer death rates were investigated by Brown et al. (1993) using data from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program. The study population included cancer patients diagnosed between 1973 and 1987. Exclusion criteria included non-white patients, those diagnosed at age 85 years or older, patients less than 20 years of age, death certificate only cases and cancer found at autopsy. Non-cancer death rates were compared to that of the general population of the United States. Where rates differed, the effects of sex, age, time since cancer diagnosis and calendar year of diagnosis were examined. Non-cancer mortality rates were calculated by subtracting the cancer mortality rates from the overall mortality rates according to sex and five-year age-groupings for each calendar year. Twenty-one per cent of deaths were due to non-cancer causes of which circulatory and respiratory diseases accounted for over fifty percent. The overall non-cancer relative hazard rate was 1.37 times greater than that expected from the U.S. age- and sex-specific mortality rates. The non-cancer relative hazard decreased with age and the number of years since diagnosis for both men and women. This decrease was more gradual for patients between the ages of 20 to 54 years compared to patients aged 70 to 84 years. To examine the effect of calendar year of diagnosis and the non-cancer relative hazard rate, the first and fifth year after diagnosis were investigated. Using a log-linear model to fit the data, the non-cancer hazard rate was higher than the general U.S. population rates for all age groups and for both one and five years after diagnosis, except for men aged 70 to 84 years at 5 years after diagnosis.

2.3.10 Krongrad, Lai and Lai (1997)

Competing risks of mortality for patients with prostate cancer were investigated by Krongrad et al. (1997) using data from the Surveillance, Epidemiology and End Results (SEER) program from 1973 to 1990. The association of prognostic variables (age, race, stage and treatment modality) with the risk of death (prostate cancer or other causes) and survival time was examined. A multivariate accelerated failure time model was used to perform the competing risk analysis. A total of 102,707 prostate cancer cases were used in the analysis. Of these, 13.6% died from prostate cancer and 33.0% died from other causes. The specific non-cancer causes were unstated but were categorized as 'non-specific mortality'. Age greater than 70 years, was significantly associated with the relative risks of prostate cancer mortality (R.R. = 1.45; 95% CI 1.20-1.75, p = 0.0001) but more so for non-specific mortality (R.R. = 4.33; 95% CI 3.47-5.34, p = 0.0001). Black race was significantly associated with overall mortality but more so with prostate cancer mortality (R.R. = 1.34; 95% CI 1.26-1.42, p = 0.0001) versus (R.R. = 1.16; 95% CI 1.12-1.21, p = 0.0001). Localized stage in comparison to regional or in-situ stages, showed a lower risk for death from prostate cancer but a higher risk for non-specific mortality (R.R. = 1.08; 95% CI 1.05-1.11, p = 0.0001) versus (R.R. = 1.16; 95% CI 0.97-1.38). Radiation and surgical forms of treatment showed a significantly lowered relative risk of death for both prostate and non-specific mortality. The authors advised cautious interpretation of this finding. First, coding practices for treatment in SEER data during the period 1973 to 1990 may have included non-curative treatments thus limiting true relative risk differences across treatment level. Secondly, direct comparisons between surgery and radiation may not have been appropriate since each method utilised different staging criteria to treat an individual, making the patient populations possibly different across outcome.

2.4 Summary of the Literature Review

These studies have shown that a variety of cancer and non-cancer causes of death occur among cancer patients and that the risk of death from non-cancer causes may decrease with age. However, there were some important limitations to these studies. One of these limitations was an inconsistency in the definition of cause of death. Although some studies defined the cause of death according to ICD standards, various terms such as *cause of death*, *intercurrent cause of death, contributory cause of death* and *specific versus non-specific mortality* were also used, with each term likely having its own definition yet not provided with a clear explanation. It is uncertain whether these researchers referred to the same diseases when they described the causes of mortality across studies. It is possible that this was not the case. Consequently, comparisons among studies should be made cautiously.

A second limitation which also added complexity for comparing studies was the method for determining the underlying cause of death. Some studies, mostly earlier ones, used autopsy data which may have resulted in a biased reporting of certain underlying causes of death due to the nature of autopsies using highly select populations.

Thirdly, some studies did not perform any statistical analyses yet made references to associations of underlying cause of death and cancer type. Other concerns which question some of the inferences made in these studies were multiple testing and small sample sizes with consequential instability of comparisons. A scarcity of basic patient information such as age at diagnosis, sex and cancer diagnosis was also noted for some studies. Lastly, there was no consistent denominator when reporting the causes of death. Some proportions considered all deaths as the denominator whereas others used the total number of incident cases of cancer. Comparing risk is problematic if the denominators are not comparable.

The intention of this study was to address some of the aforementioned limitations mainly by using a clear definition – *the underlying cause of death* – as described by W.H.O., as well as to include basic demographic information of the study population such as sex, age at diagnosis and cancer type. Lastly, the denominator used in calculating the proportions of cancer and non-cancer causes of death was the number of incident cases of cancer.

2.5 Causes of death in other diseases

As stated earlier, there is limited information regarding the underlying causes of death in cancer populations. To provide a broader perspective on the methodological framework of how the causes of death could be examined for the Nova Scotia database, several other studies, though not cancer-based, were reviewed. The objectives and methods paralleled those found within the cancer literature.

2.5.1 Causes of death among patients with congestive heart failure (CHF)

Ackman et al. (1996) provided a descriptive study on the non-cardiac causes of death in a sample of hospitalized congestive heart failure (CHF) patients in Alberta. The authors had stated that with the advancement of medical technology for congestive heart failure, patients had been dying of various non-cardiac causes of death and would probably continue to show an increase in non-cardiac deaths as technology improved and the ageing of the population increased. Non-cardiac causes were not well characterized since studies outlining the underlying causes of death for CHF were also scarce. Deaths were categorized as either cardiac or non-cardiac, based on the medical record of each patient. Chi-square tests were performed to compare demographic and clinical variables for patients dying of either cause. The denominator used to calculate the proportions of underlying causes of death was the total number of deaths.

2.5.2 Causes of death among patients with schizophrenia

Newman and Bland (1991) using a population of patients with schizophrenia from Alberta, determined whether schizophrenics were at an increased risk of mortality for specific causes of death since previous studies had shown an overall increased risk of mortality compared to that of the general population but were inconclusive with respect to specific causes such as cardiovascular disease, respiratory illness and cancer. Data from the Alberta Mental Health Information System (AMHIS) database was linked to the Canadian Mortality Data Base to determine the number and the underlying causes of death. Standardized mortality ratios (SMRs) for males and females combined and separately were calculated and compared to those of the general Alberta population. Observed and expected deaths were compared using the Pearson chi-square test. Survival analyses were performed to compare the observed versus the expected mortality as well as a Cox regression model (using the covariates age, sex, marital status, education and clinic/institution at time of entry into the study) to study the effects of these covariates on mortality.

2.5.3 Causes of death among patients with Down Syndrome

Baird and Sadovnick (1988) provided research that examined the causes of death in a cohort of Down Syndrome (DS) individuals between 1952 and 1981. Although it was known that DS individuals had a much lower life expectancy compared to those of the general population, recent studies had shown that seventy percent of DS individuals were known to be alive until age thirty. With an increase in life expectancy but little information on how DS individuals' mortality compared to that of an age-matched general population, the authors examined the underlying causes of death using ICD-9 categories and compared them to those of the age-matched general population of British Columbia during the same period. Mortality rates were compared using relative risk ratios along with their 95% confidence intervals. In calculating the general population's mortality rates, numerators and denominators were adjusted by subtracting the DS cohort.

2.5.4 Causes of death among patients with rheumatoid arthritis

Mitchell et al. (1986) examined the causes of death and factors influencing survival using Cox regression analysis in 805 patients with rheumatoid arthritis. Rheumatoid arthritis was cited as being potentially fatal due to features specific to the disease itself or drug-related causes. However, the authors wanted to substantiate this information by carefully documenting patient characteristics as well as having a longer follow-up period compared to previous studies. Cause of death was obtained using physician records, hospital charts and death certificates though it was not stated whether it was the underlying cause or immediate cause of death which was used for analyses. The distribution of the causes of death in the rheumatoid arthritis population occurring over a five-year follow-up period was compared to one year of mortality for the general population of Saskatchewan. The one year of mortality experienced by Saskatchewan was the midpoint for the rheumatoid arthritis population.

2.5.5 Causes of death among Alzheimer's patients

Beard et al. (1996) studied the causes of death among incident cases of patients with Alzheimer's disease from 1960 to 1984 to evaluate the usefulness of death certificates and medical records for studying dementing illness. Death certificate and medical record information in cases with Alzheimer's disease was compared to that of an age- and gender-matched control group of patients without Alzheimer's disease. The authors first compared the number of diagnostic codes listed on the death certificate for both cases and controls and then secondly, compared death certificate information with clinicians' reports of death in cases and controls. Chi-square tests were used to compare the frequencies of the recorded conditions in each section of the death certificate for cases and controls. Logistic regression analysis was performed to determine which factors could predict the underlying cause of death based on diagnostic categories set by ICD-8.

2.5.6 Causes of death among patients with systemic lupus erythematosus (SLE)

Ward et al. (1995) examined the causes of death in 144 patients with systemic lupus erythematosus (SLE) since previous research had suggested that survival in SLE patients had increased over time producing a natural shift in the causes of death. However, it was inconclusive whether the cause of death varied specifically with duration of the disease as well as with various patient characteristics such as age, sex, race and socioeconomic status. Cause of death was determined using clinical records and death certificates. Cause of death was categorized as either SLE or other. Survival of patients was based on the date of diagnosis until the study end date. The distribution of the causes of death was reported according to patient characteristics using the number of deaths as the denominator. Associations between patient characteristics and the cause of death were determined using the analysis of variance. The association between cause of death (SLE or other causes) and disease duration was examined by using survival analysis with focus on the hazard function to determine the probability of the type of death occurring at a particular time throughout the course of disease.

2.5.7 Causes of death among patients with multiple sclerosis (MS)

Sadovnick and colleagues (1991) examined the causes of death among 145 multiple sclerosis (MS) patients attending two MS clinics. One clinic was in London, Ontario and the other was in Vancouver, British Columbia. The follow-up period was 16 years. Causes of death were examined because previous research had focused on mortality rates and patterns rather than the specific causes of death. Reporting of deaths differed for each province. The Ontario clinic was informed of each patient's vital status using various methods: notification of death from relatives or physician, a follow-up phone call, notification if the patient's body was willed for research or by chance methods such as newspaper obituaries or by other patients attending the clinic. The Vancouver clinic was registered with the Vital Statistics Registry therefore each patient's vital status was made known from the Registry. The causes of death consisted of five categories and were grouped according to sex, a disability scale, mean age at death and mean duration of disease. The relative proportions of causes of death were compared to those of the age-matched population of British Columbia using chi-square analyses.

Another study investigating the causes of death among MS patients was undertaken by Koch-Henriksen et al. (1998). Their purpose for researching the causes of death was built upon two ideas. First, death for this patient population could be attributed to a variety of causes that affect a person throughout his or her life suggesting that MS itself was not necessarily a lethal disease. Secondly, to understand the natural history of the disease and to assist in planning for terminal care and treatment, knowledge of the causes of death is important. Record linkage was performed between the Danish Multiple Sclerosis Registry and Denmark's National Registry of Causes of Death whereby causes of death were coded using ICD-6, 7 and 8. The distribution of deaths was grouped according to major ICD category, age, calendar period and post-mortem status. The total number of deaths was used to calculate the proportion of deaths from specific causes. Specific causes of death in the MS population were compared to those of the general population of Denmark using standardized mortality ratios (SMRs) and 95% confidence intervals.

2.6 Summary of the Causes of Death Found in Other Disease Groups

These studies that examined the causes of death among other diseases, provided at least two objectives that paralleled those found in the cancer literature. The first common objective was to understand the nature of the disease which included mortality from the disease itself as well as other causes. It may be important to examine the causes of death over time, especially if treatment for a disease has changed, allowing individuals to be cured, and hence shift the distribution of causes. The second common objective was to compare specific underlying causes of death with a general population's mortality to determine whether certain diseased populations were at an increased or decreased risk of mortality. It may be known that a certain disease increases the overall risk of mortality relative to a general population without the disease, but often it is unknown whether that disease shows an increased or decreased risk of mortality for other specific causes of death. If a diseased population is at an increased risk of mortality for a particular cause of death, then strategies for assisting certain diseased populations can be made and implemented based on this knowledge.

Chapter 3 - Material and Methods

3.1 Data Source

Cancer incidence data were obtained from the National Cancer Incidence Reporting System (NCIRS) as reported annually by the Nova Scotia Cancer Registry to the Health Statistics Division at Statistics Canada (see Appendix A for information on NCIRS). Incidence years were 1969 to 1988 inclusive. The vital statistics registries covering the years 1969 to 1989 inclusive, collected information on mortality. In 1991, a computerized record linkage of the Nova Scotia cancer incidence data to the Canadian Mortality Database (CMDB) was performed using diagnostic years from 1969 to 1988 and mortality years from 1969 to 1989. Probabilistic linkage software (General Iterative Record Linkage System or (GIRLS)) was used to achieve this linkage since a unique numerical identifier was not listed on death certificates (see Appendix B). Linkage was completed in late 1993. Permission to use these data was obtained from the Nova Scotia Cancer Registry (refer to Appendix C).

3.2 Nova Scotia Cancer Registry

The Nova Scotia Cancer Registry, which began in 1964, is population-based. Provincial legislation requires that all cancers diagnosed within the province involving Nova Scotia residents be reported to the Registry (Queen Elizabeth II Health Sciences Centre, 1995). Reporting sources may include pathology reports, death certificate registration and neoplasm report forms filled out by physicians and health record departments. Up until 1982, registration of cancer cases was submitted to the Registry using only hospital record departments or physicians. During the 1980s two other sources of cancer registration were introduced: 1) pathology reports from 1982 onward and 2) Vital Statistics who began adding their death lists to the Registry (Croteau et al., 1990).

Computerization of cancer data was initiated in Nova Scotia in 1983. Until that time, the only computerized records that existed were found at Statistics Canada. An audit performed on the Registry data in 1989, suggested that in comparing published age-adjusted incidence rates for Nova Scotia and Canada, Nova Scotia may have had a 20 to 25% under-reporting of cancer cases prior to the mid-1980s (Cancer Treatment and Research Foundation of Nova Scotia, 1990).

Updating of the Registry covering the period between 1970 and 1983 was performed by the addition of site and histology index cards from the Halifax Tumour Clinic. The number of incident cases increased slightly (from less than 2% and between 2% and 4%) for each year but showed a marked increase for the years 1978, 1981 and 1982 (12.08%, 13.42% and 21.62% respectively). It was suggested that for 1981 and 1982 the increase may have been attributed to the transition from a manual to an automated system. For 1978, possible reasons for under-reporting were unknown (Cancer Treatment and Research Foundation of Nova Scotia, 1990). With the additional information of death certificates only (DCOs) provided to the Registry from Statistics Canada in 1986, incident rates, especially from 1969 to 1985, were expected to increase as the data were continually updated.

3.3 The Province of Nova Scotia and General Population

Nova Scotia has a total area of 54 400 km^2 and is the second smallest in size of the 10 Canadian provinces (Nova Scotia Department of Finance, 1994). It is located in the eastern part of Canada and consists of a peninsula (connected to Canada by 27 km of land) and the island of Cape Breton. The province is divided into 18 counties and the population is over 900,000 (Nova Scotia Department of Finance, 1994). About 46.5% of the population reside in rural areas while the remaining 53.5% of the population dwell in urban regions. According to the 1991 Canadian Census, 58% of Nova Scotia's population can be traced to British origins, while 6.3% is of French origin. Other ethnic backgrounds include German, Dutch, Black and Native Peoples. The largest employer (33.8%) if the province is the service sector industry (ie. community, business and personal service groups). Other major employment industries include trade (retail and wholesale outlets), public administration and manufacturing. Per capita income as recorded in 1992 was $18,956, which represented 83.8% of the Canadian average. The average household income in 1992 for Nova Scotia was $38,373 and the average family income was $46,872; these average incomes were 87.1% and 87.3% of the Canadian population household and family incomes.

Provincial taxes provide funding for free hospital in-patient care (up to ward level) and medically required services from physicians. The Department of Health administers health services. Prescriptions are available to those over 65 for a minimum fee.

3.4 Cancer Database

This database is a patient-oriented file, that initially contained a total of 70,781 cancer diagnoses relating to 65,534 patients diagnosed with cancer in Nova Scotia from January 1st, 1968 to December 31st, 1988. A separate record entry was made for each cancer diagnosis according to the patient identification number. Patients with more than one diagnosis of cancer were incorporated into the study population by selecting the first cancer diagnosis, using the earliest date, and the underlying cause of death if applicable. Selecting the first cancer diagnosis and not all diagnoses was based on two ideas. First, the data set was easier to work with using only one cancer diagnosis. Secondly, more than one cancer diagnosis may not have necessarily been responsible for the underlying cause of death. What was of importance for this research was to examine the underlying causes of death for persons with cancer, regardless of the number of diagnoses each individual may have had.

3.5 Classification of Cancer and Underlying Cause of Death

Cancer cases were classified according to cancer type, based on the International Classification of Diseases (9th Revision) (World Health Organization, 1977). This classification system distinguishes between types of cancer based on the anatomic location with the exception of melanoma, leukemias and lymphomas that are characterized by their tissue or cellular origin.

Mortality data in Canada is confined to the underlying cause of death (defined previously) taken from death certificates using the International Classification of Diseases provided by the World Health Organization. Canadian cancer mortality statistics originated from death records maintained by the provincial and territorial registrars of vital statistics for persons resident in that province or territory at the time of death (NCIC, 1998).

Cause of death information on the death certificate should form a causal sequence based on the underlying cause of death (Baird and Sadovnick, 1988). Since 1979, the 9th Revision of the ICD (ICD-9) has been used in Canada to establish the cause of death. Cancer deaths are considered "those attributed to some form of cancer as the underlying cause of death by the certifying physician" (NCIC, 1998, p.12). This study used the underlying cause of death as defined by W.H.O., however throughout the rest of the text the simpler term *cause of death* will be used.

3.6 Patient Inclusion

Cancers that were included in the analyses were patients diagnosed with a malignant neoplasm (ICD-9 rubrics 140-208). This consisted of twenty-five major types of cancer that were defined and ordered according to the first three digits of the ICD-9 code. The major cancer groupings are shown in Table 1. Proportions of causes of death included persons diagnosed with ill-defined and secondary cancers (ICD-9 195 -199).

The outcome of the analyses was the cause of death determined by record linkage to the Nova Scotia death certificates. The unit of analysis was the patient. Cause of death for deceased patients from 1979 onward was categorized using the ICD-9 (Table 2) broad disease groupings. Deaths that occurred before 1979 were coded using ICD-8 broad disease groupings. Linkage to deaths from all Canadian sources was completed for the years 1969 to 1989; consequently, December 31st, 1989 was used as the cut-off date for the analyses.

3.7 Patient exclusion

Patients diagnosed with non-melanotic skin cancer (ICD-9 173, n =9,974) were excluded since this cancer type is known for incomplete registration and is therefore not comparable with other types of cancer (Scotto, Fears and Fraumeni, 1983; NCIC, 1998). Patients diagnosed with an ICD-9 cancer diagnosis number greater than 208 (n = 3,838) were excluded since these cancers were benign, in-situ or uncertain or of unspecified behaviour. Two male patients (n = 2) were diagnosed with diseases of blood and blood forming organs (ICD-9 289) and not cancer and were therefore excluded from the analyses.

Patients who had date and age at diagnosis information missing ($\underline{n}$ = 500) and any patient

Table 1. Cancer sites by ICD-9 grouping.

Cancer Site	ICD-9 Code
Mouth and Pharynx	140 – 149
Esophagus	150
Stomach	151
Colon and rectum	153 – 154
Liver	155
Gallbladder	156
Pancreas	157
Larynx	161
Lung	162
Bone	170
Connective tissue	171
Malignant melanoma	172
Female breast	174
Uterus	179, 182
Cervix uteri	180
Ovary	183
Prostate	185
Testis	186
Bladder	188
Kidney	189
Brain and central nervous system	191, 192
Thyroid	193
Lymphoma	200 – 202
Multiple myeloma	203
Leukemias	204 – 208
All sites combined but excluding non-melanotic skin cancer (includes 195 - 199)	140 – 208

Table 2. Underlying causes of death by broad disease groupings, ICD-9 and ICD-8.

