

INTERNATIONAL CIRCUMPOLAR SURVEILLANCE - TUBERCULOSIS



A SEVEN-YEAR EPIDEMIOLOGICAL REVIEW OF
TUBERCULOSIS
IN THE CIRCUMPOLAR REGION
2006 - 2012

June 2016

INTERNATIONAL CIRCUMPOLAR SURVEILLANCE – TUBERCULOSIS WORKING GROUP - PARTICIPATING JURISDICTIONS¹

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Acknowledgements

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EXECUTIVE SUMMARY

Created in 1998, the overall goal of the International Circumpolar Surveillance (ICS) project is to establish an integrated network of hospital and public health facilities throughout the Arctic countries to monitor infectious diseases of concern. Tuberculosis (TB) was set as a priority among the ICS network as it was apparent that certain circumpolar jurisdictions still carried a significant burden of TB and the emergence of multi-drug-resistant strains was becoming an issue in some of those jurisdictions. Consequently, the International Circumpolar Surveillance – Tuberculosis (ICS-TB) Working Group was created in November 2006.

The ICS-TB Working Group initiated a review of TB notifications to improve understanding of the epidemiology of TB in the circumpolar region. The main objective of this project is to analyse demographic, clinical and laboratory characteristics of TB disease in northern populations to assess disease trends and incidence across circumpolar regions. The ultimate project goal is to establish baseline data on TB cases which will be updated through ongoing annual surveillance to inform TB prevention and control in circumpolar regions.

It has been agreed among the participating jurisdictions that the Public Health Agency of Canada (PHAC) will be the custodian of the ICS-TB data as well as the technical lead for this project. Therefore a bilateral *“ICS-TB Memorandum of Understanding (MoU) for the Sharing of Information in Relation to Tuberculosis in the North Circumpolar Populations”* was developed and voluntarily signed between the PHAC and by nine of the ten participating jurisdictions [Canada (Northwest Territories, Nunavik, Nunavut, Yukon), Greenland, Norway, Sweden, Russian Federation (Arkhangelsk), United States (Alaska) and Finland], which provided aggregated data versus line listed data, did not require an MoU.

This report uses a common case definition and presents core data elements which were established by the ICS-TB Working Group. All active TB cases reported from 2006 to 2012 that met the case definition were analysed. Distribution of TB incidence by jurisdiction, age and sex, TB diagnostic sites, indicators for TB drug resistance and treatment outcome were calculated.

From 2006 to 2012, TB disease incidence rates ranged from 4.3 to 199.5 cases per 100,000 population across participating jurisdictions. The burden of TB is spread across all age groups in the ICS-TB jurisdictions, with the highest incidence rate being among individuals 15 to 24 years old for three jurisdictions. Median age of cases ranged from 20 to 46 years old. The incidence rate ranged from 4.7 to 236.0 cases per 100,000 in males and from 3.8 to 182.9 cases per 100,000 population in females.

Yukon had the highest proportion of new cases (97% of all cases) and Arkhangelsk had the highest proportion of re-treatment cases (26% of all cases). Alaska reported the highest percentage of laboratory-confirmed cases (87%) and Archangelsk reported the highest percentage of clinically-confirmed cases (46%). The highest percentage of pulmonary disease was reported in Arkhangelsk (94%). However for Arkhangelsk, it is not possible to classify a case as “both pulmonary and extrapulmonary”; therefore, if a case is diagnosed in both diagnostic sites, it is reported as “pulmonary”. Northern Sweden and northern Norway both reported the highest proportion of extrapulmonary and “both pulmonary and extrapulmonary” cases. Nunavik had the smallest proportion of smear-positive (26%) cases among pulmonary TB cases.

The proportion of cases with resistance to at least one drug (excluding MDR- or XDR-TB) ranged from zero to 21% across jurisdictions, with the highest proportion in northern Norway (21%). Four jurisdictions reported multidrug (MDR) or extensively drug-resistant (XDR-TB) strains, with the highest proportion of cases being in Arkhangelsk (48%). Arkhangelsk was the only jurisdiction which reported XDR-TB strains. Yukon had the highest proportion of cases that were cured or who completed treatment (97%).

The current surveillance data provided by the participating ICS-TB jurisdictions highlights the large variation of TB disease rates as well as drug resistance patterns in participating circumpolar regions. It demonstrates that overall, TB remains a serious public health issue in circumpolar regions and the current project contributes towards a comprehensive understanding of TB in the north. As the epidemiology of TB in circumpolar regions evolves and changes, members of the International Circumpolar Surveillance – Tuberculosis Working Group will continue to share expertise to acquire a better understanding of the epidemiology of TB and work collaboratively to reduce the TB burden in circumpolar regions and across the world.

INTRODUCTION

Created in 1998, the overall goal of the International Circumpolar Surveillance (ICS) project is to establish an integrated network of hospital and public health facilities throughout Arctic countries to monitor infectious diseases. The ICS project is managed within the Sustainable Development Working Group (SDWG) of the Arctic Human Health Experts Group (AHHEG) under the Arctic Council. The ICS project is a joint activity with the International Union for Circumpolar Health Infectious Disease Working Group (1).

TB was set as a priority among the ICS network because it was apparent that certain circumpolar jurisdictions still carry a significant burden of TB and that the emergence of multi-drug-resistant strains was becoming an issue in some of those jurisdictions. A number of key factors in this region of the globe are particular drivers for TB transmission between individuals and within communities, including the physical environment (crowding and poor ventilation), poverty, poor access to health services and lifestyle behaviours (alcoholism, tobacco use, and malnutrition) (2,3,4). The elevated rates of TB, coupled with existing complex issues in circumpolar jurisdictions emphasize the need to continuously monitor and assess TB disease trends to improve population health outcomes.

On February 1, 2006, representatives from several countries occupying territory in circumpolar regions (specifically, northern Canada, Greenland and US-Alaska) met in Yellowknife, Northwest Territories, Canada to establish a TB surveillance subgroup of the ICS network. As a result, a proposal was submitted to the ICS Steering Committee on March 19, 2006. The Steering Committee unanimously approved the creation of the International Circumpolar Surveillance – Tuberculosis (ICS-TB) Working Group in November 2006.

As the Working Group expanded, two special meetings were held in Moscow (2008) and Khanty-Mansiysk (2011), Russian Federation to strengthen collaboration with the Russian Federation and to work towards the formalization of information exchange between the ICS-TB Working Group and the Russian Federation. The meetings resulted in Russian regions agreeing to participate in the ICS-TB Working Group.

As of 2015, the ICS-TB Working Group includes official representatives from northern Canada, Finland, Greenland, Norway, Sweden, the Russian Federation and the United States of America (US - Alaska) (**Figure 1**).

FUNCTIONS OF THE ICS-TB WORKING GROUP

The mission of the ICS-TB Working Group is to provide a forum to address issues of common concern, to share lessons learned and to discuss evidence-based practices related to TB in order to enhance TB surveillance, prevention and control activities in circumpolar jurisdictions.

Its mandate is to increase international knowledge of TB epidemiology in circumpolar regions as well as to provide epidemiological evidence for priority setting and program planning, design, implementation and evaluation across circumpolar jurisdictions.

EPIDEMIOLOGICAL REVIEW OF TUBERCULOSIS IN THE CIRCUMPOLAR REGION

Background

In 2007, a survey was conducted among the current ICS-TB country representatives (i.e. northern Canada, Alaska (US), Greenland, Russian Federation and Sweden) to gain input on the objectives of the ICS-TB Working Group. Two surveillance-specific components were identified: the assessment of 1) TB disease trends over time and 2) incidence across the circumpolar region (5). Participants agreed to produce an initial report based on a retrospective analysis of TB data from participating northern countries.

To better inform and support the data analysis presented in the current report, the ICS-TB Working Group also reviewed the methods and systems used for TB surveillance across circumpolar jurisdictions.

The main objective of this report is to analyse demographic, clinical and laboratory characteristics of TB disease in northern populations to assess disease trends and incidence rates across circumpolar regions. The ultimate goal is to establish baseline data on TB cases to be updated through ongoing surveillance, to better inform TB prevention and control projects in circumpolar regions.

Tuberculosis

TB is an infectious disease caused by *Mycobacterium tuberculosis* (*M. tuberculosis*) that primarily affects the lungs but can also affect any part of the body. TB is transmitted through the inhalation of airborne infectious droplet nuclei produced by an individual with infectious pulmonary and/or laryngeal TB when they cough, sneeze, talk or spit. The droplets may stay in the air for hours, depending on environmental factors such as air circulation and ventilation, proximity to the source case (such as overcrowding) and duration of exposure. The infectious dose is very low, varying from one to ten bacilli but usually, a susceptible individual requires prolonged exposure before becoming infected. Adolescents and adults are most likely to transmit TB infection, although young children can sometimes be infectious (6).

Following exposure, 95% of individuals without treatment develop latent TB infection (LTBI) and 5% develop active TB (primary) within the first two years after infection. Of those persons with LTBI, approximately 5% will develop active TB disease over the course of their lifetime. The probability of progressing to active TB disease is greater in immunologically challenged individuals, children less than five years of age and people with risk factors such as substance abuse or poor nutritional status (6).

The most frequent type of TB pathogenicity is respiratory TB (including pulmonary TB and primary TB). Systematic manifestations consist mainly of cough, hemoptysis (sputum with blood), fever, night sweats, weight loss, general fatigue and malaise (7). Depending on the disease progression, lung cavities or other abnormalities can be present. However, as symptoms are often nonspecific, diagnosis may be delayed (8). As TB can progress to active disease in any part of the body, any infected sites outside the lungs and respiratory tract are generally reported as extrapulmonary TB, although a medical classification list is available for reporting by the World Health Organization (WHO) (i.e. the International Statistical Classification of Diseases and Related Health Problems (ICD) – WHO, 2011).

Recommended drugs for first-line TB therapy include isoniazid (INH), rifampin (RMP), ethambutol (EMB) and pyrazinamide (PZA) and treatment normally lasts six months. Some countries still use streptomycin as first-line drug therapy, but its higher rates of toxicity as well as the inconvenience and pain of daily injections have relegated streptomycin to second-line status in many jurisdictions (9).

Treatment completion is a fundamental principal in TB control as well as the prevention of drug resistance. Multidrug-resistant TB is defined by resistance to at least INH and RMP, the two most important anti-TB drugs, while extensively drug-resistant (XDR-TB) is defined as resistance to INH and RMP as well as any fluoroquinolone and any one of the second-line injectable agents, amikacin, kanamycin or capreomycin. Multidrug-resistant and XDR-TB cases take longer and are more difficult to treat than fully susceptible strains because second-line drugs are generally less effective, more expensive and more likely to cause greater side effects (10).

Methods

This report presents descriptive results from the ICS-TB Surveillance System (ICSTBSS), a case-based surveillance system that maintains voluntarily-reported non-nominal data on people diagnosed with active TB disease in ICS participating countries.

Participation

Submission of TB surveillance data was voluntary among the ICS-TB member jurisdictions. The following jurisdictions provided data for the current report: Alaska from the United States of America, Arkhangelsk from the Russian Federation, the Northwest Territories, Nunavik, Nunavut and Yukon from Canada, Finland, Greenland, Norway and Sweden. For the purpose of this review, all of these areas are referred to as “jurisdictions”.

Case definition

The following case definitions, aligned with those of the World Health Organization (11), were used:

Definite (Laboratory-confirmed) case

- A patient with culture-confirmed disease due to *Mycobacterium tuberculosis* complex, or
- A patient who is sputum smear-positive for acid-fast bacilli (AFB).

Probable (clinical) case

If a region submits data on a probable clinically-identified case, the case should meet the following two conditions:

- A clinician’s judgment that the patient’s clinical and/or radiological signs and/or symptoms are compatible with TB; and
- A clinician’s decision to treat the patient with a full course of anti-TB treatment.

Core data elements

A list of core data elements was developed with the agreement and understanding that they would be provided to the greatest possible extent. Most of the selected elements were already collected by the jurisdictions and captured in a standardised way via forms (12).

