

ORIGINAL ARTICLE

# CANCER AMONG THE CIRCUMPOLAR INUIT, 1989–2003

## I. BACKGROUND AND METHODS

### *Circumpolar Inuit Cancer Review Working Group*

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Received 29 May 2008; Accepted 24 September 2008

### ABSTRACT

**Objectives.** This is first of 2 papers on the Circumpolar Inuit Cancer Review, an international collaborative effort involving researchers and health officials from Alaska, Canada and Greenland. It covers the period 1989–2003, updating the last review (1969–1988) and together provides an overview of the trends and patterns of cancer among the Inuit in 3 countries and over a 35-year period.

**Methods.** Inuit cancer cases by age-sex group and anatomic site were obtained from the regional cancer registries. The sources of the age-sex distribution of various Inuit populations include the population registry (Greenland), and annual estimates and periodic censuses (Alaska and Canada). Incidence rates were age-standardization by the direct method to the standard world population of the International Agency for Research on Cancer.

**Conclusions.** This project demonstrates the feasibility of international partnerships in cancer surveillance, and when these partnerships are extended to other diseases and health conditions, they can contribute to the development of a Circumpolar Health Observatory.

*(Int J Circumpolar Health 2008; 67 (5):396-407)*

**Keywords:** cancer, Inuit, epidemiology, surveillance, registries

## INTRODUCTION

The pattern of cancer among various Inuit populations in the circumpolar region has been the subject of research for decades (1,2). Previous reviews have indicated an unusual pattern characterized by extremely high risk for several cancers that are rare in other populations (such as cancer of the nasopharynx and salivary glands) and relatively low risk for cancers that are common (such as breast and prostate) (3–5). There are also indications that this pattern is slowly changing, associated with the rapid changes in life-style experienced by the Inuit during the second half of the twentieth century (6).

### The Circumpolar Inuit

Inuit (plural; singular Inuk) is a collective term which has generally replaced the older

term Eskimo and refers to a number of closely related population groups inhabiting the circumpolar region who self-describe by a variety of names, including Yuit (in Siberia), Yupik and Inupiat (in Alaska), Inuvialuit and Inuit (in Canada) and Kalaallit (in Greenland). The changing pattern of health and disease among the circumpolar Inuit has been extensively reviewed elsewhere (7). Figure 1 shows the present distribution of various regional linguistic groups of Inuit. Worldwide there are approximately 165,000 Inuit, a relatively small population, highlighting the value of pooling national and regional data in studying a relatively rare disease such as cancer.

This paper, together with its companion paper, report on an international collaboration in reviewing the epidemiology of cancer among the Inuit in Alaska, Canada and Greenland during the period 1989–2003. The first



Figure 1. Distribution of regional and linguistic groups of Inuit in the circumpolar countries.

paper discusses in detail the background and methods used in data collection and analysis. The second paper presents data on the major trends and patterns. We hope that this project provides a model for health researchers in different circumpolar countries for sharing data and encouraging collaboration in data analysis.

### **International collaboration**

During the 1980s, cancer researchers from Alaska (A. Lanier), Denmark/Greenland (N. H. Nielsen, H. Storm) and Canada (L. Gaudette, A.B. Miller) created an international working group under the auspices of the International Union of Circumpolar Health (IUCH), pooled data collected from various regional registries in a standardized format and conducted joint analyses. As a result, a series of papers were published in a special issue of *Acta Oncologica* in 1996 (8). Data from four 5-year periods 1969–1973, 1974–1978, 1979–1983 and 1984–1988 were reviewed. (Note that for Alaska, data from all Alaska Natives rather than Inuit/Eskimo exclusively were presented. Inuit/Eskimo comprised approximately 53% of the Alaska Native population during this period.)