Cause of Death	ICD-9	ICD-8
Infective and Parasitic Diseases	001-139	000-136
Malignant Neoplasms	140-239	140-239
Endocrine/Nutritional/Metabolic	240-279	240-279
Blood Diseases	280-289	280-289
Mental Disorders	290-319	290-315
Nervous System/Sense Organ Disease	320-389	320-389
Circulatory Diseases	390-459	390-458
Respiratory Diseases	460-519	460-519
Digestive Diseases	520-579	520-577
Genitourinary Diseases	580-629	580-629
Complications of Pregnancy	630-676	630-678
Skin/Subcutaneous Tissue	680-709	680-709
Musculoskeletal Diseases	710-739	710-738
Congenital Anomalies	740-759	740-759
Perinatal Mortality	760-779	760-779
Symptoms/Ill-defined	780-799	780-796
Accidents, Poisonings and Violence	800-999	800-999

who had been registered with a cancer diagnosis through death certificate only (DCO) (n = 6,951) were excluded. Patients designated as DCO were those whose method of diagnosis was coded as *missing*, *unknown* or *clinical* and whose source of cancer registration was through vital statistics. Among patients without an age at diagnosis, birth date information was missing and therefore age at diagnosis could not be calculated. Eleven male cancer cases (n = 11) coded as dying of female breast cancer and other and unspecified female genital organs (n = 2) were excluded.

3.8 Study Population

The study population consisted of a linked cancer incidence-mortality database file representing 44,253 patients (n = 22,899 males and n = 21,354 females) with malignant neoplasms diagnosed in Nova Scotia from January 1st, 1968 to December 31st, 1988. The mortality period was from January 1st, 1969 to December 31st, 1989 inclusive. Ninety-eight per cent (98.1%) of these cancers were histologically confirmed.

3.9 Methodology for thesis objectives

Objective 1: Causes of death for the Nova Scotia cancer patient cohort

The causes of death were grouped together using broad disease categories according to ICD-8 and ICD-9. Counts of causes of death were stratified by sex and then stratified by sex and age at diagnosis. Proportions of deaths for males and females combined, were calculated using the total number of incident cases of cancer. The proportion of deaths for males and females separately, was calculated using the incident cases of cancer for each sex.

Objective 2: Causes of death using the overall cumulative five-year cause-specific mortality

The second objective was to examine the overall cumulative five-year cause-specific mortality by examining the relative proportions dying from cancer and non-cancer causes of death among males and females diagnosed with the three most commonly diagnosed cancers in Canada. These three cancers, as opposed to the entire study population, were analyzed since they account for at least 50% of the new cases in Canada in each sex (NCIC, 1998). The second reason for using these cancer diagnoses as opposed to the entire database, was to compare cause-specific mortality between these different cancer types since each cancer type has different lifetime probabilities of dying from the specific cancer once diagnosed due to differences in prognoses (NCIC, 1998). Among males, cancer diagnoses included prostate, lung and colorectal cancers. For females, breast, lung and colorectal cancers were included. Crude five-year cumulative all cause mortality was calculated according to cancer type, five-year calendar period and age at diagnosis. The cancer and non-cancer causes of death groupings included: death from the cancer diagnosis; death from other neoplasms; death from circulatory diseases; death from respiratory diseases; death from digestive diseases; and lastly, death from all other causes combined. Five-year follow-up intervals allowed for an equal distribution of follow-up time so that mortality (within each cancer type) could be compared equally across the calendar periods. Approximate ninety-five percent confidence intervals were calculated for the overall proportion of deaths during each calendar period for the selected cancers by using

$$\hat{p}-1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}, \hat{p}+1.96\sqrt{\frac{\hat{p}(1-\hat{p}}{n}}$$

(Pagano and Gauvreau, 1993) which has its foundation built upon the binomial distribution but where *n* is sufficiently large (where both *np* and *n*(1-*p)* are greater than or equal to five) the distribution can be approximated with the normal distribution. $\hat{p}$ is the point estimate of the population proportion based on the sample proportion. Where confidence intervals did not overlap among the three calendar periods, this suggested a possible true increase or decrease in the five-year cumulative mortality over time.

Objective 3: Comparison of mortality in patients with cancer versus the general Nova Scotia population

Standardized mortality ratio

The primary method of data analysis was the standardized mortality ratio SMR) which was calculated to compare the mortality between the general Nova Scotia population and persons diagnosed with the three most common cancers in Canada. The SMR is the ratio of the observed to the expected number of deaths by applying published mortality rates to the cohort age structure from a reference population (Breslow and Day, 1987; Kelsey, Whittemore, Evans and Thompson, 1996) shown by:

$$SMR = \frac{\sum_{j=1}^{J} d_j}{\sum_{j=1}^{J} n_j \lambda_j^*} = \frac{D}{E^*}$$

where $E^* = \sum n_j \lambda_j^*$ is the total expected number of deaths for the cohort in the j[th] age group and where $D = \sum d_j$ is the total observed number of deaths. This ratio measures the degree to which the risk of mortality is higher or lower in the cohort than the reference population by examining whether the number of deaths is higher or lower than expected had the group developed the disease at the same rate as the comparison population. The use of an SMR is viewed as an adjustment process (Hennekens and Buring, 1987) or an indirect method of standardization since standard rates are applied to the weights in the study group to control for the effects of potential confounding factors. The weights in the study cohort are the person-years at risk which is the summation of time each individual has contributed to the population at risk for mortality throughout the period of observation. For example, if a patient is observed for one year, then one year is contributed by that individual to the total amount of person-years at risk calculation.

Testing the significance for the observed SMR

The observed number of deaths was assumed to follow a Poisson distribution. To test the statistical significance of a difference between observed and expected number of deaths, an approximation method by Byar was used (Rothman and Boice, 1979) which is suggested as an accurate approximation to the exact Poisson test. The test is shown as

$$\chi = (9\tilde{D})^{1/2}\{1 - \frac{1}{9\tilde{D}} - \left(\frac{E^*}{\tilde{D}}\right)^{1/3}\},$$

where $D^{\sim} = D$ (the number of observed deaths) if D exceeds E^{*} (the expected number of deaths), and $D^{\sim} = D + 1$ otherwise. The p-value is obtained by consulting the unit normal distribution. An alpha level of .05 was used to compare the difference between the observed and the expected death counts.

The Pearson chi-squre test shown by

$$\chi^2 = \left(\frac{O-E}{E}\right)^2$$

was considered as a method for testing the observed versus the expected deaths, however, where the number of deaths is small, the Poisson distribution becomes more skewed and the normal approximation implicit in the chi-square test will be inadequate (Breslow and Day, 1987).

Confidence intervals for the SMR

Approximate two-sided ninety-five per cent confidence intervals for each SMR were calculated using Byar's approximation shown by

$$LowerLimit = \frac{O}{E}\left(1 - \frac{1}{9O} - \frac{1.96}{3\sqrt{O}}\right)^3;$$

$$UpperLimit = \frac{(O+1)}{E}\left(1 - \frac{1}{9(O+1)} + \frac{1.96}{3\sqrt{O+1}}\right)^3$$

(Rothman and Boice, 1979), where O is the total observed number of deaths. The confidence intervals around the SMR determine the range of possible values for the true SMR consistent with the observed data as well as study precision if a non-signficant difference is shown between the observed and expected deaths (Breslow and Day, 1987).

Person-years at risk calculation

The number of person-years at risk was obtained by following every cancer patient from the time of diagnosis until the time of death (if applicable) using four programs created in SAS v.6.12 program package (SAS Institute Inc, North Carolina). If death did not occur then follow-up was from the date of diagnosis until the cut-off date, December 31st, 1989. Each program calculated the amount of person-years at risk according to calendar period, age-group, cancer diagnosis and sex. For instance, if an individual contributed time to the first two calendar periods (1969 to 1973 and 1974 to 1978), the first and second program would capture that individual's time. The last two programs which covered the last two calendar periods (1979 to 1983 and 1984 to 1989) would capture zero person-years at risk because that individual would not have contributed any time to those periods. The four calendar periods were 1969 to 1973, 1974 to 1978, 1979 to 1983 and 1984 to 1989. A sample SAS computer program is shown in Appendix D.

Calculation of expected deaths

The expected number of deaths in each stratum (age group, sex, cancer type, cause of death and calendar period) were calculated by multiplying the age-

, sex-, and disease-specific mortality rates of Nova Scotia by the person-years at risk within each stratum. Crude age-, sex- and disease-specific mortality rates for the years 1971, 1976, 1981 and 1986 were used within the appropriate calendar period since these were the approximate midpoints of each calendar period. Crude mortality rates were obtained from Orius98 v.2, a disease surveillance system prepared by the Cancer Bureau at Health Canada. Mortality data are provided to Health Canada by Statistics Canada. The total expected number of deaths was the sum of expected numbers among all age groups and calendar periods. The SMR was the ratio of the total number of observed deaths divided by the total expected deaths, according to cancer diagnosis and cause of death.

Causes of death due to circulatory, respiratory and digestive diseases were selected for comparison with those of the Nova Scotia general population. These were chosen because previous studies (Ederer et al., 1963; Ambrus et al., 1975; Houten and Reilley, 1980; Rutqvist, 1984; Koch et al., 1987; and Brown et al., 1993) revealed these diseases to be substantial conbtributors to mortality among cancer patients. It was of interest to investigate whether the same could be shown for these data. Although infectious diseases were cited as significant causes of mortality among cancer patients in earlier studies (Klastersky et al., 1972; Inagaki et al., 1974; Ambrus et al., 1975), underlying causes of deaths from diseases more chronic in nature were selected in this study to reflect current causes of mortality within the general population.

Chapter 4 - Results

This section first describes the distribution of the cancer diagnoses among males and females in the cancer cohort, followed by the results of the research objectives.

4.1 Distribution of cancer diagnoses

The distributions of cancer diagnoses for males and females are shown in Table 3. A total of 58,065 patients from Nova Scotia were diagnosed with cancer (all types) between 1968 and 1988 with males and females having similar overall cancer frequencies (28,967 and 29,098 respectively). However, the distribution of specific cancer diagnoses differed between males and females. Among males diagnosed with malignant neoplasms, the three most diagnosed cancers were digestive cancer (26.3%), respiratory cancer (24.6%) and cancer of the genital organs (17.5%) which consisted primarily of prostate cancer. Among females, the three most diagnosed malignant neoplasms were breast cancer (27.6%), digestive cancer (25.2%) and cancer of the genital organs (17.8%). Cancers of the respiratory system was the fourth leading cause of cancer (7.7%) in females, with lung cancer accounting for 92.8% of all respiratory cancers.

Among the digestive cancers diagnosed in males ($\underline{n}$ = 6,035), 78.0% were stomach and colorectal cancers. For males diagnosed with respiratory cancers,

Table 3. Cancer cases by site and sex, Nova Scotia, 1969-1988.

Site	ICD-9	Total	Males	Females
All Cancer Sites	**140-289**	**58,065**	**28,967**	**29,098**
Oral (Buccal cavity and pharynx)	**140-149**	**1,466**	**1,159**	**307**
Lip	140	528	498	30
Tongue	141	207	144	63
Salivary Gland	142	108	57	51
Floor of Mouth	144	139	107	32
Pharynx	146, 147, 148	255	198	57
Other and Unspecified	143, 145, 149	229	155	74
Digestive Organs	**150-159**	**11,415**	**6,035**	**5,380**
Esophagus	150	422	302	120
Stomach	151	1860	1,170	690
Small Intestine	152	104	43	61
Large Intestine	153	4824	2,157	2,667
Rectum	154	2390	1,388	1,002
Liver and billiary passages	155, 156	481	219	262
Pancreas	157	1185	688	497
Other and unspecified	158, 159	149	68	81
Respiratory System	**160-165**	**7,281**	**5,632**	**1,649**
Larynx	161	576	505	71
Lung	162	6,543	5,013	1,530
Other and Unspecified	160, 163-165	162	114	48
Bone Tissue and Skin	**170-172**	**1344**	**644**	**700**
Bone	170	142	70	72
Connective Tissue	171	314	173	141
Skin (melanoma)	172	888	401	487
Breast	**174, 175**	**5,935**	**38**	**5,897**
Genital Organs	**179-187**	**7,848**	**4,014**	**3,834**
Cervix	180	1,276	...	1,276
Body of uterus	182	1,288	...	1,288
Ovary	183	992	...	992
Prostate	185	3,660	3,660	...
Other and Unspecified	179, 181, 184, 186, 187	632	354	278
Urinary Organs	**188-189**	**3,176**	**2,273**	**903**
Bladder	188	2,137	1,635	502
Kidney and other urinary	189	1,039	638	401

Table 3 cont'd. Cancer cases by site and sex, Nova Scotia, 1969-1988.

Site	ICD-9	Total	Males	Females
Eye	**190**	**127**	**73**	**54**
Brain and central nervous system	**191-192**	**829**	**484**	**345**
Endocrine Glands	**193-194**	**418**	**125**	**293**
Thyroid	193	377	100	277
Other endocrine	194	41	25	16
Leukaemia	**204-208**	**1,016**	**590**	**426**
Other blood and lymph tissues	**200-203**	**2,192**	**1,210**	**982**
All other and unspecified sites	**195-199**	**1,206**	**622**	**584**
Non-melanoma skin cancer	**173**	**9,974**	**5,753**	**4,221**
Benign neoplasms	**210-229**	**11**	**6**	**5**
Carcinoma in-situ	**230-234**	**3,754**	**300**	**3,454**
Neoplasms of uncertain behaviour	**235-238**	**70**	**9**	**61**
Neoplasms of unspecified behaviour	**239**	**3**	**0**	**3**

89% were lung cancer cases. Prostate cancer accounted for 91.2% (n = 3,660) of males diagnosed with genital organ cancer.

Among females diagnosed with digestive cancer, 81% were diagnosed with stomach or colorectal cancer. Cervical, uterine and ovarian cancer accounted for 91.7% (n = 3,556) of females diagnosed with genital organ cancer. Of all female genital organ cancers, uterine cancer was the most frequent, accounting for 33.9% of all diagnoses.

When all cancer diagnoses were considered, including cancers with an ICD-9 173 (non-malanotic skin cancer) and ICD-9 greater than 208, non-melanotic skin cancer accounted for 17.2% of the cancer diagnoses for males and females combined. In-situ carcinoma (ICD-9 230-234) was considerably higher among females in comparison to males (n = 3,454 versus n = 300). Among females with this cancer diagnosis, 93.3% (n = 3,211) had carcinoma in-situ of the breast and genitourinary system. Of these, 93% (n=2,985) were diagnosed with carcinoma in-situ of the cervix uteri.

Frequencies of non-melanotic skin cancer (ICD-9 173), benign neoplasms (ICD-9 210-227), carcinoma in-situ (ICD-9 230-234), neoplasms of uncertain behaviour (ICD-9 235-238) and neoplasms of unspecified behaviour (ICD-9 239) are also shown in Table 3. These conditions were not included in the anlayses for reasons mentioned earlier in the inclusion and exclusion criteria.

4.2 Distribution of cancer diagnoses by age and sex

Malignant neoplasms were grouped by sex and age at diagnosis using 10-year intervals with the exception of the first age interval (20 years) shown in Table 4. The number of incident cases among males increased gradually from 0 to 39 years of age. The number of incident cases of cancer doubled for men aged 40 to 49 in comparison to men diagnosed in the previous age group. The number of incident cases of cancer continued to increase for those aged 50 to 69 with a decrease in incident cancer cases beginning in those aged 70 years-of-age and older.

Table 4. Age distribution of malignant neoplasms, Nova Scotia males and females 1968-1988.

Age	Males n	Males %	Females n	Females %
0-19	400	1.8	299	1.4
20-29	412	1.8	442	2.1
30-39	626	2.7	1,153	5.4
40-49	1,350	5.9	2,374	11.1
50-59	3,984	17.4	4,380	20.5
60-69	7,154	31.2	5,427	25.4
70-79	6,276	27.4	4,718	22.1
>= 80	2,697	11.8	2,561	12.0
Total:	22,899	100.0	21,354	100.0

Females diagnosed with malignant neoplasms showed a gradual increase in the number of inciden cases of cancer up until age 29 but a larger increase in the number of cancers occurred much sooner in women starting at age 30. The number of incident cases of cancer peaked for women aged 60 to 69 then started to decline in those aged 70 years and older.

Just over seventy percent (70.3%) of male incident cases of cancer were diagnosed at age 60 and older. Almost sixty percent (59.5%) of female incident cases of cancer were diagnosed in those aged 60 and older, leaving 40.5% of all incident cancer in women diagnosed between 0 to 59 years of age. The difference in age distribution of the incident number of cancer cases between males and females was due to a larger proportion of women being diagnosed with breast and genital cancers before the age of 60.

4.3 Distribution of causes of death among patients with malignant neoplasms

The overall mortality for males diagnosed with malignant neoplasms was 74.2% (n = 17,000); among females diagnosed with malignant neoplasms, the overall mortality was 60.2% (n = 12,847). The most frequent cause of death was from neoplasms (ICD8/ICD-9 140-239). Fifty-nine per cent (59.1%) of male incident cancer cases and fifty per cent (50.0%) of female incident cancers had died by the end of the follow-up period from cancer (Table 5). Deaths attributed to cancer included either the original cancer diagnosis or another cancer as the underlying cause of death.

Mortality from circulatory diseases (ICD8 390-458; ICD9 390-459) was the second highest cause of death for both sexes. Among males, 9.3% (n = 2,129) died from circulatory causes while among females, 6.3% (n = 1,355) died from this cause.

Respiratory diseases (ICD8/ICD9 390-459) was the third highest cause of death for both men and women. Among males with malignant neoplasms, 2.5% (n=574) died from respiratory diseases. Among females, 1.2% (n=256) died from respiratory diseases.

Table 5. Distribution of underlying causes of death among males and females diagnosed with malignant neoplasms (1969-1988) by ICD-8 and ICD-9 broad disease grouping (1969-1989).

Underlying cause of death ICD-8 and ICD-9	Total n	Total (%) [a]	Males n	Males (%) [b]	Females n	Females (%) [b]
Infective and Parasitic Diseases (ICD-8 000-136; ICD-9 001-139)	90	0.20	50	0.22	40	0.19
Neoplasms (ICD-8 / ICD-9 140-239)	24,210	54.17	13,538	59.12	10,672	49.98
Endocrine/Nutritional/Metabolic Disease (ICD-8 / ICD-9 240-279)	211	0.47	112	0.49	99	0.46
Blood Diseases (ICD-8 / ICD-9 280-289)	62	0.14	37	0.16	25	0.12
Mental Disorders (ICD-8 290-315 / ICD 290-319)	47	0.11	28	0.12	19	0.09
Nervous System/Sense Organ Diseases (ICD-8 / ICD-9 320-389)	80	0.18	42	0.18	38	0.18
Circulatory Disease (ICD-8 390-458 / ICD-9 390-459)	3,484	7.80	2,129	9.30	1,355	6.35
Respiratory Disease (ICD-8 / ICD-9 460-519)	830	1.86	574	2.51	256	1.20
Digestive Disease (ICD-8 520-577 / ICD-9 520-579)	371	0.83	208	0.91	163	0.76
Genitourinary Disease (ICD-8 / ICD-9 580-629)	188	0.42	110	0.48	78	0.37
Complications of Pregnancy (ICD-8 630-678 / ICD-9 630-676)	0	0.00	0	0.00	0	0.00
Skin/Subcutaneous Tissue Disease (ICD-8 / ICD-9 680-709)	13	0.03	7	0.03	6	0.03
Musculoskeletal Disease (ICD-8 710-738 / ICD-9 710-739)	17	0.04	10	0.04	7	0.03
Congenital Anomalies (ICD-8 740-759 / ICD-9 740-759)	4	0.01	2	0.01	2	0.01
Perinatal Mortality (ICD-8 / ICD-9 760-779)	0	0.00	0	0.00	0	0.00
Symptons/Ill-Defined (ICD-8 780-796 / ICD-9 780-799)	37	0.45	18	0.08	19	0.09
Accidents/Poisoning/Violence (ICD-8 / ICD-9 800-999)	203	0.45	135	0.59	68	0.32
Total	29,847	67.45	17,000	74.24	12,847	60.16

a The denominator used to calculate the percentages was the total number of incident cancers, 44,253.
b The denominators used to calculate the percentages for males and females were 22,899 male incident cases and 21,354 female incident cases of malignant neoplasms.

Digestive diseases (ICD8 520-577; ICD9 520-579) was the fourth highest cause of death for both men and women. Almost one per cent of the males and females died from causes in this broad disease grouping representing 0.9% and 0.8% for males and females, respectively.

Mortality due to accidents, poisonings or violence (ICD8/ICD9 800-999) was the fifth highest cause of death among males (0.6%), while deaths from endocrine, nutritional or metabolic disease (ICD8/ICD9 240-279) was the fifth cause of death for females (0.5%). The remaining causes of death are also shown in Table 5.

4.4 Cause of death by age at diagnosis

All causes of death

With the exception of persons diagnosed before age 20, the proportion of persons dying among incident cases of cancer from all causes of death increased with age as shown in Table 6. When the proportion of deaths in each age group was calculated using all ages of incident cancer cases as the denominator, an increase in the proportion of deaths occurred up until age sixty-nine in both men and women, followed by a decrease.

