ABSTRACT

Objectives. To assess the overall and main site-specific cancer incidence in Nenetskij Avtonomnyj Okrug (NAO).

Study Design. A register-based analysis of incidence in the period 1993–2006.

Methods. NAO, a part of Arkhangelskaja Oblast in north-west Russia, has a population of 42,000 inhabitants. The central oncological hospital of the oblast registers all new cases of cancer. All new cases recorded in the study period among official residents of NAO were included in the study, except for secondary malignant neoplasm, cases revealed by autopsy and cancers diagnosed within 6 months of a previous cancer diagnosis. The census and annual sex and age-group-specific population figures for NAO were obtained from the regional statistics office. Crude and age-adjusted incidence rates (to the world standard population) were estimated.

Results. The average crude cancer incidence per year was 204/100,000 among men and 194/100,000 among women. Adjusted for age, the incidence was 322/100,000 and 182/100,000, respectively. The most frequent primary site of cancer was trachea, bronchus and lung, which constituted 17.3% of all cases (of which 87% were among men), followed by stomach cancer (12.5%). Breast cancer constituted 17.5% of all cases among women.

Conclusions. The results are consistent with reports of a low cancer risk among women compared with men in Russia and compared with women in Western countries and with results that point out that public health measures are needed to curb the lung cancer epidemic among men in Russia. The high risks of pancreas, kidney and oesophagus cancers among men should be investigated further. (Int J Circumpolar Health 2008; 67(5):433–444)

Keywords: cancer incidence, Arkhangelsk, Nenets, Russia, Arctic
INTRODUCTION

The northern part of the Russian Federation is vast and encompasses many ethnic groups living under different socio-economic and climatic conditions. Most of these groups are indigenous to the area, and include the largest populations in the circumpolar Arctic. These groups, as with other populations in Russia, have undergone rapid socio-economic changes during the last 20 years; changes that included periods of economic hardship for most people (1).

In general, little is known about cancer incidence in the Russian Federation, as the routines and procedures for reporting, registration and diagnostics have not been standardised between the different administrative districts (2,3). However, transparent reports about cancer incidence, which also included quality assessment, have been reported from a few individual districts; one of them is Arkhangelskaja Oblast in the north-western part of the country (4). The cancer registration in this oblast also includes the cancers revealed among residents of the Nenetskij Avtonomnyj Okrug (NAO) in the north (Fig. 1). The population in this okrug (federal district) also includes the Izma Komi and Indigenous Nenets who traditionally have been reindeer herders on the tundra. The general morbidity among the Nenets has reportedly been three times higher than the general population in the okrug (5). Comparable knowledge about the cancer incidence in northern regions of the Russian Federation will provide important insight for generating hypotheses about the roles ethnic, environmental and lifestyle aspects play in cancer.

The aim of this study was to assess the overall and main site-specific cancer incidence in the NAO in the period 1993–2006.

![Figure 1. Northern Europe. Source: Det norske barentssekretariatet (www.barents.no).](image-url)
MATERIAL AND METHODS

Context
NAO is located in the far north of the European part of the Russian Federation and has almost all of its landmass (all tundra) north of the Arctic Circle. The region is almost as large as Great Britain, but in 2006, it had a population of only 41,989 (a decrease of about 22% from the census in 1989 and about the same as at the census in 2002), of which about 18,000 were living in the administrative centre Narjan-Mar (the “Red Town” in the Nenet language). The other 2 larger settlements are Iskatelej (7,000 inhabitants) and Amderm (650 inhabitants) (6). The remaining population live in fewer than 60 small communities consisting of 30 to a few hundred inhabitants each spread all over the region, but mostly along the river Pečora. Distances of more than 500 km from one community to the next are not uncommon. The majority of the inhabitants in the rural areas are male. In Narjan-Mar in the mid-1990s, about 34% of the houses had indoor water and less than one-third had hot water supply; about 50% of the houses had central heating and about 80% were supplied with gas (7).