Since then, various regional reports updating Inuit cancer statistics have been published in Alaska (9), Northwest Territories (10), Nunavut (11) and Greenland (12). At the 13<sup>th</sup> International Congress on Circumpolar Health in Novosibirsk, Russia in 2006, there was discussion among participants to revive the circumpolar cancer working group and update the review to cover the 15-year period since 1989. Concurrently, other parallel developments, such as the formation of the Canada-United States Indigenous Cancer

Collaborative, also support and promote data-sharing and joint research on cancer among Indigenous populations that extend across national borders.

With funding provided by the Canadian Institutes of Health Research (CIHR), a planning meeting was convened in Vancouver, Canada, in June 2007, bringing together representatives of regional cancer agencies, health authorities and Indigenous people's organizations. A working group was established and issues of data-sharing, maintenance of privacy and confidentiality and dissemination of results were discussed and agreed upon in subsequent electronic communications. K. Young of the University of Toronto was given the task of collecting and pooling aggregate data contributed by working group members and performing preliminary data analysis. None of the data files contained personal identifiers. The present 2 papers are the result of this collaborative effort. Note that there was no access to the individual regional cancer databases and no sharing of individual files or records.

### **Ascertainment of cancer cases**

Cancer cases in all Inuit regions are reported to and registered in well-established, population-based cancer registries. The sources of cases varied across regions, with most including various proportions of physician notifications, pathology reports, hospital discharge summaries and death certificates.

The classification of cancer cases was based only on the coding system used in the most recent edition of *Cancer Incidence in Five Continents* (13), namely, the International Classification of Diseases, 10<sup>th</sup> edition (ICD-10). Table I lists the codes used in this review.

**Table I.** Classification and coding of selected cancer sites.

Site	ICD-10	ICD-9
<b>Lip, oral cavity and pharynx</b>		
Salivary glands	C07-08	142
Mouth	C03-06	143-5
Nasopharynx	C11	147
<b>Digestive organs</b>		
Esophagus	C15	150
Stomach	C16	151
Colon/rectum	C18-21	153-4
Liver	C22	155
Gallbladder/bile ducts	C23-24	156
Pancreas	C25	157
<b>Respiratory and intrathoracic organs</b>		
Nasal cavities/sinuses	C30-31	160
Larynx	C32	161
Trachea/bronchus/lung	C33-34	162
<b>Bone and soft tissues</b>		
Bone	C40-41	170
Connective tissue	C49	171
<b>Skin</b>		
Malignant melanoma skin	C43	172
<b>Breast</b>		
Breast	C50	174
<b>Female genital organs</b>		
Cervix uteri	C53	180
Corpus uteri	C54	182
Ovary	C56	183
<b>Male genital organs</b>		
Prostate	C61	185
Testis	C62	186
<b>Urinary tract</b>		
Kidney	C64-65	189
Bladder	C67	188
<b>Eye, brain and other CNS</b>		
Eye	C69	190
Brain/CNS	C70-72	191-2
<b>Endocrine glands</b>		
Thyroid	C73	193
<b>Lymphoid/haematopoietic tissues</b>		
Non-Hodgkin lymphoma	C82-85	200,202
Hodgkin's disease	C81	201
Leukemia	C91-95	204-8
Multiple myeloma	C90	203
All others		
All sites		

Only cases coded as malignant neoplasms (ICD-9 codes 140-208; ICD-10 codes C00 to C96) were included in this review, excluding benign and in situ neoplasms. Non-melanoma skin cancer (ICD-9 173; ICD-10 C44) was excluded, because of the inconsistency across registries in including/excluding it. By excluding it, the total number of cancer cases from all sites is more comparable, without being influenced by this common, rarely fatal and often under-reported cancer.

Data from three 5-year periods were reviewed: 1989–1993, 1994–1998 and 1999–2003. However, for Greenland, data were available to the end of 2002 only. Table II shows the number of cases collected from the various regions and the corresponding mean annual population.

