Cancer Incidence and Mortality in Northeastern Ontario, 1991-1998

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ABSTRACT

Background: This descriptive epidemiology study reports the cancer incidence and mortality experience of Northeastern Ontario residents during the 8-year period from 1991-1998.

Methods: Standardized Incidence Ratios (SIRs), Standardized Mortality Ratios (SMRs) and 95% confidence intervals (CI) were calculated for a number of cancer sites (n=25 for males, n=26 for females), using rates determined from the Ontario population as the referent population.

Results: During the period 1991-1998, 24,019 cases of primary incident cancers (excluding non-melanotic skin cancer) and 11,677 deaths attributed to cancer occurred in Northeastern Ontario residents. Several cancer sites were significantly elevated in Northeastern Ontario residents. For example, trachea-bronchus-lung cancer incidence and mortality rates were significantly elevated. Rates were over 20% higher than those for the province of Ontario, for both males and females (SIR = 122, 95% CI = 118-127; SIR = 123, 95% CI = 117-129 for males and females, respectively; SMR = 125, 95% CI = 120-130; SMR = 125, 95% CI = 118-132 for males and females, respectively).

Conclusions: For both males and females, the cancer incidence and mortality experience of residents of Northeastern Ontario were significantly higher than would be expected based on Ontario cancer rates, overall, and for a number of individual sites. While this study does not identify causal associations between risk factors and disease, these data should aid in cancer control planning, and generating hypotheses for further study.

La traduction du résumé se trouve à la fin de l'article.

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The catchment area of the Northeastern Ontario Regional Cancer Centre (NEORCC) consists of the following nine census divisions: Algoma, Cochrane, Manitoulin, Sudbury District, Sudbury Region, Timiskaming, Nipissing, Parry Sound, and Muskoka. In 1991, more than 629,000 people resided in this area.¹ There are a variety of ethnic groups reported when catchment area respondents are asked about their ethnic background (e.g., British, Italian, Ukrainian, Finnish), including native groups who reside in a number of locations, but the most common groups reported are English and French Canadian.¹⁻⁴ Industries operating within the catchment area are varied, and predominantly have included: mining; community, business, and personal service; trade; manufacturing; and construction. Other industries, which are represented to a lesser extent, include: agriculture; forestry and lumbering; government-service related occupations; and pulp and paper.¹⁻³ In a previous study that reported cancer incidence and mortality trends from this catchment area during 1971-1980, and 1981-1990, Northeastern Ontario residents were reported to have significantly elevated rates of incidence and mortality from a number of cancers, when compared to expected rates based on Ontario provincial estimates.⁵

This descriptive epidemiological study reports the cancer incidence and mortality experience in this catchment area, during a more recent 8-year period, from 1991-1998. The observed incidence and mortality rates within the catchment area are compared to the "expected" incidence and mortality rates, which were determined by applying the Ontario provincial rates to the catchment area population. Additionally, trend information is provided for common sites identified as significantly elevated.

METHODS

Primary incident cancer case data were obtained from the Ontario Cancer Registry of Cancer Care Ontario. These data are collected passively from four sources: 1) hospital discharge reports, 2) pathology reports, 3) death certificates from the Registrar General of Ontario, and 4) reports from patients who have attend-

ed either one of the regional cancer centres of Cancer Care Ontario or Princess Margaret Hospital. All cases were coded according to the Ninth Revision of the International Classification of Diseases (ICD) codes.⁶ A person was considered a primary incident case if he or she were a resident in one of the nine census divisions at time of diagnosis.

Mortality data were provided by the Ontario Cancer Registry, who obtain these data directly from the Registrar General of Ontario. A person was included for mortality report if he or she were resident in one of the nine census divisions at the time of death.⁷ Residence at death was coded according to the Standard Geographic Classification system.⁸

Census and intercensal population data for Ontario, revised for census undercount, were obtained from Statistics Canada.⁹

Standardized incidence and mortality ratios (SIR/SMR), and 95% confidence intervals (95% CI), were calculated for a number of cancer sites ($n=25$ for males, $n=26$ for females), using rates determined from the Ontario population as the referent population. Additionally, for the two significantly elevated sites that represented the largest burden in this population (i.e., trachea-bronchus-lung, and colorectal), we calculated SIRs in 3-year intervals, through an expanded period of time (1972-1998).