To further increase data comparability, a Data Dictionary was drafted based on definitions used by the Canadian TB Reporting System (13) and the WHO (14). For each variable, the proposed definition was discussed and consensus was reached by members.

The results of the analysis are illustrated by tables, figures and maps which summarize the following TB disease-related data:

- Distribution of TB incidence by jurisdiction
- Age and sex distribution
- TB diagnostic sites
- Indicators for TB drug resistance
- Treatment outcome

The list of the core data elements can be found in **Appendix 1**.

Laboratory testing

When possible, laboratory test methods were provided by jurisdictions to complement test result information.

Data sharing and submission

It was agreed among the participating jurisdictions that the Public Health Agency of Canada (PHAC) would be the custodian of the ICS-TB data as well as the technical lead for this project. Therefore, a bilateral “*ICS-TB Memorandum of Understanding (MoU) for the Sharing of Information in Relation to Tuberculosis in the North Circumpolar Populations*” was developed and signed between the PHAC and each of the participating jurisdictions with the exception of Finland, which provided aggregated data.

Data submission was handled in accordance with the “*ICS-TB Epidemiological Review Data Dictionary*”, the “*ICS-TB Epidemiological Review Protocol and Data Elements*” as well as the “*ICS-TB Retrospective Data Project – Reporting Guidelines for the Core Data Elements*”, documents that were developed to inform and standardise the process.

Jurisdictions agreed to submit line listed data² on cases of TB disease in a non-nominal format (i.e. without personal identifying information) to a central database maintained by the PHAC. Once the data elements were first extracted from each jurisdiction’s TB data warehouse, data were safely transferred to CCDIC using an Inter-Business Vault, a Secure File Transfer Protocol tool developed by the PHAC. Upon receipt, CCDIC uploaded each jurisdiction’s data into the secure database.

Analysis of the data and reports

All data were stored and analysed by the PHAC on behalf of the ICS-TB Working Group and so the PHAC was therefore responsible for producing the final report. However, the structure of the report was agreed upon by members of the Working Group, who also provided content review of the data and jurisdictional approval and clearance (if required) prior to dissemination. The report was initially approved by all participating jurisdictional representatives as per their own internal regulations and then by the Co-chairs’ organizations, according to their respective rules and policies.

The final report was reviewed and approved by the ICS Steering Committee prior to dissemination.

Analytic process

Data for active TB cases (new and re-treatment) for the period 2006 to 2012 reported to each participating jurisdiction TB Program, according to their own individual policies for data reporting, were

² Except for Finland, which submitted aggregated data that were already publically available.

submitted to the PHAC following the MoU signing. Treatment outcome data are presented up to the year 2011. Final data were extracted from the ICSTBSS database on May 12, 2015.

In this report the term “crude incidence rate” refers to individuals newly diagnosed with active TB disease (new and re-treatment) in each reporting year per 100,000 population.

Descriptive analyses were performed using SAS EG Version 5.1 and Microsoft Excel 2010™.

Population estimates were obtained from the following web links:

- Alaska: <http://laborstats.alaska.gov/pop/popest.htm>
- Arkhangelsk: http://arhangelskstat.gks.ru/wps/wcm/connect/rosstat_ts/arhangelskstat/ru/statistics/population/
- Canada: Statistics Canada, Demography Division, Demographic Estimates Section, July Population Estimates, 2013. Preliminary postcensal estimates
- Greenland: <http://www.stat.gl/dialog/topmain.asp?lang=en&subject=Population&sc=BE>
- Norway: <http://www.ssb.no/en/befolkning/statistikker/folkendrkv/kvartal>
- Sweden: http://www.scb.se/en_/Finding-statistics/Statistics-by-subject-area/Population/Population-composition/Population-statistics/

No statistical procedures were used for comparative analyses in this report, nor were any statistical techniques applied to account for missing data. Data in tables with small cell sizes ($n < 5$) were not suppressed, since disclosure was not deemed to pose any risk of identifying individual cases. These procedures are in line with the PHAC’s directive for the collection, use and dissemination of information relating to public health (15).

THE CIRCUMPOLAR REGION AND PARTICIPATING JURISDICTIONS – A BRIEF DESCRIPTION

Circumpolar region

Overall, the circumpolar region covers 17 million square km and as of 2010 was inhabited by close to ten million people (16). According to the Arctic Council, the circumpolar region encompasses political administrative regions from eight Arctic States: the State of Alaska (USA), Greenland and Faroe Islands (represented on the Arctic Council by the Kingdom of Denmark), Iceland, the northernmost “counties” in Norway, Sweden and Finland, the 12 administrative divisions of the northern Russian Federation and the three northern territories (Yukon, the Northwest Territories and Nunavut) of northern Canada (16). However, due to similarities in climate, geography, population, living conditions and health issues, two other northern jurisdictions in Canada, namely Nunavik in the northern part of the province of Québec and Labrador (from the Newfoundland and Labrador province) have been included in ICS-TB.

Although Arctic regions have several features in common, there are also considerable differences across circumpolar jurisdictions in terms of population characteristics (e.g. population density, age and sex structure, Indigenous peoples’ representation, etc.), climatic conditions, health status and health care systems and access to health care (16). A brief summary of each participating ICS-TB jurisdiction is provided below.

TB surveillance across the circumpolar region

TB surveillance is a well-established centralised and publically-funded activity of the public health system across all participating circumpolar jurisdictions. Reporting of active TB cases and their respective treatment outcome is mandatory in each ICS-TB jurisdiction with reporting completeness estimated to be close to 100% by most of the jurisdictions and aligned with the WHO recommendations (12).

Although there are slight variations in the definitions of “active TB case” across jurisdictions, identical components were found in all definitions and aligned with the WHO definitions (12,17) which allowed for the development of the harmonised definitions used in this report.

Monitoring of emerging trends and patterns in anti-TB drug resistance is a key activity in TB control. Testing of TB isolates for smear results, culture confirmation and drug sensitivity testing is done across all ICS-TB participating jurisdictions and laboratory results are all reported directly from the laboratory to the TB surveillance program (12).

Canada – The Northwest Territories ^{3, 4, 5, 6}

³ Statistics Canada. 2012. *Canada (Code 01) and Northwest Territories / Territoires du Nord-Ouest, Northwest Territories (Code 6110)* (table). *Census Profile*. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE. Ottawa. Released October 24, 2012.

<http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E> (accessed May 25, 2016)

⁴ Statistics Canada. 2013. Northwest Territories and Nova Scotia (table). *Health Profile*. Statistics Canada Catalogue no. 82-228-XWE. Ottawa. Released December 12, 2013.

<http://www12.statcan.gc.ca/health-sante/82-228/index.cfm?Lang=E> (accessed May 27, 2016).

The Northwest Territories is the most populous of the three territories in Canada, with a population around 41,462 (2011) and a population density of 0.036 persons per km². In 1999, the Northwest Territories was subdivided to create Nunavut. The Northwest Territories mainly contain boreal forest and have a warmer climate than the other two territories; however, the northern regions are a part of the Canadian Arctic Archipelago. Less than half of the population resides in rural communities (41%), with just over 50% identifying as Aboriginal and 7.1% being foreign-born. The median age is 32.3 years with a life expectancy of 75.1 and 80.1 years for males and females respectively.

TB prevention and control in the Northwest Territories falls under the territorial Public Health Act. Populations predominantly affected by TB in the Northwest Territories are Aboriginal populations (Dene, Inuit, and Métis), foreign-born individuals and homeless populations. Several factors may influence the transmission of TB and development of active TB in the Northwest Territories, including overcrowding, tobacco use, alcohol and substance abuse, diabetes and inadequate previous treatment of LTBI. Current challenges experienced by the Northwest Territories include a lack of funding for a focused strategy to eliminate LTBI, real time data capture and accurate historical information surveillance databases and a lack of targeted TB prevention workers in regional centres as well as dedicated TB physician specialists.

Canada - Nunavik^{7, 8}

Nunavik is situated in the northern part of the province of Québec, Canada and comprises nearly a third of the total area of the province. Nunavik's population of just over 12,000 (2011), representing a population density of 0.02 persons per km² is sparsely distributed, with only one (out of 14) communities exceeding 2,000 individuals. Approximately 90% of the individuals residing in Nunavik are Inuit with a foreign-born population of less than 1%. In addition, the median age is 22.7 years old with a life expectancy of 70.7 years and 74.5 and for males and females respectively.

Nunavik began collecting TB surveillance data in 1990. TB prevention and control in Nunavik falls under the province of Québec's Public Health Act, which provides guidance on surveillance and monitoring as well as prevention and control of infectious diseases. Within Nunavik, young males are both at higher risk of acquiring and developing TB. Despite continuous efforts, several challenges are faced by this region with regards to TB prevention and control including, but not limited to, difficulty in early identification of source cases due to geographical distances between remote villages and diagnostic

⁵ Statistics Canada. 2013. *Northwest Territories (Code 61) (table). National Household Survey (NHS) Profile. 2011 Census.* Statistics Canada Catalogue no. 99-004-XWE. Ottawa. Released June 26, 2013. <http://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/prof/index.cfm?Lang=E> (accessed May 27, 2016).

⁶ Statistics Canada. 2013. *Northwest Territories (Code 61) (table). National Household Survey (NHS) Profile. 2011 National Household Survey.* Statistics Canada Catalogue no. 99-004-XWE. Ottawa. Released September 11, 2013.

<http://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/prof/index.cfm?Lang=E> (accessed May 27, 2016).

⁷ Statistics Canada. 2013. *Région du Nunavik (Health Region), Quebec and Quebec (table). Health Profile. 2011 Census.* Statistics Canada Catalogue no. 82-228-XWE. Ottawa. Released December 12, 2013. <http://www12.statcan.gc.ca/health-sante/82-228/index.cfm?Lang=E> (accessed May 26, 2016).

⁸ Statistics Canada. 2013. *Nunavik, Inuit region, Quebec (Code 640002) (table). National Household Survey (NHS) Aboriginal Population Profile. 2011 Census.* Statistics Canada Catalogue no. 99-011-X2011007. Ottawa. Released November 13, 2013.

<http://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/aprof/index.cfm?Lang=E> (accessed May 26, 2016).

technology/laboratory facilities (i.e., chest x-rays, smears), difficulties in facilitating compliance to LTBI prophylaxis and the rapid turnover of clinicians and front-line public health workers.

Canada – Nunavut^{9, 10}

Created in 1999 from a subdivision of the Northwest Territories, Nunavut is the largest and newest territory of Canada, with a population close to 31 906 people, but a density of 0.02 persons per km², which makes it the least populous province or territory in Canada. The population includes over 80% Inuit and less than 2% foreign-born and is distributed almost evenly between rural and urban settings. The median age in Nunavut is about 24 years old with a life expectancy of 68.8 years in males and 75.2 years in females. Inuit account for almost all TB cases in the Territory. Several risk factors in the Inuit population are associated with the transmission and development of TB in Nunavut such as smoking (in 57% of the population of 12 years or over), homelessness, overcrowded houses, poor nutrition and food insecurity as well as diabetes.

An important gap in Nunavut is the lack of an effective electronic surveillance system due to the lack of sufficient information technology infrastructure and bandwidth in the Territory. Other challenges include high staff turnover rates, which results in a lack of experienced TB nurses and difficulties maintaining continuity of care and client trust, as well as several common mental health issues such as addiction, fetal alcohol spectrum disorder and abuse that make program adherence problematic.

Canada – Yukon¹¹

Yukon is the smallest territory of Canada in terms of land area. The Territory was separated from the Northwest Territories in 1898. The Territory's climate varies depending on its geography, which consists of Arctic regions in the north, subarctic in the central region and humid continental regions in the south. Yukon boasts a population size close to 34,000 (2013) with a population density of approximately 0.1 persons per km². The estimated ratio for individuals residing in rural versus urban communities in Yukon is 1:1.5 and approximately a quarter of the population are Indigenous while 11.3% are foreign-born. The median age for individuals residing in Yukon is 39.1 with a life expectancy of 74.2 and 79.1 for males and females respectively.