Neoplasms

Among males and females whose cause of death was due to neoplasms, the proportions of deaths among the incident cases of cancer for each age group

Table 6. **Numbers and proportions of underlying causes of death by age at diagnosis among males and females diagnosed with malignant neoplasms, Nova Scotia, 1969-1988, by ICD-8 and ICD-9 broad disease grouping (N = 44,253)**

	Males (n = 22,899)								Females (n = 21,354)							
Underlying Cause of Death ICD-8 / ICD-9	0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Infective and Parasitic Diseases	2	0	1	1	7	9	21	9	0	0	0	1	5	11	15	8
Neoplasms	183	145	242	772	2,499	4,443	3,749	1,505	114	124	386	1,033	2,204	2,824	2,566	1,421
Endocrine/Nutritional/Metabolic Disease	1	0	0	3	9	31	49	19	0	0	0	1	15	25	37	21
Blood Diseases	1	0	0	3	6	11	13	3	0	0	0	3	5	5	7	5
Mental Disorders	0	0	1	1	5	8	7	6	0	0	0	0	2	3	8	6
Nervous System/Sense Organ Diseases	2	1	1	0	5	7	19	7	1	1	2	3	4	11	12	4
Circulatory Diseases	1	1	6	36	186	598	760	541	1	1	5	34	103	324	475	412
Respiratory Diseases	2	2	4	8	56	149	228	125	1	1	1	5	45	63	80	60
Digestive Diseases	1	2	1	4	26	56	73	45	0	1	2	9	21	28	60	42
Genitourinary Diseases	0	1	0	4	8	20	43	34	0	0	1	2	6	19	27	23
Complications of Pregnancy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skin/Subcutaneous Tissue Disease	0	0	0	0	0	4	2	1	0	0	0	1	0	2	4	0
Musculoskeletal Disease	0	0	0	0	1	3	4	2	0	0	1	0	2	2	0	2
Congenital Anomalies	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	1
Perinatal Mortality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Symptoms/Ill-Defined Conditions	0	0	0	0	2	4	6	6	1	0	1	1	1	2	5	8
Accidents/Poisonings/Violence	1	2	4	13	27	34	30	24	0	0	0	6	11	16	22	13
Total	194	154	260	845	2,837	5,377	5,004	2,329	118	128	399	1,099	2,424	3,335	3,318	2,026
Incident Cases of Cancer for each age group	400	412	626	1,350	3,984	7,154	6,276	2,697	299	442	1,153	2,374	4,380	5,427	4,718	2,561
Percentage of deaths per incident cases of cancer	48.5	37.4	41.5	62.6	71.2	75.2	79.7	86.4	39.5	29.0	34.6	46.3	55.3	61.5	70.3	79.1

increased with age (with the exception of males diagnosed between the ages of 0-19) until age 69 followed by a decrease in persons aged 70 years and older (Table 6).

The proportions of deaths due to specific cancers are shown in Table 7. Neoplasms accounted for 59.1% of deaths among males diagnosed with cancer. Twenty per cent (20.1%) were caused by respiratory cancers, chiefly, lung cancer. Slightly more than seventeen per cent (17.5%) of male incident cases of cancer died from digestive cancers. The third most common cancer death was from genital cancer (6.2%) in which prostate cancer was the main cause of death.

Among females, fifty per cent (50.0%) of the incident cases died from neoplastic causes. Digestive cancer accounted for the largest proportion of cancer deaths (15.7%) among female incident cases of cancer. Breast cancer was the second cancer cause of death (9.9%). Respiratory and genital organ cancers represented similar proportions (6.4% each).

The proportion of deaths from neoplasms was the leading cause of death in each age interval for both males and females. However, the proportion of deaths attributed to the remaining causes as a whole, increased with age at diagnosis, starting at age twenty. The four other prominent causes of death will be described below. Comparisons between males and females for each cause of death are given.

Table 7. Underlying cause of death due to neoplasms among males and females diagnosed with malignant neoplasms, Nova Scotia, 1969-1989 (N = 44,253).

Underlying Cause of Death	Males n	Males %	Females n	Females %
Oral cancer	315	1.4	118	0.6
Digestive cancer	4,012	17.5	3,351	15.7
Respiratory cancer	4,593	20.1	1,376	6.4
Bone tissue and skin cancer	256	1.1	213	1.0
Non-melanoma skin cancer	15	0.1	9	0.0
Breast cancer	11	0.0	2,107	9.9
Genital organ cancer	1,425	6.2	1,373	6.4
Urinary organs cancer	766	3.3	378	1.8
Eye cancer	8	0.0	6	0.0
Brain and central nervous system cancer	328	1.4	236	1.1
Endocrine cancer	45	0.2	53	0.3
Leukaemia	452	2.0	310	1.4
Other blood and lymph tissues	588	2.6	492	2.3
All other and unspecified sites	573	2.5	539	2.5
Benign neoplasms	14	0.0	11	0.0
Carcinoma in-situ	5	0.0	2	0.0
Neoplasms of uncertain behaviour	55	0.2	32	0.2
Neoplasms of unspecified behaviour	77	0.3	66	0.3
Total:	13,538	59.1	10,672	50.0

Circulatory Diseases

The proportion of deaths due to circulatory diseases increased with age at diagnosis among both male and female incident cases of cancer. Table 8 shows that ischaemic heart disease (ICD-8 410-413; ICD-9 410-414, 429.2) had the largest proportion of deaths within this disease grouping, accounting for 5.3% and 3.1% of all male and female incident cases of cancer, respectively. Ischaemic heart disease included acute myocardial infarction, old myocardial infarction and angina pectoris. Cerebrovascular disease (ICD-8/ICD-9 430-438) was the second most common cause of death within this disease grouping, accounting for 1.5% and 1.3% of deaths among men and women diagnosed with malignant neoplasms respectively.

Table 8. Circulatory Diseases as the Underlying Cause of Death Among 44,253 Men and Women Diagnosed with Malignant Neoplasms, Nova Scotia, 1969-1989.

	Males		Females	
Underlying Cause of Death	n	%	n	%
Chronic rheumatic heart disease	7	0.0	17	0.1
Hypertensive disease	26	0.1	32	0.1
Ischaemic heart disease	1,225	5.3	673	3.1
Diseases of pulmonary circulation	40	0.2	26	0.1
Other forms of heart disease	304	1.3	222	1.0
Cerebrovascular heart disease	346	1.5	282	1.3
Diseases of arteries, arterioles and capillaries	149	0.6	76	0.4
Diseases of veins, lymphatics and other diseases of the circulatory system	32	0.1	27	0.1
Total:	2,129	9.2	1,355	6.3

Respiratory Diseases

Respiratory diseases was the third leading cause of death for both males and females. The proportion of persons dying from causes within this disease grouping increased with age at diagnosis for both males and females, starting at age 40 and older (Table 6). Proportions of persons who died from the specific diseases within this broad disease grouping are shown in Table 9. Pneumonia and influenza (ICD-8 480-486, 470-474; ICD-9 480-487) were the prominent underlying causes of death for both men and women (1.1% and 0.6% respectively), followed by chronic obstructive pulmonary disease and allied conditions (ICD-8 490-493, 519.3; ICD-9 490-496) (1.0% and 0.3% among men and women respectively).

Table 9. Respiratory Diseases as the Underlying Cause of Death Among 44,253 Men and Women Diagnosed with Malignant Neoplasms, Nova Scotia, 1969-1989.

	Males		Female	
Underlying Cause of Death	n	%	n	%
Acute respiratory infections	4	0.0	1	0.0
Other diseases of the respiratory tract	4	0.0	3	0.0
Pneumonia and influenza	246	1.1	130	0.6
Chronic obstructive pulmonary disease (COPD) and allied conditions	232	1.0	74	0.3
Pneumoconioses and other lung diseases due to external agents	26	0.1	10	0.0
Other diseases of the respiratory system	62	0.3	38	0.2
Total:	574	2.5	256	1.2

Digestive Diseases

Digestive diseases was the fourth leading cause of death among males and females, with over ninety per cent (94.3%) of these deaths in persons diagnosed at aged 50 and older. The majority of deaths among men (0.4%) was due to *other diseases of the digestive system* (ICD-8 570-577; ICD-9 570-579) which included chronic liver disease and cirrhosis, liver abscesses and sequelae of chronic liver disease and gastro-intestinal haemorrhage shown in Table 10. Diseases of intestines and peritoneum as well as other diseases of the digestive system were the prominent underlying causes of death for both males and females ranging from 0.2 to 0.4% of the incident cases of malignant neoplasms.

Table 10. Digestive Diseases as the Underlying Cause of Death Among 44,253 Men and Women Diagnosed with Malignant Neoplasms, Nova Scotia, 1969-1989.

	Males		Females	
Underlying Cause of Death	n	%	n	%
Diseases of oral cavity, salivary glands and jaws	2	0.0	0	0.0
Diseases of the esophagus, stomach and duodenum	45	0.2	25	0.1
Appendicitis	3	0.0	2	0.0
Hernia of abdominal cavity	1	0.0	3	0.0
Noninfective enteritis and colitis	13	0.1	14	0.1
Diseases of intestines and peritoneum	50	0.2	60	0.3
Other diseases of the digestive system	94	0.4	59	0.3
Total:	208	0.9	163	0.8

Endocrine, Nutritional and Metabolic Diseases

Endocrine, nutritional and metabolic diseases was the fifth leading cause of death for females, accounting for 0.5% of females diagnosed with malignant neoplasms. This was the sixth leading cause of death for males, accounting for 0.5% of males diagnosed with malignant neoplasms. Almost ninety per cent (88.4%) of deaths occurred in males aged 60 years or older; among females, 83.4% of the deaths occurred in women 60 years of age and older.

Diabetes mellitus (ICD-8/ICD-9 250) which was grouped under *diseases of other endocrine glands*, was the main cause of death within this broad disease grouping, accounting for 0.4% (n = 81) of deaths among all females and 0.3% (n = 72) of deaths among all males diagnosed with malignant neoplasms (Table 11).

Table 11. Endocrine, Nutritional and Metabolic Diseases as the Underlying Cause of Death Among 44,253 Men and Women Diagnosed with Malignant Neoplasms, Nova Scotia, 1969-1989.

	Males		Females	
Underlying Cause of Death	n	%	n	%
Diseases of other endocrine glands	72	0.3	81	0.4
Nutritional deficiencies	3	0.0	4	0.0
Other metabolic disorders and immunity disorders	37	0.2	14	0.1
Total:	112	0.5	99	0.5

Accidents, Poisonings and Violence

Deaths from accidents, poisoning and violence was the fifth leading cause of death among males (0.6%) and the seventh leading cause of death among females (0.3%). Just over sixty-five per cent (65.2%) of deaths among males occurred in men 60 years of age and older. Seventy-five per cent (75.0%) of deaths occurred among women 60 years of age and older.

The specific causes within this disease category, shown in Table 12, were suicide and self-inflicted injury which accounted for 0.2% (n = 43) of deaths among male incident cases. Accidental falls also accounted for 0.2% of deaths among male cases but the absolute number of deaths (n = 36) was less than the number of deaths from suicide and self-inflicted injury. Among women, accidental falls and motor vehicle traffic accidents each accounted for 0.1% of deaths.

4.5 Overall five-year cumulative mortality by cause of death and major cancer - Males

Results for the five-year cumulative mortality among men are shown in Tables 13, 14 and 15 and for women in Tables 16, 17 and 18. Approximate 95% confidence intervals are reported in text and not in these tables. For men, cancer diagnoses included prostate, colorectal and lung cancer. Among women, the cancer diagnoses were breast, colorectal and lung cancer.

4.5.1 Overall five-year cumulative mortality - Prostate Cancer

The overall five-year cumulative mortality for prostate cancer (Tables 13, 14;

Table 12. Accidents, poisonings and violence as the underlying cause of death among 44,253 males and females diagnosed with malignant neoplasms, Nova Scotia, 1969-1989.

Underlying Cause of Death	Males n	Males %	Females n	Females %
Motor vehicle traffic accidents	16	0.1	14	0.1
Non traffic accident involving off-road motor vehicle	1	0.0	0	0.0
Accidental poisoning by drugs, medicaments and biologicals	0	0.0	1	0.0
Accidental poisoning by other solid and liquid substances, gases and vapors	1	0.0	0	0.0
Misadventures to patients during surgical and medical care	2	0.0	0	0.0
Surgical and medical procedures as cause of abnormal reactions of patients to later complications without mention of misadventure at time of procedure	0	0.0	5	0.0
Accidental falls	36	0.2	28	0.1
Accidents by fire and flames	10	0.0	3	0.0
Accidents due to natural and environmental factors	3	0.0	0	0.0
Accidental drowning and submersion	4	0.0	1	0.0
Accidental fall into water	6	0.0	8	0.0
Inhalation and ingestion of other objects causing obstruction of respiratory tract or suffocation	4	0.0	1	0.0
Mechanical suffocation	1	0.0	0	0.0
Foreign body accidentally entering other orifice	1	0.0	0	0.0
Other accidents	2	0.0	1	0.0
Drugs, medical and biological substances causing adverse effects in therapeutic use	2	0.0	0	0.0
Suicide and self-inflicted injury	43	0.2	4	0.0
Homicide and injury purposely inflicted by other persons	1	0.0	0	0.0
Injury undetermined whether accidentally or purposely inflicted	2	0.0	2	0.0
Total:	135	0.6	68	0.3

and 15) decreased over calendar period with 62.4% (95%CI 58.9, 65.9) of incident cases dying among those diagnosed between 1969 and 1973, 60.1% (95% CI 56.7, 63.5) for those diagnosed between 1974 and 1978 and 52.2% (95% CI 48.9, 55.5) for men diagnosed between 1979 and 1983. While the overall 5-year cumulative mortality decreased by calendar period, incident cases of prostate cancer increased over the same period of time. Cumulative five-year mortality increased by age group (excluding those up to age 49 since there the incident number of cases was particularly small) and was consistent within each calendar period. Incident cases of prostate cancer also increased with age, with the majority of cancer cases occurring in men 70 to 79 years of age.

4.5.2 Five-year cumulative cause-specific mortality - Prostate Cancer

When all ages were combined, prostate cancer was the major cause of death. This was consistent across calendar period and generally by age at diagnosis. Although prostate cancer was the major cause of death, the proportion of prostate cancer deaths decreased over the three calendar periods. In fact, when death from prostate cancer and death from other neoplasms were combined, the proportion dying from cancer also decreased (38.6% for 1969 to 1973; 37.8% for 1974 to 1978; and 31.0% for 1979 to 1983). Circulatory diseases was the second cause of death among prostate cancer patients. The proportion of deaths from circulatory diseases decreased throughout each calendar period (17.4% for those diagnosed between 1969 and 1973; 16.8% for those diagnosed between 1974 and 1978; and 14.8% for those diagnosed between 1979 and

Table 13. Cumulative five-year cause-specific mortality by cancer type and age at diagnosis for Nova Scotia males diagnosed from 1969 to1973.

Cancer type	Cases	Proportion	0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
			Age Group							
Prostate Cancer	747	100.0	0	0	0	1	48	178	302	218
Deaths										
Prostate Cancer	247	33.1	0	0	0	1	12	49	117	68
Other Neoplasms	41	5.5	0	0	0	0	3	10	13	15
Circulatory Diseases	130	17.4	0	0	0	0	2	16	40	72
Respiratory Diseases	25	3.3	0	0	0	0	0	1	13	11
Digestive Diseases	4	0.5	0	0	0	0	0	1	3	0
All other causes	19	2.5	0	0	0	0	0	5	6	8
Total	466		0	0	0	1	17	77	186	166
Percentage dead within 5 years of diagnosis		62.4	...	...	...	100.0	35.4	43.3	61.6	76.1
Colorectal Cancer	747	100.0	2	2	13	40	134	237	207	112
Deaths										
Colorectal Cancer	392	52.5	1	1	8	22	69	109	114	68
Other Neoplasms	35	4.7	1	0	0	3	2	9	13	7
Circulatory Diseases	58	7.8	0	0	0	0	4	14	24	16
Respiratory Diseases	10	1.3	0	0	0	0	2	3	3	2
Digestive Diseases	0	0.0	0	0	0	0	0	0	0	0
All other causes	6	0.8	0	0	0	0	1	2	1	2
Total	501		2	1	8	25	78	137	155	95
Percentage dead within 5 years of diagnosis		67.1	100.0	50.0	61.5	62.5	58.2	57.8	74.9	84.8
Lung Cancer	879	100	1	2	9	64	245	309	198	51
Deaths										
Lung Cancer	712	81.0	0	1	7	56	191	262	162	33
Other Neoplasms	39	4.4	0	0	0	1	17	9	8	4
Circulatory Diseases	32	3.6	0	0	0	1	3	9	14	5
Respiratory Diseases	6	0.7	0	0	0	0	0	4	1	1
Digestive Diseases	4	0.5	0	0	0	0	0	2	1	1
All other causes	4	0.5	0	0	0	0	1	2	1	0
Total	797		0	1	7	58	212	288	187	44
Percentage dead within 5 years of diagnosis		90.7	...	50.0	77.8	90.6	86.5	93.2	94.4	86.3

Table 14. Cumulative five-year cause-specific mortality by cancer type and age at diagnosis for Nova Scotia males diagnosed from 1974 to 1978.

Cancer type	Cases	Proportion	Age Group 0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Prostate Cancer	785	100.0	0	0	0	4	62	232	308	179
Deaths										
Prostate Cancer	274	34.9	0	0	0	1	23	80	105	65
Other Neoplasms	23	2.9	0	0	0	1	1	5	12	4
Circulatory Diseases	132	16.8	0	0	0	0	4	22	54	52
Respiratory Diseases	17	2.2	0	0	0	0	0	1	8	8
Digestive Diseases	2	0.3	0	0	0	0	0	1	0	1
All other causes	24	3.1	0	0	0	0	0	7	9	8
Total	472		0	0	0	2	28	116	188	138
Percentage dead within 5 years of diagnosis		60.1	...	...	...	50.0	45.2	50.0	61.0	77.1
Colorectal Cancer	788	100.0	2	8	11	42	149	250	216	110
Deaths										
Colorectal Cancer	372	47.2	0	3	5	20	63	119	110	52
Other Neoplasms	60	7.6	0	0	1	5	9	17	15	13
Circulatory Diseases	49	6.2	0	0	0	0	2	12	16	19
Respiratory Diseases	10	1.3	0	0	0	0	2	1	3	4
Digestive Diseases	7	0.9	1	1	0	0	0	1	3	1
All other causes	14	1.8	0	0	0	0	2	3	5	4
Total	512		1	4	6	25	78	153	152	93
Percentage dead within 5 years of diagnosis		65.0	50.0	50.0	54.5	59.5	52.3	61.2	70.4	84.5
Lung Cancer	1,179	100	0	1	10	71	280	479	290	48
Deaths										
Lung Cancer	967	82.0	0	0	8	55	233	388	244	39
Other Neoplasms	41	3.5	0	0	1	5	9	14	11	1
Circulatory Diseases	44	3.7	0	0	0	0	8	18	12	6
Respiratory Diseases	13	1.1	0	0	0	1	2	5	3	2
Digestive Diseases	6	0.5	0	0	0	0	1	3	2	0
All other causes	8	0.7	0	0	0	2	2	3	1	0
Total	1,079		0	0	9	63	255	431	273	48
Percentage dead within 5 years of diagnosis		91.5	...	...	90.0	88.7	91.1	90.0	94.1	100.0

Table 15. Cumulative five-year cause-specific mortality by cancer type and age at diagnosis for Nova Scotia males diagnosed from 1979 to 1983.