The Indigenous Nenets (also called Jurak-Samojed) and the Izma Komi (who migrated from the south) populations have been stable at a level of about 6,000 each. Many still have their livelihoods connected to reindeer husbandry and fishing. Their combined proportion of the population has been between 23 and 31% for the last 15 years, depending on the fluctuating size of the remaining population (mainly Russians). Their proportion was higher before the immigration of Russians from the south, a result of oil and gas exploration that began 40 years ago (5).

The other main industries in NAO are electric power generation, forestry, cellulose and food production. According to official statistics, there were 10 enterprises releasing harmful substances into the atmosphere in the early 1990s (7). The main source of pollution has been the burning of mineral oil and associated gas at the production sites of these industries. In addition, a large explosion at a gas field in 1980 caused a blowout that took 7 years to get under control and resulted in heavy contamination of the area. The poor quality of drinking water has also been a health issue in NAO (8). The life expectancy in NAO (62.1 years) is higher than in most boroughs in Arkhangelskaja Oblast (9), and the mortality rate in NAO is relatively low (12.2/1,000 in 2005) compared to most regions in Russia (for example, 17.0/1,000 in Arkhangelskaja Oblast).

Until 2008, NAO was an autonomous region in the Russian Federation, but cancer treatment was administered from the city of Arkhangelsk (Fig. 1), where the central oncology hospital (AOKOD) of Arkhangelskaja Oblast and NAO is located. NAO has one general hospital in Narjan-Mar, where the region’s only oncologist works; in addition, there are 9 small hospitals, 4 outpatient clinics and approximately 20 medical assistants (feldschers). There were 34 physicians and 127 hospital beds per 10,000 inhabitants in 2004 (in rural areas: 12 and 66/10,000, respectively) (10). Due to the permafrost and the remoteness of the communities, the main modes of transportation for patients are by plane and by boat on the river Pečora (in the summer). Individuals with a clinical cancer diagnosis are sent to the AOKOD if they do not object or are not too ill to travel, where confir-
information of the diagnosis and primary treatment takes place. Histological specimens are also sent to AOKOD for verification. Military personnel stationed in NAO, who have their own health care system, are not included in the population, but their family members are.

Cancer reporting and registration

All physicians are required by law to report cancer cases to the central cancer unit in their administrative district. A standardised form is used for this purpose and forwarded to the AOKOD. The same form is filled in and forwarded after every treatment or cancer-related change in the patient’s health status. When a cancer is found at death, the information is also sent to the AOKOD. A representative of the health administration in NAO visits AOKOD once a year, and the annual cancer statistic in NAO is verified against the reports received. Information about cancer patients who are not registered as residents of the oblast or NAO is sent to the patients’ home districts and not registered in the AOKOD. Likewise, the AOKOD receives information from elsewhere about cancer diagnoses and treatment of residents from their oblast – including military personnel and students. The AOKOD has maintained and updated an electronic register of all cancer cases in the oblast, including NAO, since 1993. The information registered in each record includes region, date of birth, gender, date of diagnosis, code of diagnosis, stage, presence of multiple forms, method of verification, variant of histological diagnosis, outcome of disease and the date of the outcome. Information about ethnicity is not reported. Details about cancer reporting, registration and data quality have been reported elsewhere (4).

Study population and inclusion criteria

The study population consists of all individuals registered as residents of NAO in the period 1993–2006, and all new cancer cases registered in this period were included in the study (International Classification of Disease, version 10, ICD-10: C00–C95, except for C77-78, secondary malignant neoplasm). In instances where an individual was diagnosed with cancer more than once during a 6-month period, only the first diagnosis was included; cancers revealed by autopsy were excluded. Cancers of the recto-sigmoid junction (ICD-10: C19) were included in the incidence estimates of rectum and anus cancer, and not of colon cancer (4). The information about each case in NAO was extracted from the central register at the AOKOD based on the region of residence.

