Cancer Statistics in Nova Scotia

A Focus on 1995-1999

Cancer Care Nova Scotia

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Recommended citation:
Saint-Jacques N, MacIntyre M, Dewar R, Johnston G. Cancer Statistics in Nova Scotia: A Focus on 1995-1999.
Surveillance and Epidemiology Unit, ***Cancer Care Nova Scotia***; 2002.

Foreword

Cancer comprises a family of diseases, which challenges individuals, families and communities alike. Regrettably, as many as half of all cancers can be prevented by avoiding exposure to tobacco, eating healthy, exercising regularly and following simple screening and early detection strategies. Fortunately advanced treatment with surgery, radiation and chemotherapy, along with supportive care reduces the burden of cancer in people and society.

The mainstay of effective cancer control is good information to help develop policies and programs that can move into practice. The cornerstone of an effective cancer system is the cancer registry, which serves as a tool for planning, monitoring and evaluating diagnosis, treatment and outcomes.

Under the auspices of ***Cancer Care Nova Scotia (CCNS)***, the Nova Scotia Cancer Registry has been refreshed and reprogrammed as part of the Surveillance and Epidemiology Unit. This publication of cancer data for the five year period, 1995 through 1999, marks the turning point for the registry in finalizing data gathering and analysis as a prelude to moving to more active surveillance and epidemiologic research on cancer in our population. At the time the report was initiated, 1999 represented the most recent, complete year of data available for analysis. By combining the full 1995-1999 period, a more robust data set was created, allowing for enhanced production of statistics and increased validity of results.

Congratulations to the staff of the Surveillance and Epidemiology Unit for this important publication. Please contact us by email at epi.unit@ccns.nshealth.ca, by telephone at 1-866-599-2267 or by mail at the address listed at the back of this publication, should you require additional information.

Andrew Padmos, Commissioner
Cancer Care Nova Scotia

"Many Hearts. Many Minds. One Goal."

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Cancer Care Nova Scotia

Introduction

Cancer touches all people. It has done so since the earliest of recorded human history and will conceivably continue to do so into the distant future. The first recorded cases may date as far back as ancient Egyptian times when pictures of people with tumours have been found. The very name cancer derives from the Greek word for a crab, describing the typical appearance of malignant tumours: a central mass with tendrils growing out into the surrounding tissues, like a crab's legs and claws.

Even though cancer has been known throughout human history and has recently come under the intense scrutiny of the scientific community, it remains a complex disease that defies our attempts at prevention and control. Given the ever-increasing size and complexity of human populations, the effects of cancer have become pervasive and the need for its control critical.

To deal with the manifestation of such a complex disease requires coordinated research and management efforts. For this purpose, the Nova Scotia Cancer Registry (a component of the Surveillance and Epidemiology Unit of ***Cancer Care Nova Scotia*** – Nova Scotia Department of Health) has been mandated since 1964 to systematically compile information on the occurrence of cancer in the province including demographics, cancer type, initial treatments and final outcome.

The dissemination of information on the patterns of cancer occurrence and outcomes in the province is an essential component of a comprehensive provincial cancer control program. This information is of interest and value to the public, health care professionals, researchers, administrators and policy makers. Health care professionals, researchers and educators use this information to: better understand the causative agents and risk factors associated with various cancers; understand the relative success of cancer treatment methods; develop preventive measures to reduce incidence in the population. Health care providers and managers utilise this information to plan and project the expected needs of communities, which assist decision making around resource allocation. Patients and families touched by the disease utilise this information to understand their personal likelihood of survival and to make informed decisions as to what interventions they may opt to undertake.

Currently, more than 24,000 people are living with cancer in Nova Scotia, with approximately 5,000 new invasive diagnoses each year. Approximately two-thirds of all new cases of cancer in Nova Scotia occur after the age of sixty years. As the population is also aging, an ever-increasing burden will be placed upon the health care system, families, local communities and society in general. This report provides the current picture of these emerging trends and needs.

Highlights

1. Currently, more than 24,000 people are living with cancer in Nova Scotia (Appendix A), with approximately 5,000 new invasive cases diagnosed each year.

2. Prostate, breast, lung and colorectal cancers accounted for approximately half of all invasive cancer incidence in the province between 1995-1999.

3. Prostate cancer was the leading type of cancer among males, accounting for 24% of overall cancer incidence.

4. Breast cancer was the leading type of cancer among females, accounting for 29% of overall cancer incidence.

5. Lung cancer was the leading type of cancer-related deaths, accounting for 33% of cancer deaths in males and 23% of cancer deaths in females.

6. Approximately two-thirds of all new invasive cancer cases in Nova Scotians are diagnosed after the age of sixty years.

7. Rates of cancer incidence in males were nearly double that of females, for persons aged 80 years and older.

8. Leukemia was the leading form of cancer among children, accounting for nearly a third of all new cases. A total of 187 children aged 0 to 19 years were diagnosed with invasive cancer (all sites combined) between 1995-1999, representing an average of 37 cases per year.

9. Highest age-standardised cancer incidence rates were observed in Cape Breton County; lowest rates were observed in Kings and Colchester Counties, for both genders.

10. The age-standardised rates of cancer incidence continue to increase at an average annual rate of 1.2% in males and 1.4% in females. These increases are largely due to the influence of lung, and more recently, prostate cancers among males; and breast and lung cancers in females.

11. Both cancer incidence and mortality rates were consistently higher for males over the past 28 years (1971-1999)—a pattern driven by lung cancer.

12. Survival rates (five-year) were highest for patients diagnosed with prostate (93%) or breast cancer (82%). Survival rates were low for colorectal cancer (61% in males, 57% in females) and lower still for lung cancer (13% in males, 15% in females).

13. Survival rates were consistently higher for patients diagnosed with local as opposed to distant or more advanced stages, regardless of the type of cancer.

14. Cancer incidence cases are expected to increase 46% in males and 38% in females over the next decade.

15. Until major breakthroughs in cancer research occur, primary prevention, early detection and the judicious application of adjuvant therapy (where indicated), remain the most pragmatic means of cancer control.

Data Sources and Processing

DATA SOURCES

All cases of cancer diagnosed in the province of Nova Scotia must be legally reported (Office of the Legislative Counsel, 1989) to the Surveillance and Epidemiology Unit (herein referred to as the NSCR – Nova Scotia Cancer Registry). This information is obtained from the following sources:

Pathology reports	Provincial Pathology Laboratories
Registry report forms	Hospital Health Record Departments or Physician Offices
Cancer Centre referrals	Electronic records of patients referred to provincial Cancer Centres
Death certificates	Nova Scotia Vital Statistics
Reciprocal notifications	Other Canadian Registries

Details of the affected individual and the nature of their disease(s)[1] are recorded. All primary tumour sites are coded in accordance with the International Classification of Diseases (World Health Organisation). From 1980 to 1991, tumour topography (site) and morphology (histological type) were coded according to the ICD-O classification of diseases. Cancer cases recorded between 1992-1999 were coded according to the ICD-O-2 classifications (Appendix B). All death cases were coded according to the ninth revision of the International Classification of Diseases.

Data quality and accuracy is ensured through a network of activities including automated and manual edit processes, record linkages and data audits. NSCR operations are in accordance with the cancer registration standards of both the Canadian Cancer Registry (CCR) and the North American Association of Central Cancer Registries (NAACCR). The NSCR is also an active member of the International Association of Cancer Registries (IACR), which fosters the international exchange of information between cancer registries. In 2001, the NSCR received a gold certification in registry operations from NAACCR, an association established to enhance the quality and use of cancer registry data. Appendix C provides information on data quality indicators for major tumour sites.

DATA CONFIDENTIALITY

The maintenance of data confidentiality is a guiding principle for all NSCR operations. All activities from the initial registration of a case, through to research and reporting are governed by strict guidelines for data access and reportability. To ensure the continued anonymity of the persons followed by the NSCR, age-specific and site-specific cancer summaries are not presented when counts are below five cases.

1 *A person may be diagnosed with more than one invasive cancer in his/her lifetime.*

DATA PROCESSING

Cancer incidence records were extracted from the Oncology Patient Information System (OPIS) database and studied by gender, age group and tumour site. The most recent complete data available was for the calendar year 1999[1]. Cancer statistics were not computed for basal and squamous cell skin cancers as recommended by the CCR because these cancers are under-reported and therefore difficult to analyse reliably (see National Cancer Institute of Canada 2001). Cancer mortality statistics were derived from death records maintained by the provincial registrar of vital statistics. Population counts (intercensal and postcensal estimates) were obtained from Statistics Canada for the period of 1991-1996. Population counts for each District Health Authority (DHA) were estimated from census subdivison estimates for the years 1991 and 1996.

– confidentiality,
a key area of focus –

Cancer *incidence rates* are presented at the county, DHA and provincial levels, whereas *mortality rates* were only determined for the province as a whole. Cancer incidence rates were age-standardised (see glossary) to allow meaningful comparisons of cancer rates over time and between geographic regions. The direct method was used in this report to compute age-standardised rates. The standard population used was that of the whole of Canada, as it was in 1991.

Analyses were generally based upon a five-year time period (1995-1999) to reduce problems associated with the computation of small numbers. This approach was essential to provide a reliable and stable profile of cancer incidence, mortality and survival in the province. Variance estimates (and 95% confidence intervals) were calculated assuming that the age-specific counts were random Poisson events (e.g., in the calculation of age-standardised incidence and mortality rates—ASIR and ASMR, respectively).

Comparative incidence figures (CIF) were computed for common tumour sites (breast, prostate, lung and colorectal) and for all combined cancers. Values were derived from the ratio of the average annual (1995-1999) ASIR for a given cancer type recorded in a specific geographical area (i.e., a county or a DHA) to the average annual ASIR for that same cancer type for the whole of Nova Scotia. The computation of the 95% confidence intervals followed the methodology described by Breslow and Day (1980).

The *average annual percent change* (AAPC) was calculated for selected tumour sites by fitting a linear regression model to logarithmically transformed ASIR and ASMR, a procedure that assumes a constant rate of change in both the ASIR and ASMR, over the time studied. The slope resulting from the fit was back-transformed and expressed as percent increase or decrease in the rate of cancer incidence over the 1980-1999 period.

Projections of cancer incidence rates for the years 2005 and 2010 were computed from a weighted least squares regression model, where the weights were the inverse of the estimated variances of the actual age-standardised rates (see details in

1 This report focuses primarily on data collected between 1995-1999. However, other time frames were used for the computation of: cancer incidence and mortality trends (1971-1999); average annual percent change (AAPC) in cancer incidence and mortality (1984-1999); relative survival (1992-1996) and to determine projection estimates of cancer incidence and mortality (1984-1999). The use of a longer time period was essential to the computation of AAPC and data projections as these data are derived from linear regression models.

National Cancer Institute of Canada 2001). Projections of cancer incidence counts were extrapolated from a linear regression of the time trends and variance estimates obtained using a Poisson assumption. All tumour sites except prostate cancer were projected using data from 1984-1999. Projections for prostate cancer were based on data from 1981-1990, a period that excludes the sudden increase in prostate cancer incidence observed in the early 1990's with the introduction of improved detection and screening techniques (see National Cancer Institute of Canada 2001).

Relative survival analyses based on the Hakulinen method (see Hakulinen 1982) were applied to patients diagnosed with invasive primary cancer between 1992-1996. Because 1999 was the most recent complete year of data, survival estimates for patients diagnosed in 1995 and 1996 were based on four and three years of data respectively, as opposed to five years for all other cases. Analyses were restricted to common cancer sites to allow reliable survivorship estimates (prostate, female breast, lung and colorectal tumour sites). Due to Nova Scotia's small population size, the use of a five-year time period was necessary to produce stable survival estimates.

If a patient was diagnosed with more than one invasive tumour between 1992-1996, only the record with the earliest date of diagnosis was retained for analysis (see Ellison and Gibbons 2001). Records of individuals diagnosed prior to 1992 were excluded from analysis. Records of individuals aged less than 20 years were excluded from analysis with the exception of female breast cancer cases, which included all individuals aged 15 and older. Finally, reliable dates of diagnosis were unavailable for cases when diagnoses were established through autopsy or death certificate only (DCO). The exclusion of these cases, while necessary, may have slightly increased the survival rates presented in this report (e.g., Berrino et al. 1995).

Relative survival estimates compare the observed survival for a group of cancer patients to the survival that would be expected for members of the general population who have the same characteristics — gender, age group, province of residence — as the cancer patients (see Ellison and Gibbons 2001). Observed survival time was calculated as the difference in days between the date of diagnosis and the date of last observation (date of death or December 31, 1999, whichever was earliest) to a maximum of five years. Expected survival time was derived for each age, up to 86 years of age, from gender-specific provincial life tables provided by Statistics Canada. Using the method suggested by Dickman et al. (1998), these life tables were extended to age 99. Thus, if the five-year survivorship was 65% for a group of cancer patients that would otherwise have had a 90% survivorship, the relative survival rate would be 72% (65/90) (see Fitzpatrick and Gavin 2001 for more details). That is, relative survival rates are greater than the observed (crude) rates that do not account for increases in mortality with age. By convention, relative survival is called a "rate", although it is a ratio of two percentages.

The relative survival estimates presented in this report account for age-specific differences in background mortality, but not for the influence of age on the prognosis of a cancer patient. That is, the rates presented were not age-standardised to a "cancer patient population standard" such as that of the World Standard Cancer Population or the EUROCARE standard (see Coleman et al. 1999). This allowed the computation of relative survival estimates that more closely reflect the reality of cancer patient survival and treatment outcomes in Nova Scotia.

Data Sources and Processing

The stage of a disease (a measure of how far a cancer has spread in the body) at the time of diagnosis is another factor that greatly influences the survival of patients. Staging is based on laboratory, radiological, clinical and surgical assessments that describe the extent of the primary tumour and evidence of metastases at diagnosis. To date, the NSCR has collected only a limited set of data for staging purposes. However, information based upon a semi-quantitative localised-distant scheme (Box 1) was available and deemed adequate for the purpose of this report. While this approach is relatively crude, it nonetheless provides useful information for interpreting patient survival rates.

Finally, confidence intervals (CI) of relative survival were derived from an approximation of the formula of Greenwood (1926; as per Armitage and Berry 1985) to provide an indication of the precision associated with the calculated rates. This method accounts for the gradual reduction in sample size due to patient death. The width of the CI largely reflects the degree of precision of the calculated rates, with narrow CI being more precise. Rates with wide CI are usually unstable and common in studies based upon a small number of observed cases.

Box 1: Extent of Disease

Local	A cancer confined entirely to the organ of origin.
Regional	A cancer that has extended beyond the limits of the organ of origin into regional lymph nodes or directly into neighbouring tissue or organs.
Distant	A cancer that has spread to other lymph nodes, metastasised to remote organs.
Unknown	Information insufficient to assign the extent of the disease.

A Certified Health Record Technician assigns the extent of disease at the time of initial disease registration, with the assignment based on all available information (e.g., pathology reports, operative reports, diagnostic imaging reports and physician consultation reports).

Cancer Profile in Nova Scotia

More than 22,000 people in Nova Scotia were diagnosed with invasive cancer between 1995-1999. The incidence count of cancer was 8% higher in males (11,739 people) than in females (10,845 people; see Tables 1, 2). On average, approximately 2,000 cases were registered annually for each gender.

Prostate, lung and colorectal cancers accounted for 57% of all cancer cases recorded for males between 1995-1999 (Figure 1a). A similar proportion (56%) was accounted by breast, colorectal and lung cancers for females (Figure 2a). Half of all cancer deaths recorded in the province are related to these four disease sites (Figures 1b,2b).

Among males, prostate cancer was the most frequently diagnosed tumour site, affecting nearly 600 men in the province annually (Table 1). Females were most often diagnosed with breast cancer (Table 2). In Nova Scotia, 3,097 women were diagnosed with some form of breast cancer between 1995-1999. Over this same period, 699 women died of the disease.

In parallel with the national trends reported by the National Cancer Institute of Canada (2001), both prostate and breast cancers ranked second in the scale of cancer related deaths. Lung cancer remained the leading cause of death for both males and females, accounting for one third of the cancer deaths in men and almost one quarter of cancer deaths in females (Figures 1b, 2b).

Lung cancer age-standardised incidence rates (ASIR) in Nova Scotia are among the highest in Canada (National Cancer Institute of Canada 2001). The disease clearly affects a larger proportion of males than females, with ASIR in males being twice (96.7; [95% CI: 92.7-100.8], Table 1) that of females (49.8; [95% CI: 47.2-52.5], Table 2). An increased risk of developing lung cancer has been linked primarily to tobacco consumption but also to the exposure to

Figure 1. Percentage distribution of cancer incidence (A) and mortality (B) for selected tumour sites, males, Nova Scotia 1995-1999.

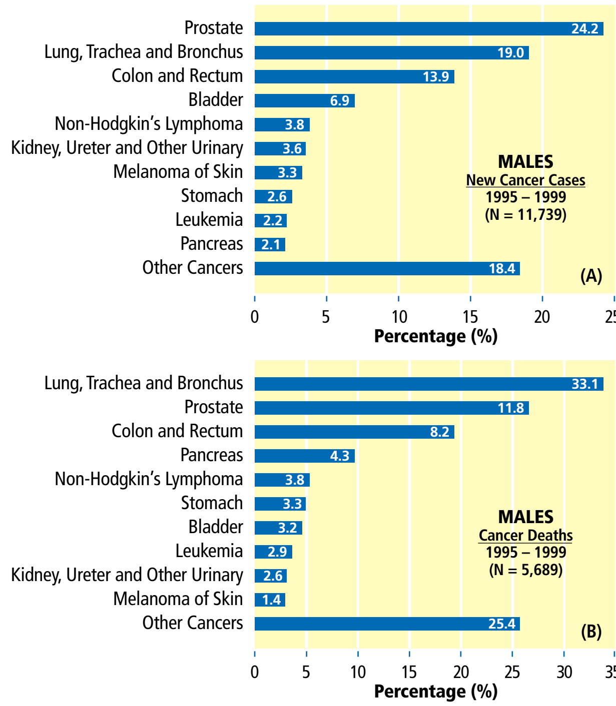

Figure 2. Percentage distribution of cancer incidence (A) and mortality (B) for selected tumour sites, females, Nova Scotia 1995-1999.