Cancer type	Cases	Proportion	0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
			Age Group							
Prostate Cancer	854	100	0	0	1	3	59	238	358	195
Deaths										
Prostate Cancer	230	26.9	0	0	0	0	12	64	103	51
Other Neoplasms	35	4.1	0	0	0	0	4	9	8	14
Circulatory Diseases	126	14.8	0	0	0	1	2	28	48	47
Respiratory Diseases	25	2.9	0	0	0	0	0	4	9	12
Digestive Diseases	10	1.2	0	0	0	0	1	0	6	3
All other causes	20	2.3	0	0	0	0	1	0	10	9
Total	446		0	0	0	1	20	105	184	136
Percentage dead within 5 years of diagnosis		52.2	...	...	...	33.3	33.9	44.1	51.4	69.7
Colorectal Cancer	866	100	2	5	20	44	141	276	267	111
Deaths										
Colorectal Cancer	310	35.8	1	2	6	13	47	104	94	43
Other Neoplasms	111	12.8	0	0	2	7	17	37	34	14
Circulatory Diseases	85	9.8	0	0	0	1	2	19	38	25
Respiratory Diseases	14	1.6	0	0	0	1	1	2	5	5
Digestive Diseases	12	1.4	0	0	0	1	0	3	4	4
All other causes	18	2.1	0	0	0	1	3	3	9	2
Total	550		1	2	8	24	70	168	184	93
Percentage dead within 5 years of diagnosis		63.5	50.0	40.0	40.0	54.5	49.6	60.9	68.9	83.8
Lung Cancer	1,373	100	1	2	9	67	309	536	371	78
Deaths										
Lung Cancer	1,090	79.4	0	0	5	57	236	416	312	64
Other Neoplasms	56	4.1	1	0	1	4	13	23	11	3
Circulatory Diseases	52	3.8	0	0	0	0	13	22	13	4
Respiratory Diseases	28	2.0	0	0	0	0	5	14	6	3
Digestive Diseases	7	0.5	0	0	0	0	1	3	3	0
All other causes	10	0.7	0	0	0	1	3	3	2	1
Total	1,243		1	0	6	62	271	481	347	75
Percentage dead within 5 years of diagnosis		90.5	100.0	...	66.7	92.5	87.7	89.7	93.5	96.2

1983). Respiratory diseases was the third cause of death throughout each calendar period. The majority of respiratory deaths occurred in men diagnosed at 70 years of age and older.

4.5.3 Overall five-year cumulative mortality - Colorectal Cancer

A decrease in the overall five-year cumulative mortality occurred in males diagnosed with colorectal cancer. During the first calendar period 67.1% (95% CI 63.7, 70.5) of incident cases died, while 65.0% (95% CI 61.7, 68.3) and 63.5% (95% CI 60.3, 66.7) died among those diagnosed within the second and third calendar periods, respectively. While an overall decrease in the cumulative mortality took place, the incident cases of colorectal cancer also increased, particularly among men 60 to 79 years of age.

4.5.4 Five-year cumulative cause-specific mortality - Colorectal Cancer

With all ages combined, colorectal cancer was the leading cause of death, accounting for 52.5% of deaths among incident cases for men diagnosed between 1969 and 1973, 47.2% among men diagnosed between 1974-1978 and 35.8% for men diagnosed between 1979 and 1983. Mortality from other neoplasms was generally the second cause of death with the exception of the first calendar period (1969 to 1973) in which other neoplasms accounted for 4.7% of deaths among incident cases of male colorectal cancer in comparison to 7.8% for those diagnosed between 1974 and 1978 and 12.8% for men diagnosed between 1979 and 1983. Mortality from circulatory diseases was generally the main non-cancer cause of death.

When death from colorectal cancer and other neoplasms were combined, representing cause of death from cancer, the proportion of cancer deaths decreased across calendar period. Cancer deaths represented 57.2% of the incident cases dying among those diagnosed during the first calendar period, 54.8% for men diagnosed during the second calendar period, and 48.6% among men diagnosed during the last calendar period. When the remaining non-cancer causes of death were grouped together, 9.9% of incident cases died among men diagnosed between 1969 and 1973; 10.2% for men diagnosed between 1974 and 1978; and 14.9% among men diagnosed between 1979 and 1983.

4.5.5 Overall five-year cumulative mortality - Lung Cancer

The overall five-year cumulative mortality experienced by male lung cancer patients was quite substantial in comparison to men diagnosed with prostate or colorectal cancer. The proportion of deaths among incident cases of lung cancer ranged from 90.5% (95% CI 89.0, 92.0) to 91.5% (95% CI 89.9, 93.1).

4.5.6 Five-year cumulative cause-specific mortality - Lung Cancer

Lung cancer was the major cause of death during each calendar period. Death from other neoplasms was generally the second cause of death with the exception of the diagnosis period 1974 to 1978 in which circulatory diseases was the second cause of death (3.7%). Circulatory diseases was the main non-cancer cause of death ranging from 3.6 to 3.8% among incident cases of lung cancer.

4.6 Overall five-year cumulative mortality by underlying cause of death and major cancer – Females

4.6.1 Overall five-year cumulative mortality – Breast Cancer

Overall five-year cumulative mortality decreased across calendar period with 39.3% (95% CI 36.6, 42.0) dying among women diagnosed between 1969 and 1973, 38.8% (95% CI 36.2, 41.4) among women diagnosed between 1974 and 1978 and lastly, 36.3% (95% CI 33.9, 38.7) among women diagnosed between 1979 and 1983. There did not appear to be any consistent mortality pattern within each age category except for women diagnosed between ages 60-69 in which a constant decrease (along with a constant increase in incidence) in overall mortality was shown across the calendar periods.

4.6.2 Five-year cumulative cause specific mortality – Breast Cancer

The major cause of death was from breast cancer (Tables 16, 17 and 18) representing 30.8% of women diagnosed between 1969 and 1973, 30.3% for those diagnosed between 1974 and 1978 and 28.0% for women diagnosed between 1979 and 1983. Breast cancer was the major underlying cause of death within each age group. Circulatory diseases represented the second cause of death among breast cancer patients and showed a slight decrease across calendar period starting at 5.2% for those diagnosed in the first period, 4.2% in the second period and 3.8% among women diagnosed in the last calendar period. The proportion of circulatory causes of death tended to concentrate in women diagnosed between 60 and 80 years of age and older. Deaths from other neoplasms was the third cause of mortality throughout each calendar period. Non-cancer causes of death were more frequent among women diagnosed at ages 60 and older.

4.6.3 Overall five-year cumulative mortality – Colorectal Cancer

Overall five-year cumulative mortality for women diagnosed with colorectal cancer decreased across calendar period. Among women diagnosed between 1969 and 1973, the overall five-year cumulative mortality was 61.1% (95% CI 57.7, 64.5). For women diagnosed between 1974 and 1978, the overall five-year cumulative mortality decreased to 57.8% (95% CI 54.5, 61.1). Among those diagnosed in the last calendar period (1979 to 1983) a further decrease in mortality was shown with the proportion of women dying among incident cases of female colorectal cancer at 55.5% (95% CI 52.3, 58.7). Although the overall cumulative five-year mortality declined over time, it was shown that incident cases of female colorectal cancer increased by calendar period especially among women 60 years of age and older.

4.6.4 Five-year cumulative cause specific mortality – Colorectal Cancer

Colorectal cancer was the main cause of death throughout each calendar period (Tables 16, 17 and 18). However, the proportion of women dying from

Table 16. Cumulative five-year cause-specific mortality by cancer type and age at diagnosis for Nova Scotia females diagnosed from 1969 to 1973.

Cancer type	Cases	Proportion	0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Breast Cancer	1,235	100	0	10	64	235	333	267	227	99
Deaths										
Breast Cancer	380	30.8	0	0	24	66	116	88	57	29
Other Neoplasms	19	1.5	0	0	0	1	7	2	7	2
Circulatory Diseases	64	5.2	0	0	0	1	1	11	25	26
Respiratory Diseases	7	0.6	0	0	0	0	2	1	2	2
Digestive Diseases	3	0.2	0	0	0	0	1	1	1	0
All other causes	12	1.0	0	0	0	2	3	1	4	2
Total	485		0	0	24	70	130	104	96	61
Percentage dead within 5 years of diagnosis		39.3	...	...	37.5	29.8	39.0	39.0	42.3	61.6
Colorectal Cancer	808	100	0	3	15	71	150	202	236	131
Deaths										
Colorectal Cancer	421	52.1	0	1	6	34	68	106	124	82
Other Neoplasms	25	3.1	0	0	0	2	9	2	9	3
Circulatory Diseases	29	3.6	0	0	0	1	0	6	8	14
Respiratory Diseases	8	1.0	0	0	0	0	2	2	0	4
Digestive Diseases	3	0.4	0	0	0	1	0	1	0	1
All other causes	8	1.0	0	0	0	0	0	2	5	1
Total	494		0	1	6	38	79	119	146	105
Percentage dead within 5 years of diagnosis		61.1	...	33.3	40.0	53.5	52.7	58.9	61.9	80.2
Lung Cancer	153	100	0	0	3	15	44	41	37	13
Deaths										
Lung Cancer	113	73.9	0	0	2	11	34	29	29	8
Other Neoplasms	6	3.9	0	0	0	1	2	2	1	0
Circulatory Diseases	7	4.6	0	0	0	1	0	1	2	3
Respiratory Diseases	1	0.7	0	0	0	0	0	1	0	0
Digestive Diseases	0	0.0	0	0	0	0	0	0	0	0
All other causes	1	0.7	0	0	0	0	1	0	0	0
Total	128		0	0	2	13	37	33	32	11
Percentage dead within 5 years of diagnosis		83.7	...	...	66.7	86.7	84.1	80.5	86.5	84.6

Table 17. Cumulative five-year cause-specific mortality by cancer type and age at diagnosis for Nova Scotia females diagnosed from 1974 to 1978.

Cancer type	Cases	Proportion	Age Group 0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Breast Cancer	1,321	100	1	15	69	230	343	346	207	110
Deaths										
Breast Cancer	400	30.3	0	5	29	54	122	112	48	30
Other Neoplasms	26	2.0	0	0	0	3	5	5	9	4
Circulatory Diseases	55	4.2	0	0	1	3	2	10	21	18
Respiratory Diseases	9	0.7	0	0	0	0	3	3	1	2
Digestive Diseases	6	0.5	0	0	0	1	2	0	2	1
All other causes	17	1.3	0	0	0	1	0	3	8	5
Total	513		0	5	30	62	134	133	89	60
Percentage dead within 5 years of diagnosis		38.8	...	33.3	43.5	27.0	39.1	38.4	43.0	54.5
Colorectal Cancer	865	100	1	5	19	60	164	239	245	132
Deaths										
Colorectal Cancer	389	45.0	0	1	9	26	69	93	125	66
Other Neoplasms	56	6.5	0	0	0	4	13	10	20	9
Circulatory Diseases	36	4.2	0	0	0	1	1	6	12	16
Respiratory Diseases	3	0.3	0	0	0	0	0	0	3	0
Digestive Diseases	7	0.8	0	0	0	0	1	0	4	2
All other causes	9	1.0	0	0	0	0	1	2	3	3
Total	500		0	1	9	31	85	111	167	96
Percentage dead within 5 years of diagnosis		57.8	...	20.0	47.4	51.7	51.8	46.4	68.2	72.7
Lung Cancer	295	100	1	0	4	26	95	86	64	19
Deaths										
Lung Cancer	223	75.6	1	0	4	16	73	63	51	15
Other Neoplasms	21	7.1	0	0	0	2	8	4	5	2
Circulatory Diseases	6	2.0	0	0	0	1	1	2	2	0
Respiratory Diseases	1	0.3	0	0	0	0	0	0	0	1
Digestive Diseases	0	0.0	0	0	0	0	0	0	0	0
All other causes	0	0.0	0	0	0	0	0	0	0	0
Total	251		1	0	4	19	82	69	58	18
Percentage dead within 5 years of diagnosis		85.1	100.0	100.0	100.0	73.1	86.3	80.2	90.6	94.7

Table 18. Cumulative five-year cause-specific mortality by cancer type and age at diagnosis for Nova Scotia females diagnosed from 1979 to 1983.

Cancer type	Cases	Proportion	Age Group 0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Breast Cancer	1,526	100	1	15	100	233	372	390	275	140
Deaths										
Breast Cancer	428	28.0	0	7	31	58	125	97	77	33
Other Neoplasms	25	1.6	0	0	2	4	1	9	4	5
Circulatory Diseases	58	3.8	0	0	0	1	3	13	14	27
Respiratory Diseases	13	0.9	0	0	0	1	0	2	5	5
Digestive Diseases	7	0.5	0	0	0	0	0	1	4	2
All other causes	23	1.5	0	0	0	0	0	7	3	13
Total	554		0	7	33	64	129	129	107	85
Percentage dead within 5 years of diagnosis		36.3	...	46.7	33.0	27.5	34.7	33.1	38.9	60.7
Colorectal Cancer	913	100	2	2	17	57	135	259	248	193
Deaths										
Colorectal Cancer	292	32.0	0	1	6	23	37	73	84	68
Other Neoplasms	141	15.4	0	0	2	6	22	42	32	37
Circulatory Diseases	42	4.6	0	0	0	0	1	11	18	12
Respiratory Diseases	10	1.1	0	0	0	0	1	3	4	2
Digestive Diseases	7	0.8	0	0	0	1	0	1	2	3
All other causes	15	1.6	0	0	0	0	1	3	5	6
Total	507		0	1	8	30	62	133	145	128
Percentage dead within 5 years of diagnosis		55.5	...	50.0	47.1	52.6	45.9	51.4	58.5	66.3
Lung Cancer	438	100	0	2	12	47	109	158	89	21
Deaths										
Lung Cancer	314	71.7	0	0	6	36	84	111	63	14
Other Neoplasms	24	5.5	0	1	0	2	3	9	8	1
Circulatory Diseases	11	2.5	0	0	0	1	1	4	4	1
Respiratory Diseases	5	1.1	0	0	0	0	0	2	1	2
Digestive Diseases	1	0.2	0	0	0	0	0	1	0	0
All other causes	5	1.1	0	0	0	1	0	3	1	0
Total	360		0	1	6	40	88	130	77	18
Percentage dead within 5 years of diagnosis		82.2	...	50.0	50.0	85.1	80.7	82.3	86.5	85.7

colorectal cancer decreased across each calendar period with 52.1% dying among those diagnosed between 1969 and 1973, 45.0% among those diagnosed between 1974 and 1978 and 32.0% among women diagnosed between 1979 and 1983. Death from other neoplasms was generally the second cause of mortality, with the exception of the first calendar period in which circulatory diseases was second (3.6%) to colorectal cancer. The proportion of deaths due to other neoplasms showed a steady increase across calendar period, accounting for 3.1% of the incident cases of female colorectal cancer in the first calendar period, and 6.5% and 15.4% during the second and third calendar periods, respectively.

4.6.5 Overall five-year cumulative mortality – Lung Cancer

The overall five-year cumulative mortality among female lung cancer cases was quite substantial in comparison to breast or colorectal cancers among women, being consistently greater than 80% during each calendar period. An increase in the overall five-year cumulative mortality between the first two calendar periods (83.7% (95% CI 77.8, 89.6) to 85.1% (95% CI 81.0, 89.2)) occurred, followed by a decrease (82.2% (95% CI 78.6, 85.8)) during the last calendar period. As shown by the other cancer diagnoses, lung cancer incidence consistently increased for each period of diagnosis especially between 1979 and 1983 in which 438 women were diagnosed with lung cancer in comparison to the first two calendar periods ($\underline{n}$ = 153 and $\underline{n}$ = 295, respectively).

4.6.6 Five-year cumulative cause specific mortality – Lung Cancer

Lung cancer remained the leading cause of death throughout each calendar period (Tables 16, 17 and 18), with 73.9% of the female lung cancer cases dying from lung cancer among women diagnosed between 1969 and 1973, 75.6% dying for those diagnosed between 1974 and 1978 and 71.7% dying for women diagnosed between 1979 and 1983. Death from other neoplasms was generally the second cause of death with the exception of the first calendar period in which circulatory diseases was second to lung cancer, representing 4.6% of incident cases of lung cancer. As shown in Tables 16, 17 and 18, the proportion of women dying from non-cancer causes of death was very small, ranging from 2.3% from 1974-1978 to 6.0% from 1969-1973.

4.7 Summary of the overall five-year cumulative mortality

The overall five-year cumulative mortality appeared worse for males and females diagnosed with lung cancer in comparison to persons diagnosed with colorectal, prostate or breast cancer. Although there was a slight decrease in the five-year cumulative overall mortality for persons diagnosed with colorectal and breast cancer, prostate cancer showed the largest decrease. The cause of death most prominent among all cancer diagnoses, was the original cancer diagnosis, followed by deaths due to other neoplasms or circulatory diseases depending on the cancer diagnosis and calendar period. Circulatory diseases was the most frequent non-cancer cause of death.

Among men and women diagnosed at 39 years of age or younger, a smaller proportion of non-cancer underlying causes of death was shown, compared to those diagnosed at older ages. These results may imply that behaviour of cancer is different at younger ages compared to older ages, considering that persons who were diagnosed at 39 years and younger typically had the underlying cause of death attributed to the original cancer diagnosis. Secondly, these results may indicate an absence of competing causes of death at younger ages.

4.8 Standardized mortality ratios

Standardized mortality ratios (SMRs) were calculated for men and women diagnosed with lung, colorectal, breast or prostate cancer. The SMRs for each cancer diagnosis corresponded to three causes of death: circulatory diseases, respiratory diseases and diseases of the digestive system. The results are shown in Table 19. Calculations of the expected number of deaths for each cancer and cause of death are shown in Appendix E.

Interestingly, among male and female lung cancer cases, the SMR for respiratory diseases was highest. Similarly, among males and females with colorectal cancer, the SMR for digestive diseases was highest. Although the SMR for digestive diseases was statistically significant among male lung cancer cases ($p < .001$) this was not shown among females with lung cancer ($p > .05$). Prostate cancer cases had a significantly increased risk for circulatory and respiratory diseases, but not for digestive diseases ($p > .05$). Breast cancer patients showed a significantly increased risk of mortality for all three disease groupings, however the risk of death from respiratory diseases was highest.

Table 19. Summary of standardized mortality ratios by cancer diagnosis, underlying cause of death and sex, Nova Scotia, 1969-1989.

Cancer type and Underlying cause of death	OBS.	EXP.	SMR	95% CI
Breast Cancer				
Circulatory diseases	454	329.40	1.38**	1.25 - 1.51
Respiratory diseases	84	45.06	1.86**	1.49 - 2.31
Digestive diseases	36	23.08	1.56*	1.09 - 2.15
Prostate Cancer				
Circulatory diseases	678	505.57	1.34**	1.24 - 1.44
Respiratory diseases	160	106.27	1.51**	1.28 - 1.75
Digestive diseases	37	29.47	1.26	0.89 - 1.73
Female Colorectal Cancer				
Circulatory diseases	266	225.96	1.18*	1.04 - 1.33
Respiratory diseases	45	30.75	1.46*	1.07 - 1.96
Digestive diseases	35	14.81	2.36**	1.65 - 3.29
Male Colorectal Cancer				
Circulatory diseases	383	274.15	1.40**	1.26 - 1.54
Respiratory diseases	86	56.02	1.53**	1.22 - 1.89
Digestive diseases	33	16.74	1.97**	1.36 - 2.77
Female Lung Cancer				
Circulatory diseases	45	21.60	2.08**	1.52 - 2.79
Respiratory diseases	15	3.11	4.82**	2.69 - 7.95
Digestive diseases	5	1.68	2.98	0.96 - 6.95
Male Lung Cancer				
Circulatory diseases	224	116.67	1.92**	1.68 - 2.19
Respiratory diseases	93	22.82	4.07**	3.28 - 4.99
Digestive diseases	28	7.71	3.63**	2.41 - 5.25

* $p < 0.05$

** $p < 0.001$

Chapter 5 - Interpretation

5.1 Introduction

In comparison to the vast amount of research concerning cancer-specific mortality, relatively few studies have examined the causes of death among cancer patients. This study has attempted to add information to this area of research by considering all causes of death in a population diagnosed with malignant neoplasms in Nova Scotia, Canada between 1969 and 1988.

Fifty-four per cent (54.2%) of the incident cases of malignant neoplasms died from cancer. Circulatory and respiratory diseases were the second and third leading causes of death, representing 7.8% and 1.9% of the incident cases respectively.

The overall cumulative five-year cause-specific mortality for the three most commonly diagnosed malignancies among men and women in Canada revealed the largest proportion of deaths to be attributed to the original cancer diagnosis. The most common non-cancer underlying cause of death, shown among all selected cancers, was circulatory diseases. Lung cancer had the highest overall cumulative five-year mortality for both males and females; prostate and breast cancer had the lowest overall cumulative five-year mortality among males and females, respectively.

Most of the seleceted cancer cohorts showed a signifcantly increased risk of mortality from circulatory, respiratory and digestive diseases. An interesting observation was that among males and females diagnosed with colorectal cancer, the SMR was highest for digestive diseases. Among males and females diagnosed with lung cancer, the SMR was highest for respiratory diseases.

5.2 Discussion

Before discussing what the results from this research may indicate, it is first emphasized that cancer is a disease which primarily affects the elderly (Yancik, 1997; NCIC, 1998). As was shown in this study, over seventy percent of males and almost sixty percent of females diagnosed with malignant neoplasms were sixty years of age or older, therefore, one may expect certain underlying causes of death to predominate for this population (Wilkins, 1995). Among persons aged 65 years or older, several chronic conditions such as arthritis, heart disease, diabetes, hypertension or chronic obstructive pulmonary disease as well as medications for the control of these diseases, may be present and possibly affect cancer prognosis and survival. How comorbidities interact with treatment decisions or to what degree they impact cancer survival is not completely understood (Satariano and Ragland, 1994; Yancik et al., 1996).