If the SIR or SMR is greater than 100, the cancer rate in the local area is considered higher than the rate in Ontario. Additionally, if 100 is enclosed within the range of the 95% confidence intervals, the observed elevation is said to be due to chance; otherwise it is considered to be statistically significant.

RESULTS

During the period 1991-1998, 24,019 cases of primary incident cancers (excluding non-melanotic skin cancer) occurred in Northeastern Ontario residents. During this same time period, 11,677 deaths attributed to cancer occurred in Northeastern Ontario residents.

Male cancer incidence data appear in Table I. Of the 25 sites reported, 10 sites were significantly different than expected based on the provincial rates. Most differences (9/10) represent excesses in Northeastern Ontario incidence. Of these,

the highest reported SIRs occurred for cancers of the esophagus (32% increase), trachea-bronchus-lung (22%), lip and oral cavity (19%) and colorectal (19%). Testicular cancers showed a deficit in cancer incidence.

Male cancer mortality data appear in Table II. Of the 25 sites reported, 7 sites were significantly different and all represented significant excesses in Northeastern Ontario. Highest SMRs occurred for lymphosarcoma (72% increase), larynx (36%), esophagus (27%) and trachea-bronchus-lung (25%).

Female cancer incidence data appear in Table III. All 8 significant differences represent excesses in Northeastern Ontario females, with the highest incidences reported for cancers of the connective tissue and other soft tissue (33% increase), kidney and unspecified urinary (27% increase), cervix (26% increase), and trachea-bronchus-lung (23%).

Female cancer mortality data appear in Table IV. All 4 sites of significant difference represent excesses; the highest SMRs were reported for cancers of the cervix (31% increase), other lymphomas (26% increase), and trachea-bronchus-lung (25% increase).

Figures 1 and 2 illustrate that the incidences of trachea-bronchus-lung, and to a lesser extent colorectal, cancers in Northeastern Ontario residents have been elevated for a substantial period of time.

DISCUSSION

This study reports on the cancer incidence and mortality experience of Northeastern Ontario residents, during the 8-year period from 1991-1998. For both males and females, the cancer incidence and mortality experience of residents were significantly higher than would be expected based on Ontario cancer rates, overall, and for a number of individual sites.

Comparison of this information with an earlier study suggests that the number of sites with significantly elevated cancer incidences in this catchment area has increased. For males, cancer incidence was significantly elevated for 9 cancer sites, with the highest ratios for cancers of the esophagus, and trachea-bronchus-lung; these cancers have rates that are more than 20% higher than the Ontario province as a

whole. In an earlier published study of this area, during a 10-year time period (1981-1990), with statistics calculated similarly, 5 of the same 25 measured cancer incidence sites were significantly elevated.⁵ At present, these 5 sites continue to be elevated (all sites combined excluding non-melanotic skin, colorectal, pancreas, larynx, and trachea-bronchus-lung). Additionally, cancer incidence in Northeastern Ontario males is significantly elevated for 4 sites (lip and oral cavity, stomach, esophagus, and leukemia) that were not significantly elevated in the earlier study. As well, of 3 cancer sites that showed a significant deficit of cancer in the earlier study, 1 site continues to be deficit (cancer of the testis), while 2 sites (melanoma of the skin, and prostate cancer) have rates that are similar to the population of Ontario.

Male cancer mortality in Northeastern Ontario residents was also elevated during this interval, and when compared to earlier mortality information, it appears that the number of sites of significantly increased mortality has increased. In the present study, 7 sites were significantly elevated. Of these 7 sites, 3 sites were significantly increased in the earlier study (all sites except non-melanotic skin, larynx, trachea-bronchus-lung), while 4 sites which are significantly elevated in this study, were not significantly elevated earlier (esophagus, stomach, colorectal, and lymphosarcoma). One site, cancer of the pancreas, elevated in the earlier study, remains elevated, although not significantly so.