Yukon began collecting TB surveillance data in 1955 (case counts only), which became progressively more detailed over time. TB prevention and control in Yukon falls under the territorial Public Health and Safety Act. TB primarily affects First Nation populations and foreign-born individuals from high-endemic countries. Several risk factors perpetuate TB transmission within rural communities, which include persons who previously refused preventative therapy or who were not candidates for prevention therapy, alcohol use and housing density. Despite the efforts put into TB prevention and control, Yukon faces a number of barriers such as social factors (alcohol use and addictions) which reduce the eligibility and feasibility of initiating or following preventative therapy in contacts of infectious TB, "TB fatigue"

⁹ Statistics Canada. 2012. *Nunavut (Code 62) and Canada (Code 01) (table). Census Profile*. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE. Ottawa. Released October 24, 2012. <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E> (accessed May 26, 2016).

¹⁰ Statistics Canada. 2013. *Nunavut and Quebec (table). Health Profile*. Statistics Canada Catalogue no. 82-228-XWE. Ottawa. Released December 12, 2013. <http://www12.statcan.gc.ca/health-sante/82-228/index.cfm?Lang=E> (accessed May 27, 2016).

¹¹ Statistics Canada. 2013. *Yukon and Quebec (table). Health Profile*. Statistics Canada Catalogue no. 82-228-XWE. Ottawa. Released December 12, 2013. <http://www12.statcan.gc.ca/health-sante/82-228/index.cfm?Lang=E> (accessed May 27, 2016).

within community members and health care providers resulting from the ongoing presence of TB within small communities, “smouldering” outbreaks and difficulty maintaining TB support workers with appropriate skill sets due to budgetary constraints.

Finland

Finland is a Scandinavian country in Northern Europe bordered by Sweden (west), Norway (north), Russia (east) and the Gulf of Finland (south). Only the three northernmost “counties”, Lappi, Oulu and Kainuu, are included in the circumpolar region as defined previously (16). In 2014, Finland’s population was close to 5.5 million¹². The overall population density is 18 persons per km², but it is much lower in the northern counties with two persons per km² in Lappi, 11 persons per km² in Oulu and four persons per km² in Kainuu. Close to 70% of the population live in urban areas. It is estimated that in Finland, less than 1% of the population is Indigenous (i.e. the Sami population) and close to 6% is foreign-born. The life expectancy is 77.3 years for males and 83.8 for females.

Finland began collecting TB surveillance data in 1995. In Finland, the most vulnerable population at risk of acquiring or developing active TB is foreign-born individuals from high-TB incidence countries, people who abuse alcohol as well as homeless people, mainly through transmission of TB among household contacts or alcoholics and homeless individuals. Since TB is a fairly rare disease in Finland, diagnostic delays sometimes cause transmission and outbreaks and it could be therefore beneficial to increase awareness among health care personnel.

Greenland

Greenland is an autonomous country within the Kingdom of Denmark and in terms of land area, is the world’s largest non-continental island with less than 20% of the country being ice-free. With a population of less than 56,000 (2016)¹³ and a population density of 0.14 persons per km² (ice-free area), it is considered the least densely populated country in the world. Approximately 90% of Greenland’s population live in towns while the remaining 10% reside in more than 60 settlements. The settlements can vary in size from four to almost 600 persons per km² and are mainly composed of hunters, fishermen and miners. About 12% of the population is born outside Greenland and life expectancy is 68.7 years for males and 73.5 years for females. Greenland began steadily collecting TB surveillance data in 1961. In Greenland, identifying as Inuit is a risk factor for the transmission of TB and for the development of active TB as well as living in a small settlement, being unemployed and the frequent intake of alcohol.

Greenland experiences a number of challenges in terms of TB surveillance and control, including: a high staff turnover resulting in lack of in-depth knowledge about TB among health personnel and geographical and infrastructural barriers, since a considerable proportion of the population resides in remote areas with limited trained health personnel simple diagnostic procedures (i.e., biological samples, chest x-rays, etc.) require expensive transportation by helicopter or boat. Lastly, as with many jurisdictions, addressing the determinants of health such as unemployment, poverty, education and inadequate housing, is also a constant challenge.

¹² Statistics Finland. 2016. Finland preliminary population figure 5,489, 821 at the end of April. Helsinki. Released May 19, 2016. http://www.stat.fi/til/vamuu/2016/04/vamuu_2016_04_2016-05-19_tie_001_en.html

¹³ Statistics Greenland. 2016. Greenland in Figures 2016. 13th edition. Nuuk. [http://www.stat.gl/publ/en/GF/2016/pdf/Greenland in Figures 2016.pdf](http://www.stat.gl/publ/en/GF/2016/pdf/Greenland%20in%20Figures%202016.pdf)

Norway

Norway is a Scandinavian unitary constitutional monarchy which covers the western portion of the Scandinavian Peninsula, Jan Mayen, the Arctic Archipelago of Svalbard, the sub-Antarctic Bouvet Island and Queen Maud Land, a section of the Antarctica. However, only the northernmost “counties”, namely Finnmark, Troms and Nordland, are considered part of the circumpolar region. Norway has a population of 5.2 million (2015)¹⁴ with a population density of 17 persons per km². Approximately 1.2% of the population is Indigenous and 12.9% is foreign-born. The median age is 39.4 with a life expectancy of 80 years for males and 84 for females.

Norway began collecting TB surveillance data in 1962 and TB prevention and control falls under the Communicable Disease Control Act which outlines the roles and responsibilities of public health agencies such as the Norwegian Institute of Public Health, with respect to communicable disease control measures. In Norway, foreign-born individuals and particularly newly-arrived immigrants represent the population most at risk for the development of active TB. This may be influenced by several factors including challenges in reaching the foreign-born population, delays in accessing health services which leads to undiagnosed TB, existing gaps in TB screening programs for immigrants and general practitioners not being accustomed to TB.

Russian Federation – Arkhangelsk Oblast

The Arkhangelsk Oblast is located in the north-east region of the Russian Federation which includes the Arctic archipelagos of Franz Josef Land and Novaya Zemlya, as well as the Solovetsky Islands in the White Sea. The population is approximately 1.2 million¹⁵ with a global population density of 2.02 persons per km², three-quarters of which reside in urban settings. The vast majority of the population is Russian-born with 1% identified as Indigenous and 4% as foreign-born. The median age of the population is around 37 years and life expectancy settles at 64 for males and 76 for females.

TB prevention and control and active screening for TB are conducted according to Russian regulations¹⁶. The systematic collection of surveillance data for TB was initiated in 2006; however data from 2007 and onwards are presented in this report. In Arkhangelsk, incarcerated individuals are recognised as one of the most at-risk populations for the transmission and the development of active TB, as well as homeless people and human immunodeficiency virus (HIV) patients (18). The Arkhangelsk Oblast faces challenges linked with accessing drugs for appropriate treatment, as well as treating a high number of MDR- and XDR-TB cases.

Sweden

¹⁴ Statistics Norway. Population and population change, Q 2015. *Population and population changes*. Oslo. <http://www.ssb.no/en/befolkning/statistikker/folkendrkv/kvartal>

¹⁵ Federal State Statistics Service. 2016. Оценка численности населения на 1 января текущего года по субъектам РФ. Население. Arkhangelsk. Released April 28, 2016. http://arhangelskstat.gks.ru/wps/wcm/connect/rosstat_ts/arhangelskstat/ru/statistics/population/

¹⁶ Government regulation Russian Federation, No. 892 (“Implementing Federal law: ‘preventing tuberculosis’”) 2001. [in Russian] Resolution of the Chief Medical Officer of Russian Federation and Ministry of Health Care of Russian Federation, No. 62 (“About implementing USPH rules and regulations: ‘preventing tuberculosis’” SP 3.1.1295-03). 2003. [in Russian]

Sweden is a Scandinavian country located in Northern Europe and is the third-largest country in the European Union (in terms of land area). Sweden's population of 9.9 million (2016)¹⁷, representing a population density of 23 persons per km², is mainly concentrated in the south. Only the two northernmost "counties" Norrbotten and Västerbotten are included in the circumpolar region and represent about 5% of the total Swedish population. Foreign-born individuals account for 16% of the total population and Indigenous people make up less than 1% of the population¹⁸. The median age is 41.2 years and life expectancy is 80 and 84 for males and females respectively.

Sweden began collecting TB surveillance data in the early 1900s with reliable TB data being available since 1940. TB prevention and control falls under the Swedish Communicable Disease Act. Within this legislative framework, TB control activities include contact tracing, surveillance as well as screening of foreign-born persons from high-burden countries, since they are the most at-risk population for the development of active TB. A number of key determinants also contribute to the development of active TB within other subpopulations in Sweden, including homelessness and drug and/or alcohol abuse. One of the main challenges Sweden faces, particularly with respect to the screening of new arrivals, is the lack of inclusiveness of the screening program, as screening has been mainly reserved for asylum seekers.

United States of America - Alaska

While Alaska is the largest state (in terms of land area), it is among the least populated in the United States of America, with a population of 735,625¹⁹ and population density of 3.4 persons per km². Alaska is comprised of both rural and urban communities, with roughly a third of the population classified as rural. Approximately 15% of the population identifies as Alaska Native or American Indian and 7% are foreign-born. The median age of the population is 33.8 years with life expectancies of 75.7 years for men and 80.5 years for women, but 70.7 years for Alaska Natives overall.

Alaska began collecting TB surveillance data in 1952. TB prevention and control falls under a number of statutes and regulations by the State of Alaska with respect to TB testing, reporting and screening. Populations most at risk for acquiring and developing active TB in Alaska are the Alaska Native population, homeless individuals, individuals from the rural Southwest and Northern regions of the State, as well as foreign-born populations. Key drivers of ongoing TB transmission in Alaska include the large historical impact of TB in the Alaskan Native population, challenges in medical and public health infrastructure, access barriers to health care services and care, geographical barriers, overcrowding in poorly ventilated housing in rural areas and high turnover of insufficient medical and nursing staff in rural jurisdictions. The main challenges Alaska is experiencing relate to limited economic resources, lack of adequate health care infrastructure, vast geography and challenges with access to care and early TB diagnosis.

¹⁷ Statistics Sweden. 2016. Preliminary Population Statistics. Population statistics. Stockholm. Released May 12, 2016

Statistics Sweden. 2016. Preliminary Population Statistics. Population statistics. Stockholm. Released May 12, 2016
http://www.scb.se/en_/Finding-statistics/Statistics-by-subject-area/Population/Population-composition/Population-statistics/#c_li_196358

¹⁸ "The Sami – an Indigenous People in Sweden" report.

¹⁹ State of Alaska. 2016. 2015 Population by Borough/Census Area and Economic Region. *Population Estimates*. Juneau. Released January 13, 2016.