Interpretations of these results, limitations and suggestions for further study will be discussed in the following sections.

5.2.1 Overall underlying causes of death

Almost eighty per cent (79.7% for males and 80.4% for females) of the cancer deaths were attributed to digestive, respiratory, breast and genital organ and urinary organ cancers. These results reflect the aggressive nature of cancer, particularly lung cancer, which often has a poor prognosis once a person is diagnosed with the disease (NCIC, 1998). The high proportion of cancer deaths may also be a reflection of death certificate completion in cancer patients. Death certificate completion for cancer deaths is considered more straightforward in comparison to other causes of death since cancer patients tend to have a lower prevalence of comorbid conditions as suggested from multiple-cause of death studies (Mackenbach, Kunst, Lautenbach, Oei and Bijlsma, 1997; Wilkins, Wysocki, Morin and Wood, 1997). With fewer comorbidities listed on the death certificate, the underlying cause of death becomes more clear in its designation.

Circulatory causes as the second overall underlying cause of death may not be unexpected since cardiovascular disease contributes to mortality and morbidity in older patients with cancer (Wei, 1995). Results from this study are similar to those of Houten and Reilley (1980), Rutqvist (1984), Koch et al. (1987) and Brown et al. (1993) in which cardiovascular and respiratory diseases contributed substantially to non-cancer deaths in their specific cancer populations. Many age-related pathophysiologic changes to the heart such as thickening of blood vessel walls, atherosclerotic plaque formation and changes in muscle contraction can set off a cascade of events leading to such outcomes as myocardial ischemia and diastolic dysfunction, which appears responsible for heart failure among the elderly (Wei, 1992). Aside from the physiologic changes that occur from middle to older age, a second consideration is that those who died from circulatory diseases were persons diagnosed with less lethal forms of cancer. For example, the overall cumulative five-year cause-specific mortality revealed circulatory deaths to be the major non-cancer cause of death among prostate, breast and colorectal cancers. In comparison to lung cancer, these cancers have screening programs associated with them. Such screening can detect cancer at an earlier stage allowing treatment to be given, potentially lengthening survival, and then possibly resulting in the patient dying from a competing cause, such as circulatory disease.

Respiratory disease was the third overall cause of death. The respiratory system is a common site for complications due to cancer and cancer therapy (Stover and Kaner, 1996). Factors which may lead to pulmonary complications include immunosuppression in the individual caused by the cancer or cancer therapy, the suitability of the large capillary bed supplied by the lungs as a site for cancer metastases and pulmonary emboli, and lastly, sensitivity of the lungs to side effects of cancer treatments which can lead to respiratory symptoms. In contrast to early studies by Klastersky et al. (1972) and Inagaki et al. (1974), in which deaths from infectious diseases and pneumonia were quite prominent, underlying cause of death from infectious and parasitic diseases (ICD-8 000-136 / ICD-9 001-139) in this study represented only 0.2 per cent of deaths among incident cases of malignant neoplasms. However, earlier studies did not explicitly state the use of ICD grouping but relied more on findings from autopsy data and medical history. To compare the results of this study with earlier findings, it may be appropriate to combine deaths caused by infectious and parasitic diseases with pneumonia and influenza as well as acute respiratory infections categorized under the broad grouping of respiratory diseases (ICD-8/ICD-9 460-519) since both categories contain the same causes of death as the earlier studies.

5.2.2 Cumulative five-year cause-specific mortality

Patients diagnosed with breast, prostate, colorectal or lung cancer in three different calendar periods, were followed five years to examine the relative proportions dying from cancer and non-cancer causes of death. Among persons diagnosed with breast, prostate or colorectal cancer, the overall five-year cumulative mortality was lower than in persons diagnosed with lung cancer. The proportions of non-cancer underlying causes of death was lowest for lung cancer throughout all three calendar periods. Proportions of non-cancer causes of death varied between 2.3 to 6.0% for women and 5.3 to 7.0% for men across calendar period. In contrast, the proportion of non-cancer causes of death was highest for prostate cancer, which varied between 21.2 to 23.7% across calendar period. Differences between lung cancer and the remaining cancers are likely the result of differences in cancer lethality; lung cancer typically has a low five-year survival rate and a high case-fatality rate (Beckett, 1993), therefore, there is less chance that death will be from another competing cause.

Among all selected cancers, circulatory disease was the main non-cancer cause of death. The proportion of circulatory deaths was highest among patients with prostate cancer (14.8 to 17.4%) in comparison to patients with colorectal, breast cancer or lung cancer. Satariano, Ragland and Van Dan Eeden (1998) examined the causes of death in 584 men diagnosed with prostate carcinoma between 1980 and 1984 and found 46% had died from other underlying causes and the remainder from prostate cancer. Circulatory diseases, defined as ICD-9 (390-459), was the second cause of death, accounting for almost 25% of non-cancer causes. The authors found that age at diagnosis was an important factor in the type of death (prostate cancer or other cause), with the likelihood of dying from a non-cancer cause increasing with older age at diagnosis. As shown for all selected cancer cohorts in this study, circulatory deaths as well as all other non-cancer causes of death became more frequent from ages 50 onward.

An interesting observation was that the overall cumulative five-year mortality for prostate cancer decreased over time. During the first calendar period the overall five-year cumulative mortality was 62.4% and by the last calendar period, 52.2%. Because the approximate 95% confidence interval for the last calendar period did not overlap with those of the first two calendar periods, it is suggested that a true decrease in the overall five-year cumulative mortality may have occurred. It is unlikely that prostate specific antigen (PSA) screening contributed to this decrease since PSA was not used extensively before 1990 (Le, Marrett, Robson, Semenciw, Turner and Walter, 1995; National Cancer Institute of Canada, 1998). Research by Meyer, Moore, Bairati and Fradet (1999) examined prostate cancer mortality in Quebec and Canada between 1976 and 1997 and found that prostate cancer mortality only started to decline in 1991, followed by a more substantial decline from 1996 to 1997. They also concluded that the reduction in prostate cancer mortality was likely not the result of PSA screening since it had only been widespread since 1990, but was a consequence of better prostate cancer management or improved treatment. A possible explanation in this study is that this observation was the result of an increase in early-stage prostate cancer detection either through routine examination or transurethral resection of the prostate (TURP) resulting in potentially longer survival (Potosky, Kessler, Gridley, Brown and Horm, 1990; Levy, Gibbons, Collins, Perkins and Mao, 1993). In fact, Canadian data revealed an increase in prostate cancer survival between 1970 and 1980 possibly as the result of earlier detection (National Cancer Institute of Canada, 1991).

For all selected cancers, the proportion of non-cancer causes of death tended to be more common among men and women diagnosed with cancer from age 50 and older. Non-cancer causes of death were barely noticeable in patients who died at younger ages. This is likely due to the fact that as persons become older, other chronic illnesses or diseases become more prevalent. Satariano and Ragland (1994) examined the effects of comorbidity and three-year survival in

936 breast cancer patients aged 40 to 84 and found that the prevalence of comorbidity increased with age and that the number of comorbid conditions was inversely related with the risk of breast cancer death. Swanson and Lin (1994) examined breast cancer survival among those women diagnosed at age 20 and older using SEER data and showed that both black and white women diagnosed at 80 years of age and older were significantly ($p < .05$) more likely to die from other causes of death and that women diagnosed at 20 to 29 years and 30 to 39 years of age were more likely to die of breast cancer than any of the older age groups.

Although the prevalence of comorbidity generally increases with age and may help to explain the variation in proportions of cancer and non-cancer causes of death by age-group, it is also possible that patients who presented with cancer at younger ages may have had more aggressive forms of the disease compared to persons diagnosed at older ages, therefore increasing the probability of dying from the original cancer diagnosis.

5.2.3 Standardized mortality ratios

The main finding in this study was that for most selected cancer cohorts, a signifcantly increased risk of mortality for circulatory, respiratory and digestive diseases was shown. Deaths from digestive diseases for both prostate cancer and female lung cancer cases were not signficantly increased. The 95% confidence interval was particularly wide for the female lung cancer cases (0.96-

6.95), suggesting that the data were compatible with an increased risk but that sample size was not sufficient enough to exclude chance as a likely explanation. Although this SMR did not reach statistical significance it is not an indication that deaths from digestive diseases are not worthy of further investigation among female lung cancer cases. This cause of death should continue to be studied but in an investigation where there is adequate sample size. With respect to prostate cancer cases, because the width of the 95% confidence interval was much narrower (0.89-1.73), this is more supportive evidence to suggest that there was no true increased risk of death from digestive diseases.

Among males and females diagnosed with lung cancer, the SMR was highest for respiratory diseases, with values of 4.07 (95% CI 3.28-4.99) and 4.82 (95% CI 2.69-7.95), respectively. Equally interesting was that among males and females diagnosed with colorectal cancer, the SMR was highest for digestive diseases, with values of 1.97 (95% CI 1.36-2.77) and 2.36 (95% CI 1.65-3.29), respectively. It is uncertain whether the increased mortality shown by the SMRs was real or a reflection of death certificate coding practices. It is evident that the same organ systems are affected in each case (e.g. colorectal cancer and digestive diseases) and are perhaps made vulnerable to diseases of those systems, whether it is from the spread of cancer or from treatment measures. However, it is unknown whether the recorded cause of death was independent of the cancer or was actually a complication of the cancer but recorded as a non-cancer cause of death.

Mannino, Ford, Giovino and Thun (1998) examined how often lung cancer was recorded as the underlying cause of death when mentioned anywhere on the death certificate using multiple cause of death files compiled by the National Center for Health Statistics in the United States. Almost 92% had lung cancer listed as the underlying cause of death. However, in cases where it was not recorded as the underlying cause, it was suggested that there may have been a combination of factors responsible such as cancer remission, the number of other chronic conditions the individual may have had listed or a factor of how the death certificate was completed. Koch et al. (1987) showed that among women diagnosed with breast cancer but having died from a non-cancer cause, 64% of the cases were considered free of breast cancer at the time of death but with no certitude of cure since almost 54% died within the first 10 years after diagnosis.

That there was an increased risk of mortality from circulatory diseases among the breast cancer patients in this study, is consistent with two other studies (Rutqvist, 1984; Koch et al., 1987). In fact, in Rutqvist's study, breast cancer patients had an SMR of 1.20 (95% CI 1.10-1.31) for circulatory diseases, whereas in this study an SMR of 1.38 (95%CI 1.25-1.51) was shown. An increased risk of mortality from respiratory (SMR=1.86) and digestive diseases (SMR=1.56) was also evident among breast cancer patients. The reasons for this increase are not completely known, but this may be a reflection of how cancer in the breast affects other organs in the body. For example, breast cancer is known to spread to the lungs (Houten and Reilley, 1980). Further investigation is warranted, as the observed number of deaths was almost double the expected number.

Among prostate cancer patients a significantly increased risk of mortality from circulatory and respiratory diseases was shown. Circulatory deaths have been noted as a substantial contributor to mortality among men with this cancer (Satariano et al., 1998); however, the interaction between cardiovascular disease and prostate cancer is not entirely understood.

In summary, several interesting SMRs were observed among the selected cancer cohorts. What seems apparent, is that the increased risk of mortality from these causes provides some indication that the general health of cancer patients is an area of reseach that may require further investigation. These findings also inspire further examination into cause of death coding, particularly when deaths are from non-cancer causes.

5.3 Strengths and limitations

The following section describes the strengths and limitations of this research.

5.3.1 Strengths

Cancer-specific mortality statistics provide important information about the lethality of cancer as well as progress made against the disease. However, these statistics do not capture the non-cancer causes of death among cancer patients. This study provided information on all causes of death using ICD-8 and ICD-9 broad disease groupings among a well-defined population of almost thirty thousand cancer patients diagnosed with malignant neoplasms in Nova Scotia and who died during a 20 year period. The cumulative five-year cause-specific mortality permitted an examination of the causes of death among four cancer sites, stratified according to calendar period of diagnosis, age, sex, and five years of follow-up time. Although it may not be surprising that deaths from circulatory and respiratory diseases were the most prominent non-cancer causes of death, mainly among persons sixty years of age and older, this information is typically not obtained by cancer mortality statistics. This study has also provided some indication that certain cancer patients may be at an increased risk of death from non-cancer causes and thus provides a stepping stone for further research, perhaps in other Canadian provinces.

5.3.2 Limitations

There are several limitations to this study including the use of death certifcates, methodological limitations of the SMR, missing patient information and the study population. These limitations are discussed in the following.

5.3.2.1 Use of death certificates

Underlying cause of death as recorded on the death certificate, was linked with cancer registry records in this study. Death certificates are the most common sources of information for the underlying causes of death among populations.

However, the responsibility of completing the death certificate belongs almost always to the physician. His or her ability to correctly certify the underlying cause of death is a major determining factor of accuracy and completeness of the death certificate (Jordan and Bass, 1993). The certifier is also expected to list the causes (immediate, antecedent and underlying cause), in an order that reflects a logical sequence of events causing death (Kircher and Anderson, 1987; Wilkins et al., 1997). Where information on the death certificate does not comply with the standard, W.H.O. sets rules which govern the selection of the underlying cause from the information recorded on the death certificate (World Health Organization, 1977).

Although we could not examine whether the death certificate was completed according to W.H.O. standards, there was some evidence of inaccurate death certificate coding. The first and most simple example was shown among the patient exclusions, whereby 13 male cancer cases were assigned female underlying causes of death (female breast cancer and other and unspecified female genital organ cancer). Errors in death certificate completion have been discussed by Kircher and Anderson (1987) and Jordan and Bass (1993). One of the comments discussed and investigated by these researchers was that many physicians tended not to distinguish between the mechanism and cause of death. For example, congestive heart failure (a mechanism) is considered vague in description and is only acceptable when accompanied and explained by a specific underlying cause of death such as coronary artery disease. Jordan and

Bass examined the types and frequency of errors in death certificate completion and found that the recording of a mechanism of death without an explanation occurred in 9.9% of the 426 death certificates sampled. This type of error varied among the different medical departments. The department of oncology had the second highest ranking of acceptable death certificate completion. If mechanisms such as cardiac arrest, respiratory failure and heart failure are unaccompanied by an underlying cause of death they are considered errors in death certificate completion because they are usually the result of some underlying condition. This type of error in this study was not quantified; however, mechanisms, such as those mentioned above, were listed as underlying causes of death.

Important reasons for inaccurate death certificate completion include a lack of knowledge surrounding the circumstances leading up to death, a lack of training in death certificate completion, incorrect selection of the underlying cause of death when there are a number of diseases or conditions involved (especially among older persons who may have a variety of illnesses) and diagnostic or coding errors (Percy, Stanek and Gloeckler, 1981; Kircher and Anderson, 1987; Moriyama, 1989; Flanders, 1992; Jordan and Bass, 1993; James and Bull, 1996; Messite and Stellman, 1996). Ill-defined causes assigned as the underlying cause of death may result from some of these factors. However, this disease grouping is usually selected as the underlying cause of death when it is the only cause reported on the death certificate (Israel, Rosenberg and Curtin, 1986).

Important consequences of reporting ill-defined underlying causes of death include misclassification of the specific site or malignancy (in the case of a cancer death) and misclassification of the pathologies causing death in the elderly (Percy et al., 1981; Kohn, 1982).

Ill-defined causes recorded as the underlying cause of death were present in this study. Suggested examples (D'Amico, Agozzino, Biagino, Simonetti and Marinelli, 1999) included ICD-9 159–159.9 (malignant neoplasm of other and ill-defined sites within the GI/peritoneum; ICD-9 179 (malignant neoplasm of uterus, part unspecified); ICD-9 195-195.8 (malignant neoplasm of other and ill-defined sites); ICD-9 199-199.1 (malignant neoplasm without specification of site); ICD-9 208 (leukemia of unspecified cell type); ICD-9 427.9 (cardiac dysrhythmia, not otherwise specified); and ICD-9 780-796 (symptoms, signs and ill-defined conditions). The highest proportion of deaths falling into any one of these categories was for malignant neoplasm without specification of site (ICD-9 199-199.1); 490 deaths were listed in this category. Although this may be considered an ill-defined cause, it is important to note that for this category the type of cancer that has caused death is a disseminated cancer; designating a more precise cancer site as the underlying cause of death may not be possible if a history of cancer is unknown.

The degree to which death certificates were completed accurately is not entirely known nor was it an objective of this study. Since death certificates were the only source of obtaining the underlying cause of death, acknowledging the inherent errors associated with them and their possible influence on study results is important. Ill-defined causes of death and cancer causes of death without specification of site provide some insight into the process of death certification as well as the natural history of cancer. It may be true that the certifying physician may not completely understand the requirements of death certification or know the complete medical history of an individual, but there is also an indication that cancer is a disease that can be detected at a very late stage, having already spread througout the body.

5.3.3 Methodological issues of the standardized mortality ratio

When one wishes to compare mortality from several causes of death in a particular cohort to that of the general population, the standardized mortality ratio (SMR) is used (Breslow and Day, 1987). This method determines whether the number of deaths observed in the study population is greater or less than one might expect, had the study population developed the disease at the same rate as the general population (Hennekens and Buring, 1987). There are two advantages in using the SMR. First, only the total number of deaths is required instead of the age-specific amounts. Secondly, the SMR is less sensitive to numerical instabilities in one or two of the age-specific categories because the weights (person-years at risk) tend to minimize the variance of the weighted average of the ratios of age-specific rates for cohort and standard population (Breslow and Day, 1987).

Although there are advantages to using this summary measure, there are certain limitations. Some limitations include: the reliance of death certificate data for the underlying cause of death; the choice of the general population standard in deriving the estimated deaths; the use of a summary measure to represent all age-specific mortality ratios; and lastly, the challenge in comparing two SMRs. Reliance on death certificates and the associated errors with their usage have been discussed previously and will not be discussed in this section. Comments on the choice of the general population standard, the use of the SMR as a summary measure and the challenge in comparing SMRs are discussed below.

Crude mortality rates for the specific underlying causes of death were based on the province of Nova Scotia as opposed to the general population of Canada. Using Nova Scotia mortality rates to calculate the expected deaths instead of the Canadian national mortality rates limits the possibility of comparing the SMRs of this study with other SMRs since national population mortality rates are generally based on large, stable numbers and therefore can permit direct comparison of findings (Tsai and Wen, 1986). A second potential limitation in using Nova Scotia mortality figures concerns an underestimation of risk. Since the cancer cohorts and mortality rates derive from the same province, it is quite possible that, because of the same geographical location, similarities in risk factors and exposures may be alike, thus potentially resulting in a masking of risk. In other words, because the general population consists of exposed and non-exposed individuals, the expected number of deaths will reflect the effect of exposure resulting in an underestimate of an increased or decreased risk (Tsai and Wen, 1986; Hennekens and Buring, 1987). One way to modify this problem would be to adjust the crude mortality rates of Nova Scotia by subtracting the cancer cohort from the numerators and denominators in order for them not to be incorporated in the general population counts as was done in Baird and Sadovnick's (1988) study on the causes of death among individuals with Down syndrome.

Despite these limitations, Nova Scotia mortality rates were used because research which has examined the causes of death among cancer patients is quite rare (at least in Canada), and it was thought that as a first step, geographical comparisons would be made by comparing mortality in the cancer cohort to that of the general population of Nova Scotia. In addition, the crude mortality rates for Nova Scotia were easily computed and readily available using Orius98 software.

Although the SMR can provide information about whether a specific cohort has experienced a higher or lower mortality than expected, the SMR is considered a weighted average of the age-specific mortality ratios across calendar time and age groups (Tsai and Wen, 1986). When the SMR is calculated, it represents all the individual age-specific mortality ratios and is considered a summary measure. However, for the SMR to be representative, mortality ratios should be homogeneous across age groups (Tsai and Wen, 1986). Age-specific mortality ratios were not calculated in this study. Instead, the total number of cause-specific deaths were compared to the total number of cause-specific expected deaths within each cancer cohort. To evaluate whether the overall SMR adequately summarized the mortality experience among all age groups, the assumption of proportionality between the age-specific ratios and those of the general population would need to be tested (Kelsey, et al., 1996).

Several SMRs were calculated in this study and it is advised that comparisons not be made, whether by taking the absolute difference between two SMRs or by taking their ratio. Comparisons can be biased and lead to wrong conclusions if certain conditions are not evaluated. One condition that should be examined is whether the age-specific mortality ratios within each study population are similar across age groups. The other condition is to examine whether the age structures of the two populations are similar. If the age structure of the two populations are dissimilar, then each standardized mortality ratio is standardized to a different population and they are therefore not comparable (Hennekens and Buring, 1987). Although these two conditions are advised, both are not required (Tsai and Wen, 1986).