Female incidence rates in Northeastern Ontario are significantly different than Ontario rates for 8 cancer sites. The earlier study identified 8 sites of significantly different rates, 5 sites with excesses and 3 sites with deficits. Some sites remain significantly elevated (colorectal, trachea-bronchus-lung, cervix). In addition, excess cancers in female Northeastern Ontario residents are identified for other sites (i.e., all sites combined, connective tissues and other soft tissue, kidney and unspecified urinary, lymphosarcoma, and multiple myeloma). Two sites, larynx and leukemia, which were identified as significant excesses in the earlier study, remain elevated but not significantly so in this study.

Female mortality rates are significantly elevated for 4 cancer sites in Northeastern

TABLE I**Male Cancer Incidence in Northeastern Ontario, 1991-1998**

ICD9	Cancer Site	O	E	SIR	95% CI	sig
140-208	All sites except non-melanotic skin	13043	11963.19	109.03	(107.16-110.91)	**
140-145	Lip and oral cavity	323	271.69	118.89	(106.27-132.58)	**
146-149	Pharynx and ill-defined upper aero-digestive	151	131.96	114.43	(96.90-134.20)	*
150	Esophagus	219	165.64	132.22	(115.28-150.94)	**
151	Stomach	380	334.06	113.75	(102.60-125.79)	*
153,154	Colorectal	1910	1607.95	118.78	(113.52-124.23)	**
157	Pancreas	293	259.76	112.79	(100.25-126.48)	*
160	Nasal cavity, mid-ear and accessory sinuses	28	22.73	123.21	(81.87-178.07)	*
161	Larynx	210	179.34	117.09	(101.79-134.05)	*
162	Trachea, bronchus, lung	2551	2083.69	122.43	(117.72-127.27)	**
170	Bone and articular cartilage	31	28.86	107.40	(72.98-152.45)	*
171	Connective tissue and other soft tissue	85	80.02	106.22	(84.85-131.34)	*
172	Melanoma of the skin	282	314.59	89.64	(79.48-100.74)	*
175	Male breast	26	20.44	127.20	(83.09-186.38)	*
185	Prostate	3080	3013.36	102.21	(98.63-105.89)	*
186	Testis	93	122.19	76.11	(61.43-93.24)	**
188	Bladder	652	611.89	106.55	(98.53-115.06)	*
189	Kidney and unspecified urinary	413	397.57	103.88	(94.10-114.4)	*
191,192	Brain and other nervous system	232	224.55	103.32	(90.45-117.51)	*
193	Thyroid	67	76.96	87.06	(67.47-110.56)	*
200	Lymphosarcoma	269	282.38	95.26	(84.22-107.35)	*
201	Hodgkin's Disease	88	84.04	104.71	(83.98-129.01)	*
202	Other lymphomas	202	215.98	93.53	(81.07-107.35)	*
203	Multiple myeloma	185	167.47	110.47	(95.12-127.59)	*
204-208	Leukemia	424	371.52	114.12	(103.52-125.52)	**

ICD9= International Classification of Diseases, Ninth Revision

O= Observed number of cases

E= Expected number of cases

SIR= Standardized Incidence Ratio

CI= Confidence interval

* indicates statistical significance at $p < 0.05$ ** indicates statistical significance at $p < 0.01$ **TABLE II****Male Cancer Mortality in Northeastern Ontario, 1991-1998**