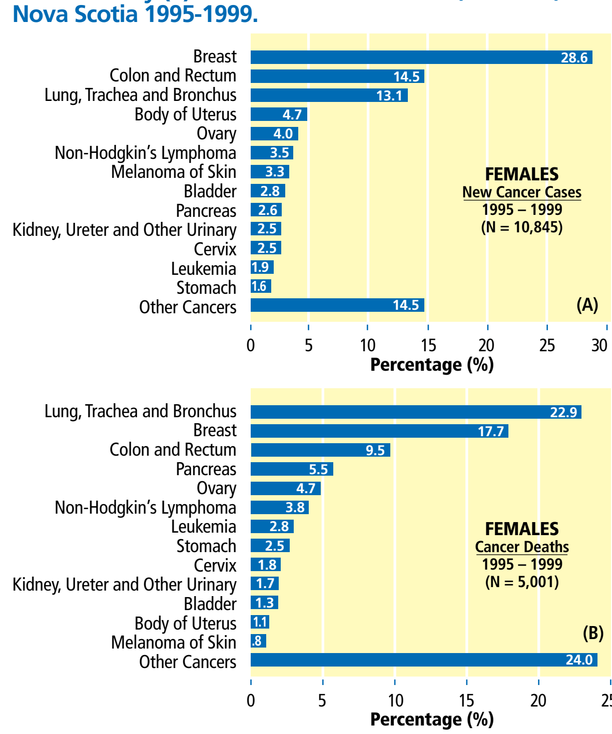

Table 1. Incidence counts[1] and rates of invasive cancer among males, Nova Scotia 1995-1999.

MALES	Age at Diagnosis						Total Incidence		Incidence Rate[2] per 100,000	
Tumour Site	0-29	30-49	50-59	60-69	70-79	80+	1995-99	1999	1995-99	1999
ORAL (buccal cavity and pharynx)										
Lip		16	13	13	17	11	70	15	3.0	3.2
Tongue		11	14	19	14	8	67	12	2.8	2.6
Mouth, Other		10	19	19	21	11	82	18	3.5	3.8
Pharynx and Tonsil		21	24	38	29	8	121	30	5.0	6.1
DIGESTIVE ORGANS										
Esophagus		10	33	48	40	16	147	39	6.2	8.0
Stomach		18	47	81	96	63	305	69	13.2	14.5
Small Bowel				14	9	8	39	8	1.7	1.7
Colon and Rectum (colorectal)		94	218	436	545	337	1,631	334	70.9	70.5
Liver and Biliary Tract		7	21	37	48	24	138	22	5.9	4.5
Pancreas		18	35	66	85	45	249	54	10.8	11.4
Peritoneum and GI[3] Unspecified				5	14	8	35	8	1.5	1.7
RESPIRATORY SYSTEMS										
Paranasal Sinuses				5	5		16	< 5	0.7	0.2
Larynx		9	26	64	51	14	164	25	7.1	5.3
Lung, Trachea and Bronchus		91	316	695	812	319	2,234	501	96.7	106.0
Mediastinum, Pleura			7	9	18	7	46	8	2.0	1.7
BONE, CONNECTIVE TISSUE AND SKIN										
Bone and Connective Tissue	19	15	9	11	13	10	77	13	3.4	2.7
Melanoma of Skin	11	87	71	96	83	40	388	105	16.6	21.7
BREAST				10	12		25	< 5	1.1	0.6
GENITAL ORGANS										
Prostate		30	307	911	1,091	499	2,838	658	124.8	140.2
Testis	45	61	10				118	24	5.3	5.8
Penis and Male Genital Unspecified			6	6	10	7	33	9	1.4	1.9
URINARY ORGANS										
Bladder	5	39	110	220	259	174	807	187	35.3	39.6
Kidney, Ureter and Other Urinary		67	82	93	128	45	419	88	17.6	18.4
EYE AND LACRIMAL GLAND	8				5		25	< 5	1.1	0.8
BRAIN AND CENTRAL NERVOUS SYSTEM										
Brain	25	54	20	42	38	12	191	35	8.2	7.7
Meninges, Spinal Cord and other CNS[4]							6	< 5	0.3	0.2
ENDOCRINE GLANDS										
Thyroid		16	7	11			44	11	1.9	2.3
Other Endocrine	5						8	< 5	0.3	0.4
LEUKEMIA	32	39	36	56	58	40	261	65	11.4	13.9
OTHER BLOOD AND LYMPH TISSUE										
Non-Hodgkin's Lymphoma	17	104	80	99	86	61	447	101	19.1	21.4
Hodgkin's Lymphoma	35	14	6		6		64	13	2.9	2.6
Multiple Myeloma		16	17	29	34	34	131	23	5.7	4.7
MISCELLANEOUS PROLIFERATIVE				5			10	< 5	0.4	0.2
OTHER AND ILL DEFINED SITES		15		13	17	15	66	19	2.9	4.2
UNKNOWN PRIMARY		33	67	105	152	80	437	83	19.0	17.5
ALL CANCERS	**225**	**918**	**1,620**	**3,266**	**3,804**	**1,906**	**11,739**	**2,589**	**510.0**	**548.1**

1 Age-specific/site-specific counts < 5 are not presented to ensure confidentiality.
2 Rates are standardised to the age distribution of the 1991 Canadian population.
3 GI, gastrointestinal.
4 CNS, central nervous system.

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Table 2. Incidence counts[1] and rates of invasive cancer among females, Nova Scotia 1995-1999.

FEMALES	Age at Diagnosis						Total Incidence		Incidence Rate[2] per 100,000	
Tumour Site	0-29	30-49	50-59	60-69	70-79	80+	1995-99	1999	1995-99	1999
ORAL (buccal cavity and pharynx)										
Lip					8		16	< 5	0.5	0.4
Tongue				8	10	7	31	< 5	1.0	0.7
Mouth, Other			10	10	12	17	54	14	1.8	2.3
Pharynx and Tonsil			7	10	15		34	5	1.3	0.9
DIGESTIVE ORGANS										
Esophagus		6	5	11	14	19	55	9	1.8	1.4
Stomach		13	18	30	63	50	176	31	5.8	4.8
Small Bowel			8	5	9		30	10	1.0	1.6
Colon and Rectum (colorectal)		117	208	308	493	443	1,571	315	51.2	50.0
Liver and Biliary Tract			11	23	28	33	99	21	3.2	3.2
Pancreas		16	29	62	97	76	281	70	9.2	11.1
Peritoneum and GI[3] Unspecified		7		6	12	22	49	13	1.5	2.2
RESPIRATORY SYSTEM										
Paranasal Sinuses							10	< 5	0.4	0.2
Larynx			8	14	9		38	5	1.4	1.0
Lung, Trachea and Bronchus		114	232	399	466	211	1,425	313	49.8	52.6
Mediastinum, Pleura							9	< 5	0.3	0.3
BONE, CONNECTIVE TISSUE AND SKIN										
Bone and Connective Tissue	6	15	5	8	10	8	52	11	1.9	2.0
Melanoma of Skin	20	121	60	58	66	30	355	100	13.1	18.0
BREAST	5	686	668	676	671	391	3,097	654	110.0	112.0
GENITAL ORGANS										
Cervix	11	139	36	39	31	11	267	59	10.5	11.7
Body of Uterus		58	109	141	143	56	509	112	18.1	19.2
Ovary	14	105	70	96	84	61	430	92	15.6	16.1
Other Female Genital		18	12	19	28	27	106	22	3.6	3.4
URINARY ORGANS										
Bladder		19	44	54	105	81	305	69	9.9	10.7
Kidney, Ureter and Other Urinary		30	56	59	86	39	273	68	9.5	11.3
EYE AND LACRIMAL GLAND							12	< 5	0.4	0.3
BRAIN AND CENTRAL NERVOUS SYSTEM										
Brain	23	26	20	25	28	25	147	26	5.4	4.7
Meninges, Spinal Cord and other CNS[4]							12	< 5	0.4	0.5
ENDOCRINE GLANDS										
Thyroid	20	54	29	21	17	9	150	34	5.9	6.7
Other Endocrine							7	< 5	0.2	0.2
LEUKEMIA	37	27	22	33	43	46	208	37	7.5	6.4
OTHER BLOODS AND LYMPH TISSUE										
Non-Hodgkin's Lymphoma	14	57	65	88	97	57	378	80	13.5	14.1
Hodgkin's Lymphoma	18	22		8			57	11	2.4	2.6
Multiple Myeloma			14	24	38	25	105	24	3.5	3.8
MISCELLANEOUS PROLIFERATIVE							5	< 5	0.2	0.3
OTHER AND ILL DEFINED SITES		5	5		16	16	46	10	1.4	1.5
UNKNOWN PRIMARY		34	48	88	135	139	446	88	14.4	13.6
ALL CANCERS	**199**	**1,722**	**1,815**	**2,337**	**2,848**	**1,924**	**10,845**	**2,321**	**377.7**	**391.6**

1 Age-specific/site-specific counts < 5 are not presented to ensure confidentiality.

2 Rates are standardised to the age distribution of the 1991 Canadian population.

3 GI, gastrointestinal.

4 CNS, central nervous system.

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environmental tobacco smoke (Hirayama 1981, Schottenfeld and Fraumeni 1996; Johnson et al. 2001). In fact, 80-90% of all cases of lung cancer are directly attributable to tobacco consumption, with an average lag time of about twenty years (Stanley and Stjernsward 1989, Koo and Ho 1990 as per Croteau et al. 1994; Schottenfeld and Fraumeni 1996). Currently, the prevalence of smokers remains high among adult Nova Scotians (30%), pregnant women (25%) and youth (36%; Nova Scotia Department of Health, 2001).

AGE AND GENDER

The incidence of invasive cancer in a population is above all, an age and gender dependent phenomenon. The manner in which the incidence of cancer varies with age is presented in Figures 3 and 4. As may be observed, more than two-thirds all new cancer cases in Nova Scotians, occur after the age of 60 years (Tables 1-2). Further, the relative increase in incidence rates with age was much more pronounced for males than for females (Figure 5). For example, males aged [70-79] have roughly 60 times the risk of contracting lung cancer in the next year relative to men aged [30-49], whereas the corresponding relative risk in females is only 20. When all tumour sites were combined, males demonstrated comparable (although slightly lower) incidence rates relative to females, for those aged 55 years or less. However, the incidence rates rose much more rapidly with age among men than among women after age 55, and by age 80+ the incidence rates for males were nearly double that of females.

Figure 3. Age-specific incidence rate for common tumour sites, males, Nova Scotia 1995-1999.

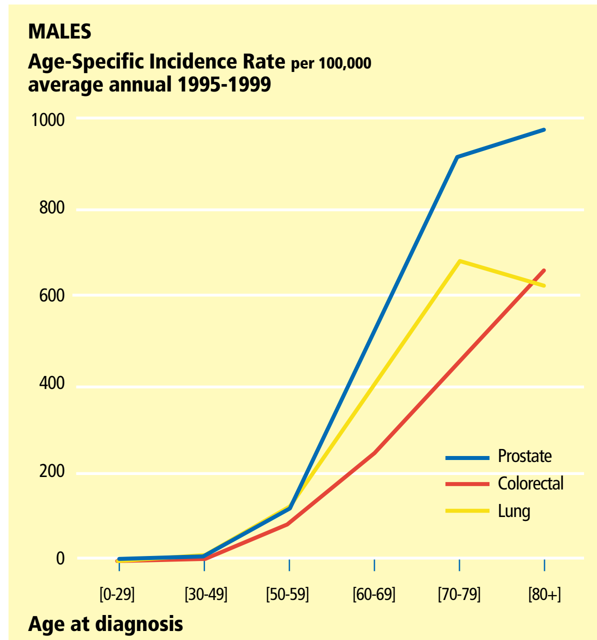


Figure 4. Age-specific incidence rate for common tumour sites, females, Nova Scotia 1995-1999.

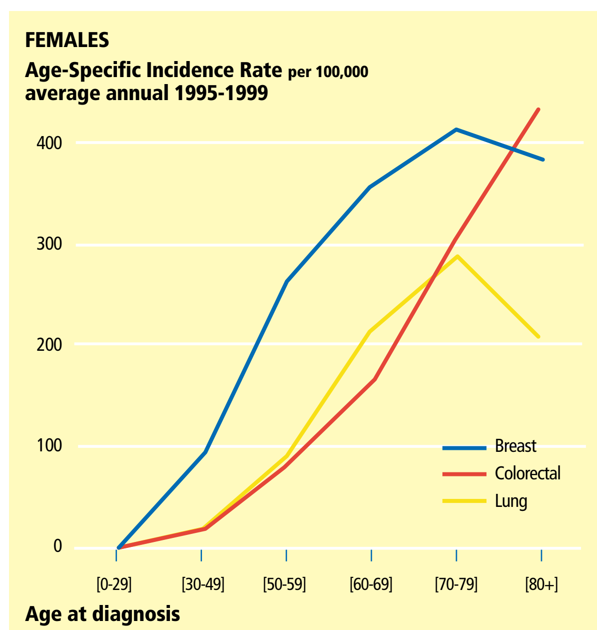
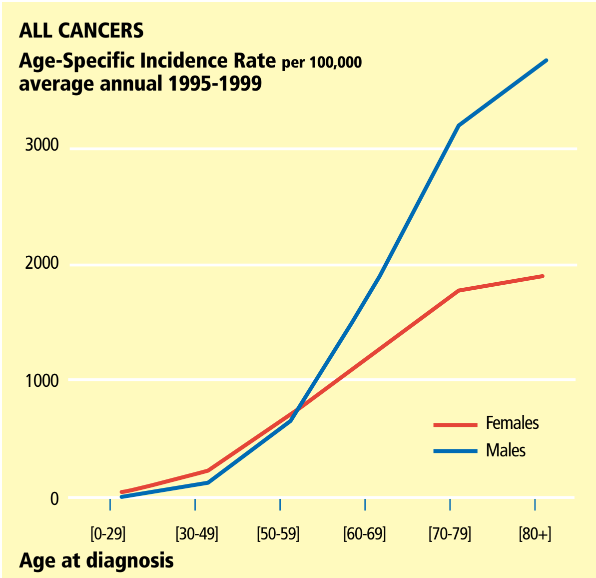


Figure 5. Age-specific incidence rate for all tumour sites combined, males and females, Nova Scotia 1995-1999.



Two factors may in part explain these elevated incidence rates for older males. Firstly, the leading cancer among men (prostate cancer) generally occurs at a much later age than the leading cancer among women (breast cancer). Secondly, males have a shorter life expectancy than females, and so while the number of new cancer cases in males and females may be similar, the number of people in the age class is shrinking more rapidly among males than females.

CHILDHOOD CANCER

Cancer in children is much less common than cancer in adults, representing less than one percent (0.8%) of all cancer cases diagnosed in the province between 1995-1999. During this five-year period, a total of 187 children aged [0-19], were diagnosed with invasive cancer, representing an annual average of 37.4 cases (Table 3).

Leukemia accounted for 31% of these cases and remained, as reported nationally, the most common of the childhood cancers (National Cancer Institute of Canada 2001). Lymphomas (17.1%) and cancers of the brain and spinal cord (17.1%) were also common (Table 3).

Differences in the incidence of childhood cancer by age and gender were not detailed in this report to maintain data confidentiality and to reduce problems associated with the computation of small numbers. However, gender differences in retinoblastoma (cancer in the retina of the eye) were evident: the frequency of its occurrence was four times higher in males than in females. Due to the small number of cases, it is impossible to demonstrate the robustness of this trend. However, similar patterns have been reported for Louisiana children: the frequency of occurrence was two times higher in males than females, with most of the cancers being found in children of the youngest age group [0-4 years] (Chen et al. 2001). When all cancers are combined, these gender differences become diminished with the male:female cancer incidence being a ratio of 5:4.

Table 3. Incidence counts[1] and rates of invasive cancer among children aged [0-19], Nova Scotia 1995-1999.

CHILDREN TUMOUR SITE	TOTAL INCIDENCE	RATIO M:F[2]	INCIDENCE RATE[3] per 1,000,000	95% CONFIDENCE INTERVAL
LEUKEMIA	58	1:1	49.1	[36.4, 61.8]
Lymphoid	44	1:1	37.6	[26.5, 48.7]
Acute Non-Lymphocytic	8	1:3	6.6	[2.0, 11.2]
Chronic Myeloid	< 5	1:2	2.5	[-0.3, 5.4]
Other	< 5	2:1	2.4	[-0.3, 5.0]
LYMPHOMAS	32	3:1	25.6	[16.7, 34.5]
Hodgkin's Lymphoma	23	3:1	18.3	[10.8, 25.8]
Non-Hodgkin's Lymphoma	7	3:1	5.6	[1.5, 9.8]
Other	< 5	na	1.7	[-0.7, 4.1]
BRAIN AND SPINAL[4]	32	1:1	26.6	[17.4, 35.8]
Ependymoma	< 5	1:1	3.4	[0.1, 6.8]
Astrocytoma	14	2:1	11.5	[5.5, 17.6]
Primitive Neuroectodermal	13	2:3	10.7	[4.9, 16.6]
Other	< 5	na	0.9	[-0.9, 2.7]
SYMPATHETIC NERVOUS SYSTEM	< 5	3:1	3.6	[0.1, 7.0]
Neuroblastoma	< 5	3:1	3.6	[0.1, 7.0]
RETINOBLASTOMA	10	4:1	9.1	[3.5, 14.8]
RENAL TUMOURS	6	1:1	5.4	[1.1, 9.7]
BONE	6	1:1	5.0	[1.0, 9.0]
SOFT TISSUE	10	3:2	8.1	[3.1, 13.1]
GERM CELL AND OTHER GONADAL	12	1:1	9.7	[4.2, 15.2]
CARCINOMAS AND EPITHELIAL NEOPLASMS	16	1:2	12.6	[6.4, 18.7]
OTHER CANCERS	< 5	na	0.8	[-0.8, 2.3]
ALL CANCERS	**187**	**5:4**	**155.5**	**[133.1, 177.8]**

1 Site-specific counts < 5 are not presented to ensure confidentiality.
2 Ratio Males:Females, not available (na) in the absence of incidence for either gender.
3 Rates are standardised to the age distribution of the 1991 Canadian population.
4 Benign and uncertain neoplasms are excluded.