<http://laborstats.alaska.gov/pop/popest.htm>

Figure 1: International circumpolar surveillance tuberculosis jurisdictions

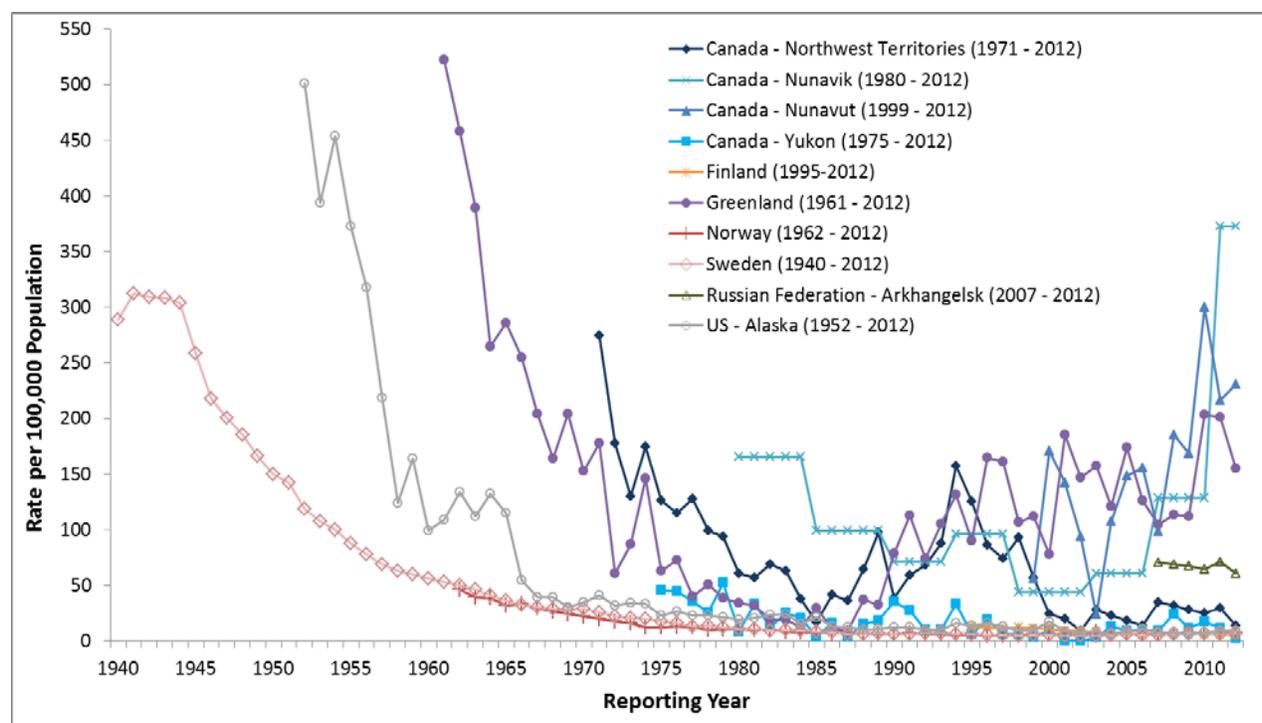


RESULTS

Historical context

Aggregated historical data (TB case count and crude incidence rate) were provided by each jurisdiction²⁰ from the first year in which TB surveillance data began to be collected in their respective jurisdiction up to 2012. In all ICS-TB jurisdictions for which data are available, the number of reported TB cases and the corresponding incidence rates were higher prior to the mid-1960s and then, following the introduction of the five first TB medications between 1948 and 1963, this number declined considerably for most jurisdictions until the 1980s (**Figure 2**). However, some jurisdictions such as Nunavik and Greenland experienced an increase in their incidence rate over the past 10 to 15 years.

Figure 2: Trends in TB in the participating ICS-TB jurisdictions, 1940-2012*



*Data received at CCDIC no later than May 2015. Data presented for Sweden, Norway and Finland include the entire country, not just the northernmost regions. Note that prior to its inception in 1999, Nunavut was embedded in the Northwest Territories; therefore Nunavut cases prior 1999 are included in the Northwest Territories case count.

Case reporting for 2006-2012

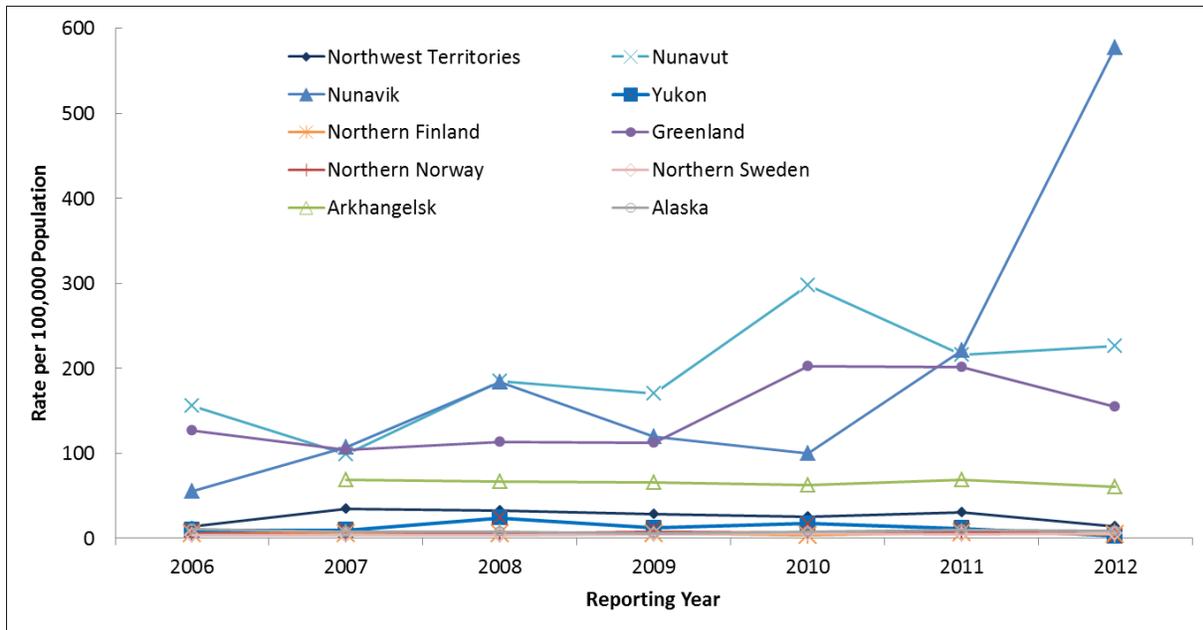
Over the seven years presented in this report, a total of 7,213 cases of active TB were reported among the ICS-TB participating jurisdictions²¹. Three ICS-TB jurisdictions had a yearly crude TB incidence rate higher than 100 cases per 100,000 population: Nunavut, Nunavik and Greenland (**Figures 3 and 4, Table 1**) which are mainly Inuit territories. Arkhangelsk's crude TB incidence rate varied between 50 and 100

²⁰ Data for the entire country for Finland, Norway and Sweden.

²¹ Excluding 2006 data from Arkhangelsk.

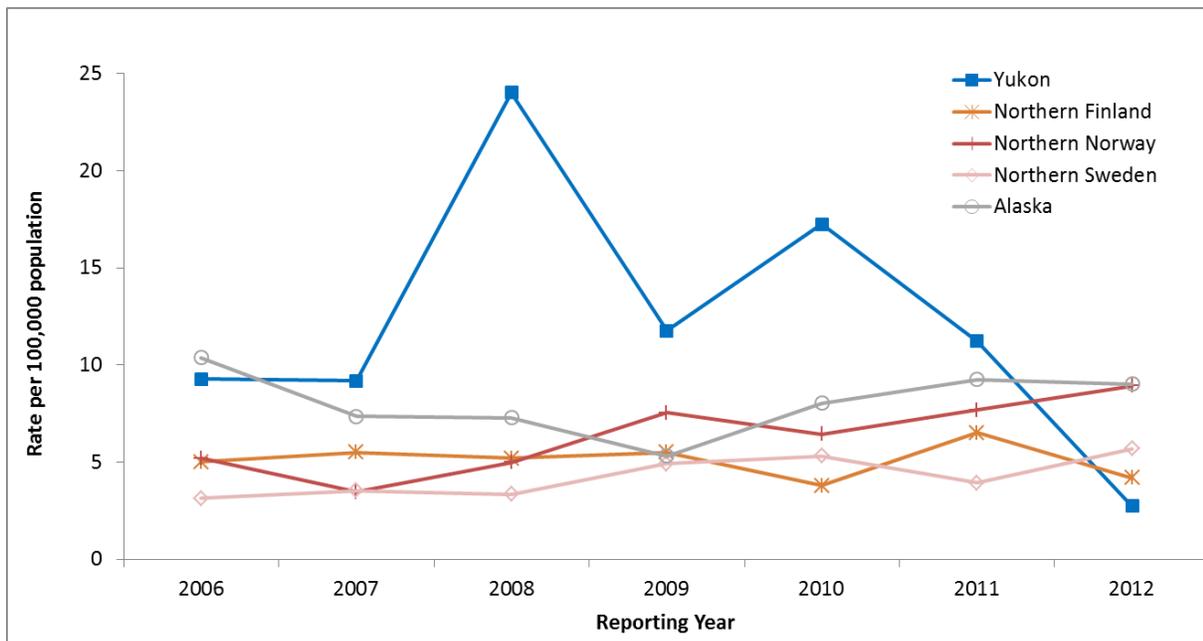
cases per 100,000 population. Finally Yukon, Finland²², Norway, Sweden and Alaska maintained an overall crude TB incidence rate below 20 cases per 100,000 population for the given time period.

Figure 3: Reported crude TB incidence rate (new and re-treatment cases) by ICS-TB jurisdiction, 2006-2012*



*2006 data for Arkhangelsk not available.

Figure 4: ICS-TB jurisdictions with an overall reported crude TB incidence rate (new and re-treatment cases) below 20 cases per 100,000 population, 2006-2012



²² Data directly provided by Finland (2015-06-18).

Table 1: Reported new active and re-treatment TB cases and incidence rate per 100,000 population - ICS-TB jurisdictions, 2006-2012

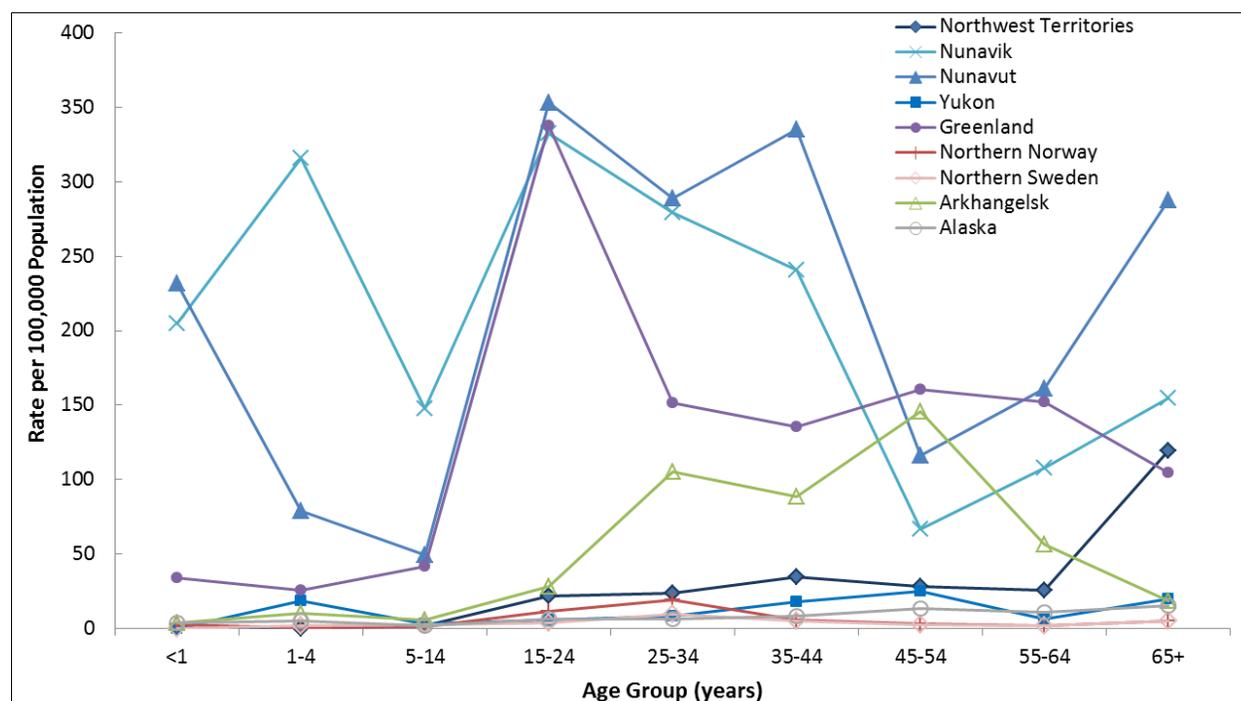
Jurisdiction	Average population size (2006-2012)		Reporting year							All years
			2006	2007	2008	2009	2010	2011	2012	
Northwest Territories	43 303	Cases	6	15	14	12	11	13	6	77
		Rate	13.9	34.7	32.3	28.0	25.4	29.9	13.8	25.4
Nunavik	11 675	Cases	6	12	21	14	12	27	71	163
		Rate	54.8	107.2	184.0	119.9	100.1	221.1	577.4	199.5
Nunavut	32 861	Cases	48	31	59	56	100	74	79	447
		Rate	155.7	98.2	184.6	170.7	297.9	215.9	225.7	194.3
Yukon	34 186	Cases	3	3	8	4	6	4	1	29
		Rate	9.3	9.2	24.0	11.8	17.2	11.2	2.7	12.1
Northern Finland	664 199	Cases	42	38	30	59	31	53	35	288
		Rate	5.0	5.5	5.2	5.5	3.8	6.5	4.2	5.1
Greenland	56 574	Cases	72	59	64	63	114	114	88	574
		Rate	126.5	104.2	113.4	112.1	201.9	201.4	155.1	144.9
Northern Norway	465 013	Cases	24	16	23	35	30	36	42	206
		Rate	5.2	3.5	5.0	7.6	6.4	7.7	8.9	6.9
Northern Sweden	510,249	Cases	16	18	17	25	27	20	29	152
		Rate	3.14	3.54	3.35	4.93	5.32	3.94	5.70	4.3
Arkhangelsk	1 244 088	Cases	N/A	874	847	826	777	843	713	4880
		Rate	N/A	70.6	68.9	67.7	64.1	71.3	60.9	65.4
Alaska	700 697	Cases	70	50	50	37	57	67	66	397
		Rate	10.4	7.4	7.3	5.3	8.0	9.3	9.0	8.1

*Average population from 2007 to 2012.