ICD9	Cancer Site	O	E	SMR	95% CI	sig
140-208	All sites except non-melanotic skin	6553	5780.81	113.36	(110.63-116.14)	**
140-145	Lip and oral cavity	64	66.49	96.25	(74.13-122.91)	*
146-149	Pharynx and ill-defined upper aero-digestive	76	68.47	110.99	(87.45-138.93)	*
150	Esophagus	226	177.86	127.06	(111.04-144.75)	**
151	Stomach	246	213.66	115.14	(101.20-130.46)	*
153,154	Colorectal	682	612.89	111.28	(103.08-119.95)	**
157	Pancreas	281	261.42	107.49	(95.29-120.82)	*
160	Nasal cavity, mid-ear and accessory sinuses	7	6.80	102.88	(41.36-211.96)	*
161	Larynx	98	72.02	136.08	(110.48-165.84)	**
162	Trachea, bronchus, lung	2168	1734.66	124.98	(119.78-130.36)	**
170	Bone and articular cartilage	8	10.62	75.36	(32.53-148.48)	*
171	Connective tissue and other soft tissue	29	28.29	102.51	(68.65-147.22)	*
172	Melanoma of the skin	77	82.88	92.90	(73.32-116.11)	*
175	Male breast	nr	nr	nr	nr	
185	Prostate	704	665.62	105.77	(98.10-113.88)	*
186	Testis	nr	nr	nr	nr	
188	Bladder	183	168.95	108.31	(93.19-125.20)	*
189	Kidney and unspecified urinary	143	134.78	106.10	(89.42-124.99)	*
191,192	Brain and other nervous system	159	139.05	114.35	(97.26-133.57)	*
193	Thyroid	9	9.42	95.55	(43.69-181.38)	*
200	Lymphosarcoma	18	10.44	172.34	(102.14-272.37)	*
201	Hodgkin's Disease	15	17.01	88.18	(49.36-145.45)	*
202	Other lymphomas	218	208.41	104.60	(91.18-119.45)	*
203	Multiple myeloma	107	103.48	103.40	(84.74-124.95)	*
204-208	Leukemia	228	217.55	104.80	(91.64-119.33)	*

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nr=not reported, O<5

Ontario resident females. Three sites identified as significantly elevated in the earlier study continue to be (all sites combined, trachea-bronchus-lung, and cervix); 1 site

not significant in the earlier study is significant in this study (other lymphomas); and 1 site that was significantly increased in the earlier study remains elevated, but not sig-

nificantly so (kidney and unspecified urinary).

The majority of incident cancers are limited to a few sites. For example, almost

TABLE III

Female Cancer Incidence in Northeastern Ontario, 1991-1998

ICD9	Cancer Site	O	E	SIR	95% CI	sig
140-208	All sites except non-melanotic skin	10976	10387.10	105.67	(103.70-107.67)	**
140-145	Lip and oral cavity	138	129.08	106.91	(89.82-126.31)	
146-149	Pharynx and ill-defined upper aero-digestive	46	46.41	99.12	(72.57-132.21)	
150	Esophagus	78	67.41	115.72	(91.47-144.42)	
151	Stomach	190	177.02	107.33	(92.61-123.73)	
153,154	Colorectal	1501	1341.86	111.86	(106.27-117.67)	**
157	Pancreas	267	253.73	105.23	(92.98-118.64)	
160	Nasal cavity, mid-ear and accessory sinuses	13	15.90	81.78	(43.54-139.85)	
161	Larynx	41	35.22	116.42	(83.55-157.94)	
162	Trachea, bronchus, lung	1506	1227.87	122.65	(116.53-129.01)	**
170	Bone and articular cartilage	32	25.78	124.13	(84.90-175.23)	
171	Connective tissue and other soft tissue	83	62.61	132.56	(105.58-164.33)	*
172	Melanoma of the skin	260	268.13	96.97	(85.54-109.50)	
174	Female breast	2961	3012.74	98.28	(94.77-101.89)	
180	Cervix	330	262.51	125.71	(112.51-140.03)	**
179,181,182	Non-cervical uterine (i.e., other uterus)	570	590.45	96.54	(88.77-104.80)	
183	Ovary	423	446.57	94.72	(85.91-104.19)	
188	Bladder	212	194.81	108.82	(94.67-124.50)	
189	Kidney and unspecified urinary	276	217.75	126.75	(112.24-142.62)	**
191,192	Brain and other nervous system	164	179.76	91.23	(77.80-106.31)	
193	Thyroid	221	238.77	92.56	(80.76-105.60)	
200	Lymphosarcoma	267	223.25	119.60	(105.68-134.84)	**
201	Hodgkin's Disease	69	66.49	103.77	(80.74-131.33)	
202	Other lymphomas	184	178.81	102.90	(88.57-118.89)	
203	Multiple myeloma	164	139.03	117.96	(100.60-137.46)	*
204-208	Leukemia	297	269.62	110.16	(97.98-123.42)	