IN SITU CANCER

In situ cancers are localised lesions that have not invaded beyond the epithelial layer. If left untreated, in situ malignancies may progress to become invasive cancers and metastasise to other body sites through the lymphatic system or bloodstream (National Cancer Institute of Canada 2001). A summary of the frequency of in situ cancers registered between 1995-1999 is presented in Table 4. A marked difference in the frequency of diagnosis of in situ cancers was found between genders. Of the 2,833 people diagnosed, 342 were male and 2,491 were female. The main female in situ cancers were cervical and breast cancers (70% and 16.5%, respectively of the 2,491 women). The high incidence of these female in situ cancers likely reflects the positive effects of the province-wide cervical and breast screening programs, which allows their detection at an early stage.

Table 4. Incidence counts[1] and rates of In Situ cancer among males and females, Nova Scotia 1995-1999.

Tumour Site	0-29	30-49	50-59	60-69	70-79	80+	Total Incidence	Incidence Rate[2] per 100,000
			Age at Diagnosis					
MALES								
DIGESTIVE ORGANS								
Colon and Rectum (colorectal)		6	7	15	21	8	57	2.4
RESPIRATORY SYSTEM								
Larynx		< 5	< 5	< 5	< 5	< 5	10	0.4
Lung, Trachea and Bronchus			< 5	< 5	< 5	< 5	9	0.4
SKIN								
Melanoma of Skin	< 5	17	33	42	32	21	147	6.2
GENITAL ORGANS								
Prostate			< 5	13	12	< 5	31	1.4
Penis and Male Genital Unspecified		< 5	< 5	< 5	< 5	< 5	12	0.5
URINARY ORGANS								
Bladder		< 5	12	8	19	6	49	2.1
Kidney, Ureter and Other Urinary		< 5	< 5	< 5	< 5	< 5	7	0.3
OTHER CANCERS		< 5	< 5	6	7	< 5	20	0.9
ALL CANCERS	**< 5**	**33**	**63**	**95**	**101**	**48**	**342**	**14.6**
FEMALES								
DIGESTIVE ORGANS								
Colon and Rectum (colorectal)		5	6	11	24	9	55	1.9
SKIN								
Melanoma of Skin	7	44	25	23	19	15	133	5.0
BREAST	< 5	88	139	102	63	16	410	15.2
GENITAL ORGANS								
Cervix	751	876	57	27	14	17	1,742	81.0
Body of Uterus	< 5	< 5		< 5	< 5		7	0.3
Other Female Genital	14	67	18	< 5	10	< 5	115	4.6
URINARY ORGANS								
Bladder		< 5	< 5	< 5	< 5	< 5	9	0.3
Kidney, Ureter and Other Urinary		< 5	< 5	< 5	< 5	< 5	6	0.2
OTHER CANCERS		< 5		6	< 5	< 5	14	0.5
ALL CANCERS	**775**	**1,088**	**246**	**180**	**137**	**65**	**2,491**	**108.9**

1 Age-specific/site-specific counts < 5 are not presented to ensure confidentiality.
2 Rates are standardised to the age distribution of the 1991 Canadian population.

Geographic Patterns of Cancer Occurrence

Geographical variations in the rate of cancer incidence are generally more pronounced between populations that are more disparate in genetic, social, cultural, occupational and environmental traits. The characterisation of any such differences in geographical patterns of cancer incidence is a valuable and critical first step in the identification of locally important causes of cancer (e.g., see Parkin et al. 1992).

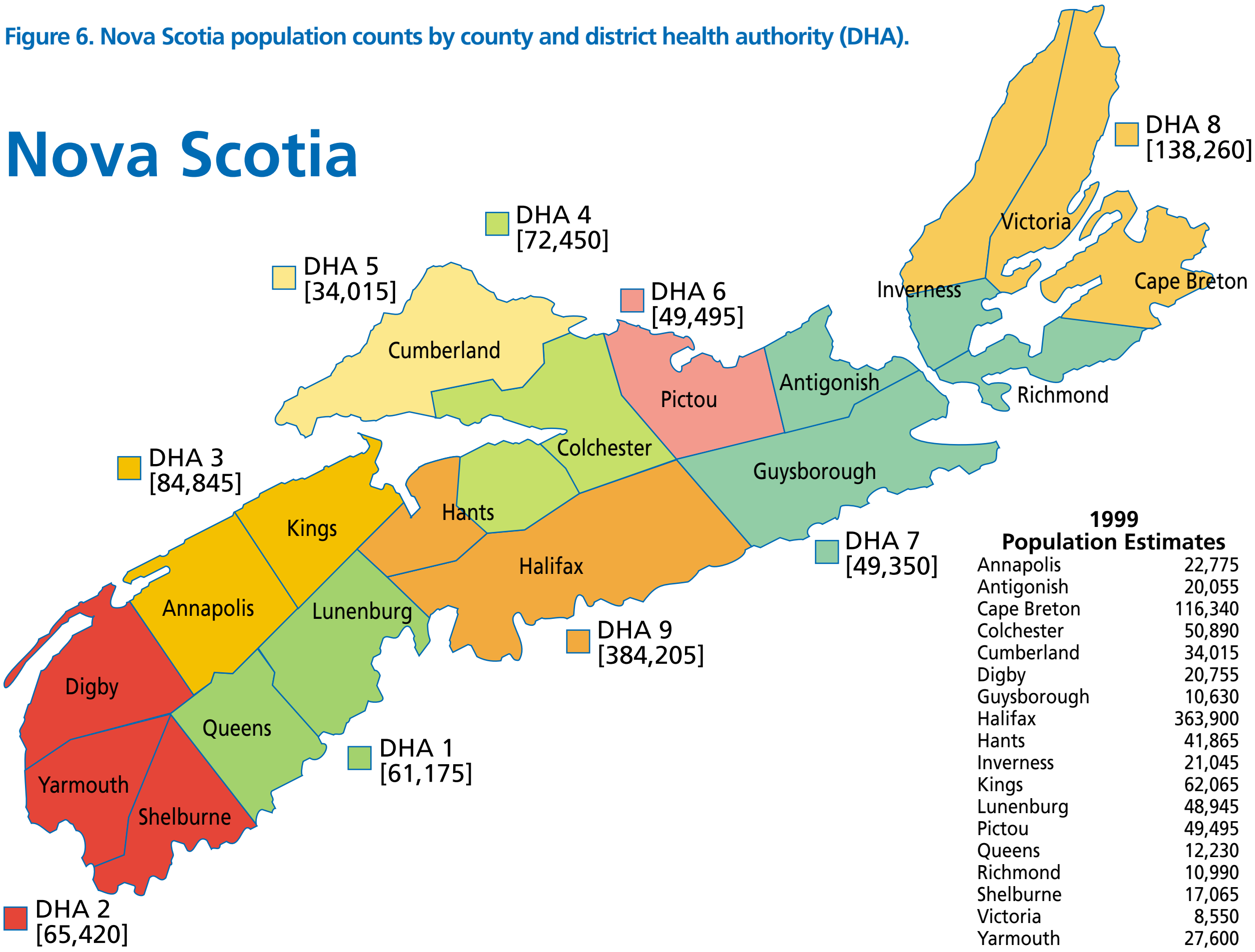
As populations in very small geographic regions (e.g., within the Province of Nova Scotia) tend to be more alike, sharing similar genetic, social, cultural, occupational and environmental traits, the geographic variations of cancer incidence also tend to be less pronounced. Nonetheless, geographic patterns do exist and this information remains essential for health care planners and providers, educators, decisions makers and the public in general, by providing an indication of the relative burden faced by each community. Due to the varied administrative needs of the above stakeholders, geographical patterns of both the rate and number of cancer incidence across Nova Scotia were characterised. This information was expressed not only at the level of counties but also using

Box 2: District Health Authorities

In this report the respective District Health Authorities are referred to as follows:

DHA1	South Shore District Health Authority
DHA2	Southwest Nova District Health Authority
DHA3	Annapolis Valley Health
DHA4	Colchester East Hants Health Authority
DHA5	Cumberland Health Authority
DHA6	Pictou County Health Authority
DHA7	Guysborough Antigonish Strait Health Authority
DHA8	Cape Breton District Health Authority
DHA9	Capital Health

Figure 6. Nova Scotia population counts by county and district health authority (DHA).



1999 Population Estimates

Annapolis	22,775
Antigonish	20,055
Cape Breton	116,340
Colchester	50,890
Cumberland	34,015
Digby	20,755
Guysborough	10,630
Halifax	363,900
Hants	41,865
Inverness	21,045
Kings	62,065
Lunenburg	48,945
Pictou	49,495
Queens	12,230
Richmond	10,990
Shelburne	17,065
Victoria	8,550
Yarmouth	27,600

District Health Authority structures (DHAs – organisational units that integrate the delivery of health care services, whose boundaries closely mirror those of the counties; see Figure 6, Box 2).

COUNTIES

Total incidence

The total incidence (counts) of cancer in both males and females was highest in Halifax and Cape Breton Counties. As more than 50% of the provincial population live in these counties, this is an expected result (Tables 5-6).

Incidence rates

All cancer sites combined

When examined in terms of the rate of cancer incidence for all cancer sites combined, some important geographic variations were observed. Among males, Inverness, Cape Breton and Antigonish Counties exhibited significantly higher rates relative to the provincial average; while Kings, Yarmouth and Colchester Counties demonstrated significantly lower rates (Figure 7).

Among females, Richmond, Victoria, Guysborough and Cape Breton demonstrated higher rates (although these latter rates were not statistically significant); while Digby, Kings, Shelburne and Colchester Counties demonstrated statistically significant lower cancer rates (Figure 7).

In only three counties were these geographical trends found to be consistent for both genders: Cape Breton County consistently demonstrated cancer rates higher than the provincial average, while

Table 5. Incidence counts and rates of invasive cancers among males, by county, Nova Scotia 1995-1999.

MALES COUNTY	TUMOUR SITE PROSTATE	COLORECTAL	LUNG	OTHER	TOTAL INCIDENCE	INCIDENCE RATE[1] per 100,000	95% CONFIDENCE INTERVAL
Annapolis	66	48	75	153	342	471.3	[420.8, 521.9]
Antigonish	63	49	33	116	261	586.1	[513.6, 658.7]
Cape Breton	441	242	363	747	1,793	582.6	[555.3, 609.8]
Colchester	167	80	116	248	611	466.8	[429.6, 504.0]
Cumberland	112	90	126	230	558	528.8	[484.6, 573.1]
Digby	89	45	63	144	341	505.0	[450.5, 559.5]
Guysborough	30	19	40	76	165	456.0	[385.9, 526.0]
Halifax	936	465	640	1,631	3,672	510.1	[493.3, 526.9]
Hants	131	77	108	220	536	543.5	[497.2, 589.8]
Inverness	91	55	57	130	333	585.5	[522.1, 648.9]
Kings	121	92	129	297	639	432.4	[398.7, 466.1]
Lunenburg	181	114	120	296	711	477.9	[442.4, 513.4]
Pictou	167	102	136	251	656	489.8	[451.9, 527.6]
Queens	40	26	45	89	200	509.3	[438.1, 580.6]
Richmond	42	28	43	90	203	542.2	[466.4, 618.0]
Shelburne	58	29	42	105	234	482.2	[420.1, 544.3]
Victoria	25	17	20	51	113	452.7	[368.4, 537.0]
Yarmouth	75	53	73	158	359	454.6	[406.8, 502.4]
All Nova Scotia[2]	**2,838**	**1,631**	**2,234**	**5,036**	**11,739**	**510.0**	**[500.7, 519.3]**

1 Rates are standardised to the age distribution of the 1991 Canadian population.
2 12 cases could not be assigned to a specific county.

Table 6. Incidence counts and rates of invasive cancers among females, by county, Nova Scotia 1995-1999.

FEMALES COUNTY	TUMOUR SITE BREAST	COLORECTAL	LUNG	OTHER	TOTAL INCIDENCE	INCIDENCE RATE[1] per 100,000	95% CONFIDENCE INTERVAL
Annapolis	73	45	38	140	296	338.2	[297.4, 378.9]
Antigonish	59	28	29	82	198	349.0	[298.5, 399.5]
Cape Breton	432	233	236	722	1,623	403.4	[383.2, 423.6]
Colchester	140	88	60	248	536	340.6	[311.1, 370.1]
Cumberland	143	95	69	210	517	396.6	[360.5, 432.6]
Digby	66	32	32	116	246	315.1	[273.7, 356.5]
Guysborough	34	24	22	75	155	409.8	[342.5, 477.1]
Halifax	1,135	498	501	1,575	3,709	386.7	[374.0, 399.3]
Hants	117	74	51	200	442	384.6	[348.1, 421.1]
Inverness	72	35	33	105	245	366.7	[318.9, 414.6]
Kings	175	92	68	268	603	337.2	[309.8, 364.7]
Lunenburg	189	89	77	310	665	388.5	[358.0, 419.0]
Pictou	172	88	94	275	629	372.4	[342.0, 402.8]
Queens	55	29	22	77	183	395.3	[336.1, 454.5]
Richmond	51	22	16	69	158	419.8	[353.0, 486.6]
Shelburne	55	27	20	78	180	327.6	[278.7, 376.5]
Victoria	31	13	10	56	110	419.6	[338.8, 500.4]
Yarmouth	98	57	45	142	342	352.3	[313.0, 391.6]
All Nova Scotia[2]	**3,097**	**1,571**	**1,425**	**4,752**	**10,845**	**377.7**	**[370.4, 384.9]**

1 Rates are standardised to the age distribution of the 1991 Canadian population.
2 8 cases could not be assigned to a specific county.

Figure 7. Comparative incidence figures (CIF) based on age-standardised incidence rates, comparing county to provincial level estimates, all cancers by gender 1995-1999.

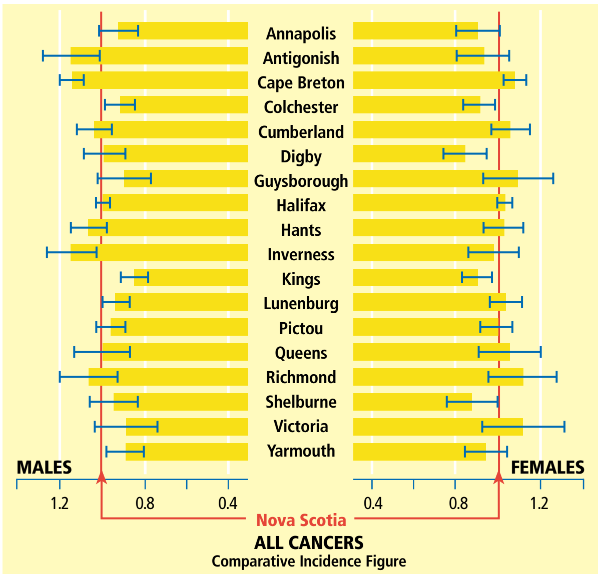
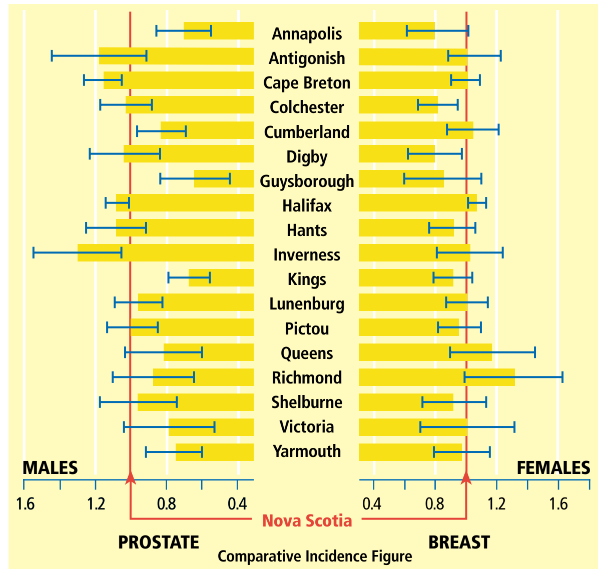


Figure 8. Comparative incidence figures (CIF) based on age-standardised incidence rates, comparing county to provincial level estimates, breast and prostate cancers 1995-1999.



The rate of cancer in a given county varies significantly from that of the province if the 95% confidence interval (⊢⊣) of the CIF value (▬) does not cross the red reference line (i.e., Nova Scotia estimate).

Kings and Colchester Counties consistently demonstrated rates lower than the provincial average. Variations in lifestyle, occupation, socio-economic status and other unaccounted risk factors may explain some of these observed patterns of geographic variations. The magnitude of their influence on the rate of cancer incidence should be further examined.

Common Tumour Sites

Males

When examined more carefully in terms of specific types of cancers in males, Inverness County's high rate clearly reflects the influence of high rates of prostate and colorectal cancers in the county (Figures 8, 10). Cape Breton County's high rates are driven by lung and prostate cancers (both of which surpass the provincial average by 21% and 15% respectively; Figures 8-9), as well as colorectal and "other" cancers (12% and 11% greater than the provincial average, respectively; Figure 10). Antigonish County's high rates are mostly attributable to the elevated rate of male colorectal cancer, which exceeds the provincial average by 54%.

In contrast, the low rates of cancers in males observed in Kings and Yarmouth Counties reflect the substantially lower rates of prostate cancer found in these counties (Figure 8). In Colchester County, it is the rate of "other" cancers (12% lower than the provincial average) that appears to drive the observation of low cancer incidence rates for males (all-sites); lung and colorectal cancer rates were also lower than the provincial average but were not statistically lower (Figures 9-10).

Females

When examined in terms of the specific types of cancers in females, Richmond County's high rate of cancer incidence seems to reflect a high rate of breast cancer incidence (Figure 8). While the rate of this malignancy was not statistically different from the provincial average, it remained the highest in Nova Scotia (31% higher than the provincial average). As

Figure 9. Comparative incidence figures (CIF) based on age-standardised incidence rates, comparing county to provincial level estimates, lung cancer by gender, 1995-1999.