Incidence estimations

The cancer incidence for the period 2003–2006 was estimated using the official administrative age- and sex-specific population figures. For the period 1993–2002, the age-sex distribution of the population was interpolated from the census figures of 1989 and 2002. The figures were obtained from Arkhangelskij Oblkomstat, the regional branch of Goskomstat (the federal statistical bureau). The incidence rates were age standardised using the sex-specific world standard with 5-year intervals until 75 years and older.

Ethical considerations

The cancer reporting and registration was federally legislated. The database obtained for this study did not contain personal identifiers.
| Primary organ                              | Disease code | ICD-9 | ICD-10 | Men Number of cases | Incidence rate of cases | Women Number of cases | Incidence rate |
|-------------------------------------------|--------------|-------|--------|---------------------|-------------------------|-----------------------|----------------|
| Mouth                                     | 140-145      | C00-08| C00-08 | 14                  | 4.4                     | 5                     | 1.7            |
| Tonsil / oropharynx                      | 146          | C09-10| C09-10 | 2                   | 0.6                     | 1                     | 0.3            |
| Nasopharynx                               | 147          | C11   | C11    | 0                   | 0.0                     | 1                     | 0.3            |
| Periform sinus and other unspecified     | 149          | C12, C14| C12, C14| 2                   | 0.6                     | 0                     | 0.0            |
| Hypopharynx                               | 148          | C13   | C13    | 2                   | 0.6                     | 1                     | 0.3            |
| Oesophagus                                 | 150          | C15   | C15    | 54                  | 17.0                    | 37                    | 11.8           |
| Stomach                                   | 151          | C16   | C16    | 88                  | 27.7                    | 69                    | 22.1           |
| Small intestine                           | 152          | C17   | C17    | 0                   | 0.0                     | 1                     | 0.3            |
| Colon                                     | 153          | C18   | C18    | 33                  | 10.4                    | 43                    | 13.8           |
| Rectosigmoid junction, rectum and anus    | 154          | C19-21| C19-21 | 34                  | 10.7                    | 33                    | 10.6           |
| Liver                                     | 155          | C22   | C22    | 13                  | 4.1                     | 9                     | 2.9            |
| Gallbladder and other unspecified         | 156          | C23-24| C23-24 | 4                   | 1.3                     | 9                     | 2.9            |
| Pancreas                                  | 157          | C25   | C25    | 29                  | 9.1                     | 19                    | 6.1            |
| Other digestive organs                    | 159          | C26   | C26    | 0                   | 0.0                     | 1                     | 0.3            |
| Nasal cavity and paranasal sinuses        | 160          | C30-31| C30-31 | 0                   | 0.0                     | 3                     | 1.0            |
| Larynx                                    | 161          | C32   | C32    | 13                  | 4.1                     | 0                     | 0.0            |
| Trachea, bronchus and lung                | 162          | C33-34| C33-34 | 189                 | 59.6                    | 28                    | 9.0            |
| Pleura, thymus, mediastinum and heart     | 163,164      | C37-38| C37-38 | 2                   | 0.6                     | 0                     | 0.0            |
| Bone, connective tissue,                  |              |       |        |                     |                         |                       |                |
| Kaposi's sarcoma                          | 170          | C40-41, C46| C40-41, C46| 8                  | 2.5                     | 8                     | 2.6            |
| Melanoma of skin                          | 172          | C43   | C43    | 3                   | 0.9                     | 5                     | 1.6            |
| Other skin                                | 173          | C44   | C44    | 22                  | 6.9                     | 39                    | 12.5           |
| Nervous system                            | 192          | C47, C70, C72 | C47, C70, C72| 1                   | 0.3                     | 1                     | 0.3            |
| Retroperitoneum and peritoneum            | 158          | C48   | C48    | 1                   | 0.3                     | 0                     | 0.0            |
| Connective and other soft tissue          | 171          | C49   | C49    | 4                   | 1.3                     | 3                     | 1.0            |
| Breast                                    | 174,175      | C50   | C50    | 0                   | 0.0                     | 106                   | 33.9           |
| Vulva. vagina. other female genital organ | 180          | C51-52, C57| C51-52, C57| 1                   | 0.3                     |                       |                |
| Cervix uteri                              | 180          | C53   | C53    | 37                  | 11.8                    |                       |                |
| Corpus uteri                              | 182          | C54   | C54    | 24                  | 7.7                     |                       |                |
| Ovary                                     | 183          | C56   | C56    | 38                  | 12.2                    |                       |                |
| Placenta                                  | 181          | C58   | C58    | 1                   | 0.3                     |                       |                |
| Prostate                                  | 185          | C61   | C61    | 19                  | 6.0                     |                       |                |
| Testis                                    | 186          | C62   | C62    | 6                   | 1.9                     |                       |                |
| Urinary tract, except bladder             | 189          | C64-66, C68| C64-66, C68| 32                  | 10.1                    | 22                    | 7.0            |
| Bladder                                   | 188          | C67   | C67    | 18                  | 5.7                     | 8                     | 2.6            |
| Eye                                       | 190          | C69   | C69    | 1                   | 0.3                     | 2                     | 0.6            |
| Brain                                     | 191          | C71   | C71    | 12                  | 3.8                     | 14                    | 4.5            |
| Thyroid gland                             | 193          | C73   | C73    | 0                   | 0.0                     | 11                    | 3.5            |
| Other or unspecified site                 | 195,199      | C76, C80| C76, C80| 12                  | 3.8                     | 6                     | 1.9            |
| Hodgkin's disease                         | 201          | C81   | C81    | 3                   | 0.9                     | 5                     | 1.6            |
| Non-Hodgkin's lymphoma                    | 200          | C82-83, C85 | C82-83, C85| 11                  | 3.5                     | 4                     | 1.3            |
| Multiple myeloma                          | 203          | C88-90| C88-90 | 5                   | 1.6                     | 1                     | 0.3            |
| Leukaemias                                | 204-208      | C91-94| C91-94 | 11                  | 3.5                     | 11                    | 3.5            |
| Total                                     | 648          | 204.2 | 607    | 194.3               |                         |                       |                |