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TABLE IV

Female Cancer Mortality in Northeastern Ontario, 1991-1998

ICD9	Cancer Site	O	E	SMR	95% CI	sig
140-208	All sites except non-melanotic skin	5124	4706.05	108.88	(105.92-111.90)	**
140-145	Lip and oral cavity	36	34.19	105.30	(73.75-145.78)	
146-149	Pharynx and ill-defined upper aero-digestive	30	23.00	130.42	(88.00-186.19)	
150	Esophagus	67	63.77	105.06	(81.42-133.42)	
151	Stomach	123	121.97	100.85	(83.81-120.32)	
153,154	Colorectal	516	489.35	105.45	(96.54-114.95)	
157	Pancreas	278	246.29	112.87	(99.99-126.95)	
160	Nasal cavity, mid-ear and accessory sinuses	nr	nr	nr	nr	
161	Larynx	13	14.28	91.06	(48.49-155.72)	
162	Trachea, bronchus, lung	1175	943.60	124.52	(117.50-131.85)	**
170	Bone and articular cartilage	10	7.88	126.94	(60.87-233.44)	
171	Connective tissue and other soft tissue	26	25.45	102.16	(66.74-149.69)	
172	Melanoma of the skin	39	52.79	73.88	(52.54-101.00)	
174	Female breast	933	902.15	103.42	(96.89-110.27)	
180	Cervix	105	79.96	131.31	(107.40-158.96)	**
179,181,182	Non-cervical uterine (i.e., other uterus)	97	103.73	93.51	(75.83-114.07)	
183	Ovary	263	252.19	104.29	(92.06-117.68)	
188	Bladder	57	65.31	87.27	(66.10-113.07)	
189	Kidney and unspecified urinary	85	74.16	114.62	(91.56-141.73)	
191,192	Brain and other nervous system	101	105.32	95.90	(78.11-116.53)	
193	Thyroid	18	14.94	120.46	(71.39-190.38)	
200	Lymphosarcoma	11	6.63	165.94	(82.84-296.92)	
201	Hodgkin's Disease	16	11.39	140.44	(80.27-228.06)	
202	Other lymphomas	223	177.29	125.78	(109.81-143.42)	**
203	Multiple myeloma	84	86.75	96.83	(77.23-119.88)	
204-208	Leukemia	171	153.97	111.06	(95.04-129.01)	

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nr=not reported; O < 5

60% of the incident cancer cases diagnosed in men in Northeastern Ontario were of cancers at 3 sites: prostate, trachea-

bronchus-lung, or colorectal cancers; and, therefore these cancers represent a significant health care burden in this region.

Trend data through time (Figure 1) suggests that the trachea-bronchus-lung and colorectal cancers excess are not recent

Figure 1. Standardized Incidence Ratios (SIRs) and 95% Confidence Intervals (CI) for trachea-bronchus-lung (■) and colorectal (*) cancers over a 27-year period, for males in Northeastern Ontario. Intervals not crossing the 100 reference line are significantly different than the reference population; the rate in Northeastern Ontario is higher than the Province of Ontario as a whole.

Figure 2. SIRs and 95% CI for trachea-bronchus-lung (■) and colorectal (*) cancers over a 27-year period, for females in Northeastern Ontario. Intervals not crossing the 100 reference line are significantly different than the reference population; the rate in Northeastern Ontario is higher than the Province of Ontario as a whole.

phenomena in this area. Incidences have remained significantly elevated over a long period of time.

Over half of the female incident cancers were attributed to breast, trachea-bronchus-lung, or colorectal cancer, with breast cancer the most common cancer diagnosed (over 25% of all cancers diagnosed). As in males, the increased incidences of trachea-bronchus-lung and colorectal cancers appear to have persisted for decades, although the pattern is not as clear as in males, in part because of smaller sample sizes in females.

Breast, prostate, trachea-bronchus-lung and colorectal cancers are also estimated to be the sites of greatest burden in Ontario and Canada residents in 2002.¹⁰ However, that two largely preventable cancers, lung and colorectal, have shown significantly higher incidences over such a long period of time in Northeastern Ontario residents is of concern.