Age and sex

The burden of TB is spread across all age groups in the ICS-TB jurisdictions. When reviewing all reporting years, the highest incidence rate was among those 15 to 24 years old for the jurisdictions of Nunavik, Nunavut and Greenland, 25 to 34 years old for Norway and Sweden, 45 to 54 years old in Yukon and Arkhangelsk and finally, 65 years and older for Alaska and the Northwest Territories (**Figure 5, Table 2**).

Figure 5: Reported crude TB incidence rate (new and re-treatment cases) by age groups and ICS-TB jurisdictions*, 2006-2012**



*Data from Finland not available.

**2006 data for Arkhangelsk not available.

Table 2: Reported new active and re-treatment TB cases and incidence rate per 100,000 by age groups and ICS-TB jurisdictions*, 2006-2012**

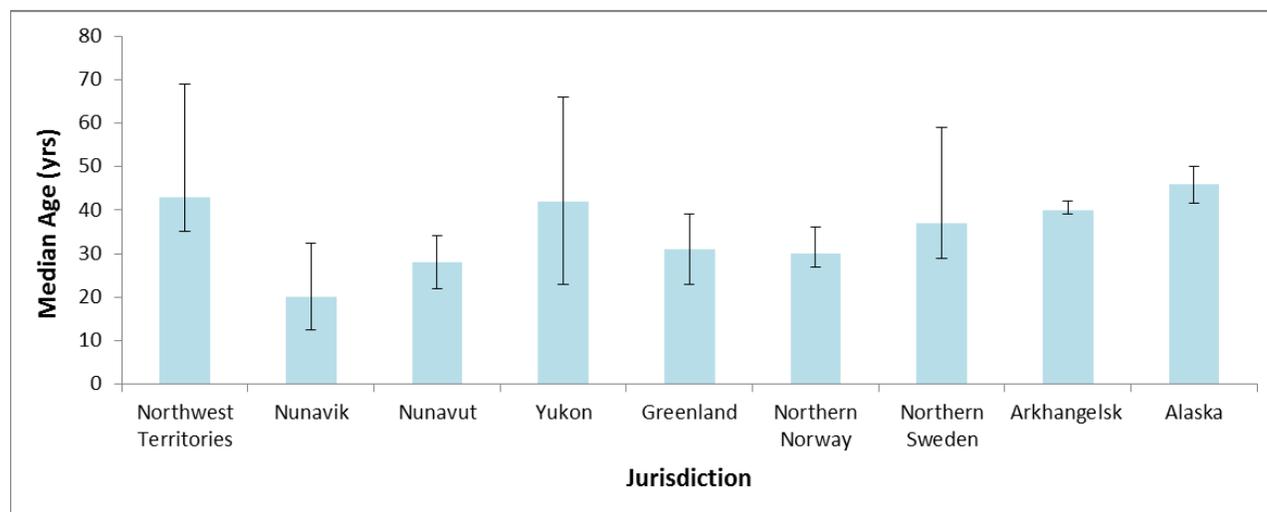
Jurisdiction		Age group									Total
		<1	1-4	5-14	15-24	25-34	35-44	45-54	55-64	65+	
Northwest Territories	Cases	0	0	1	11	11	16	12	7	19	77
	Rate	0.0	0.0	2.0	21.7	23.6	34.6	28.0	25.7	119.7	25.4
Nunavik	Cases	4	25	24	43	29	17	12	5	4	163
	Rate	204.6	316.2	147.9	332.4	279.6	240.6	66.5	107.7	154.6	199.5
Nunavut	Cases	13	17	22	133	88	78	54	22	20	447
	Rate	232.0	79.2	49.5	353.3	288.8	335.1	116.2	161.1	287.6	194.3
Yukon	Cases	0	2	1	2	3	8	7	2	4	29
	Rate	0.0	18.6	3.1	5.9	8.3	18.1	25.4	6.3	20.2	12.1
Greenland	Cases	2	6	26	172	98	86	101	56	27	574
	Rate	34.0	25.5	42.0	338.0	151.4	135.4	160.7	151.9	104.7	144.9
Norway	Cases	1	1	6	51	71	28	13	8	27	206
	Rate	2.7	0.7	1.4	11.9	19.0	6.0	2.9	1.9	5.3	6.3
Sweden	Cases	0	3	9	18	40	24	11	10	37	152
	Rate	0.0	2.0	2.4	3.6	9.8	5.4	2.4	2.1	5.3	4.3
Arkhangelsk	Cases	4	38	75	389	1207	1230	1196	544	197	4880
	Rate	4.1	10.1	5.7	28.5	105.5	88.8	145.7	56.3	18.9	57.4
Alaska	Cases	3	16	16	44	41	63	95	61	58	397
	Rate	3.9	5.4	2.1	6.4	6.1	8.1	13.4	10.7	15.7	8.1

*Data from Finland not available.

** 2006 data for Arkhangelsk not available.

The median age for reported active TB cases was lowest in Nunavik (20 years old) and highest in Alaska (46 years old). The large fluctuations observed in the yearly median age for individual jurisdictions are due mainly to the small number of reported cases in those jurisdictions (**Figure 6, Table 3**).

Figure 6: Median age* of reported active TB cases (new and re-treatment cases) by ICS-TB jurisdictions, 2006-2012*****



*The range represents the minimum and maximum percentage for a given year.

**Data from Finland not available.

***2006 data for Arkhangelsk not available.

Table 3: Median age of reported active TB cases (new and re-treatment cases) by ICS-TB jurisdictions*, 2006-2012**

Jurisdiction	Total number of cases	Reporting year							Overall
		2006	2007	2008	2009	2010	2011	2012	
Northwest Territories	77	69	43	41	44	35	41	61	43
Nunavik	163	13	16	18	27	33	20	21	20
Nunavut	447	22	34	23	30	30	27	34	28
Yukon	29	23	42	39	38	51	43	66	42
Greenland	574	31	39	27	32	31	23	39	31
Northern Norway	206	31	36	36	30	30	27	29	30
Northern Sweden	152	39	43	59	37	30	42	29	37
Arkhangelsk	4880	N/A	40	41	40	42	39	39	40
Alaska	397	43	50	46	50	48	47	42	46

*Data from Finland not available.

**2006 data for Arkhangelsk not available.

In all ICS-TB jurisdictions, the overall incidence rate was higher in males than females. The highest overall male-female difference in incidence rate was in Arkhangelsk with a rate almost 3.5 times higher in males than females (**Table 4**). The overall incidence was comparable in males and females for Norway, Sweden and Greenland.

Table 4: Reported crude incidence rate (per 100,000 population) by sex and ICS-TB jurisdictions*, 2006-2012**

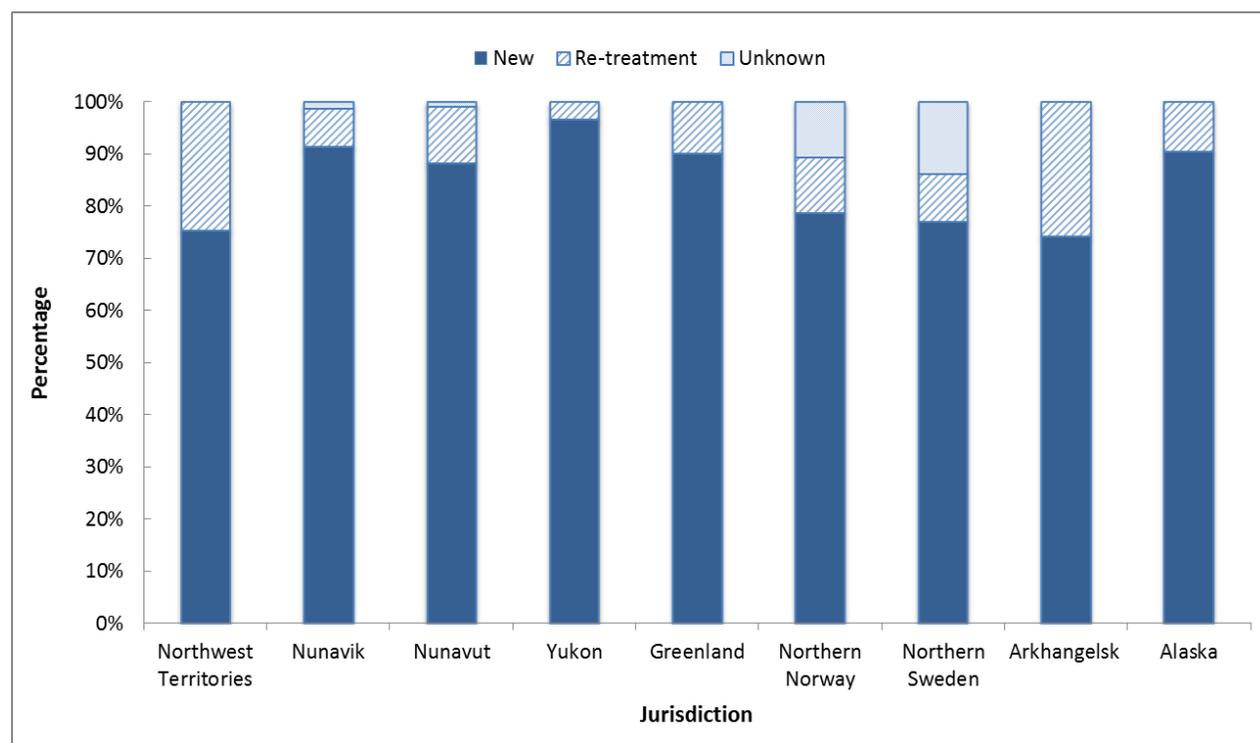
Jurisdictions	Sex	Reporting year (rate per 100,000 pop)							Total
		2006	2007	2008	2009	2010	2011	2012	
Northwest Territories	Males	17.8	53.5	44.7	36.2	35.9	35.8	13.4	33.9
	Females	9.6	14.4	19.1	19.2	14.3	23.6	14.1	16.4
Nunavik	Males	35.6	156.6	205	134.1	81.9	273.1	588.5	215.3
	Females	75.1	55	161.9	105.1	119.1	167	565.8	182.9
Nunavut	Males	175.9	91.8	241.3	164.7	396.9	270.6	292.6	236
	Females	134.1	105.2	123.5	177.1	191.5	157.3	153.9	149.6
Yukon	Males	18.1	12	29.3	23	22.5	5.5	5.4	16.3
	Females	0	6.3	18.5	0	11.8	17.2	0	7.7
Greenland	Males	149.1	126.6	127.2	137.5	207.1	207.1	186.4	163
	Females	101.1	78.8	97.8	83.4	196.1	195	119.8	124.6
Northern Sweden	Males	1.9	4.7	1.6	7.0	5.8	4.7	7.4	4.7
	Females	4.3	2.4	5.2	2.8	4.8	3.2	4.0	3.8
Arkhangelsk	Males	N/A	111.9	112.6	108.6	94.7	117.9	100.1	99.7
	Females	N/A	34.5	30.7	32.1	37.5	30.6	26.6	29.3
Alaska	Males	10.9	9.7	9.3	6.6	9.5	11.2	9.2	9.5
	Females	9.8	4.9	5.1	3.9	6.5	7.2	8.8	6.6

*Data from Finland and Norway not available.