*There were no cases of cancers C39 (other respiratory); C55 (uterus, unspecified); C60, C63 (penis and other male genital); C74–75 (adrenal and other endocrine); and C84, C96 (other lymphoid and histiocytic).
RESULTS

There were 1,310 records of cancer diagnosed in the study period; of these, 20 were revealed only by autopsy and 35 were the patients’ second cancer. The total crude cancer incidence was 199 per 100,000 population per year on average; 204/100,000 among men, and 194/100,000 among women. The frequencies and crude incidences by primary site and sex are presented in Table I. The most frequent primary sites were trachea, bronchus and lung, which constituted 17.3% of all cases (of which 87% were among men), followed by cancers of the stomach (12.5%), breast (8.4%) and oesophagus (7.3%). Breast cancer constituted 17.5% of all cases among women. The distribution of the most frequent cancers and their age-standardised incidence are presented in Table II.

The average age-adjusted incidences were 322/100,000 among men and 182/100,000 among women. The largest organ-specific differences in average risk between men and women were for trachea, bronchus and lung (98 vs. 9/100,000), oesophagus (29 vs. 11/100,000), stomach (47 vs. 21/100,000) and pancreas (14 vs. 6/100,000). The mean age at diagnosis was 59 years; 58 among men and 60 among women. As depicted in Figures 2 and 3, the incidences appear to be slightly higher for the most frequent cancers in NAO compared to Arkhangelskaja Oblast.