**Greenland**

Data on cases were obtained from the research database on cancer among Greenlanders created by J. Friberg and colleagues at the Department of Epidemiology Research, Danish Epidemiology Research Centre, Statens Serum Institut in Copenhagen (12). Cases were retrieved from the Danish Cancer Registry (Cancerregisteret), which registers cases from both Denmark and Greenland. Through data linkage with the population registry (established in Denmark in

1968 and in Greenland in 1972), cases occurring among individuals born in Greenland and resident in Greenland at the time of diagnosis were identified. Reporting of cancer cases to the Danish Cancer Registry is mandatory in both Greenland and Denmark, and since 1975 the main source of information in the registry has been notifications from physicians diagnosing and treating cancer patients together with pathology reports and death certificates.

Ethnic origin is not captured by the cancer or population registry in either Greenland or Denmark. Traditionally, researchers have used “born in Greenland” as a proxy label for indigenous Greenlanders, that is, Inuit. This practice is far from ideal, and can be expected to be less and less accurate as travel and migration between Greenland and Denmark increases.

Overall, 78% of cancers were verified histologically, while cancers at unknown or not specified sites constituted 4% of all cases (12).

The Danish Cancer Registry is maintained by the National Board of Health. Information about the registry is available from its annual reports (14).

**Alaska**

Cancer data for Alaska Native people (which include persons identified by U.S. federal agencies as “Eskimo, Indian and Aleut”) are

**Table II.** Number of cases and mean annual population of Inuit regions.

	Years of data	Number of cases in period			Mean annual population		
		Male	Female	Total	Male	Female	Total
Alaska	1989–2003	803	888	1691	23566	22954	46520
Canada	1989–2003	465	581	1046	17931	17012	34943
Northwest Territories	1989–2003	59	65	124	2097	2079	4175
Nunavut	1989–2003	289	390	679	10856	10325	21182
Nunavik	1989–2003	117	126	243	4978	4608	9586
Greenland	1989–2002	738	874	1612	24672	23659	48331
Circumpolar Inuit		2006	2343	4349	66168	63625	129793

collected by the Alaska Native Tumor Registry (ANTR), a state-wide population-based registry which includes all cancer cases diagnosed since 1969. It is currently maintained by the Alaska Native Epidemiology Center of the Alaska Native Tribal Health Consortium in Anchorage, Alaska. ANTR covers Alaska Native patients living in Alaska at the time of diagnosis who meet eligibility criteria for health care benefits from the Indian Health Service and its contracted providers. Procedures for data collection and coding follow standards of the Surveillance, Epidemiology and End Results (SEER) Program of the National Cancer Institute. Ninety-one percent of tumours included in this analysis were histologically confirmed. Less than 3% of the tumours were coded to a non-specific site. Among Alaska Natives, only those who self-identified themselves as Eskimo were included in the present review. Further information about ANTR can be obtained from the 35-year review by A. Lanier, J. Kelly and colleagues (9).

### *Canada*

Statistics Canada, Canada's national statistical agency, has collected cancer incidence data since 1969, when the National Cancer Incidence Reporting System was started. NCIRS was an event-oriented system. In 1992, it was replaced by the Canadian Cancer Registry (CCR), a person-oriented system, which ensures that individuals are registered in only the jurisdiction of residence at the time of registration. CCR receives cancer data from all provincial and territorial cancer registries where internal record linkage and national death clearance are done annually. It then returns the data to the contributing registries.

The Northwest Territories Cancer Registry (NWTCR) is maintained by the Population Health Division of the Department of Health and Social Services, under the authority of the NWT Disease Registries Act. It includes cancer cases diagnosed among permanent residents of the NWT, who may, however, obtain cancer care services outside the territory. The department's contract with out-of-territory laboratories requires that a copy of pathology reports indicative of cancer are forwarded to NWTCR.

Mandatory reporting of cancer in the NWT began in 1990. Prior to that time, cancer data had to be compiled from a variety of sources, primarily death certificates and the cancer registries of the provinces where NWT residents were treated for cancer.