**2006 data for Arkhangelsk not available.

TB disease history

The highest proportion of new cases versus re-treatment cases was in Yukon (97%) followed by Nunavik (91%) and Greenland (90%). The highest proportion of re-treatment cases (defined as having had at least one previous diagnosis of TB disease in the past) was in Arkhangelsk (26% of all reported cases), followed closely by the Northwest Territories (25%). Previous history of TB disease was reported as unknown for 11% and 14% of the reported cases for Norway and Sweden respectively (**Figure 7; Table 5**).

Figure 7: Reported percentages of TB cases by treatment history and ICS-TB jurisdiction*, 2006-2012**

*Data from Finland not available.

**Excluding 2006 data for Arkhangelsk.

Table 5: Reported percentages of TB cases by treatment history and ICS-TB jurisdiction*, 2006-2012**

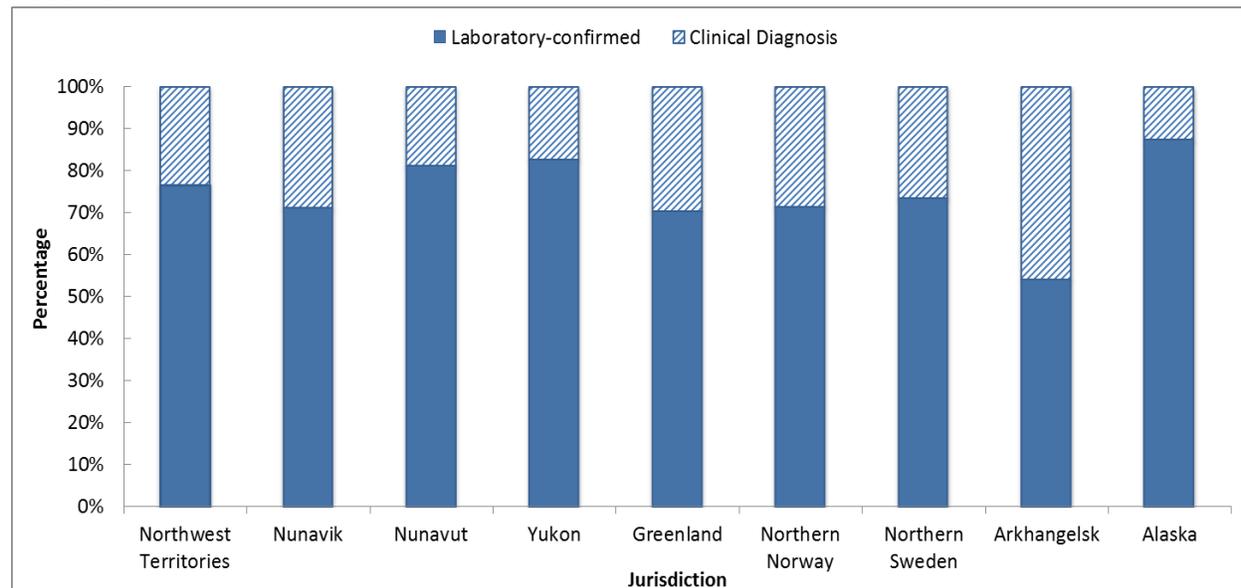
Treatment history	Jurisdiction								
	Northwest Territories	Nunavik	Nunavut	Yukon	Greenland	Northern Norway	Northern Sweden	Arkhangelsk**	Alaska
New	75.3	91.4	88.1	96.6	90.1	78.6	77.0	74.1	90.4
Re-treatment	24.7	7.4	11.0	3.4	9.9	10.7	9.2	25.9	9.6
Unknown	0.0	1.2	0.9	0.0	0.0	10.7	13.8	0.0	0.0

*Data from Finland not available.

** Excluding 2006 data for Arkhangelsk.

Disease type and diagnostic classification

Over the seven-year reporting period, about 60% of reported cases were laboratory-confirmed, which includes all smear and/or culture-positive cases. Alaska reported the highest percentage of laboratory-confirmed cases (87%) and Arkhangelsk reported the highest percentage of clinically-confirmed cases (46%) (Table 6).

Figure 8: Reported percentage of TB cases by confirmed diagnostic status and jurisdiction*, 2006-2012**

*Data from Finland not available.

** Excluding 2006 data for Arkhangelsk.

Table 6: Reported percentage of TB cases by confirmed diagnostic status and jurisdiction*, 2006-2012**

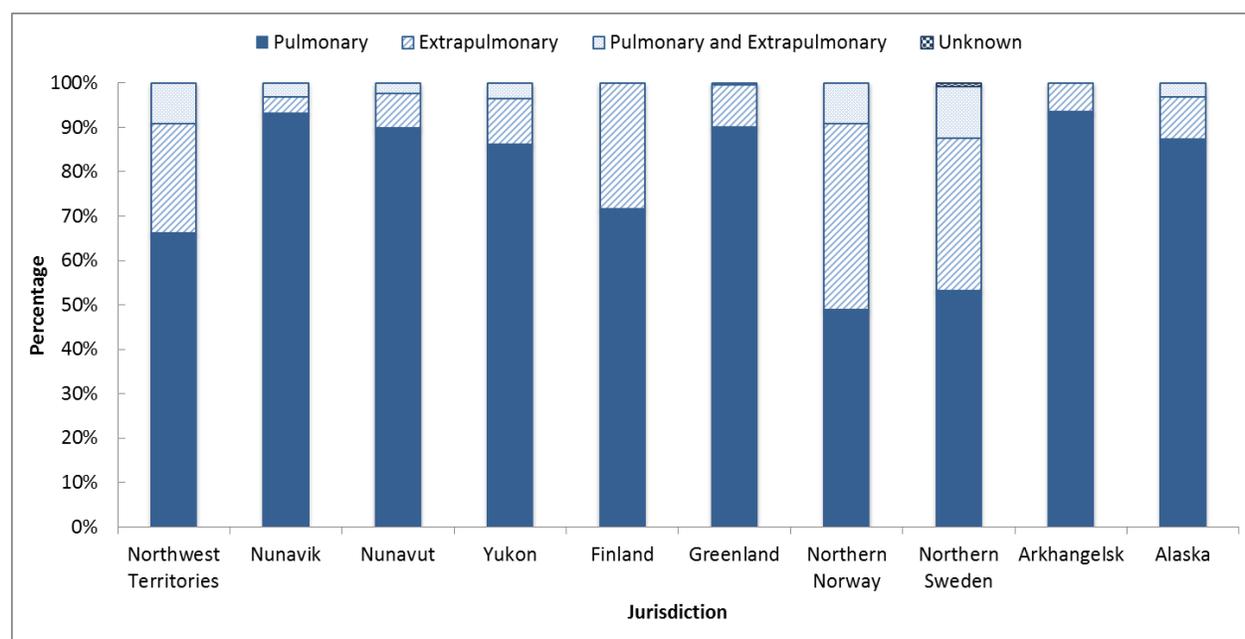
Diagnostic status	Jurisdiction (%)								
	Northwest Territories	Nunavik	Nunavut	Yukon	Greenland	Northern Norway	Northern Sweden	Arkhangelsk	Alaska
Laboratory-confirmed	76.6	71.2	81.2	82.8	70.4	71.4	73.4	54.2	87.4
Clinical diagnosis	23.4	28.8	18.8	17.2	29.6	28.6	26.3	45.8	12.6

*Data from Finland not available.

**Excluding 2006 data for Arkhangelsk.

In this report, active TB disease is classified as either pulmonary or extrapulmonary. Pulmonary TB refers to a patient with TB disease involving the lung parenchyma (17). Primary disease is also captured under the respiratory classification. Extrapulmonary TB is TB that is outside the lungs and respiratory tract (17).

The highest percentage of pulmonary disease was reported in Arkhangelsk (94%), followed closely by Nunavik (93%), Greenland (90%) and Nunavut (90%). Note: It is not possible to classify a case as “both pulmonary and extrapulmonary” for Arkhangelsk; therefore, if a case is diagnosed in both diagnostic sites, it is reported as “pulmonary”. Sweden and Norway reported the highest proportion of both extrapulmonary and “both pulmonary and extrapulmonary” cases (**Figure 9; Table 7**).

Figure 9: Reported proportion of TB cases by diagnostic site and jurisdiction*, 2006-2012**

*Data provided directly by Finland.

**Excluding 2006 data for Arkhangelsk.

Table 7: Reported proportion of TB cases by diagnostic site and jurisdiction*, 2006-2012**

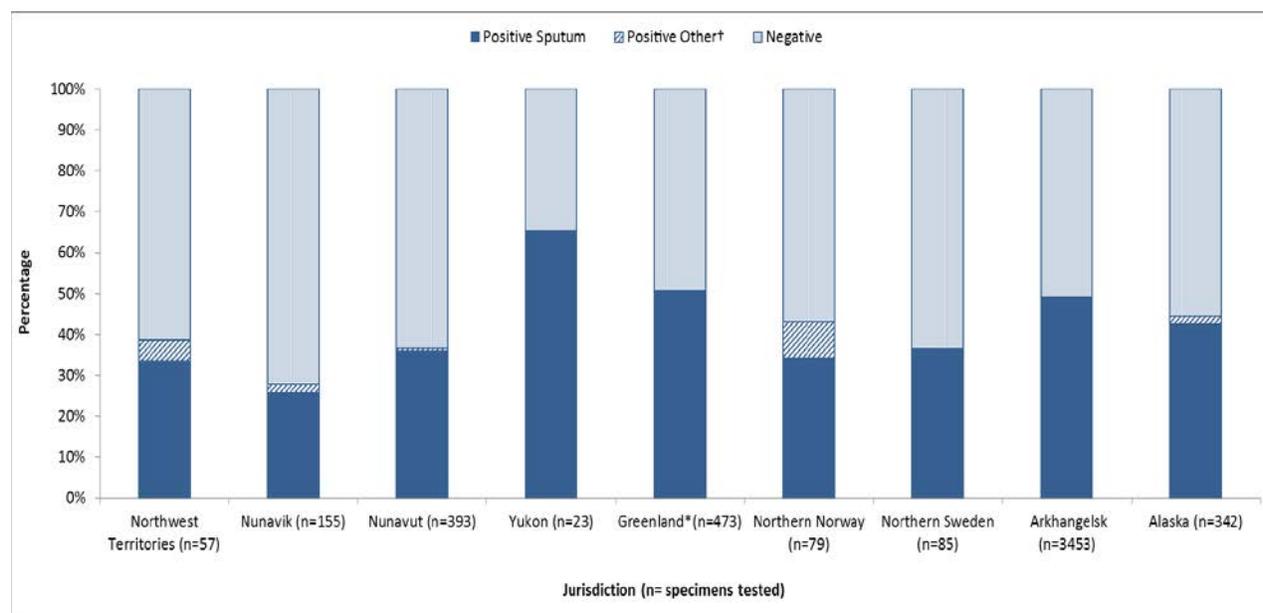
Diagnostic site	Jurisdiction (%)									
	Northwest Territories	Nunavik	Nunavut	Yukon	Northern Finland	Greenland	Northern Norway	Northern Sweden	Arkhangelsk	Alaska
Pulmonary	66.2	93.3	89.9	86.2	71.8	90.1	49.0	53.3	93.5	87.4
Extrapulmonary	24.7	3.7	7.8	10.3	28.2	9.6	41.8	34.2	6.5	9.6
Pulmonary and extrapulmonary	9.1	3.1	2.2	3.4	0.0	0.3	9.2	11.8	0.0	3.0
Unknown	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0

*Data provided directly by Finland.