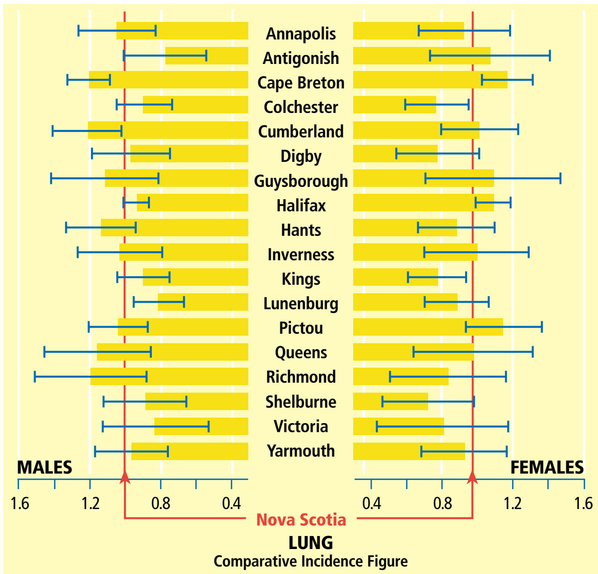
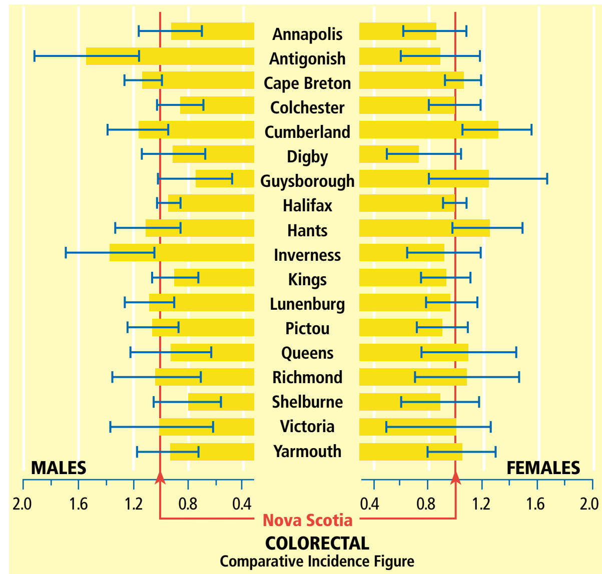


Figure 10. Comparative incidence figures (CIF) based on age-standardised incidence rates, comparing county to provincial level estimates, colorectal cancer by gender 1995-1999.



The rate of cancer in a given county varies significantly from that of the province if the 95% confidence interval (⊢⊣) of the CIF value (▬) does not cross the red reference line (i.e., Nova Scotia estimate).

such, efforts should be made to determine whether the increased occurrence of invasive breast cancer in Richmond is stable over time, or simply reflects a numerical artefact of small population size.

In Victoria and Guysborough, it is the rate of "other" cancers (35% and 19% higher than the provincial average, respectively) that appears to influence their high rates of cancer incidence in females, although the influence of variation in rates due to small population size may also play a role. Cape Breton County's high rates are mostly attributable to the elevated rate of female lung cancer, which exceeds the provincial average by 17% (Figure 9).

In contrast, the low cancer rates for females from Digby County are due to the concurrent low incidence of colorectal, lung and breast cancers (29%, 23% and 21% lower than the provincial average, respectively; Figures 8-10). In Shelburne, Colchester and Kings Counties, lung cancer incidence rates are significantly lower by 28%, 23% and 22%, respectively (Figure 9). The rate of female breast cancer in Colchester was also among the lowest of the province, ranking second behind Digby (Figure 8).

DISTRICT HEALTH AUTHORITIES

Total incidence

The total incidence (counts) of cancer between the years 1995-1999, for both males and females was again highest in the most populated DHAs (DHA 9 – Halifax and Hants Counties, and DHA 8 – Inverness, Cape Breton and Victoria Counties; Tables 7-8; Figure 6).

Incidence rates

All cancer sites combined

Among males, DHA 8 (Inverness, Cape Breton and Victoria Counties) exhibited significantly higher rates in all cancer sites combined, relative to the provincial average; while DHA 3 (Annapolis and Kings Counties) demonstrated significantly lower rates (Table 7).

Among females, DHA 8 (Inverness, Cape Breton and Victoria Counties) and DHA 5 (Cumberland County) had higher rates (although all these latter rates

Table 7. Incidence counts and rates of invasive cancers among males, by district health authority (DHA), Nova Scotia, 1995-1999.

MALES	Tumour Site						
District Health Authority	Prostate	Colorectal	Lung	Other	Total Incidence	Incidence Rate[1] per 100,000	95% Confidence Interval
DHA1	221	140	165	385	911	484.4	[452.6, 516.1]
DHA2	222	127	178	407	934	478.2	[447.1, 509.2]
DHA3	187	140	204	450	981	443.8	[416.0, 471.6]
DHA4	230	109	176	350	865	493.4	[460.3, 526.5]
DHA5	112	90	126	230	558	528.8	[484.6, 573.1]
DHA6	167	102	136	251	656	489.8	[451.9, 527.6]
DHA7	157	113	132	322	724	529.4	[490.4, 568.3]
DHA8	535	297	424	888	2,144	577.9	[553.2, 602.5]
DHA9	1,004	513	688	1,749	3,954	511.0	[494.8, 527.2]
All Nova Scotia[2]	**2,838**	**1,631**	**2,234**	**5,036**	**11,739**	**510.0**	**[500.7, 519.3]**

1 Rates are standardised to the age distribution of the 1991 Canadian population.

2 12 cases could not be assigned to a specific county.

Table 8. Incidence counts and rates of invasive cancers among females, by district health authority (DHA), Nova Scotia, 1995-1999.

FEMALES	Tumour Site						
District Health Authority	Breast	Colorectal	Lung	Other	Total Incidence	Incidence Rate[1] per 100,000	95% Confidence Interval
DHA1	244	118	99	387	848	389.7	[362.6, 416.8]
DHA2	219	116	97	336	768	332.8	[308.2, 357.3]
DHA3	248	137	106	408	899	338.3	[315.6, 361.1]
DHA4	203	122	81	338	744	358.9	[332.7, 385.0]
DHA5	143	95	69	210	517	396.6	[360.5, 432.6]
DHA6	172	88	94	275	629	372.4	[342.0, 402.8]
DHA7	173	83	81	264	601	387.8	[355.8, 419.7]
DHA8	506	272	265	845	1,888	398.8	[380.3, 417.4]
DHA9	1,189	538	531	1,685	3,943	384.8	[372.6, 397.0]
All Nova Scotia[2]	**3,097**	**1,571**	**1,425**	**4,752**	**10,845**	**377.7**	**[370.4, 384.9]**

1 Rates are standardised to the age distribution of the 1991 Canadian population.

2 8 cases could not be assigned to a specific county.

were not statistically significant); while DHA 3 (Annapolis and Kings) and DHA 2 (Digby, Yarmouth and Shelburne Counties) had significantly lower cancer rates (Table 8).

CONCLUDING COMMENTS

A variety of factors may account for the observed differences in the rate of cancer incidence at the intra-provincial level, and so the interpretation of even the largest differences must be done cautiously. Random (chance) variations become quite important when population size is small. Only continued monitoring can confirm if such trends are numerical artefacts or real patterns. Cancers also have variable latent phases. As such, a high incidence rate observed at one time more likely relates to causes from a very different time period. Similarly, due to the high mobility of individuals, exposure to risk factors becomes even more decoupled from the actual manifestation of a cancer.

It is beyond the scope of this study to determine which of these or other unaccounted factors (e.g., variations in the utilisation or implementation of screening and early detection programs such as mammography and prostate specific antigen (PSA) tests) are involved in producing the observed geographical patterns of cancer incidence. More careful analysis and continued monitoring is required to arrive upon clear and reliable answers.

Trends in Cancer Incidence and Mortality

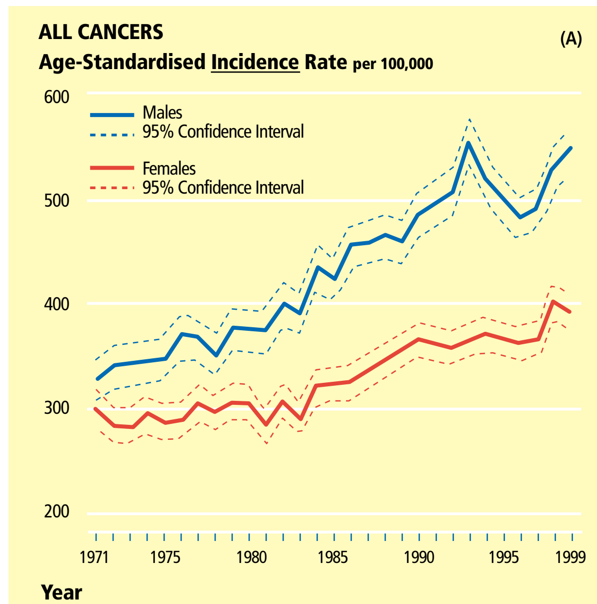
An historical analysis of the trends in cancer incidence and mortality can provide key information on the potential causes of cancer and the success (or lack thereof) of prevention and intervention efforts. The difficulty in such historical analyses is the sheer complexity and number of factors that can influence the onset and terminal result of cancer: exposure to risk factors (e.g., age, physical activity, diet, smoking, ionising or solar radiations, alcohol, drugs, parasites, viruses, environmental and or occupational exposure), time lags in the manifestation of the disease, varying degrees of effort in detecting the disease, availability and improvements in therapies and interventions, variations in population structure due to selective immigration/emigration, variations in age-structure, life-style changes and education. This section therefore describes the observed patterns of cancer incidence and cancer-related mortality for the whole of Nova Scotia with the above proviso. Analyses include data for the study period of 1971-1999 with emphasis on common tumour types.

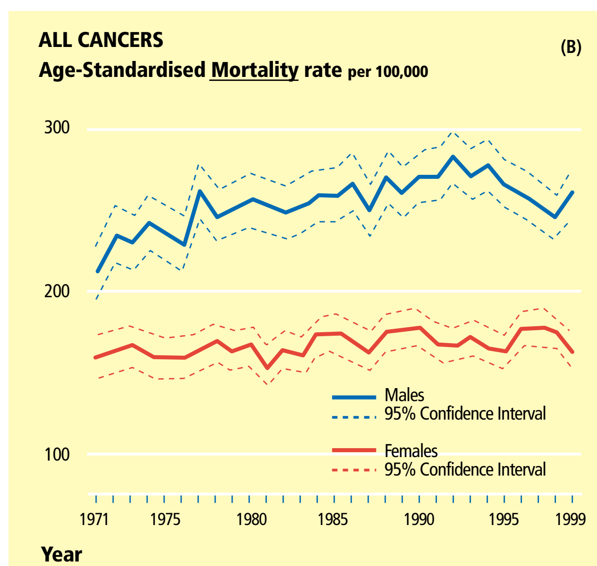
ALL CANCER SITES COMBINED

During the study period (1971-1999), cancer incidence and mortality rates were consistently higher for males than females (Figure 11A).

Cancer incidence rates for both genders also increased during this period. Male cancer incidence rates increased 67.5% (from 327 to 548 cases per 100,000), which was more than double the increase of 30.6% (from 300 to 392 cases per 100,000) observed for females. These increasing rates of cancer incidence (i.e., the slopes in Figure 11A) translate to an average increase of 8 additional cancer cases per 100,000 per year for males, and an increase of 4 cancer cases per 100,000 per year for females.

Figure 11. Trends in age-standardised incidence (A) and mortality (B), rates of cancer (all sites), males and females, Nova Scotia 1971-1999.





During more recent years (1984 to 1999), this increasing trend diminished slightly for males (dropping to 6.5 additional cancer cases per 100,000 per year), while the incidence rates remained constant for females at 4.4 per 100,000 per year. In other words, gender-related differences in the rate of cancer incidence have diminished/narrowed in more recent years.

During the study period (1971-1999), the mortality rates due to cancers (all sites combined) also increased (Figure 11B). However, these increases were higher for males (22.9%; from 213 to 261 deaths per 100,000) than for females (2.0%; from 160 to 163 deaths per 100,000). These differences represent an additional 48 deaths due to cancer per 100,000 for males and an additional 3 deaths due to cancer per 100,000 for females, by the year 1999 (relative to 1971).

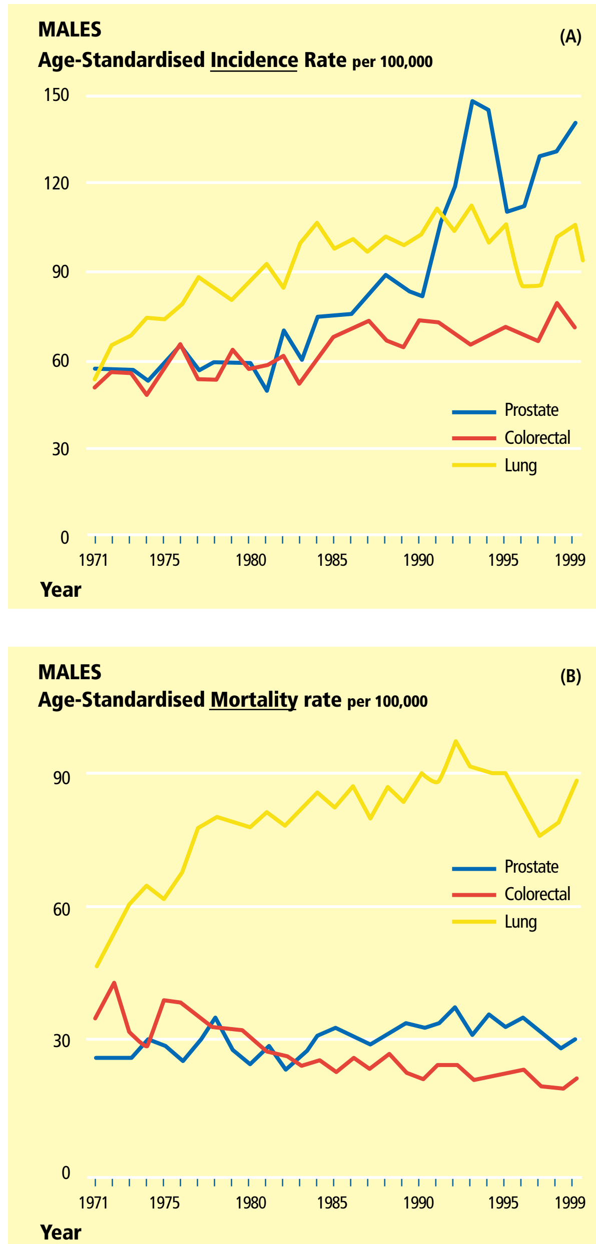
The above patterns of cancer incidence and mortality due to cancer are not congruent. To understand this difference, a closer look at the common tumour sites is required (below).

COMMON TUMOUR SITES

Males

For males, the most pronounced increases in incidence rates were for prostate cancer, more than doubling during the study period (from 57 to 140 per 100,000; Figure 12A). In strict contrast, age-standardised mortality rates attributable to prostate cancer were stable during this period (Figure 12B). This appears to indicate that much of the variation in incidence rates is due to changes in the methods of detection of this disease. Prior to 1990, the increasing use of surgical techniques for the management of benign prostatic conditions (e.g., trans-urethral resection of the prostate or "TURP", see Coleman et al. 1999, National Cancer Institute of Canada 2001) likely resulted in the gradual increase of prostate cancer incidence rates. However, the more rapid post 1990 (and in particular, the period 1991-94) exponential increases in incidence rates are likely attributable to the wide adoption of early detection procedures based upon the determination of PSA (Prostate-Specific Antigen)

Figure 12. Trends in age-standardised incidence (A) and mortality (B) rates for common tumour sites, males, Nova Scotia 1971-1999.



Note that the observed increase in the rate of lung cancer incidence and mortality for the years 1998-1999 appears greater than that reported at the national level. However, preliminary analyses for the year 2000 and 2001 show important declines in the rate of invasive lung cancer incidence.

level. The downturn observed in the age-standardised incidence rate in the mid 1990's may be due to more conservative use of PSA testing.

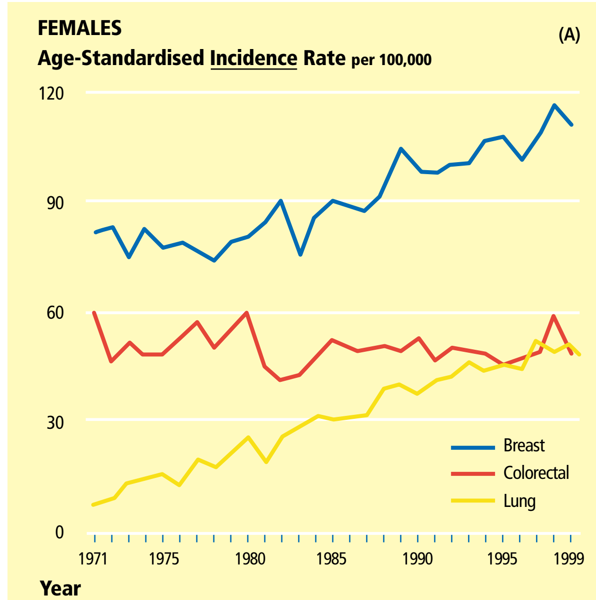
As with prostate cancer, lung cancer incidence rates doubled over the study period (from 53 to 106 per 100,000; Figure 12A). However, the incidence rates increased rapidly prior to 1985, plateaued between the years 1984 to 1995, and even slightly decreased between 1996-1998. This latter decline in the rate of increase of lung cancer among males is consistent with national trends. These national shifts have been attributed to a reduction in male tobacco consumption in the mid-1960s (National Cancer Institute of Canada 2001). Mortality rates for males are dominated by lung cancers and correspond closely to their incidence rates during the study period (Figure 12B).