In 1999, Nunavut, Canada's newest territory, officially came into being, consisting of the Baffin, Kivalliq and Kitikmeot regions of the former NWT. Essentially a duplicate health care system parallel to that of the NWT was created, including a Nunavut Cancer Registry (NCR). NCR is maintained by Cancer Care Ontario on contract to the Nunavut Department of Health and Social Services

The NCR retrieved cases whose residence was in what is now within the boundaries of Nunavut from the NWTCR retroactively to 1992. For the purpose of this review, Nunavut cases from 1989 to 1991 were also removed from the NWTCR and added to Nunavut.

The existence of CCR improves case ascertainment in all jurisdictions. Cases in the NWTCR may be deleted if, at the time of diagnosis, the case was a resident in another jurisdiction. Conversely, unreported cases among NWT residents who may have been diagnosed and registered elsewhere can be added to NWTCR.

During the period 1990–2000, 2.3% of the cancer cases in NWTCR were from death certificates only, and 92% of cases had been confirmed histologically (10).

The territorial health care system in the NWT identifies an individual as Dene, Métis, Inuit or non-Aboriginal by the letter in the alphanumeric health insurance and registration number. Upon registering for a health card, the individual must self-identify as one of these 4 ethnic groups. In Nunavut, NCR distinguishes Inuit and all others in terms of ethnic status. Data submitted to CCR are stripped of ethnic status, but this is added back into the data set returned from CCR.

The Nunavik region of the province of Québec is predominantly (90%) Inuit in its ethnic composition. In Québec's regionalized health care system, Nunavik is designated region 17. Data from Fichier des tumeurs du Québec (Québec Tumour File) can be disaggregated by health regions. However, it is not possible to identify Inuit cases. For the purpose of this review, all cancer cases among Nunavik residents are considered to be Inuit. Note that cancer registry data in Québec are derived solely from hospitalization and day surgery records and are not integrated with mortality data.

The current review does not include data from the Nunatsiavut region of Labrador where Inuit communities are also located. However, feasibility studies are underway to investigate electronic data linkage of the Newfoundland and Labrador cancer registry with the list of beneficiaries of the Nunatsiavut land claims settlement.

Further information on Canadian cancer registration practices is available from Statistics Canada (15) and the reports on cancer in

the Northwest Territories by M. Santos and colleagues (10) and Nunavut by Healey and colleagues (11).

### **Estimation of Inuit population**

An accurate estimation of the Inuit population in the various circumpolar regions is a difficult task.

#### ***Greenland***

Greenland, in common with the Nordic countries, has a well-established population registry, which is continuously updated, and thus capable of generating the precise population of the country at a point in time. Population counts by age, sex and place of birth on 1 January each year is available from the interactive Statbank websites of Statistics Greenland ([www.stat.gl](http://www.stat.gl)). Only individuals born in Greenland were included in the denominator.

To obtain mid-year (ie., 1 July) or mean annual population of a specific year, the 1 January population of that year and the 1 January population of the following year were averaged. As with cancer cases, persons who were born in Greenland are considered to be Inuit.

#### ***Alaska***

Unlike the Nordic countries, national population registries do not exist in either Canada or the United States. The chief source of information on the size and characteristics of the population is the census.

In the United States, a census is conducted once every 10 years in the year ending in "0." In the "intercensal" years, the U.S. Census Bureau produces annual estimates of the population (16–18), taking into account

data on births, deaths and migrations, so-called components of population change. In the calculation of rates these estimates were used, even for those years when the census was conducted. Detailed documentation and description of the methodology are available from the U.S. Census Bureau (19–21).

From these sources, estimates of the annual mid-year population of the State of Alaska, all races combined, by age and sex for each year between 1989 and 2003 were obtained.

To obtain the Eskimo population of Alaska, the proportion of Eskimos in the total population of Alaska in each age-sex group from the 1990 and 2000 Census were applied to the estimate of the annual total population of Alaska:

- The proportion of Eskimos in Alaska from the 1990 Census was applied to the mean annual estimates of Alaska in the period 1989–1994.
- The proportion of Eskimos in Alaska from the 2000 Census was applied to the mean annual estimates of Alaska in the period 1995–2003.