**Excluding 2006 data for Arkhangelsk.

Microscopy (smear)-positive cases normally denote a probable case of infectious pulmonary TB. Among ICS-TB jurisdictions, Yukon reported the highest number of smear positives among cases reported with pulmonary TB only or both pulmonary and extrapulmonary TB, representing 65% of all reported cases tested in that category. Nunavik had the smallest proportion of smear-positive (26%) cases among pulmonary TB only or both pulmonary and extrapulmonary TB cases (**Figure 10; Table 8**).

Figure 10: Smear results in percentage among all pulmonary TB cases (including both pulmonary and extrapulmonary) by jurisdiction*, 2006-2012**



*Data not available for Finland.

**No cases reported with both pulmonary and extrapulmonary cases for Arkhangelsk and excluding 2006 data.

†Other specimens include bronchial wash, gastric wash, cerebral-spinal fluid, node biopsy, urine.

Table 8: Smear results in percentage* among all pulmonary TB cases (including individual infected diagnosed with both pulmonary and extrapulmonary) by jurisdiction, 2006-2012*****

Smear results (%)	Jurisdiction								
	Northwest Territories (n=57)	Nunavik (n=155)	Nunavut (n=393)	Yukon (n=23)	Greenland (n=473)**	Northern Norway (n=79)	Northern Sweden (n=85)	Arkhangelsk (n=3453)**	Alaska (n=342)
Positive sputum	33.3	25.8	35.9	65.2	50.7	34.2	36.5	49.1	42.4
Positive other†	5.3	1.9	0.8	0.0	0.0	8.8	0.0	0.0	2.0
Negative	61.4	72.3	63.4	34.8	49.3	57.0	63.5	50.9	55.6

*Percentage calculated on the number of pulmonary smear tested.

**Data from Finland not available.

***Excluding 2006 data for Arkhangelsk.

†Other specimens include bronchial wash, gastric wash, cerebral-spinal fluid, node biopsy, urine.

Drug resistance and treatment regimen

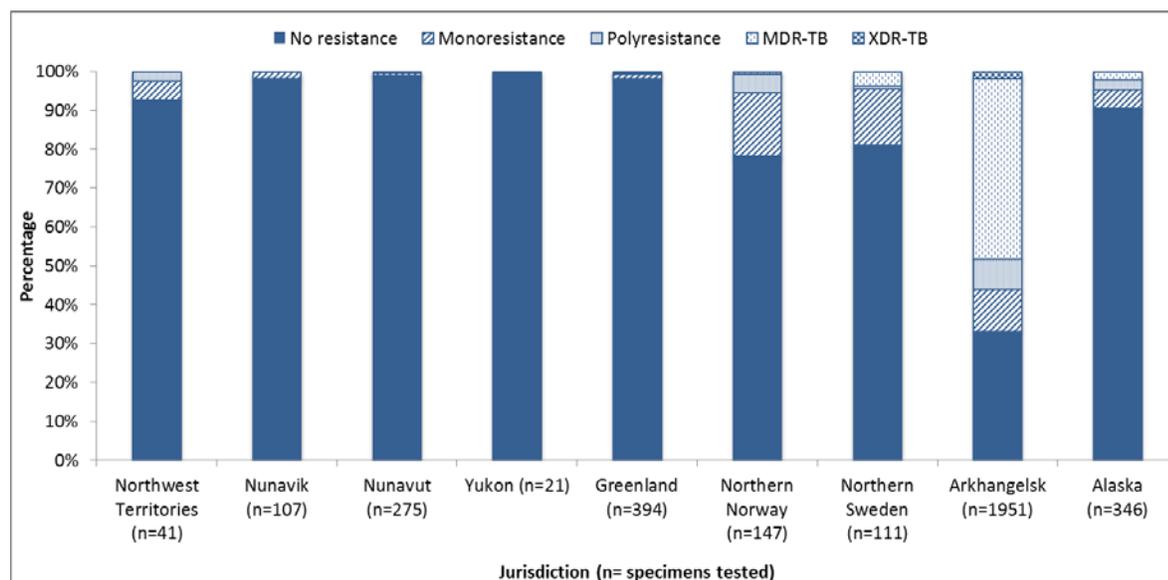
Phenotypic drug susceptibility testing (DST) is recommended by the WHO for all first culture-positive TB isolates obtained from each new TB case. The following resistance patterns are described in this report²³:

²³ Please refer to **Appendix 2** for a complete list of drug testing by ICS-TB jurisdictions.

- ❖ Monoresistance: Resistance to one of the first-line drugs used by the ICS-TB jurisdictions [isoniazid (INH), rifampin (RMP), ethambutol (EMB), pyrazinamide (PZA) or streptomycin (SM)].
- ❖ Polyresistance: Resistance to more than one first-line anti-TB drug, other than both isoniazid and rifampicin.
- ❖ Multidrug-resistant tuberculosis (MDR-TB): TB that is resistant to at least the two best first-line anti-TB drugs (INH and RMP) but which does not meet the definition of extensively drug-resistant TB (XDR-TB).
- ❖ Extensively drug-resistant TB (XDR-TB): TB that is resistant to at least the two best first-line anti-TB drugs (INH and RMP) plus resistant to second-line drugs including any fluoroquinolone and to at least one of three injectable second-line anti-TB drugs (amikacin, capreomycin and kanamycin).

The proportion of cases with resistance to at least one drug (excluding MDR- or XDR-TB) ranged from zero to 21% across jurisdictions, with the highest proportion being reported in Norway (21%) followed by Arkhangelsk (19%). Resistance to at least one drug was reported in Yukon, Nunavut, Greenland and Nunavik over the seven years. Four jurisdictions reported MDR-TB or XDR-TB strains, with the highest proportion of cases being in Arkhangelsk (48%). Arkhangelsk was the only jurisdiction which reported XDR-TB strains (**Figure 11; Table 9**).

Figure 11: Reported proportion of drug resistance among TB cases by ICS-TB jurisdictions*, 2006-2012**



*Data from Finland not available.

**Excluding 2006 data for Arkhangelsk.

Table 9: Reported percentage* of drug resistance among TB cases by ICS-TB jurisdictions, 2006-2012*****

Drug resistance	Jurisdiction (%)								
	Northwest Territories (n*=41)	Nunavik (n=107)	Nunavut (n=275)	Yukon (n=21)	Greenland (n=394)	Northern Norway (n=147)	Northern Sweden (n=111)	Arkhangelsk (n=1951)	Alaska (n=346)
No resistance	92.7	98.1	98.9	100.0	98.2	78.2	81.1	33.1	90.5
Monoresistance	4.9	1.9	0.7	0.0	1.3	16.3	14.4	10.8	4.9
Polyresistance	2.4	0.0	0.4	0.0	0.3	4.8	0.9	8.0	2.6
MDR-TB	0.0	0.0	0.0	0.0	0.3	0.7	3.6	46.3	2.0
XDR-TB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0

*Percentage calculated on the number of specimens tested (n=number of specimens tested).

**Data from Finland not available.

***Excluding 2006 data for Arkhangelsk.

TB strains resistant to isoniazid only were the most prevalent, and isoniazid monoresistance was the only resistance patterns reported by the Northwest Territories, Nunavik, Nunavut and Greenland. No resistance to isoniazid was reported by Yukon. The highest proportion of monoresistance was found in Northern Norway at 16.3% of all specimens tested for drug resistance; (Tables 9 and 10).

Monoresistance to streptomycin was the second most commonly reported form of resistance, particularly in Norway and Arkhangelsk²⁴. Note that Canadian territories do not test for resistance to streptomycin.

Table 10: Reported proportion of monoresistance among TB cases by ICS-TB jurisdictions*, 2006-2012**

Drug resistance	Jurisdiction							
	Northwest Territories (n=2)	Nunavik (n=2)	Nunavut (n=2)	Greenland (n=5)	Northern Norway (n=24)	Northern Sweden (n=16)	Arkhangelsk (n=210)	Alaska (n=17)
Isoniazid	100.0	100.0	100.0	100.0	50.0	56.3	40.5	70.6
Rifampin	0.0	0.0	0.0	0.0	0.0	0.0	3.3	5.9
Ethambutol	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0
Pyrazinamide	0.0	0.0	0.0	0.0	0.0	43.8	8.1	23.5
Streptomycin	Not tested	Not tested	Not tested	Not tested	50.0	Not tested	43.8	Not tested

*No monoresistance reported for Yukon and Finland data not available.

**Excluding 2006 data for Arkhangelsk.

Among all reported cases²⁵, the proportion of cases on a RMP-INH-PZA-EMB (RIPE) treatment regime across jurisdictions²⁶ varied considerably. The largest proportion of cases on the RIPE regime was

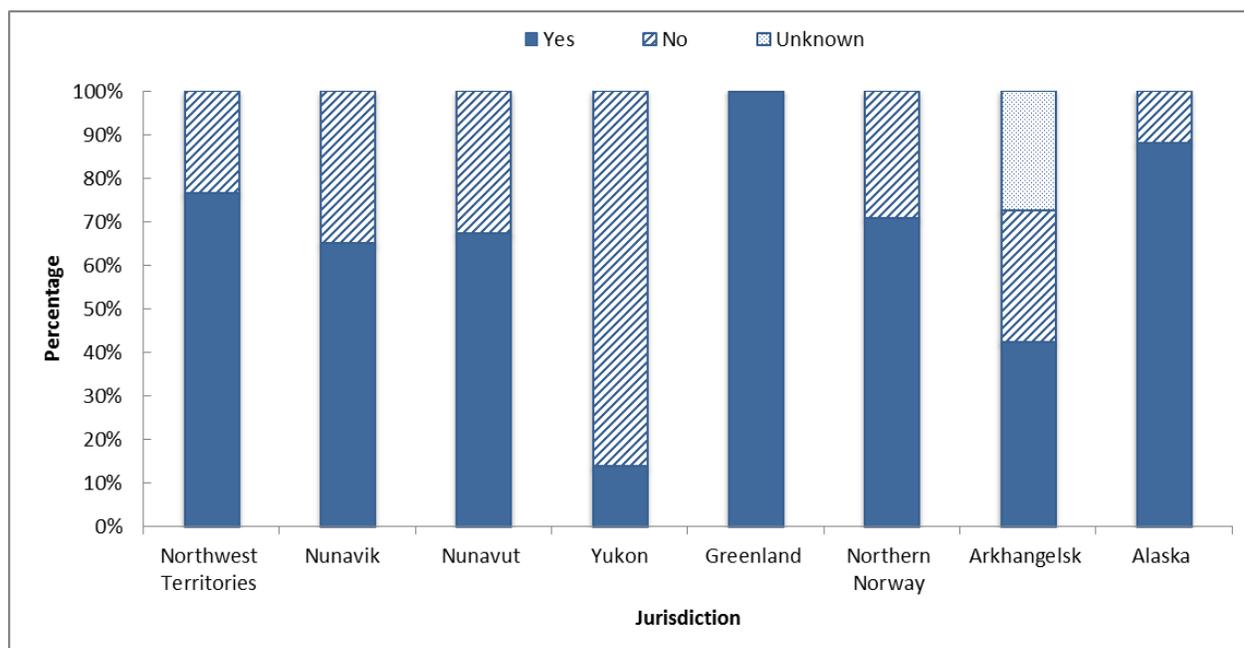
²⁴ Before 2010, drug sensitivity testing was performed on EMB, PZA and SM in the Arkhangelsk region. Since 2010, testing of those drugs have stopped in that jurisdiction as SM was no longer recommended by the WHO (WHO's Guidelines for treatment of tuberculosis, fourth edition). In addition, EMB and PZA were also removed from the routine drug sensitivity testing if patients were susceptible for INH and RMP; therefore a standardised treatment of RIPE without testing for EMB and PZA.