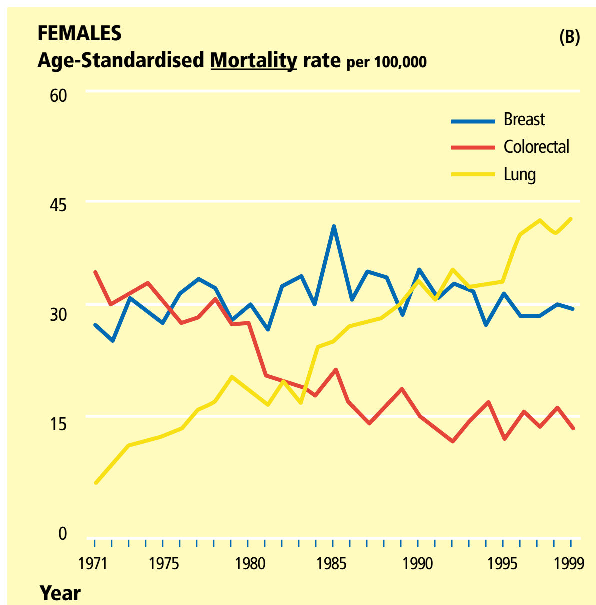
Colorectal cancer incidence rates for males increased 43% (from 50 to 71 per 100,000) during the study period. Most of this increase occurred between 1983-87, after which the trends remained stable (Figure 12A). In strong contrast, mortality rates associated with colorectal cancer declined 40% during the study period (Figure 12B). Some evidence suggests increased casual screening efforts, education, changes in lifestyle (e.g., diet, exercise) and more refined surgical interventions may be contributing to these trends (Troisi et al. 1999, Chu et al. 1995, National Cancer Institute of Canada 2001).

Females

Among females, breast cancer incidence rates are dominant (Figure 13A), although this is not the case with mortality rates (Figure 13B). Incidence rates increased 35% (from 83 to 112 cases per 100,000) during the study period, with most of the increase occurring after 1984. In distinct contrast, mortality rates were generally stable and even declined during the period after 1984. This latter decline in mortality rates associated with breast cancer has also been reported elsewhere (United States, United Kingdom, Australia; see National Cancer Institute of Canada 2001). The cause of this decline is uncertain, but among the potential causes are: early detection through screening, improved treatment and changes in risk or protective factors.

Figure 13. Trends in age-standardised incidence (A) and mortality (B) rates for common tumour sites, females, Nova Scotia 1971-1999.

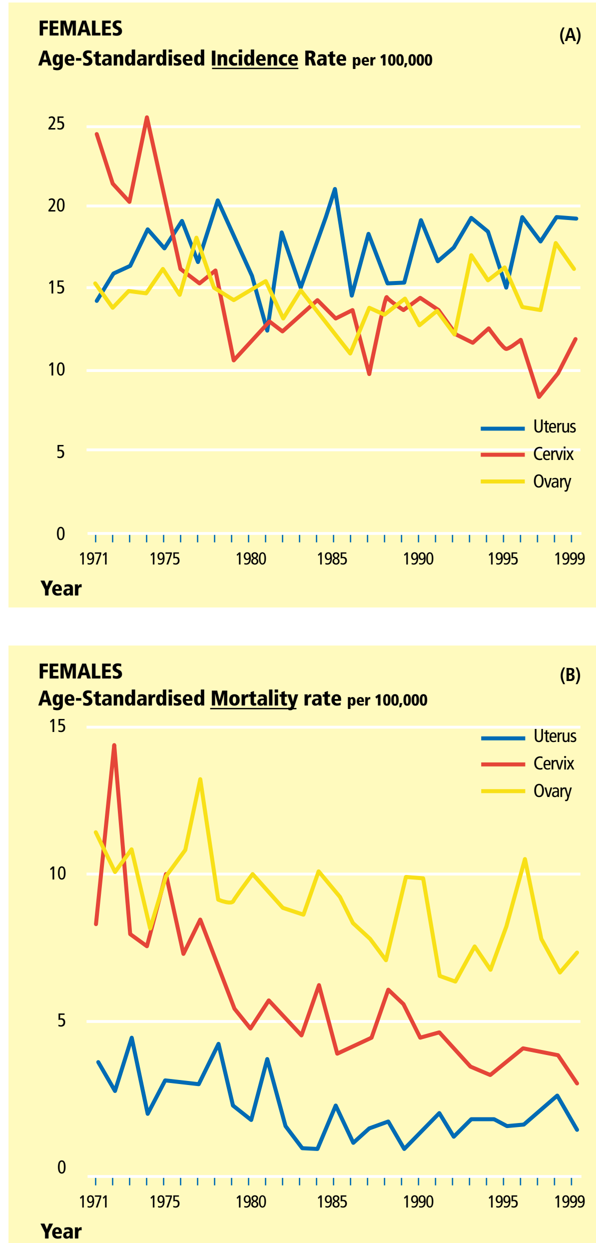




Variations in lung cancer incidence and mortality rates were striking (Figures 13A, 13B). Consistent and parallel increases in both rates were seen during the study period. Similar increases have been reported in other areas of the world and have been associated with the growing popularity of tobacco consumption among women (Schottenfeld and Fraumeni 1996). At the national level, lung cancer incidence has plateaued since 1992—no such pattern was evident in Nova Scotia. While both incidence and mortality rates are still lower than that of males, they have rapidly reached the levels of pre-1971 males.

Colorectal cancer incidence rates for females remained stable between 1971 and 1999, while mortality rates declined significantly (61%; from 36 to 14 cases per 100,000; Figure 13). As mentioned earlier, alterations in lifestyle and increased early detection and more refined surgical interventions may in part, be responsible for the reduction in mortality rates. These declines in both incidence and mortality rates for colorectal cancers were more pronounced for females than males.

Figure 14. Trends in age-standardised incidence (A) and mortality (B) rates for selected tumour sites, females, Nova Scotia 1971-1999.



The trends for the incidence and mortality rates for cancers of the cervix, uterus and ovary are presented in Figure 14A-B. Between 1971-1999, mortality rates associated with these cancers decreased, 66%, 65% and 36% respectively. However, trends in the incidence of these cancers were not consistent. The incidence rates of uterine cancer fluctuated from 12 to 21 cases per 100,000 annually, with no clear trend. The incidence rates of ovarian cancer also fluctuated between 11 to 18 cases per 100,000. The consistent decrease in mortality rates and stable incidence rates associated with uterine and ovarian cancers seems to indicate improvements in the management and treatment of these diseases. Cervical cancers however, demonstrated striking declines in their incidence (52% decrease; Figure 14A). The correlated decrease in mortality rates associated with cervical cancers suggests improvements in the early detection and treatment of this disease. The incidence rates declined most rapidly between 1971-1981, a decline that is largely attributable to the broad application of cervical cytology screening tests (Papanicolaou or "Pap" tests). Incidence rates subsequently plateaued for a ten-year period and then declined again between 1990-1999. This latter decline coincides closely with the diligent efforts of the Nova Scotia Gynaecological Cancer Screening Programme (NSGCSP) that was officially recognized as a provincial program by the Department of Health in 1991. The increases in incidence rates in 1998 and 1999 may reflect the recent efforts to target for screening, "never screened" and "under-screened" women.

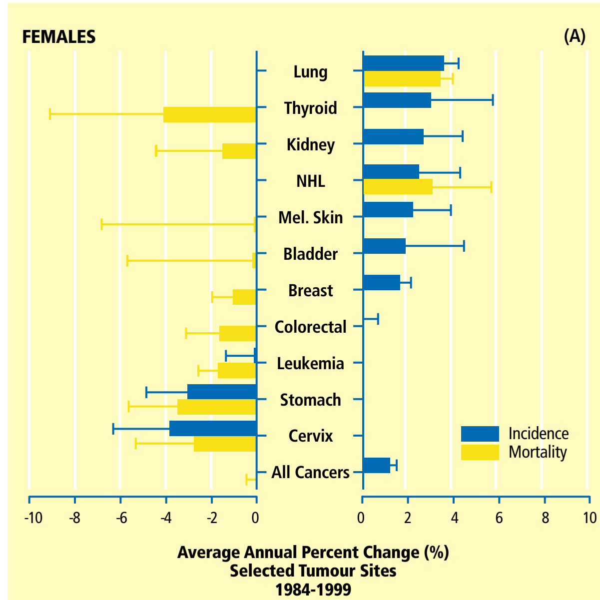
CONCLUDING COMMENTS

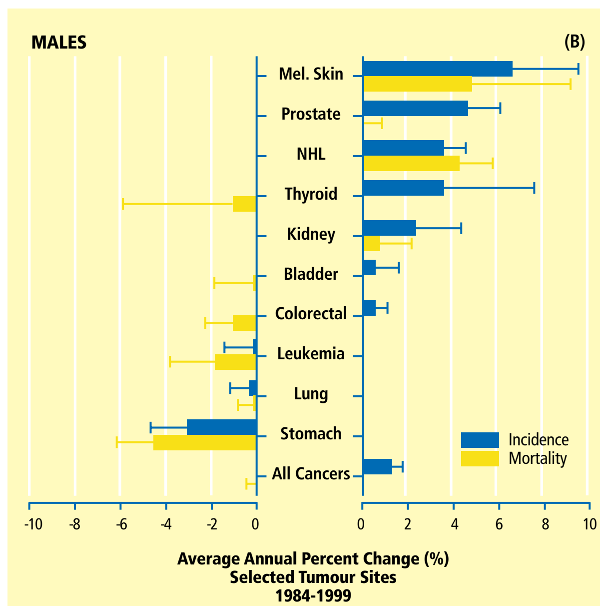
In Nova Scotia, the rates of cancer incidence continue to increase at an average annual rate of 1.2% and 1.4%, for males and females, respectively, since 1984. However, mortality rates due to cancer remain stable (see Figures 15A, 15B).

1. The overall increase in the rates of cancer incidence among females is largely driven by the rising incidence of breast and lung malignancies. Between 1984-1999, the rates of lung cancer increased on average, 3.6% annually, showing the highest rate of increase of all cancers diagnosed among women (Figure 15A). The rate of increase in breast cancer was lower (1.3%) but remained important due to the large number of women diagnosed with the disease each year (Figure 15A).

2. The overall increase in the rates of cancer incidence among males is largely driven by the growing incidence of prostate cancer. Prior to 1984, the high incidence rates of lung cancer were most probably an important factor (see Figure 12).

Figure 15. Average annual percent change (AAPC) in age-standardised incidence rates, selected tumour sites, females (A) and males (B), Nova Scotia 1984-1999. A 95% confidence interval (|—) is presented for each estimate.





3. Gender differences in overall cancer rates (see Figure 11) reflect the higher incidence of lung malignancies among males. In the early 1970s, the number of males diagnosed with lung cancer was 5.7 times greater (177 per 100,000)

than the number of females (31 per 100,000). Gender discrepancies remained significant in recent years, despite the rising incidence of lung malignancies among females. This is due in part, to the increased incidence of prostate cancer among males in the mid 1980s (see Figure 12), increasing 4.7% annually (between 1984-1999; Figure 15B).

4. Six tumour types were observed to increase at an average annual incidence rate greater than 2% among males and females since 1984. These tumours were melanoma of the skin (6.8%), prostate (4.7%), non-Hodgkin's lymphoma (3.7%), thyroid (3.0%) and kidney (2.4%) in males; and lung (3.6%), thyroid (3.0%), kidney (2.7%), non-Hodgkin's lymphoma (2.5%) and melanoma of the skin (2.2%) in females (Figure 15A-B). However, increased mortality rates were only associated with melanoma of the skin (4.8%), non-Hodgkin's lymphoma (4.3%) and to a lesser extent, kidney (0.7%) in males; and with lung (3.4%) and non-Hodgkin's lymphoma (2.9%) in females (Figure 15A-B).

5. Large declines in incidence and mortality rates were observed for two tumour types: stomach and cervical cancers. Decreased incidence and mortality rates for stomach cancer in males (3.0% and 4.6%, respectively) and females (3.0% and 3.5%, respectively) may be attributable to improved diets and lifestyles, while declines in the average annual incidence and mortality rates for cervical cancer (3.8% and 2.8%, respectively) are largely attributable to early detection through organised screening programmes (see National Cancer Institute of Canada 2001).

Not surprisingly, the temporal variations of cancer incidence and mortality rates observed for Nova Scotia are largely consistent with those reported at the national level (National Cancer Institute of Canada 2001). However, some distinct differences were detected: the incidence of some cancers increases at a higher rate in Nova Scotia (e.g., melanoma of the skin in males 6.8% in Nova Scotia vs. 2.7% in Canada), while that of others decline at a faster rate (e.g., cervical cancer in females 3.8% in Nova Scotia vs. 1.6% in Canada). Continued monitoring is necessary to understand these differences.

Cancer Survival

Cancer survival refers to the amount of time between first diagnosis and death of a cancer patient (Schottenfeld and Fraumeni 1996, Fitzpatrick and Gavin 2001). Information on how long a patient is likely to live is of considerable interest not only for the patient diagnosed with cancer but also to health care professionals as it provides a measure of the success (or lack thereof) of treatments (Box 3).

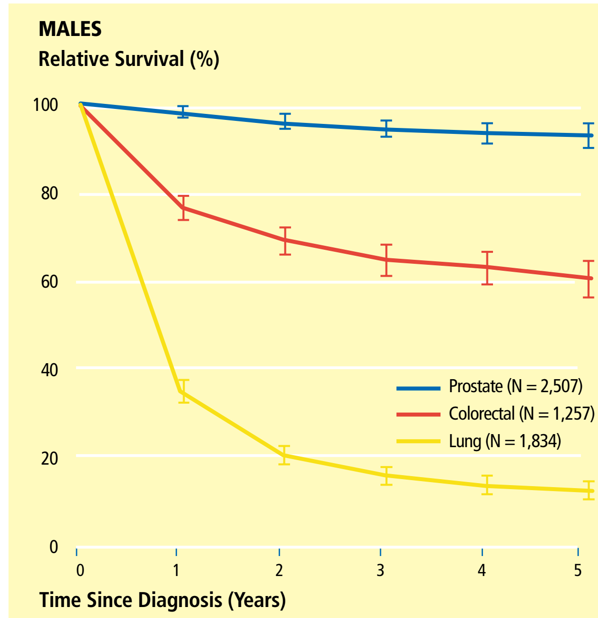
The survival of cancer patients is influenced by many factors: type of cancer; age at diagnosis; gender; socio-economic status; extent (stage) of disease (Box 1); rate of tumour development (fast or slow growth); location of the disease; presence of co-morbidity; availability of cancer treatments and supportive care; variation in diagnostic techniques; prior health; and random chance. Due to limitations of time and data availability, a complete analysis of these factors was beyond the scope of this report. Further, factors such as lead-time and length bias associated with the introduction of screening programs were also not investigated.

Box 3: A Measure of Prognosis

Survival rates measure prognosis. They are influenced by the nature of the disease, the ability to cure the disease, as well as the stage/extent of the disease at the time of diagnosis. In cancer research, the prognosis of a patient may be categorised as (McLaughlin et al. 1995):

Excellent prognosis	Five-year relative survival rates 85%
Good prognosis	Five-year relative survival rates 70-84%
Fair prognosis	Five-year relative survival rates 30-69%
Poor prognosis	Five-year relative survival rates < 30%

Figure 16. Five-year relative survival for common tumour sites, males, Nova Scotia 1992-1996.
The total number of cases (N) retained for analysis appears in parenthesis and a 95% confidence interval (⊢⊣) is presented for each estimate.



In this section, we focus upon the survival of Nova Scotians diagnosed with the major invasive tumours (prostate, breast, lung and colorectal cancers) for the years of 1992-1996. Their five-year survival is reported as a function of age, gender, tumour type and disease extent at the time of diagnosis. To account for the age and gender dependence of survival rates, survival is expressed relative to the background mortality rates of the general population, unaffected by cancer.

COMMON TUMOUR SITES

Males

Prostate cancer – Males

The relative cancer survival rates for males diagnosed with invasive cancers were highest for prostate cancer, followed by colorectal and lung cancers (Figure 16). The one-year survival rate for males diagnosed with prostate cancer was 98% of the survival rate of the general population. The five-year survival rate was 93%. These survivorship estimates are excellent (Box 3) and exceed those reported elsewhere in Canada (69 to 91%; Ellison and Gibbons 2001) and Europe (42 to 69%; Coleman et al. 1999, Fitzpatrick and Gavin 2001) but may in part reflect a bias attributable to the wide adoption of PSA testing (Prostate-Specific Antigen) during the study period of 1992-1996. The early detection of a large number of latent and/or indolent cases or invasive but asymptomatic cases increase survival estimates as these diagnosed patients will appear to live longer with the disease (e.g., Ellison and Gibbons 2001).

Survival for prostate cancer was strongly dependent upon the stage of the cancer at diagnosis, with only 27% of patients diagnosed with distant malignancies living beyond five years (Figure 17). Fortunately, the majority of patients were diagnosed with local malignancies (53% or 1,331 of 2,507 cases) for which the five-year relative survival rate was 99%.

Figure 17. Prostate cancer survival by extent of disease, males, Nova Scotia 1992-1996.
The total number of cases (N) retained for analysis appears in parenthesis and a 95% confidence interval (⊢⊣) is presented for each estimate.

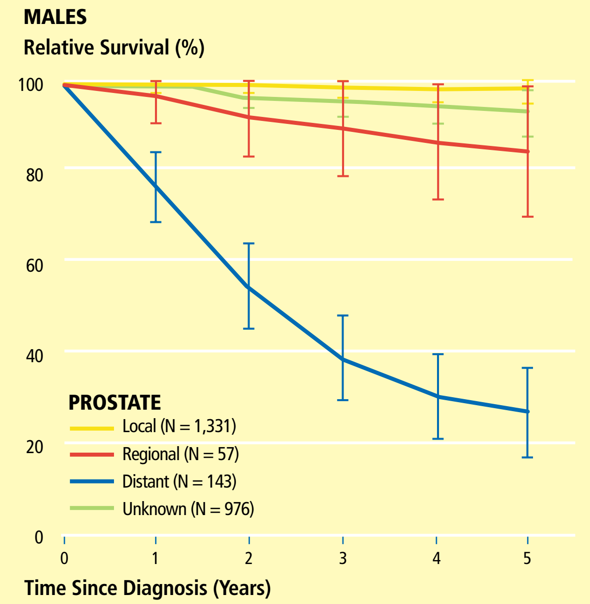


Table 9. Age-specific relative survival rates at one, three and five years, common invasive cancers, by gender, Nova Scotia 1992-1996.