5.3.4 Missing information among cancer patients

5.3.4.1 Cancer staging

Staging of disease at initial diagnosis is important for patient prognosis, treatment planning as well as examining mortality (Yancik et al., 1996; Yancik and Ries, 1994). Cancer stage at the time of diagnosis was not available among these data. Had this information been made available, a further understanding of the relationship between cancer stage and underlying cause of death (cancer versus non-cancer) may have been provided. For example, prostate cancer had the highest proportion of deaths from circulatory diseases when the cumulative five-year cause-specific mortality was calculated. This high proportion may have been partly the result of men being diagnosed with less advanced cancer. In fact, research by Satariano and colleagues (1998) showed that men diagnosed with early stage prostate carcinoma were more likely to die from a non-cancer cause. In Hakulinen and Teppo's (1977) study of the causes of death among breast and intestinal cancers, extent of tumour (classified as localized or non-localized) was available and was used as a stratifying variable in the comparison of the causes of death between the cancer and general population of Finland. Non-localized breast cancer cases had higher than expected deaths from accidents, poisonings and violence (termed *violent deaths*) during the first five years of follow-up.

Results from the cumulative five-year cause-specific mortality had shown that in almost all persons diagnosed with cancer at 39 years of age and younger and who had died, the underlying cause of death was due to the original cancer diagnosis. Although stage information at diagnosis was unavailable, it is possible that the cancers selected for five-year observation were more advanced in stage.

Feldman and Welch's (1998) study of breast cancer survival in women diagnosed at thirty years of age or younger showed that most deaths occurred within the first five years after diagnosis and that 92% had died from metastatic breast cancer. Although their study population was small, consisting of only twenty-nine women, they suggested that survival is poor when breast cancer is diagnosed at younger ages probably as a result of the disease being presented at more advanced stage. Sariego, Zrada, Byrd and Matsumoto (1995) used SEER data to retrospectively examine breast cancer survival in women diagnosed at age 35 years or younger and who had undergone surgical treatment for the disease. Fifty-six per cent of the study population had either regional nodal metastases or distant metastases while the remaining forty-four per cent had localized breast cancer. The authors stated that no signficant differences between age and five- and ten-year survival were shown but that there was a significant difference between stage and five- and ten-year survival. Unfortunately, no statistical testing was performed so it is uncertain how these authors reached this conclusion. However, the fact that stage information was considered within the design of the study warrants attention and would have likely been used in this study had it been available.

5.3.4.2 Treatment regimen

The use and type of cancer treatment was unavailable for this research. Anticancer drugs are known to adversely affect various organs of the body such as the heart (Frishman et al., 1997; Wei, 1995), kidneys, bladder, lungs and nervous system, as well as interfering with blood clotting ability (Coleman, 1998; Stover and Kaner, 1996; Donati, 1994); therefore, the underlying causes of death, whether from cancer or other causes, may have been influenced by late complications of cancer treatment. However, associating a type of treatment with an underlying cause of death would be difficult due to factors such as age, the co-existence of other drug/surgical therapies, pre-existing comorbidities; these factors often dictate the type of treatment to be given (Frishman et al., 1997; Wei, 1995).

5.3.5 Study population

Exclusion of non-melanotic skin cancer (ICD-9 173) may have resulted in an underestimation of the proportions of cancer and non-cancer underlying causes of death since over ten thousand people were diagnosed with this cancer. However, the intention of this study was to include malignant neoplasms that were reported regularly as opposed to non-melanotic skin cancers which are somewhat underreported because many cases are not brought to the attention of a physician (NCIC, 1998). Additionally, patient identifiers for this cancer are generally poorer, as there are few admissions and no multiple sources of data (R. Dewar (Nova Scotia Cancer Registry), personal communication, August 1999). This makes record linkage more difficult and therefore linkage error (missed deaths or deaths incorrectly ascribed to ICD 173 patients) is more likely.

Persons diagnosed through death certificate only (DCO cases) were excluded because of the method of registration being through Vital Statistics. This exclusion resulted in a loss of 9% of cases. Unregistered cancer cases usually implies a short survival period (Mao et al., 1991). Because many cancers with short survival tend to be lethal cancers such as lung cancer or pancreatic cancer, exclusion of these cases may have resulted in an underestimation of cancer deaths.

This study covered a twenty-year mortality period during which two versions of the ICD were implemented. Advancement in medical knowledge and diagnostic technology could influence how causes of death were diagnosed and recorded, possibly resulting in an increase or decrease of specific causes.

A last consideration is that patients with more than one primary cancer were included in this study; the first cancer diagnosis (according to date order) and cause of death, if applicable, were used in the analyses. Inclusion of these patients may bias these results, perhaps by underestimating the risk for excess mortality, because their risk of mortality may be different from patients with one primary cancer. It is suggested that patients with multiple primaries may have a survival advantage due to the natural history of their tumours being different possibly as a result of immunological differences (Robinson, Rennert, Rennert and Neugut, 1993; Varty, Delrio and Boulos, 1994; Sankila and Hakulinen, 1998).

5.4 Conclusion and Future Directions

This study has attempted to contribute information about the causes of death among cancer patients using a Nova Scotian cancer cohort. Cause of death studies are often not an investigated topic in and of itself in cancer research. A reason for this lack of information is that most cancer patients will die from cancer or from complications associated with the disease. These data show that over half (54.2%) of the incident cases of cancer died from cancer, and that 13.2% died from non-cancer causes. The majority (10.5%) of non-cancer deaths were attributed to circulatory, respiratory or digestive diseases, occurring mainly in persons 50 years of age and older. Although the mortality experience of this population may not be generalizable to other jurisdictions because these data were from one province of Canada, this does not limit the potential for further study in other Canadian provinces. In fact, only one other Canadian study has reported to have investigated the non-cancer causes of death. If we are to more fully understand how cancer affects individuals, it is equally important to be aware of other risks of mortality so that they can either be prevented or detected earlier and then possibly be treated.

In this study, mortality data were limited to the underlying cause of death recorded on the death certificate. There are many limitations associated with this source of information and future studies should analyze the data by the multiple-cause approach, where all data mentioned on the death certificate would be used. Generally speaking, multiple-cause of death studies have shown that the average number of causes of death listed on death certificates is quite low when any malignant neoplasm is mentioned as the underlying cause of death. However, there may be exceptions for some cancers for which longer survival is probable and where other chronic illnesses may be prevalent. These malignancies may include male and female genital organ cancer and cancers of the urinary system (Israel et al., 1986; Mackenbach et al., 1997; Wilkins et al., 1997).

A non-cancer cause of death observed in this study that was not discussed was suicide. Forty-seven cancer patients had suicide or self-inflicted injury recorded as the underlying cause of death. In absolute terms, the number of deaths from this cause may appear minor over a twenty year mortality period, however, it is unknown whether suicide was higher than expected compared to suicide in the general population of Nova Scotia. Future cancer research may want to investigate this cause of death, perhaps using a larger data set, since an increased risk of suicide among cancer patients has been reported (Allebeck, Bolund and Ringbäck, 1989; Storm, Christensen and Jensen, 1992). Allebeck and colleagues reported an overall SMR of 1.9 (95% CI 1.8-2.1) for males and an SMR of 1.6 (95% CI 1.5-1.8) for females. Storm and colleagues reported a relative risk (RR) of suicide among men to be 1.8 (95% CI 1.6-2.1) and for women a relative risk (RR) of 1.6 (95% CI 1.3-1.9). Stomach, lung, brain and central nervous system cancers as well as the first 1 to 2 years after diagnosis appeared to be associated with an increased risk for suicide possibly as a result of advanced stage upon diagnosis or the amount of pain and other physical discomfort associated with these cancers.

Standardized mortality ratios were also calculated for selected cancer cohorts using specific causes of death. Several limitations are inherent to the SMR, namely, that it summarizes the mortality experience over all age groups. If in future this method is used to examine the causes of death in cancer patients, it is suggested that the age-specific mortality ratios be calculated to determine whether the SMR adequately describes the mortality experience of the entire cohort. It also recommended that the SMR be stratified by time since diagnosis since an increased or decreased risk for mortality may change over time. Knowing when to intervene if there is an increased risk of death from a certain cause may have important consequences for survival.

Future Canadian cancer research from other populations is needed to help substantiate whether cancer patients are at an increased risk of mortality from non-cancer causes of death. Other patient information such as cancer stage, treatment modality and comorbidity, should be incorporated to investigate how these factors may help explain the risk for other competing causes of death. Only basic patient information such as age and date at diagnosis, sex, cancer site, and underlying cause of death (if applicable) and date of death were available for analyses.

Deaths from circulatory, respiratory and digestive diseases were higher than expected (as shown from the SMRs) among prostate, colorectal, lung and breast cancers. These higher than expected ratios could suggest that cancer patients, who are usually older, are at risk for certain causes of death because they are more likely to concurrently experience other chronic ailments (Yancik et al., 1996). However, as Satariano and colleagues (1998) suggest, information on how comorbidities and cancer interrelate and what it means to have both cancer and another or possibly several comorbidity(ies) is important, especially in terms of care and treatment. Research is needed to attempt to explain the relationship between comorbidity and cancer and how it may influence cancer prognosis, quality of life and survival.

Appendix A

The National Cancer Incidence Reporting System (NCIRS) and Canadian Cancer Registry

In 1969 the National Cancer Incidence Reporting System (NCIRS) was established via the collaboration of provincial cancer registries and the National Cancer Institute of Canada (NCIC). NCIRS existed until 1991 and was changed in 1992 to the Canadian Cancer Registry (CCR). This project therefore used incidence data from the NCIRS. The goal of the CCR is to collect incidence and survival information for cancer control using a standardized, patient-oriented, updateable database. NCIRS and CCR are managed by the Health Statistics Division (HSD) at Statistics Canada (SC) whereby population-based information is compiled from each provincial and territorial cancer registry (PTCR). This information has been used in various health research applications such as trend analysis, the monitoring and evaluation of screening programs, future projections of cancer burden, potential risk factors, and survival analysis.

Cancer registration in each province is unique with respect to each registry's history and style of registration. To standardize the method of recording cancer incidence in Canada, the CCR in 1992 helped establish a standard system of reporting cases to the national level. The variables that the CCR collects are more or less a subset of the information collected by each PTCR. These include patient name, health insurance number, provincial registry identifier, birthplace, sex, date of birth, method of diagnosis, ICD-O topography and morphology, ICD-

9 code of diagnosis, reporting year, place name of residence (i.e. standard geographic code of residence), patient status, death registration number, and date of death.

Yearly incidence data, which includes basic patient and diagnostic information, are sent from the PTCR to Statistics Canada. Updates and deletions may also be sent to the CCR. As of 1992, all registries must edit their data before sending it to the CCR in accordance with the standardized layout CCR has outlined. If there are any records that have failed to be edited, CCR rejects them and returns them to the PTCR for correction and re-submission. An internal record linkage providing provincial death clearance is performed on all records in the CCR file (from 1992 onward) each year.

Appendix B

Record Linkage

...The Canadian Mortality Data Base, which is maintained by Statistics Canada, receives mortality data from provincial vital statistics registrars which are converted to a standardized format. The mortality data are linked or matched to the cancer records using a process known as the Generalized Iterative Record Linkage System (GIRLS). Record linkage is performed by a weighted probabilistic matching process where weights are assigned to each record based on rarity of names and common name misspellings through the use of the New York State Identification and Intelligence System (NYSIIS) phonetic codes. This method uses field compatibility checks to assign a final weight for each patient record. To obtain the cause of death for patients who died between 1969 and 1989, the death registration number from the Canadian Cancer Data Base (CCDB) was matched to the Canadian Mortality Data Base. If matching did not occur with the CMDB, then the analyses assumed the patient was alive up to December 31st, 1989.

Appendix C

Permission to access NCIRS cancer incidence and mortality data from the Nova Scotia Cancer Registry.

Nova Scotia Cancer Registry
Room 557 Bethune Building
1278 Tower Road
Halifax, N.S.
B3H 2Y9
ph. (902) 473-6057 fax (902) 473-4425
e-mail: crrad@qe2-hsc.ns.ca

Queen Elizabeth II
Health Sciences Centre

July 29, 1997

Ms. Martha Fair
Health Statistics Division
Statistics Canada

Dear Ms. Fair:

I have been approached by Dr. Yang Mao of Health Canada to arrange access to the NCIRS version of cancer incidence and mortality data for Nova Scotia. The data will be used by a student that he is supervising (Sharon Gushue), who intends to analyse cancer and non-cancer causes of death among former cancer patients for a Master's thesis project. The specific data fields to be made available will be negotiated by Ms. Gushue, but from my information, she will need **individual records** for all new cases diagnosed between 1969 - 1988, including all information about deaths occurring to those patients up to the end of 1989, whether in Nova Scotia or elsewhere. Personal identifying information (names) will not be required, however she will need to receive our chart number, as well as a death certificate number and province of death for those known to have died.

This is to acknowledge that The Nova Scotia Cancer Registry is aware of the request for this data, and supports Dr. Mao's access to it in accordance with the confidentiality parameters outlined in his letter to us of July 28, 1997.

Sincerely,

Maureen MacIntyre
Acting Coordinator
Nova Scotia Cancer Registry

Cc. Ron Dewar - Registry Epidemiologist
Dr. Yang Mao, LCDC

JUL 29 '97 15:31 FROM CTRF H.O. PAGE.001

Appendix D

Sample SAS program for person-years at risk calculation.

```
*This program is to calculate the number of person years
observed for each subject;
options ls = 80 ps = 60 nodate;
title 'Person years observed';
libname library '.';
libname set '.';
data peryrs;
set set.master;

*One can select the cancer type here and run the selected group
through this program;

*Setting each person-year category to 0 so that as it goes
through each individual, SAS can put the observed person years
into each specific age category.  'P' is the total number of
person years for that individual and the remaining p categories
are: p0 = 0-19 years, p20 = 20-29, p30 = 30-39, etc.;

p = 0;
p0 = 0;
p20 = 0;
p30 = 0;
p40 = 0;
p50 = 0;
p60 = 0;
p70 = 0;
p80 = 0;
p90 = 0;
p100 = 0;
p110 = 0;


*Setting up the calculations for age at diagnosis and age at
death;

agediag1 = (diagyr - birthyr) + (diagmn - birthmth)/12;
agedeath = (1900 + mdbdyear - birthyr) + (mdbdmnth -
birthmth)/12;


*Person year groups should be set up so that as the program
processes each individual, SAS can go through each interval to
see whether it is true or false and then appropriately
calculate the person-years observed for each age interval.
Total person years for each interval could then be calculated.
Each of the intervals is set to zero so that the number of
person years can be calculated for each individual;

*For those presumed alive since the study end-date is December
31st,
1989.  When the number of deaths are actually calculated, the
following will have to be turned "off" so that the number of
deaths is calculated properly;
```

```
if mdbdyear = . then agedeath = (1989 - birthyr) + (12 -
birthmth)/12;
if mdbdyear > 89 then agedeath = (1989 - birthyr) + (12 -
birthmth)/12;
if diagyr < 1984 then agediag1 = (1983 - birthyr) + (12 -
birthmth)/12;
diagyr1 = diagyr;
if diagyr < 1984 and mdbdyear > 83 then diagyr = 1984;


*This part of the program will start to set up the person-years
observed calculation for each age interval. P(n) stands for
each age interval;

if 1984 <= diagyr <= 1989 then do;

if  agediag1 < 20 then do;
if agedeath > 20 then do;
p0 = 20 - agediag1 - p;
end;
else do;
p0 = agedeath - agediag1 - p;
end;
p = p0 + p;
end;

if agediag1 < 30 then do;
if agedeath > 30 then do;
p20 = 30 - agediag1 - p;
end;
else do;
p20 = agedeath - agediag1 - p;
end;
p = p20 + p;
end;

if agediag1 < 40 then do;
if agedeath > 40 then do;
p30 = 40 - agediag1 - p;
end;
else do;
p30 = agedeath -agediag1 - p;
end;
p = p30 + p;
end;

if agediag1 < 50 then do;
if agedeath > 50 then do;
p40 = 50 - agediag1- p;
end;
else do;
p40 = agedeath - agediag1 - p;
end;
p = p40 + p;
end;

if agediag1 < 60 then do;
if agedeath > 60 then do;
p50 = 60 - agediag1 - p;
end;
else do;
p50 = agedeath - agediag1 - p;
end;
```

```
p = p50 + p;
end;

if agediag1 < 70 then do;
if agedeath > 70 then do;
p60 = 70 - agediag1 - p;
end;
else do;
p60 = agedeath - agediag1 - p;
end;
p = p60 + p;
end;

if agediag1 < 80 then do;
if agedeath > 80 then do;
p70 = 80 - agediag1 - p;
end;
else do;
p70 = agedeath - agediag1 - p;
end;
p = p70 + p;
end;

if agediag1 < 90 then do;
if agedeath > 90 then do;
p80 = 90 - agediag1 - p;
end;
else do;
p80 = agedeath - agediag1 - p;
end;
p = p80 + p;
end;

if agediag1 < 100 then do;
if agedeath > 100 then do;
p90 = 100 - agediag1 - p;
end;
else do;
p90 = agedeath - agediag1 - p;
end;
p = p90 + p;
end;

if agediag1 < 110 then do;
if agedeath > 110 then do;
p100 = 110 - agediag1 - p;
end;
else do;
p100 = agedeath - agediag1 - p;
end;
p = p100 + p;
end;
end;

*Using the proc means command, we can use the <sum> option that
will give us the sum of person years at risk for each age
group;

proc means maxdec = 2 n mean sum;
var p p0 p20 p30 p40 p50 p60 p70 p80 p90 p100 p110;
run;
```

Appendix E

Calculations for the expected number of deaths.

Table E1. Standardized mortality ratio for circulatory diseases among male lung cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Circulatory diseases mortality rates for Nova Scotia males (per 100,000)	Expected deaths: due to circulatory diseases
1969-1973:		1971	
0-19	0.75	2.38	0.00
20-29	2.08	9.04	0.00
30-39	6.33	41.57	0.00
40-49	44.75	207.06	0.09
50-59	177.83	630.13	1.12
60-69	194.67	1650.03	3.21
70-79	117.58	4043.34	4.75
80-85+	50.59	10232.69	5.18
1974-1978:		1976	
0-19	0.00	4.25	0.00
20-29	2.92	6.74	0.00
30-39	3.00	38.88	0.00
40-49	65.92	159.35	0.11
50-59	281.92	609.48	1.72
60-69	525.58	1494.71	7.86
70-79	269.33	3655.64	9.85
80-85+	66.00	10212.54	6.74
	66.67		
1979-1983:		1981	
0-19	0.67	7.59	0.00
20-29	5.67	2.62	0.00
30-39	7.08	21.83	0.00
40-49	65.08	158.99	0.10
50-59	315.67	502.76	1.59
60-69	577.67	1223.87	7.07
70-79	432.42	3267.15	14.13
80-85+	86.84	9154.97	7.95
1984-1989:		1986	
0-19	2.25	8.07	0.00
20-29	0.00	3.56	0.00
30-39	12.92	25.70	0.00
40-49	60.92	114.07	0.07
50-59	361.33	474.44	1.71
60-69	867.17	1066.16	9.25
70-79	659.67	3119.79	20.58
80-85+	187.08	7266.50	13.59
		Total expected deaths:	116.67

SMR = observed/expected
= 224/116.67
= 1.92

95% CI (1.62-2.19)

Table E2. Standardized mortality ratio for circulatory diseases among female lung cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Circulatory diseases mortality rates for Nova Scotia females (per 100,000)	Expected deaths: due to circulatory diseases
1969-1973:		1971	
0-19	0.00	0.51	0.00
20-29	0.00	3.82	0.00
30-39	2.25	28.88	0.00
40-49	6.17	58.09	0.00
50-59	35.92	178.69	0.06
60-69	36.67	702.13	0.26
70-79	29.33	2228.18	0.65
80-85+	11.33	8854.56	1.00
1974-1978:		1976	
0-19	0.00	0.95	0.00
20-29	0.00	5.40	0.00
30-39	1.92	8.77	0.00
40-49	37.42	54.48	0.02
50-59	79.92	208.56	0.17
60-69	117.33	608.20	0.71
70-79	85.25	2252.91	1.92
80-85+	24.50	8309.07	2.04
1979-1983:		1981	
0-19	0.42	0.62	0.00
20-29	1.83	2.74	0.00
30-39	16.92	18.60	0.00
40-49	36.58	26.88	0.01
50-59	137.58	153.59	0.21
60-69	202.33	554.62	1.12
70-79	124.50	1799.94	2.24
80-85+	24.16	6828.30	1.65
1984-1989:		1986	
0-19	0.00	0.84	0.00
20-29	2.83	4.86	0.00
30-39	13.00	8.68	0.00
40-49	68.25	40.99	0.03
50-59	199.33	108.39	0.22
60-69	263.92	399.23	1.05
70-79	245.08	1605.46	3.93
80-85+	68.58	6288.65	4.31
		Total expected deaths:	21.60

SMR = observed/expected
= 45/21.60
= 2.08

95% CI (1.47-2.79)