### Table II. The most frequent cancers; their sex distribution and age standardised incidence.

| Primary organ                                | ICD-10  | Both sexes (%) | Male (%) | Female (%) | Incidence, male | Incidence, female |
|----------------------------------------------|---------|----------------|----------|------------|-----------------|------------------|
| Trachea, bronchus and lung                   | C33-34  | 17.3           | 29.2     | 4.6        | 98.4           | 8.9              |
| Stomach                                      | C16     | 12.5           | 13.6     | 11.4       | 47.4           | 21.4             |
| Breast                                       | C50     | 8.4            | 0.0      | 17.5       | 0.0            | 30.4             |
| Oesophagus                                   | C15     | 7.3            | 8.3      | 6.1        | 28.5           | 11.0             |
| Colon\(^b\)                                  | C18     | 6.1            | 5.1      | 7.1        | 16.9           | 13.1             |
| Rectum and anus (incl. rectosigmoid junction)| C19–21  | 5.3            | 5.2      | 5.4        | 18.2           | 10.0             |
| Non-melanoma skin                            | C44     | 4.9            | 3.4      | 6.4        | 9.1            | 11.4             |
| Urinary tract, except bladder                | C64–66,C68 | 4.3        | 4.9      | 3.6        | 15.3           | 6.8              |
| Pancreas                                     | C25     | 3.8            | 4.5      | 3.1        | 14.1           | 6.1              |

\(^a\) Per 100,000 population.  
\(^b\) Does not include cancer of the rectosigmoid junction.
Figure 2. Age-adjusted incidence of the main cancers in Nenetskij Okrug (NO) and Arkhangel’skaja Oblast (AO) in women (1).

(1) AO data (1993-2001) obtained from Vaktskjold et al., 2005

Figure 3. Age-adjusted incidence of the main cancers in Nenetskij Okrug (NO) and Arkhangel’skaja Oblast (AO) in men (1).

(1) AO data (1993-2001) obtained from Vaktskjold et al., 2005
DISCUSSION

The average risk of cancer in NAO was almost 80% higher among men than women. However, due to the much lower life expectancy in the male population, the number of incident cases was only 7% higher. The only organs in which women had a higher risk of cancer than men were skin, colon and thyroid. Among men, cancers of the stomach and trachea, bronchus and lung constitute 43% of all cases and 45% of the overall risk.

In general, we must be careful comparing the incidence rates of cancer between various regions and countries, as the competing risks of disease and death might be very different. The most relevant and proximate region to compare NAO with is the bordering Arkhangelskaja Oblast, of which the NAO population constituted a small part (about 3%), and the patterns of risk of cancer by age were likely very similar. The difference in the average risk between men and women in NAO was about the same as that reported from Arkhangelskaja Oblast in 1993–2001 (4), and confirms that the risk of cancer among women has been relatively low in the Russian Federation (11). However, the overall risk of developing cancer appears to have been higher in NAO than in Arkhangelskaja Oblast, especially among men. The main evidence for this is a higher incidence of colon, pancreas and kidney cancers among men, and lung, oesophagus and rectum cancers among both men and women in NAO. Also, cancers of the stomach and breast appear to be higher in NAO among women. As in Arkhangelskaja Oblast, the rate of stomach cancer was relatively high and colon cancer low, just as it was in the Nordic countries 40 years ago when the rates were quite different from today (12). Hence, the prevalence of Helicobacter pylori was apparently high in these regions of Russia, while dietary factors seem to have contributed to keeping the incidence of colon cancer low (13). Besides colon cancer, the incidence of melanoma, bladder and prostate cancers were also relatively low (11).