MALES	AGE	RELATIVE SURVIVAL (%)[1] 1 year		3 year		5 year	
prostate	[20-54]	97.2	[92.8, 100.5]	88.3	[79.7, 96.9]	85.8	[76.0, 95.6]
	[55-69]	98.6	[97.4, 99.9]	94.7	[92.5, 97.0]	93.1	[90.0, 96.1]
	[70+]	98.5	[97.0, 100.0]	95.2	[92.5, 98.0]	93.5	[89.5, 97.5]
lung	[20-54]	40.6	[33.7, 47.6]	17.3	[11.8, 22.7]	15.6	[10.2, 20.9]
	[55-69]	37.4	[33.8, 41.0]	17.0	[14.1, 19.9]	13.4	[10.6, 16.3]
	[70+]	32.0	[28.8, 35.2]	15.1	[12.4, 17.8]	11.0	[8.3, 13.7]
colorectal	[20-54]	83.2	[77.1, 89.2]	62.9	[55.1, 70.8]	56.6	[48.2, 65.1]
	[55-69]	79.8	[75.8, 83.9]	67.5	[62.5, 72.5]	61.1	[55.3, 66.9]
	[70+]	73.1	[69.2, 77.0]	63.6	[58.6, 68.6]	61.8	[55.2, 68.3]
FEMALES							
breast	[15-39]	97.0	[94.0, 100.0]	81.5	[74.7, 88.2]	70.0	[61.7, 78.3]
	[40-49]	98.2	[96.8, 99.7]	90.4	[87.2, 93.5]	82.1	[77.7, 86.5]
	[50-69]	97.0	[95.8, 98.2]	90.1	[88.1, 92.2]	83.8	[81.0, 86.6]
	[70+]	92.7	[90.6, 94.8]	87.1	[83.8, 90.3]	82.5	[78.2, 86.8]
lung	[20-54]	43.1	[35.3, 51.0]	22.6	[16.0, 29.3]	16.6	[10.3, 23.0]
	[55-69]	43.3	[38.3, 48.3]	25.4	[20.8, 29.9]	18.0	[13.8, 22.2]
	[70+]	37.9	[33.4, 42.5]	18.1	[14.3, 21.9]	12.3	[8.7, 15.9]
colorectal	[20-54]	85.0	[79.0, 91.0]	66.7	[58.7, 74.7]	62.3	[53.8, 70.8]
	[55-69]	79.9	[75.4, 84.3]	62.6	[57.1, 68.2]	59.3	[53.3, 65.2]
	[70+]	72.9	[69.4, 76.4]	60.4	[56.1, 64.8]	54.1	[48.9, 59.3]

1 95% confidence intervals are shown in parentheses.

The prognosis for prostate cancer was also influenced by the age of the patient at diagnosis. Survival was poorer for younger men than for older men (Table 9). Patients aged [20-54] had relative survival rates of 86%, whereas patients aged [70+] had relative survival rates of 94%. The significance of these differences could not be tested with any reliability due to the small number of young men diagnosed with prostate cancer and the small population base in Nova Scotia. However, similar patterns have been reported elsewhere—the cause is not well understood (Coleman et al. 1999, Ellison and Gibbons 2001).

Lung cancer – Males

The relative survival rates associated with lung cancer were much lower than that of prostate cancer. The one-year relative survival rate was 35% that of the general population. The five-year relative survival rate was 13% (Figure 16). The five-year survival rate was significantly higher for cases diagnosed with a local extent (Figure 18). However, the prognosis for these cases remained poor with only a third of the cases (37%) living beyond five years (Box 3).

A large proportion of lung cancer patients were diagnosed at an advanced stage for which curative treatment is unavailable (distant metastasis, 29% relative to 17% and 6% for colorectal and prostate cancers, respectively). This may be due, in part, to the largely asymptomatic nature of the disease at earlier stages.

Most studies observe reduced survival rates with increasing age at diagnosis of lung cancer (Wingo et al. 1998, Zhang et al. 1998, Coleman et al. 1999, Ellison and Gibbons 2001, Fitzpatrick and Gavin 2001). This however, was not observed for Nova Scotian males. Clear patterns were not evident.

Approximately 85% of all lung tumours diagnosed in Nova Scotia between 1992-1996 were non-small cell cancers for which surgery is potentially curative. However, according to Coleman et al. (1999), less than 20% of patients with non-small cell cancers are operable. As such, lung cancer mortality trends continue to track those for incidence with little improvement being observed in the rates of lung cancer survival over time. It is obvious that the major hope in controlling lung cancer is through primary prevention by reducing and eliminating smoking (Wynder 1989).

Colorectal cancer – Males

The one-year relative survival rate associated with colorectal cancer was 77%, and 61% at five years (Figure 16). Again, survival was higher in cases diagnosed with a local extent (87% survivorship), relative to cases diagnosed with regional (48% survival) or distant malignancies (6% survival; Figure 19). Five-year survival rates did not vary significantly with age (Table 9). However, younger men (aged 20-54 years) did show better one-year survivorship, than men aged [70+ years].

Females

Breast cancer – Females

The relative survival rates for females diagnosed with invasive cancers were highest for breast cancer,

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Figure 18. Lung cancer survival by extent of disease, males, Nova Scotia 1992-1996.

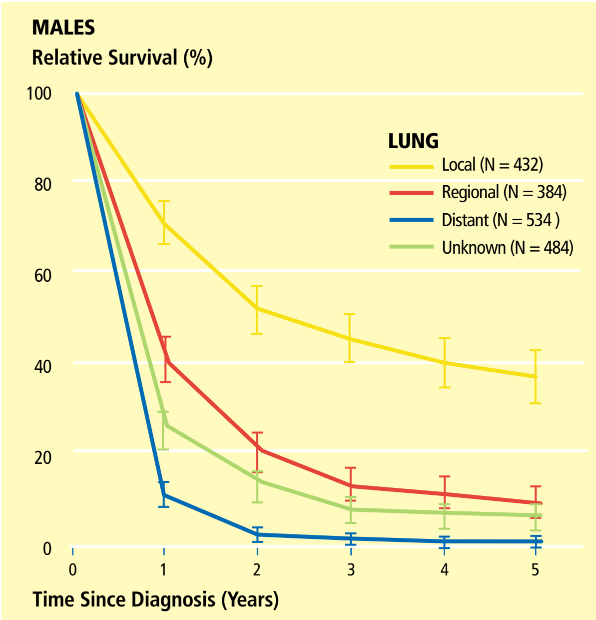
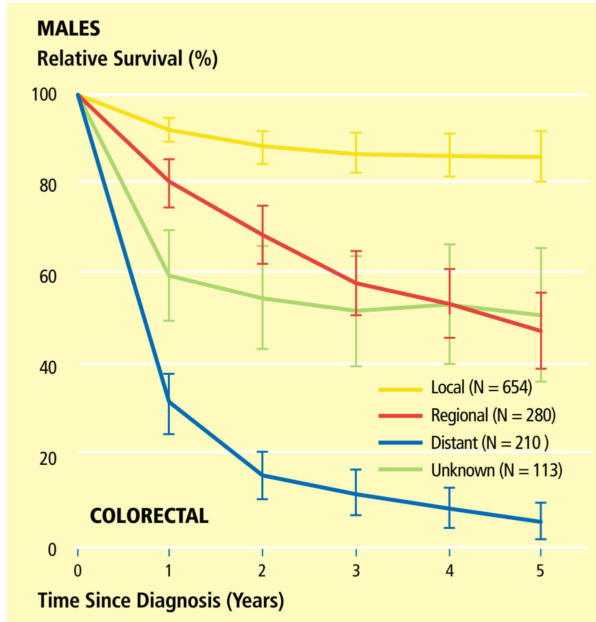


Figure 19. Colorectal cancer survival by extent of disease, males, Nova Scotia 1992-1996.



The total number of cases (N) retained for analysis appears in parenthesis and a 95% confidence interval (⊢⊣) is presented for each estimate.

followed by colorectal and lung cancers (Figure 20). The one-year survival of the 2,496 women diagnosed with invasive breast cancer was 96%; the five-year survival was 82% (Figure 20). This positive, short-term prognosis for women diagnosed with breast cancer was consistent with national trends (e.g., see Ellison and Gibbons 2001).

The stage of the tumour at diagnosis was an important determinant of the survival of patients (Figure 21). The five-year survival for women diagnosed with local tumours was 95%, whereas patients diagnosed with more advanced distant metastases had a five-year survivorship of 15%. Importantly, the proportion of women diagnosed with advanced breast tumours (6%) was considerably less than that for colorectal (15%) or lung cancers (31%). This early detection of breast tumours relative to the other major tumours is attributable to the combined influence of extensive mammographic screening efforts and the more easily detected nature of the disease itself in the early stages of its onset.

The age of a patient at diagnosis was a secondary, although still important determinant of prognosis. Younger women had lower survival rates than older women (Table 9). The five-year relative survival rate for patients aged [15-39] was 70%, whereas for patients aged [40-49], [50-69] and [70+] were respectively, 82%, 84% and 83%. While these age-dependent differences in relative survival rates were not statistically significant, the pattern is consistent with the findings of other studies (Host and Lund 1986, De La Rochefordiere et al. 1993, Guinee et al. 1994, Leon et al. 1995, Kroman et al. 1997, Olson et al. 1998, Dixon and Hortobagyi 2000, Kroman et al. 2000 Reeves et al. 2000). The lack of statistical

Figure 20. Five-year relative survival for common tumour sites, females, Nova Scotia 1992-1996.

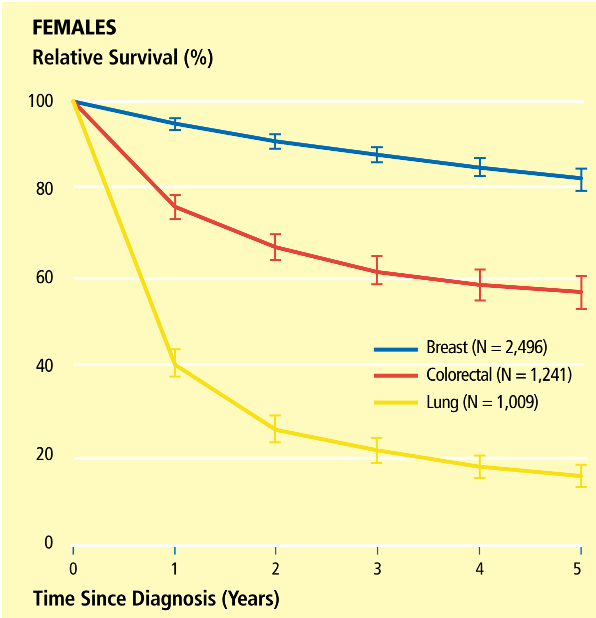
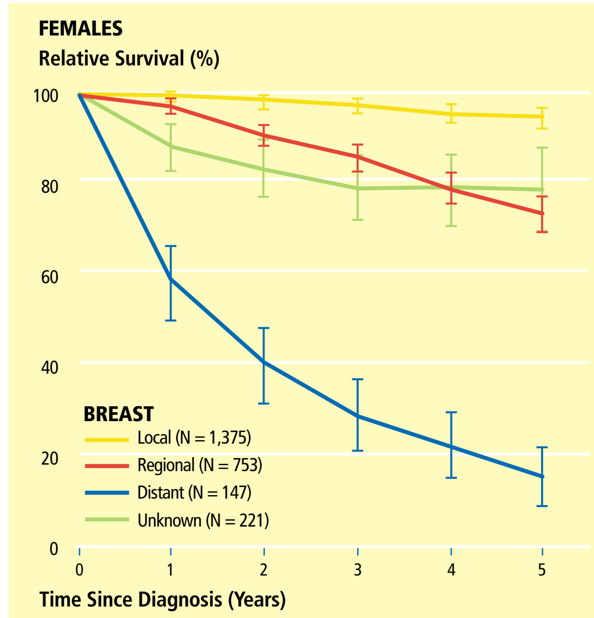


Figure 21. Breast cancer survival by extent of disease, females, Nova Scotia 1992-1996.



The total number of cases (N) retained for analysis appears in parenthesis and a 95% confidence interval (⊢⊣) is presented for each estimate.

significance in Nova Scotia is likely a statistical artefact of the rare occurrence of the disease in young women and the small total population size found in the province. The cause of this lower relative survival in younger patients is not completely understood. Among the potential determinants are:

- Tumours in younger patients may be more aggressive and rapidly developing (De La Rochefordiere et al. 1993, Peer et al. 1996, Dixon and Hortobagyi 2000, Ellison and Gibbons 2001).
- Detection is more difficult due to the higher density of breast tissue in younger women.
- Pregnancy or lactation prevents or reduces the likelihood of detection or administration of therapy. Women diagnosed while pregnant or within five years of giving birth show very poor prognoses (Guinee et al. 1994, Leon et al. 1996, Kroman et al. 1997; 1998, Olson et al. 1998, Reeves et al. 2000). Currently the relative importance of this factor is debated as some studies suggest young age at diagnosis to be the important determinant of survival (see Reeves et al. 2000).
- Hereditary (genetic) influences (Rochefordiere et al. 1993).
- The gender of the first child (Janerich et al. 1994).
- The failure of administering chemotherapy in low risk, young patients (Kroman et al. 2000).

Prevention remains the most effective means of cancer control.

Figure 22. Lung cancer survival by extent of disease, females, Nova Scotia 1992-1996.
The total number of cases (N) retained for analysis appears in parenthesis and a 95% confidence interval (⊢⊣) is presented for each estimate.

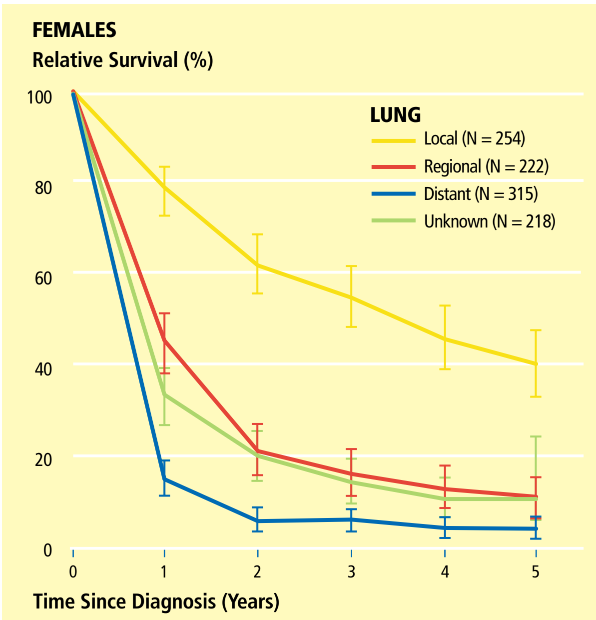
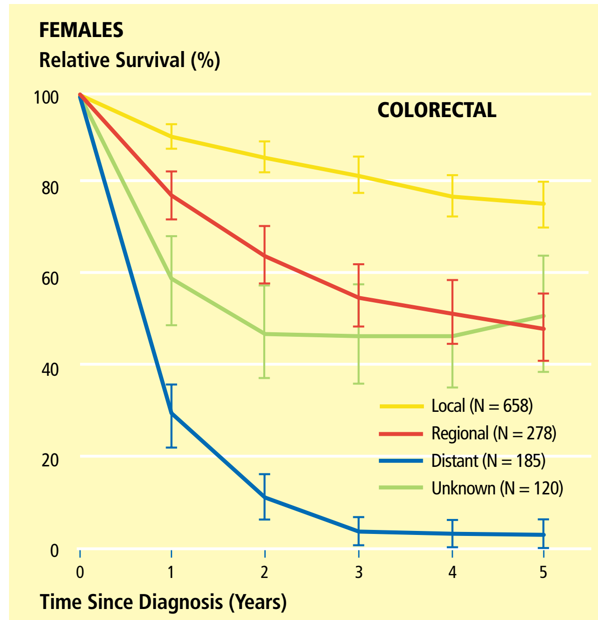


Figure 23. Colorectal cancer survival by extent of disease, females, Nova Scotia 1992-1996.
The total number of cases (N) retained for analysis appears in parenthesis and a 95% confidence interval (⊢⊣) is presented for each estimate.



Lung cancer – Females

The one-year relative survival rate for lung cancer in females was 41%, and 15% at five years (Figure 20). The extent of development of the cancer at diagnosis was again, an important factor: the five-year survival for cases diagnosed with a local extent was higher than for more advanced cases (40% vs 5%; Figure 22). Unfortunately, nearly a third of all cases studied had been diagnosed at an advanced stage (31% distant metastasis), for which treatment is mostly palliative. This is a much higher proportion than that recorded for other cancers (15% for colorectal cancer and 6% for breast cancers). As observed for males, age-specific differences in survival rates were not significant — survival was extremely poor regardless of age (Box 3).

Colorectal cancer – Females

The relative survival rates of patients diagnosed with colorectal cancer was moderately good with 77% of patients surviving one year and 57% surviving five years (Figure 20, Box 3). Again, survival was higher when diagnoses were for earlier, local extent (76% survivorship), relative to more advanced regional (49% survival) or distant tumours (4% survival; Figure 23). Younger age at diagnosis (20-54 years vs 70+ years) was associated with better one-year relative survival rates. However, this difference was not statistically significant for three- and five-year relative survival rates (Table 9). These results are consistent with national trends (Ellison and Gibbons 2001) but inconsistent with those reported elsewhere — in Northern Ireland, increased survival was significantly associated with younger age at diagnosis (Fitzpatrick and Gavin 2001).

CONCLUDING COMMENTS

Survival rates are key indicators of prognosis for both the patients and the health care system as they reflect the outcome of treatment and effectiveness of cancer control. The findings presented in this report, some encouraging, some discouraging, provide a first estimate of cancer survival for this province.

1. Five-year relative survival rates were considerably higher for patients diagnosed with either prostate (93%) or breast (82%) cancers. Prognosis was fair for patients diagnosed with colorectal cancer (57% in females, 61% in males) and poor for patients diagnosed with lung cancer (13% in males, 15% in females).