Table E3. Standardized mortality ratio for respiratory diseases among male lung cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Respiratory diseases mortality rates for Nova Scotia males (per 100,000)	Expected deaths: due to respiratory diseases
1969-1973:		1971	
0-19	0.75	58.02	0.00
20-29	2.08	0.00	0.00
30-39	6.33	7.02	0.00
40-49	44.75	31.65	0.01
50-59	177.83	72.33	0.13
60-69	194.67	208.24	0.41
70-79	117.58	531.95	0.63
80-85+	50.59	1210.23	0.61
1974-1978:		1976	
0-19	0.00	18.15	0.00
20-29	2.92	2.80	0.00
30-39	3.00	2.23	0.00
40-49	65.92	9.87	0.01
50-59	281.92	62.54	0.18
60-69	525.58	234.62	1.23
70-79	269.33	563.44	1.52
80-85+	66.67	1851.13	1.23
1979-1983:		1981	
0-19	0.67	4.95	0.00
20-29	5.67	0.00	0.00
30-39	7.08	4.34	0.00
40-49	65.08	11.99	0.01
50-59	315.67	52.59	0.17
60-69	577.67	234.93	1.36
70-79	432.42	724.65	3.13
80-85+	86.84	1832.82	1.59
1984-1989:		1986	
0-19	2.25	1.34	0.00
20-29	0.00	3.56	0.00
30-39	12.92	2.81	0.00
40-49	60.92	8.25	0.01
50-59	361.33	46.76	0.17
60-69	867.17	174.79	1.52
70-79	659.67	669.73	4.42
80-85+	187.08	2392.75	4.48
		Total expected deaths:	22.82

SMR = observed/expected
= 93/22.82
= 4.07

95% CI (3.18-4.99)

Table E4. Standardized mortality ratio for respiratory diseases among female lung cancer patients, Nova Scotia, 1969-1989

Age group	Person-years at risk	Respiratory diseases mortality rates for Nova Scotia females (per 100,000)	Expected deaths: due to respiratory diseases
1969-1973:		1971	
0-19	0.00	47.48	0.00
20-29	0.00	0.00	0.00
30-39	2.25	4.76	0.00
40-49	6.17	2.38	0.00
50-59	35.92	23.28	0.01
60-69	36.67	40.47	0.01
70-79	29.33	162.76	0.05
80-85+	11.33	799.67	0.09
1974-1978:		1976	
0-19	0.00	15.26	0.00
20-29	0.00	1.31	0.00
30-39	1.92	6.90	0.00
40-49	37.42	17.25	0.01
50-59	79.92	34.39	0.03
60-69	117.33	68.65	0.08
70-79	85.25	163.51	0.14
80-85+	24.50	1024.46	0.25
1979-1983:		1981	
0-19	0.42	3.91	0.00
20-29	1.83	2.62	0.00
30-39	16.92	6.69	0.00
40-49	36.58	12.01	0.00
50-59	137.58	29.73	0.04
60-69	202.33	89.43	0.18
70-79	124.50	214.35	0.27
80-85+	24.16	837.01	0.20
1984-1989:		1986	
0-19	0.00	1.22	0.00
20-29	2.83	0.00	0.00
30-39	13.00	2.93	0.00
40-49	68.25	7.96	0.01
50-59199.33	32.74	0.07	
60-69	263.92	78.43	0.21
70-79	245.08	279.34	0.68
80-85+	68.58	1133.00	0.78
		Total expected deaths:	3.11

SMR = observed/expected
= 15/3.11
= 4.82

95% CI (2.66-7.95)

Table E5. Standardized mortality ratio for digestive diseases among male lung cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Digestive diseases mortality rates for Nova Scotia males (per 100,000)	Expected deaths: due to digestive diseases
1969-1973:		1971	
0-19	0.75	4.42	0.00
20-29	2.08	0.00	0.00
30-39	6.33	9.25	0.00
40-49	44.75	31.72	0.01
50-59	177.83	59.28	0.11
60-69	194.67	66.36	0.13
70-79	117.58	179.87	0.21
80-85+	50.59	316.91	0.16
1974-1978:		1976	
0-19	0.00	0.00	0.00
20-29	2.92	2.67	0.00
30-39	3.00	8.49	0.00
40-49	65.92	32.01	0.02
50-59	281.92	51.87	0.15
60-69	525.58	84.20	0.44
70-79	269.33	207.29	0.56
80-85+	66.67	307.05	0.20
1979-1983:		1981	
0-19	0.67	3.80	0.00
20-29	5.67	1.40	0.00
30-39	7.08	6.92	0.00
40-49	65.08	25.83	0.02
50-59	315.67	44.81	0.14
60-69	577.67	93.77	0.54
70-79	432.42	225.93	0.98
80-85+	86.84	551.16	0.48
1984-1989:		1986	
0-19	2.25	0.00	0.00
20-29	0.00	2.27	0.00
30-39	12.92	5.81	0.00
40-49	60.92	10.53	0.01
50-59	361.33	31.66	0.11
60-69	867.17	85.88	0.74
70-79	659.67	279.19	1.84
80-85+	187.08	461.86	0.86
		Total expected deaths:	7.71

SMR = observed/expected
= 28/7.71
= 3.63

95% CI (2.35-5.25)

Table E6. Standardized mortality ratio for digestive diseases among female lung cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Digestive diseases mortality rates for Nova Scotia females (per 100,000)	Expected deaths: due to digestive diseases
1969-1973:		1971	
0-19	0.00	9.19	0.00
20-29	0.00	3.36	0.00
30-39	2.25	9.53	0.00
40-49	6.17	21.62	0.00
50-59	35.92	28.15	0.01
60-69	36.67	59.05	0.02
70-79	29.33	85.08	0.02
80-85+	11.33	307.79	0.03
1974-1978:		1976	
0-19	0.00	0.77	0.00
20-29	0.00	1.31	0.00
30-39	1.92	4.60	0.00
40-49	37.42	19.78	0.01
50-59	79.92	19.54	0.02
60-69	117.33	50.11	0.06
70-79	85.25	122.23	0.10
80-85+	24.50	269.10	0.07
1979-1983:		1981	
0-19	0.42	3.80	0.00
20-29	1.83	1.40	0.00
30-39	16.92	6.92	0.00
40-49	36.58	25.83	0.01
50-59	137.58	44.81	0.06
60-69	202.33	93.77	0.19
70-79	124.50	119.01	0.15
80-85+	24.16	486.11	0.12
1984-1989:		1986	
0-19	0.00	3.39	0.00
20-29	2.83	1.25	0.00
30-39	13.00	0.00	0.00
40-49	68.25	10.72	0.01
50-59	199.33	12.63	0.03
60-69	263.92	44.29	0.12
70-79	245.08	129.06	0.32
80-85+	68.58	474.06	0.33
		Total expected deaths:	1.68

SMR = observed/expected
= 5/1.68
= 2.98

95% CI (0.96-6.95)

Table E7. Standardized mortality ratio for circulatory diseases among male colorectal cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Circulatory diseases mortality rates for Nova Scotia males (per 100,000)	Expected deaths: due to circulatory diseases
1969-1973:		1971	
0-19	1.67	2.38	0.00
20-29	1.75	9.04	0.00
30-39	16.92	41.57	0.01
40-49	48.42	207.06	0.10
50-59	210.75	630.13	1.33
60-69	357.50	1650.03	5.90
70-79	321.25	4043.34	12.99
80-85+	129.00	10232.69	13.20
1974-1978:		1976	
0-19	2.67	4.25	0.00
20-29	13.58	6.74	0.00
30-39	28.08	38.88	0.01
40-49	69.42	159.35	0.11
50-59	328.58	609.48	2.00
60-69	667.33	1494.71	9.97
70-79	607.17	3655.64	22.20
80-85+	330.34	10212.54	33.74
1979-1983:		1981	
0-19	5.67	7.59	0.00
20-29	8.67	2.62	0.00
30-39	43.42	21.83	0.01
40-49	73.25	158.99	0.12
50-59	302.00	502.76	1.52
60-69	719.92	1223.87	8.81
70-79	911.17	3267.15	29.77
80-85+	418.25	9154.97	38.29
1984-1989:		1986	
0-19	0.00	8.07	0.00
20-29	2.83	3.56	0.00
30-39	43.83	25.70	0.01
40-49	138.50	114.07	0.16
50-59	428.17	474.44	2.03
60-69	1026.83	1066.16	10.95
70-79	1192.17	3119.79	37.19
80-85+	601.83	7266.50	43.73
		Total expected deaths:	274.15

SMR = observed/expected
= 383/274.15
= 1.40

95% CI (1.22-1.54)

Table E8. Standardized mortality ratio for circulatory diseases among female colorectal cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Circulatory diseases mortality rates for Nova Scotia females (per 100,000)	Expected deaths: due to circulatory diseases
1969-1973:		1971	
0-19	0.00	0.51	0.00
20-29	4.33	3.82	0.00
30-39	21.08	28.88	0.01
40-49	89.25	58.09	0.05
50-59	225.17	178.69	0.40
60-69	305.83	702.13	2.15
70-79	383.67	2228.18	8.55
80-85+	160.25	8854.56	14.19
1974-1978:		1976	
0-19	3.17	0.95	0.00
20-29	9.58	5.40	0.00
30-39	32.83	8.77	0.00
40-49	97.75	54.48	0.05
50-59	327.58	208.56	0.68
60-69	603.83	608.20	3.67
70-79	617.25	2252.91	13.91
80-85+	424.16	8309.07	35.24
1979-1983:		1981	
0-19	5.58	0.62	0.00
20-29	2.50	2.74	0.00
30-39	43.83	18.60	0.01
40-49	102.33	26.88	0.03
50-59	327.75	153.59	0.50
60-69	691.08	554.62	3.83
70-79	724.08	1799.94	13.03
80-85+	728.08	6828.30	49.72
1984-1989:		1986	
0-19	3.83	0.84	0.00
20-29	7.92	4.86	0.00
30-39	39.17	8.68	0.00
40-49	138.25	40.99	0.06
50-59	376.83	108.39	0.41
60-69	649.83	399.23	2.59
70-79	1071.50	1605.46	17.20
80-85+	948.83	6288.65	59.67
		Total expected deaths:	225.96

SMR = observed/expected
= 266/225.96
= 1.18

95% CI (1.01-1.33)

Table E9. Standardized mortality ratio for respiratory diseases among male colorectal cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Respiratory diseases mortality rates for Nova Scotia males (per 100,000)	Expected deaths: due to respiratory diseases
1969-1973:		1971	
0-19	1.67	58.02	0.00
20-29	1.75	0.00	0.00
30-39	16.92	7.02	0.00
40-49	48.42	31.65	0.02
50-59	210.75	72.33	0.15
60-69	357.50	208.24	0.74
70-79	321.25	531.95	1.71
80-85+	129.00	1210.23	1.56
1974-1978:		1976	
0-19	2.67	18.15	0.00
20-29	13.58	2.80	0.00
30-39	28.08	2.23	0.00
40-49	69.42	9.87	0.01
50-59	328.58	62.54	0.21
60-69	667.33	234.62	1.57
70-79	607.17	563.44	3.42
80-85+	330.34	1851.13	6.12
1979-1983:		1981	
0-19	5.67	4.95	0.00
20-29	8.67	0.00	0.00
30-39	43.42	4.34	0.00
40-49	73.25	11.99	0.01
50-59	302.00	52.59	0.16
60-69	719.92	234.93	1.69
70-79	911.17	724.65	6.60
80-85+	418.25	1832.82	7.67
1984-1989:		1986	
0-19	0.00	1.34	0.00
20-29	2.83	3.56	0.00
30-39	43.83	2.81	0.00
40-49	138.50	8.25	0.01
50-59	428.17	46.76	0.20
60-69	1026.83	174.79	1.79
70-79	1192.17	669.73	7.98
80-85+	601.83	2392.75	14.40
		Total expected deaths:	56.02

SMR = observed/expected
= 86/56.02
= 1.53

95% CI (1.18-1.89)

Table E10. Standardized mortality ratio for respiratory diseases among female colorectal cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Respiratory diseases mortality rates for Nova Scotia females (per 100,000)	Expected deaths: due to respiratory diseases
1969-1973:		1971	
0-19	0.00	47.48	0.00
20-29	4.33	0.00	0.00
30-39	21.08	4.76	0.00
40-49	89.25	2.38	0.00
50-59	225.17	23.28	0.05
60-69	305.83	40.47	0.12
70-79	383.67	162.76	0.62
80-85+	160.25	799.67	1.28
1974-1978:		1976	
0-19	3.17	15.26	0.00
20-29	9.58	1.31	0.00
30-39	32.83	6.90	0.00
40-49	97.75	17.25	0.02
50-59	327.58	34.39	0.11
60-69	603.83	68.65	0.41
70-79	617.25	163.51	1.01
80-85+	424.16	1024.46	4.35
1979-1983:		1981	
0-19	5.58	3.91	0.00
20-29	2.50	2.62	0.00
30-39	43.83	6.69	0.00
40-49	102.33	12.01	0.01
50-59	327.75	29.73	0.10
60-69	691.08	89.43	0.62
70-79	724.08	214.35	1.55
80-85+	728.08	837.01	6.09
1984-1989:		1986	
0-19	3.83	1.22	0.00
20-29	7.92	0.00	0.00
30-39	39.17	2.93	0.00
40-49	138.25	7.96	0.01
50-59	376.83	32.74	0.12
60-69	649.83	78.43	0.51
70-79	1071.50	279.34	2.99
80-85+	948.83	1133.00	10.75
		Total expected deaths:	30.75

SMR = observed/expected
= 45/30.75
= 1.46

95% CI (1.03-1.96)

Table E11. Standardized mortality ratio for digestive diseases among male colorectal cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Digestive diseases mortality rates for Nova Scotia males (per 100,000)	Expected deaths: due to digestive diseases
1969-1973:		1971	
0-19	1.67	4.42	0.00
20-29	1.75	0.00	0.00
30-39	16.92	9.25	0.00
40-49	48.42	31.72	0.02
50-59	210.75	59.28	0.12
60-69	357.50	66.36	0.24
70-79	321.25	179.87	0.58
80-85+	129.00	316.91	0.41
1974-1978:		1976	
0-19	2.67	0.00	0.00
20-29	13.58	2.67	0.00
30-39	28.08	8.49	0.00
40-49	69.42	32.01	0.02
50-59	328.58	51.87	0.17
60-69	667.33	84.20	0.56
70-79	607.17	207.29	1.26
80-85+	330.34	307.05	1.01
1979-1983:		1981	
0-19	5.67	3.80	0.00
20-29	8.67	1.40	0.00
30-39	43.42	6.92	0.00
40-49	73.25	25.83	0.02
50-59	302.00	44.81	0.14
60-69	719.92	93.77	0.68
70-79	911.17	225.93	2.06
80-85+	418.25	551.16	2.31
1984-1989:		1986	
0-19	0.00	0.00	0.00
20-29	2.83	2.27	0.00
30-39	43.83	5.81	0.00
40-49	138.50	10.53	0.01
50-59	428.17	31.66	0.14
60-69	1026.83	85.88	0.88
70-79	1192.17	279.19	3.33
80-85+	601.83	461.86	2.78
		Total expected deaths:	16.74

SMR = observed/expected
= 33/16.74
= 1.97

95% CI (1.32-2.77)

Table E12. Standardized mortality ratio for digestive diseases among female colorectal cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Digestive diseases mortality rates for Nova Scotia females (per 100,000)	Expected deaths: due to digestive diseases
1969-1973:		1971	
0-19	0.00	9.19	0.00
20-29	4.33	3.36	0.00
30-39	21.08	9.53	0.00
40-49	89.25	21.62	0.02
50-59	225.17	28.15	0.06
60-69	305.83	59.05	0.18
70-79	383.67	85.08	0.33
80-85+	160.25	307.79	0.49
1974-1978:		1976	
0-19	3.17	0.77	0.00
20-29	9.58	1.31	0.00
30-39	32.83	4.60	0.00
40-49	97.75	19.78	0.02
50-59	327.58	19.54	0.06
60-69	603.83	50.11	0.30
70-79	617.25	122.23	0.75
80-85+	424.16	269.10	1.14
1979-1983:		1981	
0-19	5.58	3.80	0.00
20-29	2.50	1.40	0.00
30-39	43.83	6.92	0.00
40-49	102.33	25.83	0.03
50-59	327.75	44.81	0.15
60-69	691.08	93.77	0.65
70-79	724.08	119.01	0.86
80-85+	728.08	486.11	3.54
1984-1989:		1986	
0-19	3.83	3.39	0.00
20-29	7.92	1.25	0.00
30-39	39.17	0.00	0.00
40-49	138.25	10.72	0.01
50-59	376.83	12.63	0.05
60-69	649.83	44.29	0.29
70-79	1071.50	129.06	1.38
80-85+	948.83	474.06	4.50
		Total expected deaths:	14.81

SMR = observed/expected
= 35/14.81
= 2.36

95% CI (1.60-3.29)

Table E13. Standardized mortality ratio for circulatory diseases among male prostate cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Circulatory diseases mortality rates for Nova Scotia males (per 100,000)	Expected deaths: due to circulatory diseases
1969-1973:		1971	
0-19	0.00	2.38	0.00
20-29	0.00	9.04	0.00
30-39	0.00	41.57	0.00
40-49	2.92	207.06	0.01
50-59	67.67	630.13	0.43
60-69	352.58	1650.03	5.82
70-79	491.00	4043.34	19.85
80-85+	368.75	10232.69	37.73
1974-1978:		1976	
0-19	0.00	4.25	0.00
20-29	0.00	6.74	0.00
30-39	0.00	38.88	0.00
40-49	2.25	159.35	0.00
50-59	122.67	609.48	0.75
60-69	622.42	1494.71	9.30
70-79	1105.92	3655.64	40.43
80-85+	722.08	10212.54	73.74
1979-1983:		1981	
0-19	0.00	7.59	0.00
20-29	0.00	2.62	0.00
30-39	0.08	21.83	0.00
40-49	1.75	158.99	0.00
50-59	144.67	502.76	0.73
60-69	714.25	1223.87	8.74
70-79	1363.75	3267.15	44.56
80-85+	1009.42	9154.97	92.41
1984-1989:		1986	
0-19	0.00	8.07	0.00
20-29	0.00	3.56	0.00
30-39	1.67	25.70	0.00
40-49	8.58	114.07	0.01
50-59	205.17	474.44	0.97
60-69	964.08	1066.16	10.28
70-79	2034.08	3119.79	63.46
80-85+	1325.91	7266.50	96.35
		Total expected deaths:	505.57

SMR = observed/expected
= 678/505.57
= 1.34

95% CI (1.20-1.44)

Table E14. Standardized mortality ratio for respiratory diseases among male prostate cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Respiratory diseases mortality rates for Nova Scotia males (per 100,000)	Expected deaths: due to respiratory diseases
1969-1973:		1971	
0-19	0.00	58.02	0.00
20-29	0.00	0.00	0.00
30-39	0.00	7.02	0.00
40-49	2.92	31.65	0.00
50-59	67.67	72.33	0.05
60-69	352.58	208.24	0.73
70-79	491.00	531.95	2.61
80-85+	368.75	1210.23	4.46
1974-1978:		1976	
0-19	0.00	18.15	0.00
20-29	0.00	2.80	0.00
30-39	0.00	2.23	0.00
40-49	2.25	9.87	0.00
50-59	122.67	62.54	0.08
60-69	622.42	234.62	1.46
70-79	1105.92	563.44	6.23
80-85+	722.08	1851.13	13.37
1979-1983:		1981	
0-19	0.00	4.95	0.00
20-29	0.00	0.00	0.00
30-39	0.08	4.34	0.00
40-49	1.75	11.99	0.00
50-59	144.67	52.59	0.08
60-69	714.25	234.93	1.68
70-79	1363.75	724.65	9.88
80-85+	1009.42	1832.82	18.50
1984-1989:		1986	
0-19	0.00	1.34	0.00
20-29	0.00	3.56	0.00
30-39	1.67	2.81	0.00
40-49	8.58	8.25	0.00
50-59	205.17	46.76	0.10
60-69	964.08	174.79	1.69
70-79	2034.08	669.73	13.62
80-85+	1325.91	2392.75	31.73
		Total expected deaths:	106.27

SMR = observed/expected
= 160/106.27
= 1.51

95% CI (1.24-1.75)