Concerning the distribution of cancers, the percentage of the total cancer burden of the three most frequent cancers (lung, stomach and breast) constituted about the same proportions of all cancers as in Arkhangelskaja Oblast (4). The distribution of each cancer in NAO was also similar to the pattern for Eastern Europe as a whole in the mid-1990s; the main deviations in NAO were that cancers of the oesophagus and pancreas constituted a higher proportion and breast cancer a lower proportion (11). In terms of cancer mortality, according to official statistics, the crude mortality of cancer in the NAO population during the period 1996–2006 was 160/100,000 for men and 116/100,000 for women, which constituted 11.5 and 12.7% of all deaths, respectively. The cancer mortality figures suggest that the majority of cancer patients in the past died from the disease. The incidence of cervix uteri, cervix corpus and ovarian cancers in NAO were similar to that in Arkhangelskaja Oblast, but according to official statistics, the 5-year survival rate in NAO is lower. For example, only about one-third of cancer patients in NAO survive at least 5 years after a diagnosis of ovarian cancer (14).

The high incidences of pancreas and oesophagus cancers are noteworthy, as they have been characterised by low survival rates (13). The risk of oesophageal cancer in NAO
is also substantially higher than that reported for Russia by the International Agency for Research of Cancer (11), and is high from the global perspective as well (13). One explanation could be the high prevalence of smoking in NAO, since the incidence of lung cancer was also high. However, smoking has traditionally not been prevalent among Russian women (15), and the risks of bladder and larynx cancers were low among men, even though these types of cancers have been associated with smoking. High alcohol consumption together with dietary factors, and perhaps in conjunction with smoking, is a more plausible explanation (11,12,16,17). The incidence of pancreatic cancer among men was higher than in Norway (18) and high in the global perspective (13), as well as being about 50% higher than in Arkhangelskaja Oblast (4). In addition, 25% of the cancers revealed by autopsy, which were not included in the study, were pancreatic. The incidence of cancers of the urinary tract was high, and according to official health statistics, the morbidity of diseases of the urinary system was twice as high as in Arkhangelskaja Oblast and Russia as a whole (19). The risk of kidney cancer has been associated with a diet low in vegetables (20), a food group which is not frequently used in the traditional diet of the Nenets.

The main difficulty in estimating the risk of specific cancers in NAO is the small size of the population, which makes it unfeasible to study the risk of rare cancers and results in a low precision in the estimates for most of the common cancer sites. This difficulty prevails with regards to most Indigenous populations in the circumpolar Arctic, which tend to be even smaller than the NAO population. An additional challenge concerning Nenets and other minorities in Russia, unlike the USSR, is that they are identified as Russians on their domestic identity cards, and ethnicity is no longer recorded in medical journals. The question now is whether we can make inferences about the risk of cancer among the Nenets and Izma Komi based on the results of this study. We know that they jointly constituted about one-quarter of the population at the beginning of the study period, increasing to almost one-third in the new millennium. It is also likely that their proportion of the population was even higher among the elderly and children. Thus, in the group that was at elevated risk for most cancers because of advanced age, their proportion is likely even higher than one-third. It may be said that the Nenets and Izma Komi represent the background risk of cancer in NAO, because a large portion of the rest of the population immigrated as adults and/or tend to leave before they reach the high-risk age groups for the mentioned cancers. One method to obtain a more accurate view of the cancer risk faced by the Nenets and Izma Komi populations would be to look at the urban and rural populations separately, as these two ethnic groups live predominately in rural areas.

The age distribution in NAO was different than the distribution in Arkhangelskaja Oblast (6), which made age standardization necessary for the comparison of incidence, and to facilitate the comparison with incidence elsewhere in the circumpolar Arctic. Compared to the World Standard Population, there were relatively low proportions of older men and children younger than 15 years. On the other hand, the age group of 35–54 was relatively large. Thus, the age standardization of the incidence estimates contributed to an
overestimation of organ-specific cancers that were most likely to develop in the age-groups that were relatively small, and vice versa, compared to the actual relative burden of those cancers in the NAO. For example, the risk of stomach and rectum cancers among men is high compared to the relative actual incidence burden in the general population.