2. The extent of the disease at diagnosis was the most consistent predictor of survival. Irrespective of the cancer type, survival rates were consistently higher for patients diagnosed with local as opposed to distant (more advanced) disease. The likelihood of effectively controlling or curing cancer diminishes enormously when a cancer is diagnosed in its later stages. Early detection remains the best alternative to primary prevention (Box 4).

3. The proportion of cases of unknown extent was consistently higher among older patients (aged 70+). Some factors contributing to this result are as follows. Older patients may choose against detailed clinical testing due to their frail health and/or due to the presence of other medical conditions. Certain invasive staging procedures (e.g., mediastinoscopy for lung cancer patients) may not be recommended for older patients, particularly when the prognosis is known to be poor (e.g., lung cancer). Staging may also be given a low priority for diseases with excellent prognosis with long symptom-free periods, for which clinical staging may require invasive surgical examinations (e.g., prostate cancer).

4. Age-dependent patterns in relative survival rates varied with the type of cancer. Poorer five-year relative survival rates were observed for younger males diagnosed with prostate cancer and for younger females diagnosed with breast cancer. However, age at diagnosis did not strongly influence the five-year survival of colorectal or lung cancer patients.

5. There are numerical/statistical limitations to the study of cancer in Nova Scotia due to its small population base. This is compounded by the rarity of certain cancers in specific segments of the population. This is particularly the case for spatial and age-specific analyses. These limitations reduce the reliability of the patterns described above.

The patterns of relative survival rates among Nova Scotians were largely comparable to Canada-wide and European studies. The possible exception to this pattern was the weaker influence of the age at diagnosis upon colorectal and lung cancer patients. As survival analyses provide an indication of the effectiveness of cancer control and treatment, continued efforts in characterizing their temporal trends are essential.

Box 4. Early Detection

The early detection of cancer is important, as more effective treatments are possible at earlier stages of disease development. This has the result of lowering premature mortality and reducing morbidity. One common approach to early detection is through the implementation of an organized screening program across an entire population or selected high-risk groups of asymptomatic people (IARC 2000).

Screening programs are introduced when a disease meets the following criteria (e.g., Schottenfeld and Fraumeni 1996):

1. Frequently occurring and causing substantial mortality and/or morbidity
2. A detectable preclinical phase is known
3. The natural history of the disease is known
4. Successful treatment is possible after detection
5. The screening test itself is safe, non-invasive, reliable and economically feasible

To date, efforts to develop effective screening tools and strategies have focused upon the prevention of major cancer types such as breast, prostate, lung, colon and rectum (colorectal) as well as the less common but well known, cervical cancer.

Declines in cervical cancer mortality rates have been linked with the increased utilisation of the Papanicolaou (Pap) Smear (Schottenfeld and Fraumeni 1996). There is little doubt that cytology (Pap smear) is an effective means of detecting abnormal cells that can be successfully treated to prevent the development of cervical cancer. New prevention strategies based on HPV (human papilloma viruses) and DNA (Deoxyribonucleic Acid) testing are being considered to compliment Pap smears to further reduce the prevalence of cervical cancer.

Improved five-year survival in women diagnosed with breast cancer has also been associated with intensive screening. However, the benefit of mammographic screening in reducing breast cancer mortality for premenopausal women and improving long-term survival (> 15 years) remains undetermined (see Schottenfeld and Fraumeni 1996).

Screening for prostate cancer has not been given a high priority, in part due to the low premature mortality associated with the disease and the lack of an appropriate treatment for the preclinical lesions (Miller 1989, Croteau et al. 1994). The main screening tests include digital rectal examination (DRE), transrectal ultrasonography (TRU) and level of serum markers such as prostate specific antigen (PSA) and acid phosphatase. The value of routine population-based screening programs for prostate cancer in reducing cancer mortality and maintaining a good quality of life, remains a contested subject (see Perron et al. 2002).

Screening for lung cancer is ineffective in reducing lung cancer mortality, even in high-risk groups such as heavy smokers. Periodic chest x-rays and sputum cytology remain the most available/affordable screening measures to detect lung tumours at an early stage but the effectiveness of these techniques is questionable (Strauss 1997, Lipskie 1999). Recent studies have suggested alternate methods of early detection that are of higher sensitivity and specificity (e.g., low-dose helical CT scan, biomarkers; Wolpaw 1996, Dominioni et al. 2000).

A number of controlled trials of colorectal cancer screening have also been conducted and are currently in progress. This is being done to evaluate the relative effectiveness of fecal occult blood testing, flexible sigmoidoscopy, double barium enema and colonoscopy as screening methods. It is clear that there are advantages and disadvantages associated with each of these tools that must be assessed prior to their widespread adoption as a routine population-based screening program. In Canada, screening recommendations for the average-risk and the high-risk groups are currently under review (Coombs et al. 2001).

Prevalence and Projections

The number of people diagnosed with cancer is steadily increasing over time (Figure 24). If these trends continue, nearly 7,000 new diagnoses of invasive cancer may be expected each year by 2010 (Table 10). This represents a 42% increase of cancer cases, relative to 1999 levels. This expected increase is greater for males (46% relative to 1999 levels) than females (38% relative to 1999 levels) and may largely be attributable to the general aging of the population. However, the parallel changes in ASIR shown in Figure 24A-B indicate that other factors may be important: e.g., population growth, increasing exposure to risk factors, enhanced ability to detect the disease, improved registration, etc.

By the year 2010, cancer is expected to become the leading cause of death in Canada. While the number of deaths due to cancer also increased over time, these increases were more gradual, relative to the increases of cancer incidence (Figure 25). If these

Table 10. Actual and projected annual cancer incidence (new cases), Nova Scotia[1].

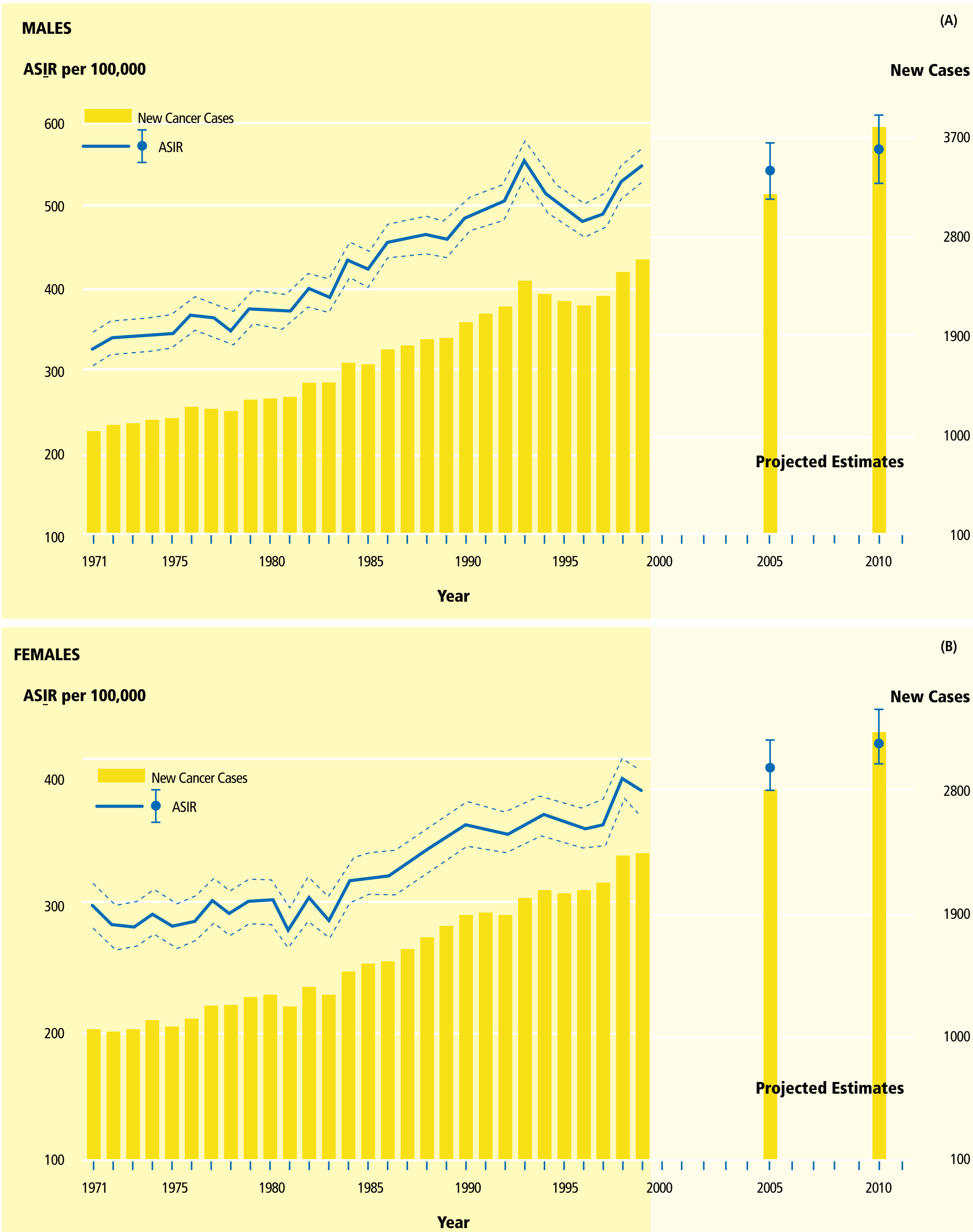
Selected Tumour Sites	Actual 1999 Males	Females	Total	Projected[2] 2005 Males	Females	Total	2010 Males	Females	Total
ORAL (buccal cavity and pharynx)	75	26	101	80	35	115	90	40	130
DIGESTIVE ORGANS									
Esophagus	39	9	48	35	15	50	40	15	55
Stomach	69	31	100	65	25	90	60	20	80
Colon and Rectum	334	315	649	415	370	785	485	405	895
Pancreas	54	70	124	60	65	125	65	75	135
RESPIRATORY SYSTEM									
Larynx	25	5	30	30	10	40	30	10	45
Lung, Trachea and Bronchus	501	313	814	565	420	985	640	520	1,160
SKIN									
Melanoma of Skin	105	100	205	120	95	215	150	110	260
FEMALE BREAST[3]	.	654	654	.	800	800	.	930	930
GENITAL ORGANS									
Cervix	.	59	59	.	55	55	.	55	55
Body of Uterus	.	112	112	.	125	125	.	145	145
Ovary	.	92	92	.	100	100	.	110	110
Prostate	658	.	658	905	.	905	1,165	.	1,165
Testis	24	.	24	25	.	25	30	.	30
URINARY ORGANS									
Bladder	187	69	256	210	80	285	245	95	340
Kidney	88	68	156	120	80	200	145	95	245
BRAIN	36	29	65	45	35	80	50	40	85
ENDOCRINE GLANDS									
Thyroid	11	34	45	10	40	50	15	45	55
LEUKEMIAS	65	37	102	65	50	115	70	55	125
OTHER BLOOD AND LYMPH TISSUE									
Non-Hodgkin's Lymphoma	101	80	181	120	105	225	145	125	270
Hodgkin's Lymphoma	13	11	24	10	15	25	10	15	25
OTHER CANCERS	204	207	411	290	260	550	345	300	640
ALL CANCERS	**2,589**	**2,321**	**4,910**	**3,175**	**2,780**	**5,955**	**3,780**	**3,200**	**6,980**

1 Projected counts are based on 1984-1999 data for all cancer sites with the exception of prostate cancer for which counts were derived from the 1981-1990 time period.

2 Projected counts have been rounded to reflect the imprecision of this process.

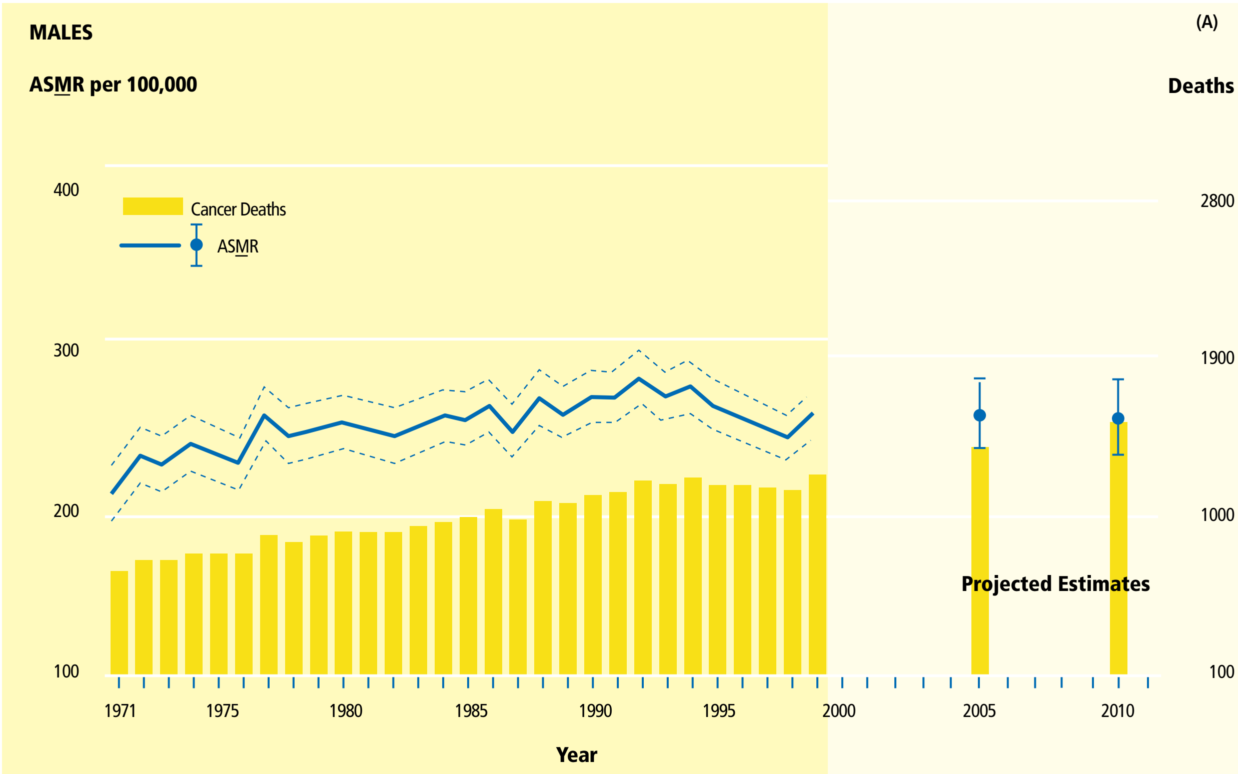
3 New cases of male breast cancers are included in "Other Cancers".

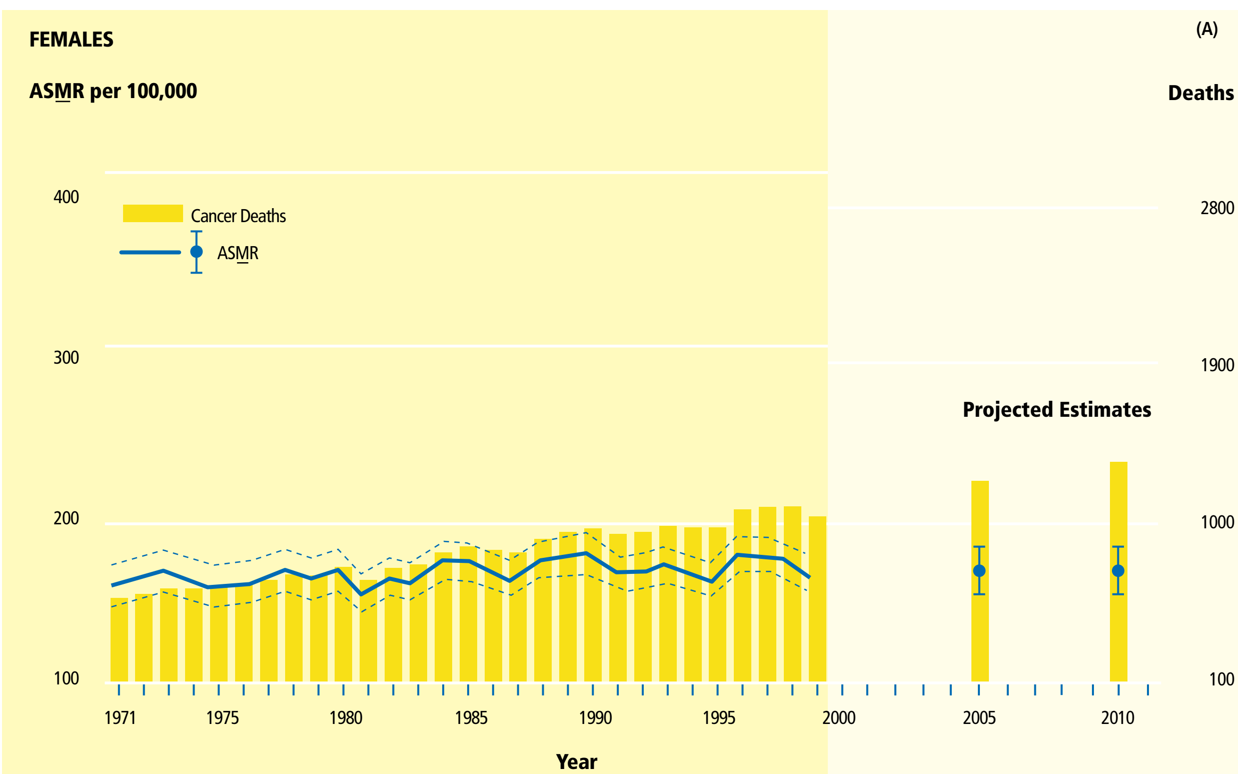
Figure 24. Trends in incidence (right scale) and age-standardised incidence rate (ASIR, left scale) for all cancers combined, males (A) and females (B), Nova Scotia 1971-1999. Dotted lines and (⊢⊣) indicate the 95% confidence intervals. Projected estimates for the years 2005 and 2010 are presented.