Table E15. Standardized mortality ratio for digestive diseases among male prostate cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Digestive diseases mortality rates for Nova Scotia males (per 100,000)	Expected deaths: due to digestive diseases
1969-1973:		1971	
0-19	0.00	4.42	0.00
20-29	0.00	0.00	0.00
30-39	0.00	9.25	0.00
40-49	2.92	31.72	0.00
50-59	67.67	59.28	0.04
60-69	352.58	66.36	0.23
70-79	491.00	179.87	0.88
80-85+	368.75	316.91	1.17
1974-1978:		1976	
0-19	0.00	0.00	0.00
20-29	0.00	2.67	0.00
30-39	0.00	8.49	0.00
40-49	2.25	32.01	0.00
50-59	122.67	51.87	0.06
60-69	622.42	84.20	0.52
70-79	1105.92	207.29	2.29
80-85+	722.08	307.05	2.22
1979-1983:		1981	
0-19	0.00	3.80	0.00
20-29	0.00	1.40	0.00
30-39	0.08	6.92	0.00
40-49	1.75	25.83	0.00
50-59	144.67	44.81	0.06
60-69	714.25	93.77	0.67
70-79	1363.75	225.93	3.08
80-85+	1009.42	551.16	5.56
1984-1989:		1986	
0-19	0.00	0.00	0.00
20-29	0.00	2.27	0.00
30-39	1.67	5.81	0.00
40-49	8.58	10.53	0.00
50-59	205.17	31.66	0.06
60-69	964.08	85.88	0.83
70-79	2034.08	279.19	5.68
80-85+	1325.91	461.86	6.12
		Total expected deaths:	29.47

SMR = observed/expected
= 37/29.47
= 1.26

95% CI (0.86-1.73)

Table E16. Standardized mortality ratio for circulatory diseases among female breast cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Circulatory diseases mortality rates for Nova Scotia females (per 100,000)	Expected deaths: due to circulatory diseases
1969-1973:		1971	
0-19	0.00	0.51	0.00
20-29	12.42	3.82	0.00
30-39	94.25	28.88	0.03
40-49	447.42	58.09	0.26
50-59	650.92	178.69	1.16
60-69	538.67	702.13	3.78
70-79	459.17	2228.18	10.23
80-85+	231.59	8854.56	20.51
1974-1978:		1976	
0-19	0.08	0.95	0.00
20-29	21.50	5.40	0.00
30-39	139.83	8.77	0.01
40-49	661.83	54.48	0.36
50-59	1215.75	208.56	2.54
60-69	1234.33	608.20	7.51
70-79	1029.33	2252.91	23.19
80-85+	541.92	8309.07	45.03
1979-1983:		1981	
0-19	2.00	0.62	0.00
20-29	22.08	2.74	0.00
30-39	209.33	18.60	0.04
40-49	608.50	26.88	0.16
50-59	1359.58	153.59	2.09
60-69	1588.75	554.62	8.81
70-79	1354.08	1799.94	24.37
80-85+	959.92	6828.30	65.55
1984-1989:		1986	
0-19	0.00	0.84	0.00
20-29	13.92	4.86	0.00
30-39	280.92	8.68	0.02
40-49	844.42	40.99	0.35
50-59	1379.92	108.39	1.50
60-69	1825.92	399.23	7.29
70-79	1740.58	1605.46	27.94
80-85+	1219.17	6288.65	76.67
		Total expected deaths:	329.40

SMR = observed/expected
= 454/329.40
= 1.38

95% CI (1.21-1.51)

Table E17. Standardized mortality ratio for respiratory diseases among female breast cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Respiratory diseases mortality rates for Nova Scotia females (per 100,000)	Expected deaths: due to respiratory diseases
1969-1973:		1971	
0-19	0.00	47.48	0.00
20-29	12.42	0.00	0.00
30-39	94.25	4.76	0.00
40-49	447.42	2.38	0.01
50-59	650.92	23.28	0.15
60-69	538.67	40.47	0.22
70-79	459.17	162.76	0.75
80-85+	231.59	799.67	1.85
1974-1978:		1976	
0-19	0.08	15.26	0.00
20-29	21.50	1.31	0.00
30-39	139.83	6.90	0.01
40-49	661.83	17.25	0.11
50-59	1215.75	34.39	0.42
60-69	1234.33	68.65	0.85
70-79	1029.33	163.51	1.68
80-85+	541.92	1024.46	5.55
1979-1983:		1981	
0-19	2.00	3.91	0.00
20-29	22.08	2.62	0.00
30-39	209.33	6.69	0.01
40-49	608.50	12.01	0.07
50-59	1359.58	29.73	0.40
60-69	1588.75	89.43	1.42
70-79	1354.08	214.35	2.90
80-85+	959.92	837.01	8.03
1984-1989:		1986	
0-19	0.00	1.22	0.00
20-29	13.92	0.00	0.00
30-39	280.92	2.93	0.01
40-49	844.42	7.96	0.07
50-59	1379.92	32.74	0.45
60-69	1825.92	78.43	1.43
70-79	1740.58	279.34	4.86
80-85+	1219.17	1133.00	13.81
		Total expected deaths:	45.06

SMR = observed/expected
= 84/45.06
= 1.86

95% CI (1.44-2.31)

Table E18. Standardized mortality ratio for digestive diseases among female breast cancer patients, Nova Scotia, 1969-1989.

Age group	Person-years at risk	Digestive diseases mortality rates for Nova Scotia females (per 100,000)	Expected deaths: due to digestive diseases
1969-1973:		1971	
0-19	0.00	9.19	0.00
20-29	12.42	3.36	0.00
30-39	94.25	9.53	0.01
40-49	447.42	21.62	0.10
50-59	650.92	28.15	0.18
60-69	538.67	59.05	0.32
70-79	459.17	85.08	0.39
80-85+	231.59	307.79	0.71
1974-1978:		1976	
0-19	0.08	0.77	0.00
20-29	21.50	1.31	0.00
30-39	139.83	4.60	0.01
40-49	661.8319.78	0.13	
50-59	1215.7519.54	0.24	
60-69	1234.33	50.11	0.62
70-79	1029.33	122.23	1.26
80-85+	541.92	269.10	1.46
1979-1983:		1981	
0-19	2.00	3.80	0.00
20-29	22.08	1.40	0.00
30-39	209.33	6.92	0.01
40-49	608.50	25.83	0.16
50-59	1359.58	44.81	0.61
60-69	1588.75	93.77	1.49
70-79	1354.08	119.01	1.61
80-85+	959.92	486.11	4.67
1984-1989:		1986	
0-19	0.00	3.39	0.00
20-29	13.92	1.25	0.00
30-39	280.92	0.00	0.00
40-49	844.42	10.72	0.09
50-59	1379.92	12.63	0.17
60-69	1825.92	44.29	0.81
70-79	1740.58	129.06	2.25
80-85+	1219.17	474.06	5.78
		Total expected deaths:	23.08

SMR = observed/expected
= 36/23.08
= 1.56

95% CI (1.06-2.15)

Bibliography

Ackman, M.L., Harjee, K.S., Mansell, G., Campbell, J.B., Teo, K.K. & Montague, T.J. (1996). Cause-specific noncardiac mortality in patients with congestive heart failure – A contemporary Canadian audit. Canadian Journal of Cardiology, 12 (9), 809-813.

Allebeck, P., Bolund, C. & Ringbäck, G. (1989). Increased suicide rate in cancer patients: A cohort study based on the Swedish cancer-environment register. Journal of Clinical Epidemiology, 42 (7), 611-616.

Ambrus, J.L., Ambrus, C.M., Mink, I.B. & Pickren, J.W. (1975). Causes of death in cancer patients. Journal of Medicine, 6 (1), 61-64.

Baird, P.A. & Sadovnick, A.D. (1988). Causes of death to age 30 in Down Syndrome. American Journal of Human Genetics, 43, 239-248.

Beard, C.M., Kokmen, E., Sigler, C., Smith, G.E., Petterson, T. & O'Brien, P.C. (1996). Cause of death in Alzheimer's disease. Annals of Epidemiology, 6 (3), 195-200.

Beckett, W.S. (1993). Epidemiology and etiology of lung cancer.[Review]. Clinics in Chest Medicine, 14 (1), 1-15.

Breslow, N.E. & Day, N.E. (1987). Rates and rate standardization. In N.E. Breslow & N.E. Day (Eds.), Statistical methods in cancer research: Vol. 2. The design and analysis of cohort studies. Lyon: IARC Scientific Publications no.82.

Brown, B.W., Brauner, C. & Minnotte, M.C. (1993). Noncancer deaths in white adult cancer patients. Journal of the National Cancer Institute, 85 (12), 979-987.

Cancer Treatment and Research Foundation of Nova Scotia. (1990). Qualitative and quantitative audit of Nova Scotia cancer registry data 1953-1988. Halifax: Cancer Treatment and Research Foundation of Nova Scotia.

Coleman, C.N. (1998). Weighing the long-term risks and benefits of treatment. In Understanding cancer: A patient's guide to diagnosis, prognosis and treatment (pp. 69-80). Baltimore: The Johns Hopkins University Press.

Croteau, N., Johnston, G., Starratt, K. & Hum, L. (1994). Cancer incidence (1971-1990) and cancer mortality (1984-1990) for Nova Scotia: Interim report. Halifax: Nova Scotia Cancer Registry and Cancer Treatment and

Research Foundation of Nova Scotia.

D'Amico, M., Agozzino, E., Biagino, A., Simonetti, A. & Marinelli, P. (1999). Ill-defined and multiple causes on death certificates – A study of misclassification in mortality statistics. European Journal of Epidemiology, 15, 141-148.

Dodd, G. (1991). Cancer control and the older person: An overview. Cancer, 68 (11), 2493-2495.

Donati, M.B. (1994). Cancer and thrombosis. Haemostasis, 24, 128-131.

Ederer, F., Cutler, S.J., Goldenberg, I.S. & Eisenberg, H. (1963). Causes of death among long-term survivors from breast cancer in Connecticut. Journal of the National Cancer Institute, 30 (5), 933-947.

Feldman, A.L. & Welch, J.P. (1998). Long-term outcome in women less than 30 years of age with breast cancer. Journal of Surgical Oncology, 68, 193-198.

Flanders, D. (1992). Inaccuracies of death certificate information. Epidemiology, 3 (1), 3-5.

Frishman, W.H., Sung, H.M., Yee, H.C.M., Liu, L.L., Keefe, D. & Einzig, A.I., Dutcher, J. (1997). Cardiovascular toxicity with cancer chemotherapy.[Review]. Current Problems in Cancer, 21 (6), 308-360.

Gaudette, L.A. (1997). Statistics Canada, Health Statistics Division Cancer Incidence in Canada, 1969 – 1993. Health Statistics Division (Catalogue 82-566-XPB). [Occasional]. Ottawa: Ministry of Industry.

Hakulinen, T. & Teppo, L. (1977). Causes of death among female patients with cancer of the breast and intestines. Annals of Clinical Research, 9, 15-24.

Hennekens, C.H. & Buring, J.E. (1987). Measure of disease frequency and association. In S.L. Mayrent (Ed.), Epidemiology in medicine (pp. 54-98). Toronto: Little, Brown and Company.

Houten, L. & Reilley, A.A. (1980). An investigation of the cause of death from cancer. Journal of Surgical Oncology, 13, 111-116.

Inagaki, J., Rodriguez, V. & Bodey, G.P. (1974). Causes of death in cancer patients. Cancer, 33 (2), 568-573.

Israel, R.A., Rosenberg, H.M. & Curtin, L.R. (1986). Analytical potential for multiple cause-of-death data.[Reviews and commentary]. American Journal of Epidemiology, 124 (2), 161-179.

James, D.S. & Bull, A.D. (1996). Information on death certificates: Cause for concern? Journal of Clinical Pathology, 49, 213-216.

Jordon, J.M. & Bass, M.J. (1993). Errors in death certificate completion in a teaching hospital. Clinical and Investigative Medicine, 16 (4), 249-255.

Kelsey, J.L., Whittemore, A.S., Evans, A.S. & Thompson, W.D. (1996). Cohort studies: Statistical analysis II. In Methods in observational epidemiology (2nd ed., pp. 167-187). New York: Oxford University Press.

Kircher, T. & Anderson, R.E. (1987). Cause of death: Proper completion of the death certificate.[Special communication]. Journal of the American Medical Association, 258 (3), 349-352.

Klastersky, J., Daneau, D. & Verhest, A. (1972). Causes of death in patients with cancer. European Journal of Cancer, 8, 149-154.

Koch, M., Hanson, J., Gaedke, H. & Wilson, D. (1987). Competing causes of death in breast cancer patients. In A.H.G. Paterson & A.W. Lees (Eds.), Fundamental Problems in Breast Cancer: Proceedings of the Second International Symposium on Fundamental Problems in Breast Cancer Held at Banff, Alberta, Canada April 26-29, 1986 (pp. 265-272). Boston: Martinus Nijhoff Publishing.

Koch-Henriksen, N., Brønnum-Hansen, H. & Stenager, E. (1998). Underlying cause of death in Danish patients with multiple sclerosis: Results from the Danish Multiple Sclerosis registry. Journal of Neurology, Neurosurgery and Psychiatry, 65, 56-59.

Kohn, R.R. (1982). Cause of death in very old people. Journal of the American Medical Association, 247 (20), 2793-2797.

Krongrad, A., Lai, H. & Lai, S. (1997). Competing risks of mortality in prostate cancer. The Journal of Urology, 158, 865-868.

Le, N.D., Marrett, L.D., Robson, D.L., Semenciw, R.M., Turner, D. & Walter, S.D. (1995). Canadian cancer incidence atlas. Ottawa: Minister of Supply and Services Canada.

Levy, I.G., Gibbons, L., Collins, J.P., Perkins, D.G. & Mao, Y. (1993). Prostate cancer trends in Canada: Rising incidence or increased detection? Canadian Medical Association Journal, 149 (5), 617-624.

Mackenbach, J.P., Kunst, A.E., Lautenbach, H., Oei, Y.B. & Bijlsma, F. (1997). Competing causes of death: A death certificate study. Journal of Clinical Epidemiology, 50 (10), 1069-1077.

Mannino, D.M., Ford, E., Giovino, G.A. & Thun, M. (1998). Lung cancer deaths in the United States from 1979 to 1992: An analysis using multiple-cause mortality data. International Journal of Epidemiology, 27, 159-166.

Mao, Y., Robson, D., Semenciw, R.M., Morrison, H.I. & Wigle, D.T. (1991). Long-term survival rates among patients with cancer in Saskatchewan, 1967-1986. Canadian Journal of Public Health, 82, 413-420.

Messite, J. & Stellman, S.D. (1996). Accuracy of death certificate completion: The need for formalized physician training.[Brief report]. Journal of the American Medical Association, 275 (10), 794-796.

Meyer, F., Moore, L., Bairati, I. & Fradet, Y. (1999). Downward trend in prostate cancer mortality in Quebec and Canada. The Journal of Urology, 161, 1189-1191.

Mitchell, D.M., Spitz, P.W., Young, D.Y., Bloch, D.A., McShane, D.J. & Fries, J.F. (1986). Survival, prognosis, and causes of death in rheumatoid arthritis. Arthritis and Rheumatism, 29 (6), 706-714.

Moriyama, I.M. (1989). Problems in measurement of accuracy of cause-of-death statistics.[Editorial]. American Journal of Public Health, 79 (10), 1349-1350.

National Cancer Institute of Canada. (1991). Canadian Cancer Statistics 1991. Toronto, Canada.

National Cancer Institute of Canada. (1998). Canadian Cancer Statistics 1998. Toronto, Canada.

Newman, S.C. & Bland, R.C. (1991). Mortality in a cohort of patients with schizophrenia: A record linkage study. The Canadian Journal of Psychiatry, 36 (4), 239-245.

Nova Scotia Department of Finance. (1994). Nova Scotia fact book (4th ed.). Statistics Division: Author.

Orius98 Version 2 [Computer software]. Ottawa: Cancer Bureau, Health Canada.

Pagano, P. & Gauvreau, K. (1993). Inference on proportions. In Principles of biostatistics. (pp. 293-310). Belmont, CA: Duxbury Press.

Percy, C., Stanek, E. & Gloeckler, L. (1981). Accuracy of cancer death certificates and its effect on cancer mortality statistics. American Journal of Public Health, 71 (3), 242-250.

Phillips, K., Glendon, G. & Knight, J.A. (1999). Putting the risk of breast cancer in perspective. The New England Journal of Medicine, 340 (2), 141-144.

Potosky, A.L., Kessler, L., Gridley, G., Brown, C.C. & Horm, J.W. (1990). Rise in prostatic cancer incidence associated with increased use of transurethral resection. Journal of the National Cancer Institute, 82 (20), 1624-1628.

Queen Elizabeth II Health Sciences Centre. (1995). Cancer incidence report, 1993-1994. Halifax: Nova Scotia Cancer Registry.

Robinson, E., Rennert, G., Rennert, H.S. & Neugut, A.I. (1993). Survival of first and second primary breast cancer. Cancer, 71 (1), 172-176.

Rothman, K.J. & Boice, J.D., Jr. (1979). Epidemiologic analysis with a programmable calculator (NIH Publication No. 79-1649). Washington, DC: U.S. Government Printing Office.

Rutqvist, L.E. (1984). Intercurrent mortality of breast carcinoma patients: An investigation of 3857 cases from the Swedish Cancer Register. Acta Radiologica - Oncology, 23 (5), 337-343.

Sadovnick, A.D., Eisen, K., Ebers, G.C. & Paty, D.W. (1991). Cause of death in patients attending multiple sclerosis clinics. Neurology, 41, 1193-1196.

Sankila, R. & Hakulinen, R. (1998). Survival of patients with colorectal carcinoma: Effect of prior breast cancer.[Brief communication]. Journal of the National Cancer Institute, 90 (1), 63-65.

Sariego, J., Zrada, S., Byrd, M. & Matsumoto, T. (1995). Breast cancer in young patients. The American Journal of Surgery, 170, 243-245.

SAS Version 6.12 [Computer software]. Cary, NC: SAS Institute Inc.

Satariano, W.A. & Ragland, D.R. (1994). The effect of comorbidity on 3-year survival of women with primary breast cancer. Annals of Internal Medicine, 120 (2), 104-110.

Satariano, W.A., Ragland, K.E. & Van Dan Eeden, S.K. (1998). Cause of death in men diagnosed with prostate carcinoma. Cancer, 83 (6), 1180-1188.

Scotto, J., Fears, T.R. & Fraumeni, J.F., Jr. (1983). Incidence of non-melanoma skin cancer in the United States (DHEW Publication No. NIH 83-2433). Washington, DC: U.S. Government Printing Office.

Statistics Canada. (1997). Births and deaths. (Health Statistics Division, Catalogue 84-210-XIB). Ottawa.

Steering Committee for Canadian Cancer Statistics. (1997). Cancer incidence and mortality, 1997. Health Reports, 8 (4), 41-51.

Storm, H.H., Christensen, N. & Jensen, O.M. (1992). Suicides among Danish patients with cancer: 1971 to 1986. Cancer, 69 (6), 1507-1512.

Stover, D.E. & Kaner, R.J. (1996). Pulmonary complications in cancer patients. CA: A Cancer Journal for Clinicians, 46 (5), 303-320.

Swanson, G.M. & Lin, C. (1994). Survival patterns among younger women with breast cancer: The effects of age, race, stage, and treatment. Monographs of the National Cancer Institute, 16, 69-77.

Tsai, S.P. & Wen, C.P. (1986). A review of methodological issues of the standardized mortality ratio (SMR) in occupational cohort studies. International Journal of Epidemiology, 15 (1), 8-21.

Varty, P., Delrio, P. & Boulos, P.B. (1994). Survival in colorectal carcinoma associated with previous extracolonic cancer. Annals of the Royal College of Surgeons of England, 76, 180-184.

Ward, M.M., Pyun, E. & Studenski, S. (1995). Causes of death in Systemic Lupus Erythematosus: Long-term followup of an inception cohort. Arthritis & Rheumatism, 38 (10), 1492-1499.

Wei, J.Y. (1992). Age and the cardiovascular system.[Review article]. The New England Journal of Medicine, 327 (24), 1735-1739.

Wei, J.Y. (1995). Cardiovascular comorbidity in the older cancer patient. Seminars in Oncology, 22 (Suppl. 1), 9-10.

Wilkins, K. (1995). Causes of death: How the sexes differ. Health Reports, 7 (2), 33-43.

Wilkins, K., Wysocki, M, Morin, C & Wood, P. (1997). Multiple causes of death. Health Reports, 9 (2), 19-29.

World Health Organization. (1977). Manual of the international statistical classification of diseases, injuries and causes of death. (Vol. 1). Geneva: World Health Organization.

Yancik, R. (1997). Cancer burden in the aged.[Special section] Cancer, 80 (7), 1273-1283.

Yancik, R., Havlik, R., Wesley, M.N., Ries, L., Long, S., Rossi, W.K. & Edwards, B.K. (1996). Cancer and comorbidity in older patients: A descriptive profile. Annals of Epidemiology, 6 (5), 399-412.

Yancik, R. & Ries, L.A. (1994). Cancer in older persons. Magnitude of the problem – how do we apply what we know?.[Review] Cancer, 74 (7), 1995-2003.