In the U.S. Census, 100% of respondents are asked (in the so-called short form) to report on their “race.” Unfortunately, the 1990 and 2000 Census are not totally comparable (22).

In the 1990 Census, Question 4 instructed respondents to “fill one circle for the race that the person considers himself/herself to be.” In addition to “White,” “Black or Negro” and several categories of “Asian and Pacific Islander,” there were separate categories for “American Indian” (with a write-in space for enrolled or principal tribe), “Eskimo” and “Aleut.”

In the 2000 Census, Question 8 instructed respondents to “mark one or more races to indicate what this person considers himself/herself to be.” There was one combined category of “American Indian or Alaska Native,” with a write-in space for enrolled or principal tribe.

An Eskimo would have to choose the “American Indian or Alaska Native” (AIAN) box and also write in “Eskimo” or similar terms under tribe. In the case of Alaska, this also included Alaska Native Regional Corporations and Alaska Native Villages. This is entirely self-identified, and not based on any legal entitlement or official recognition. Nationally, some 25% of AIAN did not specify a tribe. The written responses were then grouped according to the *American Indian and Alaska Native Tribal Detailed Classification List* (23: Appendix H). It is not known how many Alaskan Eskimos checked only the AIAN box and did not enter a tribe’s name. Further information on AIAN in the 2000 Census can be found in various U.S. Census Bureau publications (23,24).

In our analysis, the category of Eskimo in the 2000 Census included anyone identified as Eskimo either alone or in combination with any other racial category, and thus differs from the 1990 Census, where multiple categories were not allowed.

### **Canada**

Canadian censuses are conducted more frequently than in the United States, once every 5 years in the years ending in “1” and “6.”

Estimates of annual mid-year populations are available for all Canadian provinces and territories, as well as census divisions, from Statistics Canada’s *Demographic Estimates*



*Compendium* (25) (File as7101.xls and as0106.xls). Data for 1989–1995 are “revised intercensal estimates,” 1996–2000 “final intercensal estimates” and 2001–2003 “final postcensal estimates.”

As Statistics Canada provides separate population estimates for Nunavut from 1991 onwards, we could reconstitute the NWT and Nunavut populations for 1989 and 1990 from their constituent census divisions (25: File asnt8601.xls):

- Northwest Territories: census divisions of Inuvik and Fort Smith
- Nunavut: census divisions of Baffin, Keewatin and Kitikmeot

To obtain the Inuit population, we applied the proportion of Inuit in the 1991, 1996 and 2001 Census to the total NWT and Nunavut populations for the years 1989–1993, 1994–1998 and 1999–2003, respectively. Age-sex distribution of the total NWT and Nunavut populations are available from census tables (No. 97F0003XCB2001001 and No. 93F0022XDB96001) available on the Statistics Canada website ([www.statcan.ca](http://www.statcan.ca)). The age-sex distribution of the Inuit population from these censuses was drawn from custom tabulations provided by Statistics Canada.

In the Canadian Census, 2 separate questions in the “long form” given to 20% of respondents inquired about ethnic origins and Aboriginal identity. In response to the origins question, an Aboriginal person may choose a single origin in one of the 3 groups (Inuit, North American Indians and Métis), multiple Aboriginal origins, or both Aboriginal and non-Aboriginal origins. Not all persons considered Aboriginal in the “origins” question chose to “identify” as

Aboriginal, and the size of the Aboriginal population based on the identity question is thus smaller than the population based on the origins question. Note that the number of persons reported was extrapolated from the 20% sample to the entire census population based on the individual respondents’ sampling weights (26).

In our analysis we defined Inuit based on the ethnic origin question and included both single Inuit responses and multiple responses where Inuit was mentioned. Question 17 in the 3 censuses of 1991, 1996 and 2001 asked: “To which ethnic or cultural group(s) did this person’s ancestors belong?” However,

- the 1991 Census question included 15 mark-in categories and 2 write-in spaces
- the 1996 and 2001 Census did not include any mark-in categories but provided 4 write-in spaces

Despite these changes in format, Inuit are less affected than other groups and their data are generally comparable. Issues of comparability between censuses can be found in the Census Dictionary (27).