Cancer Care Nova Scotia

Figure 25. Trends in mortality (right scale) and age-standardised mortality rate (ASMR, left scale) for all cancers combined, males (A) and females (B), Nova Scotia 1971-1999. Dotted lines and (⊢⊣) indicate the 95% confidence intervals. Projected estimates for the years 2005 and 2010 are presented.





trends continue, nearly 3,000 people will die due to cancer each year, by 2010 (Table 11). This represents a 27% increase in the number of deaths due to cancer, relative to 1999 levels. As the age standardized cancer mortality rates over the past 20 years have remained relatively stable, these expected increases in deaths due to cancer seem to be associated with the aging of the Nova Scotian population.

The number of males and females dying of cancer each year is roughly similar. However, age standardized mortality rates (ASMRs) have been consistently higher for males than females. This is partly due to the generally shorter life expectancy for males and the larger proportion of males diagnosed with lung cancer for which prognosis is poor. In 1999, males ASMRs were 60% higher than those of females but

Table 11. Actual and projected annual deaths due to cancer, Nova Scotia[1].

Selected Tumour Sites	Actual 1999			Projected[2] 2005			2010		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
ORAL (buccal cavity and pharynx)	23	< 5	27	30	15	45	35	15	50
DIGESTIVE ORGANS									
Esophagus	40	14	54	45	15	60	55	20	70
Stomach	26	25	51	25	20	45	15	15	30
Colon and Rectum	98	91	189	100	95	195	100	95	195
Pancreas	61	54	115	60	65	125	65	70	130
RESPIRATORY SYSTEM									
Larynx	10	< 5	12	15	5	20	20	5	25
Lung, Trachea and Bronchus	419	263	682	460	335	795	510	415	920
SKIN									
Melanoma of Skin	18	10	28	25	10	35	30	5	40
FEMALE BREAST[3]	.	192	192	.	200	200	.	210	210
GENITAL ORGANS									
Cervix	.	16	16	.	15	15	.	15	15
Body of Uterus	.	9	9	.	15	15	.	15	15
Ovary	.	47	47	.	50	50	.	50	50
Prostate	137	.	137	165	.	165	185	.	185
Testis	.	.	.	5	.	5	5	.	5
URINARY ORGANS									
Bladder	47	16	63	40	20	60	45	20	70
Kidney	28	10	38	40	20	55	45	20	65
BRAIN	36	16	52	40	25	60	45	25	70
ENDOCRINE GLANDS									
Thyroid	< 5	< 5	< 5	5	5	10	5	5	10
LEUKEMIAS	50	27	77	35	30	65	30	30	65
OTHER BLOOD AND LYMPH TISSUE									
Non-Hodgkin's Lymphoma	43	37	80	65	55	120	85	65	150
Hodgkin's Lymphoma	.	.	.	5	5	5	.	.	5
OTHER CANCERS	187	200	387	240	240	480	270	260	535
ALL CANCERS	**1,224**	**1,035**	**2,259**	**1,380**	**1,220**	**2,600**	**1,525**	**1,345**	**2,870**

1 Projected deaths are based on 1984-1999 data for all cancer sites with the exception of prostate cancer for which death counts were derived from the 1981-1990 time period.

2 Projected deaths have been rounded to reflect the imprecision of this process.

3 New cases of male breast cancers are included in "Other Cancers".

are expected to be about 53% higher, by 2010. This expected reduction in males ASMRs is largely due to the decreasing trend in lung cancer mortality in males.

As the rate of cancer incidence is increasing more rapidly than cancer-related mortality rates, it is reasonable to expect that a greater number of people will also be living with the disease in the future. This increase in cancer prevalence among the population must be strategically addressed. In the year 2000, nearly 24,000 people were living with a cancer diagnosis in this province (Appendix A). This corresponds to a 23% increase relative to 1995.

Cancer is clearly devastating, placing a shadow on all our lives. Much remains to be known about the disease even though its influence continues to grow. The repercussions of cancer will be profound for both our health care system and society in general. Co-ordinated, synergistic efforts are critical if the disease is to be controlled, its etiology understood and more effective mechanisms of prevention, detection and treatment are to be developed. We as individuals must also make responsible lifestyle choices to help combat this cancer "epidemic". Unfortunately, we as individuals enjoy smoking tobacco, consuming high-fat foods and living high-risk lifestyles. Altering such behaviours is difficult, as more than three decades of attempting to eliminate smoking have shown. There are no simple solutions.

Cancer touches all people. It has done so since the earliest of recorded human history and will continue to do so into the distant future.

Cancer Care Nova Scotia chose the Mayflower as its emblem in honour of its resilience and deep roots in Nova Scotia's history and culture. The mayflower blooms amid the last snows of winter, facing whatever comes its way with grace and strength.

Glossary

Age
The specific age at which a cancer was diagnosed (incidence) or at which a cancer death (mortality) occurred.

Age distribution
See age structure.

Age-specific incidence count
The number of new cases of cancer diagnosed during a period of time for a specified age-range. Five and ten year age groups are commonly used.

Age-specific incidence rate
The ratio of age-specific incidence count to the population size from which the counts were derived. It is usually expressed as a rate, in units of: per 100,000 persons per year for a specified age range.

Age-specific mortality count
The number of deaths due to cancer for a specified age range. Five and ten year age groups are commonly used.

Age-specific mortality rate
The ratio of age-specific mortality count to the population size of a specified age range from which the counts were derived. It is usually expressed as a rate, in units of: per 100,000 persons per year, for a specified age range.

Age standardisation
The adjustment of a quantity (e.g., cancer incidence or mortality rates) to reflect the age structure of a reference population, allowing meaningful comparisons over time and between geographic areas. The age structure of all of Canada (from the 1991 population) was used as a standard (reference point) to facilitate comparisons with other regions of Canada.

Age-standardised incidence rates
Cancer incidence rates standardised to the reference state of the 1991 Canadian age-distribution. As cancer is more common in older people, a population that is older will show higher cancer incidence rates than one composed of younger individuals. Age-standardised incidence rates are calculated to allow the comparison of cancer rates between geographical areas and over time. See also, age standardisation.

Age-standardised mortality rates
Cancer mortality rates standardised to the reference state of the 1991 Canadian age-distribution. As cancer mortality rates vary strongly with age, mortality rates must be adjusted to allow their comparison between geographical areas and over time. See also, age standardisation.

Age structure
The frequency distribution (i.e., number) of people in a population as a function of their age.

Cancer incidence count
The number of new cases of cancer diagnosed during a period of time.

Cancer incidence rate
The ratio of the cancer incidence count to the population size from which the counts were derived (unadjusted for age-structure). It is usually expressed as a rate, in units of: per 100,000 persons per year. Also referred as the "crude incidence rate".

Cancer mortality count
The number of deaths due to cancer during a period of time.

Cancer mortality rate
The ratio of the cancer mortality count to the population size from which the incidences were derived (unadjusted for age-structure). It is usually expressed as a rate, in units of: per 100,000 persons per year. Also referred as the "crude mortality rate".

Cancer prevalence
The number of people who are currently living with cancer. In this report, estimates include all Nova Scotia residents known to be alive and diagnosed with invasive cancer within the preceding 15 years.

Comparative Incidence Figure (CIF)
The ratio of the age-standardised incidence rate of a given tumour site (e.g., breast, prostate, lung, colorectal) in a specific geographical area (e.g., a county or a District Health Authority, DHA) relative to that of the whole of Nova Scotia. CIF less than one indicate incidence rates that are less than the provincial average, while CIF greater than one indicate higher rates of cancer incidence than the provincial average.

Confidence Interval (CI)
The numerical range within which a value is expected to fall with a given probability (expressed as a percentage; e.g., 95% CI).

Glossary

District Health Authorities (DHAs)
Organisational units, defined by the provincial Department of Health, that integrate the delivery of health care services. DHAs govern, plan, manage, deliver, monitor, evaluate and fund the health services devolved to them. There are nine DHAs in Nova Scotia whose boundaries more or less mirror the already established county, or municipal lines (in some cases more than one county; see Figure 6, Box 2).

Five-year relative survival rate
The probability of living beyond the first five years after being diagnosed with a primary invasive cancer, relative to that of members of the general population who have the same characteristics, such as age, gender, and province of residence, as the cancer patients.

Invasive cancer
The uncontrolled growth of normal cells resulting in the formation of a malignant tumour that invades underlying tissues. Can be a primary or secondary cancer.

In-situ cancer
A malignant tumour strictly confined to the top layer of tissues (epithelium).

Lead-time bias
An apparent, but not real, increase in survival can occur due to the detection of a disease at its preclinical stage (asymptomatic). This may result from the introduction of a screening program and/or increased sophistication of diagnostic methods. An apparent increased survival time for those patients can result from a knowledge of the disease for a longer period of time due to its early detection, rather than a true longer survival time.

Length bias
Persons affected by slowly progressing disease have a longer preclinical stage (asymptomatic period) and are therefore more likely to be identified by a screen. When a screening program is introduced, it will detect a larger proportion of less aggressive cases who typically experience longer survival. This will create a bias of increased survival, particularly in the early years post-introduction of a screening program.

Logarithmic transformation
A mathematical procedure applied to data that reduces the influence of extreme values and so increases the relative "normality" of data and therefore the reliability of statistical tests.

Primary cancer
A malignant tumour confined to the organ of origin.

Secondary cancer
A malignant tumour that has spread (metastasised) to parts of the body remote from the primary site.

Survival rate
The proportion of people diagnosed with cancer who are still alive after a given period of time, most commonly one, five or ten years after diagnosis. Also referred as the "crude survival rate".

Standard population
A reference population that is used to standardise measurements and indices. In the context of this report, the population age structure or distribution of the whole of Canada as it was in 1991 is used as this standard population. See also, age standardisation.

Appendices

Appendix A. Cancer prevalence in Nova Scotia, 1995-1999[1].

Tumour Site	Number of people living with invasive cancer[2] Year 1995	1996	1997	1998	1999	2000
DIGESTIVE ORGANS						
Colon and Rectum (colorectal)	3,085	3,190	3,260	3,385	3,475	3,695
RESPIRATORY SYSTEM						
Lung, Trachea and Bronchus	1,300	1,305	1,310	1,350	1,395	1,515
BREAST (females)	4,120	4,285	4,470	4,720	4,935	5,235
GENITAL ORGANS						
Prostate	2,760	2,950	3,180	3,435	3,710	4,125
OTHER CANCERS	9,320	9,635	9,860	10,175	10,625	11,360
ALL CANCERS	**19,415**	**20,065**	**20,640**	**21,455**	**22,380**	**23,915**

1 Estimates include all Nova Scotia residents known to be alive in the stated year, and diagnosed with invasive cancer within the preceding 15 years.

2 Prevalence estimates have been rounded to reflect the imprecision of this process.

Appendix B. Groupings of primary tumour sites and their component International Classification of Diseases codes.

Tumour Site	International Classification of Diseases		
	ICD-9[1]	ICD-O[2]	ICD-O2[3]
ORAL (buccal cavity and pharynx)			
Lip	140	140	C00
Tongue	141	141	C01 C02
Mouth, Other	142 143 144 145	142 143 144 145	C03 C04 C05 C06 C07 C08
Pharynx and Tonsil	146 147 148 149	146 147 148 149	C09 C10 C11 C12 C13 C14
DIGESTIVE ORGANS			
Esophagus	150	150	C15
Stomach	151	151	C16
Small Bowel	152	152	C17
Colon & Rectum (colorectal)	153 154	153 154	C18 C19 C20 C21
Liver and Biliary Tract	155 156	155 156	C22 C23 C24
Pancreas	157	157	C25
Peritoneum and GI[4]	158 159	158 159	C26 C48
RESPIRATORY SYSTEM			
Paranasal Sinuses	160	160	C30 C31
Larynx	161	161	C32
Lung, Trachea and Bronchus	162	162	C33 C34
Mediastinum, Pleura	163	163 164 165	C37 C38
BONE, CONNECTIVE TISSUE AND SKIN			
Bone and Connective Tissue	170 171	170 171	C40 C41 C47 C49
Melanoma of Skin	172	173	C44
BREAST	174 175	174 175	C50
GENITAL ORGANS			
Cervix	180	180	C53
Body of Uterus	182	182	C54
Ovary	183	183	C56
Other Female Genital	181 184	179 181 184	C51 C52 C55 C57 C58
Prostate	185	185	C61
Testis	186	186	C62
Penis & Male Genital	187	187	C60 C63
URINARY ORGANS			
Bladder	188	188	C67
Kidney, Ureter & Other Urinary	189	189	C64 C65 C66 C68
EYE AND LACRIMAL GLAND	190	190	C69
BRAIN AND CENTRAL NERVOUS SYSTEM			
Brain	191	191	C71
Meninges, Spinal Cord & Other CNS	192	192	C70 C72
ENDOCRINE GLANDS			
Thyroid	193	193	C73
Other Endocrine	194	194	C74 C75
LEUKEMIA	204 205 206 207 208	980 981 982 983 984 985 986	980 982 983 986 987 989 991
OTHER BLOOD AND LYMPH TISSUE			
Non-Hodgkin's Lymphoma	200 202	959 960 961 962 963 964 969	959 967 968 969 970 971 972
Hodgkin's Lymphoma	201	965 966	965 966
Multiple Myeloma	203	973	973
MISCELLANEOUS PROLIFERATIVE	975	974	976
OTHER AND ILL DEFINED SITES	195	195	C76
UNKNOWN PRIMARY	196 197 198 199	199	C80

1 *ICD-9 refers to the Ninth Revision of the International Classification of Diseases.*
2 *ICD-O refers to the International Classification of Diseases for Oncology.*
3 *ICD-O2 refers to the Second Revision of the International Classification of Diseases for Oncology.*
4 *GI, gastrointestinal.*

Appendix C. Data quality indicators for major tumour sites, Nova Scotia, 1995-1999.

MALES	Proportion of cases confirmed microscopically (%)[1]					Proportion of cases confirmed with a Death Certificate Only (% DCO[2])					Mortality/Incidence Ratio (%)[3]				
Tumour Site	1995	1996	1997	1998	1999	1995	1996	1997	1998	1999	1995	1996	1997	1998	1999
DIGESTIVE ORGANS															
Colon and Rectum (colorectal)	94.6	95.8	94.4	96.2	94.0	0.9	1.6	0.3	0.5	0.3	31.3	34.2	28.6	29.3	29.3
RESPIRATORY SYSTEM															
Lung, Trachea and Bronchus	79.5	80.8	77.9	78.5	78.0	5.4	2.8	3.8	4.0	4.4	85.0	96.4	89.1	83.6	83.6
GENITAL ORGANS															
Prostate	96.1	96.8	96.8	97.4	97.9	0.0	1.2	0.5	1.5	0.9	28.6	29.7	23.8	20.8	20.8
ALL CANCERS	89.0	90.5	89.8	89.7	89.9	3.2	1.8	1.4	2.0	2.2	52.7	53.6	51.0	47.3	47.3
FEMALES															
DIGESTIVE ORGANS															
Colon and Rectum (colorectal)	93.2	94.9	92.6	94.3	95.6	2.1	1.0	1.6	1.1	1.6	28.2	37.2	29.9	31.4	28.9
RESPIRATORY SYSTEM															
Lung, Trachea and Bronchus	87.0	86.3	80.9	79.9	80.8	1.6	2.3	4.6	3.7	4.2	74.8	89.1	83.2	82.2	84.0
BREAST	96.8	97.9	97.5	98.2	98.2	0.8	0.2	0.8	0.4	0.8	32.6	31.1	29.7	27.9	29.4
ALL CANCERS	90.3	91.1	90.0	90.3	89.6	2.8	1.8	2.3	2.2	2.4	47.9	51.9	51.7	46.6	44.6
MALES AND FEMALES															
DIGESTIVE ORGANS															
Colon and Rectum (colorectal)	94.0	95.4	93.5	95.3	94.8	1.5	1.3	1.0	0.8	0.9	29.9	35.7	29.3	27.7	29.1
RESPIRATORY SYSTEM															
Lung, Trachea and Bronchus	82.1	83.0	79.2	79.0	79.1	3.6	2.6	4.2	3.9	4.3	81.5	93.5	86.5	79.8	83.8
BREAST	96.8	97.9	97.4	98.2	98.2	0.8	0.2	0.8	0.4	0.8	32.6	31.1	29.3	28.0	29.4
GENITAL ORGANS															
Prostate	96.1	96.8	96.8	97.4	97.9	2.3	1.2	0.5	1.5	0.9	28.6	29.7	23.8	20.9	20.8
ALL CANCERS	**89.6**	**90.8**	**89.9**	**90.0**	**89.8**	**3.0**	**1.8**	**1.8**	**2.1**	**2.3**	**50.4**	**52.8**	**51.4**	**46.3**	**46.0**

1 A high proportion (%) of microscopical confirmation indicates that figures are not overestimates of cancer incidences.

2 The proportion of DCO cases is recommended to be < 5% by the Canadian Cancer Registry. A high % of DCO cases may indicate inadequate cancer registration processes.

3 The mortality / incidence ratio is expected to be <100% and tend to be higher for cancer sites with poor survival.

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Your comments and suggestions will help improve the quality of future publications. Please help us by sharing your thoughts and ideas.

We would like to understand who uses this material. Please check the box that best describes your affiliation:

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	Not Useful	Somewhat Useful	Very Useful
Introduction	❑	❑	❑
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Data sources and processing	❑	❑	❑
Cancer profile in Nova Scotia	❑	❑	❑
Geographic patterns of cancer occurrence	❑	❑	❑
Trends in cancer incidence and mortality	❑	❑	❑
Cancer survival	❑	❑	❑
Prevalence and projections	❑	❑	❑

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Cancer Care Nova Scotia

Acknowledgments

Special thanks to the Registry Team whose skills and dedication have made this report possible:

Tamara Brownlee	Quality Management / Health Record Technician
Mary Gillis	Program Secretary
Joanne Hamm	Health Record Technician
Heidi Little	Communications Assistant
Karen Starratt	Health Record Administrator
Rosalee Walker	Research Assistant

We are grateful to Dr. Eric Holowaty (Cancer Care Ontario) and Dr. Leonard Reyno (Capital Health District Cancer Program) for their review of the document and insightful comments.

Many of the photos for this publication were provided courtesy of the Nova Scotia Department of Tourism and Culture.

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