In addition to elevated cancer rates, elevated levels of other chronic diseases have been reported in Northern Ontario residents. For example, in 1995 the North region of Ontario, of which this catchment area is a part, had the highest reported age-standardized rates for heart disease, stroke, and chronic lung disease in Ontario.¹¹

Causes for the increased rates and number of sites of cancer in Northeastern Ontario residents cannot be established in this ecologic study. However, this area of Ontario has been reported to have higher rates of smoking and obesity, and lower rates of physical activity,¹¹ and many of these risk factors are related to cancer morbidity^{12,13} and mortality.¹³⁻¹⁶ For example, smoking is strongly associated with trachea-bronchus-lung cancers, and is associated with cancers of the upper respiratory tract (lip and oral cavity, pharynx and ill-defined upper aero-digestive, larynx), upper digestive tract (esophagus), pancreas, bladder, renal pelvis (kidney and unspecified urinary), and cervix.¹² Prevention efforts, aimed at known modifiable risk factors, and encouraging screening, must be continued and enhanced in Northeastern Ontario.

Additionally, other risk factors, both known and unknown, might also be expected to be operating in this area. Future etiologic research is warranted. Given the large number of sites with can-

cer excesses, it would be impractical to list all of the potential risk factors for each cancer site. However, a review of the potential risk factors for some selected major cancer sites in Northeastern Ontario have been reported elsewhere.⁵

The statistics were calculated in a manner similar to an earlier study done in this catchment area.⁵ The indirect method of standardization was preferable to the direct method because the age-gender-cause specific rates in the study area would be based on a small number of subjects.¹⁷ Sites selected for inclusion in this report were based on sites that had been reported earlier,⁵ and that represent a wide variety of cancers, which provides a more complete view of the cancer incidence and mortality experience in this area.

These data allow for some crude indication of the increasing morbidity and mortality experience of Northeastern Ontario residents. The upper limit of 1998 was based on the latest available data. Aggregating the data into an 8-year period has allowed for the reporting of many cancer sites, including rarer cancers, and has enhanced the stability of the rates.

These data are useful for generating hypotheses that lead to further analytical epidemiological studies, which may reveal true differences and causal associations, and are important for cancer control planning in Northeastern Ontario. This study does not offer causal relationships between risk factors and disease, as proof of a causal association between a risk factor and disease necessitates more detailed study of individuals.

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RÉSUMÉ

Contexte : Étude épidémiologique descriptive de l'incidence du cancer et de la mortalité due au cancer chez les résidents du Nord-Est de l'Ontario sur une période de huit ans (1991-1998).

Méthode : Calcul des ratios standardisés d'incidence et de mortalité (RSI et RSM) et des intervalles de confiance de 95 % pour certains sièges de cancer (n = 25 pour les hommes, n = 26 pour les femmes) à partir des taux dans la population ontarienne (population de référence).

Résultats : Entre 1991 et 1998, on a recensé 24 019 cas de sièges primaires de cancer (sauf le cancer de la peau non mélanotique) et 11 677 décès attribués au cancer chez les résidents du Nord-Est de l'Ontario. Plusieurs sièges du cancer sont très importants chez ces résidents. Les taux d'incidence et de mortalité des cancers trachéo-broncho-pulmonaires, par exemple, étaient sensiblement élevés. Ils dépassaient de plus de 20 % les taux pour l'ensemble de l'Ontario, tant chez les hommes que chez les femmes (RSI = 122, IC de 95 % = 118-127 chez les hommes et RSI = 123, IC de 95 % = 117-129 chez les femmes; RSM = 125, IC de 95 % = 120-130 chez les hommes et RSM = 125, IC de 95 % = 118-132 chez les femmes).

Conclusions : L'incidence du cancer et la mortalité due au cancer chez les résidents du Nord-Est de l'Ontario (hommes et femmes) sont sensiblement plus élevées que la normale pour l'ensemble de l'Ontario et pour certains sièges particuliers de cancer. L'étude n'établit aucune relation causale entre les facteurs de risque et la maladie, mais les données obtenues devraient faciliter la planification de la lutte anticancéreuse et produire des hypothèses permettant de pousser la recherche.