The total population of Nunavik was used, as Inuit cases could not be separated from non-Inuit ones, although the latter is believed to be very small in number. Statistics Canada provides population estimates by age and sex for all health regions, including Nunavik, from 1996 onwards (28). For the period 1989–1995, the population of census division 99 (Nord-du-Québec) was obtained from *Demographic Estimates Compendium* (25) (File asqc8601). As Nunavik constituted about 25% of census division 99, this proportion was applied to the population of census division 99 to estimate the population of Nunavik.

### Age-standardization of rates

Because populations differ in their age-sex composition and the occurrence of cancer is very much age-dependent, simple comparisons of crude incidence rates among populations can be misleading. Age-standardized incidence rates (ASIR) adjust for differences in the age distribution of the population by applying the observed age-specific incidence rates for each population (the study population) to a standard population. The ASIR is thus a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of the standard population. The so-called direct method is used, according to the formula (29):

$$\text{ASIR} = \sum (r_i N_i) / \sum N_i$$

Where  $r_i$  is the age-specific rate for the  $i$ th age group of the study population,  $N_i$  is the number of persons in the  $i$ th age group of the standard population.

The rate is usually expressed as per 100,000 persons. Because of the small number of cancer cases stratified by age, sex and site, the numerator of  $r_i$  is the combined total of cases in the 5-year period, divided by the sum of the mid-year population of each of the 5 years.

To facilitate international comparisons in cancer incidence rates, the International Agency for Research on Cancer (IARC) has for years published *Cancer Incidence in Five Continents*, currently in its 8<sup>th</sup> edition (13), where it uses a hypothetical “world” population of 100,000 people.

The age-standardized incidence rates (ASIR) can be meaningfully compared only if they refer to the same standard. Thus the rates in this paper can be compared with any of the published rates in IARC or other

scientific publications that use the same world standard population. They cannot, however, be compared with published rates by some national agencies that use that country’s population from a specific year as the standard.

The 95% confidence intervals (CI) of the ASIR can be computed using the above notation according to the formula (29):

$$\text{Standard error (SE)} = \sqrt{\sum [(N_i^2 r_i) / n_i] / \sum N_i}$$

$$95\% \text{ CI} = \text{ASIR} \pm 1.96 (\text{SE})$$

Where  $n_i$  is the population of the  $i$ th age group of the study population.

### Towards a circumpolar health observatory

This paper demonstrates the feasibility and utility of international collaboration in monitoring the changing pattern of cancer in an Indigenous population whose distribution transcends national borders. It is intended that future updates will occur more frequently, perhaps at 5-year intervals. Cancer surveillance is facilitated by the existence of well-developed, population-based national and subnational cancer registries in the circumpolar countries. For many infectious diseases, surveillance is also based on disease registries, although data collection, analysis and reporting are often needed on a “just in time” basis for effective public health interventions. Some jurisdictions, such as Alaska, also have trauma registries. For non-cancer chronic diseases and other health conditions for which registries do not exist, assessing their burden requires methodological innovations that can overcome the challenges of different health information systems operating in different circumpolar countries. The establishment of a circumpolar health “observatory,” which continuously or periodically monitors the

evolving health status of circumpolar populations in a standardized and consistent manner, will contribute to improving health care delivery and also facilitate health research.

### Acknowledgements

Funding for this international collaboration was provided by the Canadian Institute of Health Research (CIHR) through the award of a team grant on circumpolar chronic disease prevention to Kue Young (CTP-79853) and a special workshop grant from the CIHR Institute of Aboriginal People's Health. We also want to thank Michèle Beaupré of Fichier des tumeurs du Québec for providing data from Nunavik. Funding for the Alaska Native Tumor Registry is provided by the Surveillance, Epidemiology and End Results (SEER) Program of the National Cancer Institute.

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