As mentioned in the Method section, the sex- and age-group specific population figures in the denominators were interpolated from the census figures from 1989 and 2002. The alternative would have been to use the official population figures. Although these figures decreased steadily from year to year in the period between the 2 censuses in 1989 and 2002, the latter census figures revealed that the real decrease had been 23% instead of 17% , as was indicated by the official administrative figures. As a result, the official figures decreased by more than 7% from 2002 to 2003. The discrepancy was different for men and women and varied between age groups, being most pronounced in the age groups above 30. The 30–34 group had actually been grossly underestimated before the census, while the 35 and older groups were overestimated (6). Using the official annual figures in the period 1993–2002 as the denominator in our estimates would have underestimated the cancer incidence. Therefore, we chose to interpolate the figures in each 5-year age group, which likely provided more accurate estimates. However, an interpolation does not capture fluctuations within the age groups well and may have influenced the standardised rates. In the period 2003–2006, we believe the official figures were more accurate than previously because the net emigration from NAO had stopped.

The population in NAO was at its lowest in 2003 (41,699). Furthermore, any population-specific factors influencing the latency of a cancer will influence the standardised incidence estimates’ comparability with those from other populations.

The overall and organ-specific incidences discussed above were all substantially higher than those reported from Arkhangelskaja Oblast. Thus, the explanation of higher rates cannot be an underestimation of the risk in NAO, although the precision of the magnitude, due to the small numbers and population figure issues, could be part of the explanation. Another issue is whether the figures from NAO were underestimated because of incomplete reporting to the AOKOD. Besides the annual report from NAO to AOKOD, an assessment of the completeness of reporting has not been carried out. The study by Vaktskjold et al. (2005) revealed that the reporting was not fully complete from all regions of Arkhangelskaja Oblast (4). Each patient clinically diagnosed with cancer receives a referral to AOKOD, but, unlike the population in Arkhangelskaja Oblast, the NAO population has had the special benefit of travel costs being refunded by the health administration. At the AOKOD, a new examination is carried out and the information obtained is recorded in the cancer register. According to the AOKOD’s statistics for 2006, there were 289 cancer patients from NAO treated in departments with 24-hour care; 33 in day-time care (inpatient); and 1,494 in the polyclinics (outpatient care) of the AOKOD. The same patient is counted each time she/he receives care or treatment, so these figures do not reveal the proportion of new cancer patients in NAO that came for treatment. However,
they do give an indication of the frequency of specialist care provided to incident and prevalent patients from NAO.

Cancers diagnosed within 6 months of a previous cancer diagnosis and cancers revealed by autopsy were excluded, but only the data from the period 1993–2001 contained this information. Thus, the figures from the period 2002–2006 likely include 15–20 cancer cases that should not have been included in the incidence estimates.

As mentioned, cancer of the sigmoid junction was included in the incidence estimate of rectum cancer – and not of colon cancer. The reason for this was that ICD-9 codes were used in registration of cases from the period 1993–1999, and ICD-10 from year 2000. Thus, in the registered ICD-9 codes it was not possible to separate cancers in the sigmoid junction and rectum. However, this categorization did not impair the comparisons made with the incidence in Arkhangelskaja Oblast, as the coding and categorization procedure in that study was identical (4). Furthermore, the diagnostic procedures, system of reporting and registration was the same in both studies for the period 1993–2001, but for the years that followed we do not know if the same quality control and registration procedures were used.

In conclusion, men were at almost an 80% higher risk for cancer than women in the period 1993–2006, which was mainly due to a very high incidence of lung and stomach cancers among men and a large gender difference for these 2 cancers. The average risks of pancreas, kidney and oesophagus cancers were also high, and should be followed up with further studies. Overall, this Arctic population had higher cancer rates than their Russian neighbours to the south, while cancers of the skin, prostate and bladder had a relatively low incidence. However, the magnitudes of the organ-specific estimates should be interpreted with care due to the small numbers. The study confirmed that female populations in Russia have had a relatively low risk of cancer compared to Western countries, and that public health measures to curb the lung cancer epidemic in Russia are needed.

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