²⁵ As several cases with known resistance to any of those four drugs were still reported to have been placed on the four drug regime, this analysis includes all reported cases.

²⁶ Data not available for Sweden.

observed in Greenland (99.8%), followed by Alaska (88%) and the Northwest Territories (77%). The jurisdictions with the smallest proportion of susceptible cases on a RIPE treatment regime are Yukon (14%) and Arkhangelsk (42%) (Figure 12; Table 11). Note that the low level of RIPE treatment regimen in Arkhangelsk is mainly due to the high proportion of MDR and XDR-TB.

Figure 12: Reported proportion of TB cases on RIPE treatment regime by ICS-TB jurisdictions*, 2006-2012**



*No data available for Sweden and Finland.

**Excluding 2006 data for Arkhangelsk.

Table 11: Reported proportion of TB cases on RIPE treatment regime by jurisdiction*, 2006 - 2012**

Treatment Regimen	Jurisdiction (%)							
	Northwest Territories	Nunavik	Nunavut	Yukon	Greenland	Northern Norway	Arkhangelsk	Alaska
Yes	76.6	65.0	67.3	13.8	99.8	70.9	42.3	88.2
No	23.4	35.0	32.7	86.2	0.2	29.1	30.2	11.8
Unknown	0.0	0.0	0.0	0.0	0.0	0.0	27.5	0.0

*No data available for Sweden and Finland.

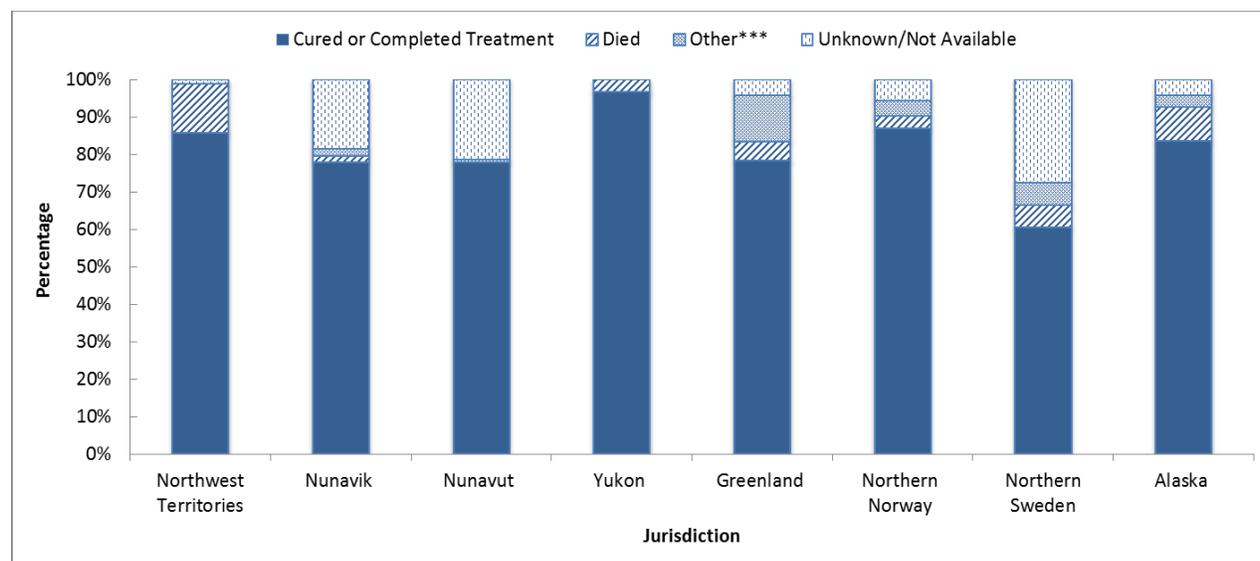
**Excluding 2006 data for Arkhangelsk.

Treatment outcome

Jurisdictions with the highest proportion of cases that were classified as cured or who had completed treatment were Yukon (97%), the Northwest Territories (86%), Norway (85%) and Alaska (84%). The jurisdiction with the lowest proportion of cases reported as cured or who completed treatment was Sweden (68%); however, it is important to note that 28% of treatment outcome data was not available

for Sweden. In addition, Arkhangelsk was excluded from this analysis as the only reported treatment outcome was “death”. It was therefore not possible to assess the proportion of the other treatment outcomes for that jurisdiction (Figure 13; Table 12).

Figure 13: Reported treatment outcomes among TB cases by jurisdiction, 2006-2012



*No data available for Finland.

**Arkhangelsk data excluded from the figure as death was the only treatment outcome available.

***The "Other" category includes treatment failure, defaulted, transferred out, absconded, treatment ongoing, treatment and dispended because of adverse effect.

Table 12: Reported treatment outcomes among TB cases by jurisdiction*, 2006-2012**

Treatment Outcome	Jurisdiction (%)								
	Northwest Territories	Nunavik	Nunavut	Yukon	Greenland	Northern Norway	Northern Sweden	Arkhangelsk	Alaska
Cured or Completed Treatment	85.7	77.9	77.9	96.6	78.4	84.6	67.8	N/A	83.6
Died	13.0	1.8	0.0	3.4	5.1	4.5	2.8	13.6	9.1
Other***	0.0	1.8	0.6	0.0	12.2	5.4	3.2	N/A	3.0
Unknown/Not Available	1.3	18.6	21.5	0.0	4.4	5.4	26.2	86.4	4.3

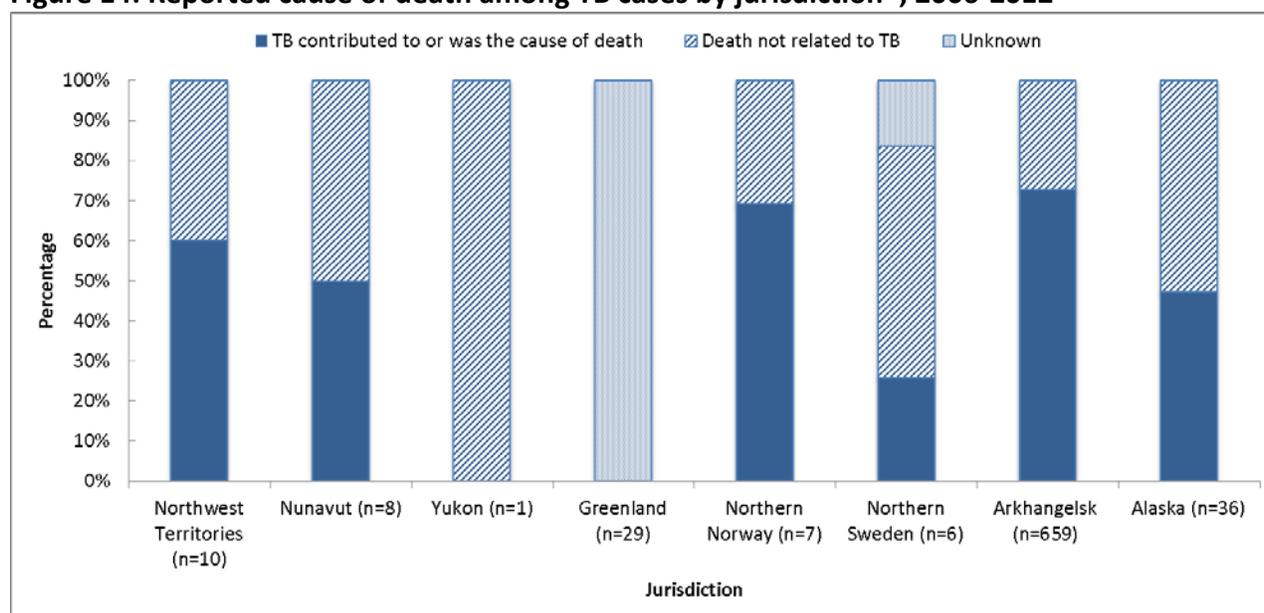
*No data available for Finland.

**Excluding 2006 data for Arkhangelsk.

***The "Other" category includes treatment failure, defaulted, transferred out, absconded, treatment ongoing, treatment and dispended because of adverse effect.

Of the total number of TB cases who died of any cause during treatment, Arkhangelsk reported the highest proportion (73%) of any form of death among TB cases, followed by Norway (69%), the Northwest Territories (60%) and Nunavut (50%). Nunavik did not report any deaths for the time period 2006-2012 (Figure 14; Table 13).

Figure 14: Reported cause of death among TB cases by jurisdiction*, 2006-2012**



*Nunavik did not report any death for the time period 2006-2012 and no data available for Finland.

**Excluding 2006 data for Arkhangelsk.

Table 13: Distribution of cause of death among TB cases by jurisdiction*, 2006-2012** (n=1,029)

Treatment history	Jurisdiction (%)							
	Northwest Territories (n=10)	Nunavut (n=8)	Yukon (n=1)	Greenland (n=29)	Northern Norway (n=7)	Northern Sweden (n=6)	Arkhangelsk (n=659)	Alaska (n=36)
TB contributed to or was the cause of death	60.0	50.0	0.0	0.0	69.2	25.9	72.7	47.2
Death not related to TB	40.0	50.0	100.0	0.0	30.8	57.8	27.3	52.8
Unknown	0.0	0.0	0.0	100.0	0.0	16.4	0.0	0.0

*Nunavik did not report any death for the time period 2006-2012 and no data available for Finland.

**Excluding 2006 data for Arkhangelsk.

DISCUSSION

The current surveillance data provided by the participating ICS-TB jurisdictions highlights a large degree of variation in TB disease rates as well as drug resistance patterns in participating circumpolar regions. According to the WHO, low incidence is defined as less than 20 cases per 100,000 population (17). From 2006 to 2012, five of the ten ICS-TB regions met that definition. Despite slight variations in the actual number of cases for some jurisdictions, fluctuations observed in the incidence rates, particularly when divided by age groups and sex, are caused mainly by the small populations sizes in circumpolar regions.

For all jurisdictions, the crude incidence rate for males was greater than for females. For half of the jurisdictions, the highest incidence rate was found among those 25-34 years or younger. A high incidence rate among a younger age group is usually considered to be an indicator of recent transmission of TB (19,20).

Overall, less than 50% of reported cases were smear-positive pulmonary cases. Pulmonary smear-positive cases may be a sign of a more advanced stage of the disease and are more likely to be contagious and therefore more capable of transmission within the community (6).

Considering global rates, the proportion of drug resistance cases across the ICS-TB participating jurisdictions remains low. Except in one jurisdiction, MDR and XDR cases were uncommon in the circumpolar region, with four jurisdictions reporting no MDR/XDR-TB cases during the specified time period and four other regions having very few cases.

DATA LIMITATIONS

Small population sizes

TB incidence rates are significantly affected by small population sizes (i.e., one TB case can increase the TB incidence rate by a magnitude of three). Population sizes vary by jurisdiction and thus, incidence rates should be interpreted with this in mind.

Reporting year

In order to conduct descriptive analyses with respect to time, the year in which the TB case was reported was required, however, for a portion of TB cases, data on reporting year were missing. To determine the reporting year for TB cases with missing data for reporting year, the year was extracted from the “Date of diagnosis” variable. When TB cases were missing data for both the reporting year and date of diagnosis variables, the year was extracted from the “CaseID” variable. The year extracted from the “Date of diagnosis” variable may not accurately reflect the reporting year (i.e., the TB case could have been diagnosed in December 2006 but case was reported in January 2007).

Smear-positive cases

In order to calculate the proportion of smear-positive pulmonary cases, the denominator used in the analysis consisted of all cases that had a sputum smear result, or other smear result (e.g., from a bronchial wash, gastric wash, cerebral-spinal fluid, node biopsy, urine or other). Data on smear results for a number of jurisdictions were not available at the time of data analyses, thus, the proportion of

smear-positive cases could either be underestimated (missing case data could be smear-positive) or overestimated (missing case data could be smear negative).

RIPE treatment regime among susceptible cases

In order to calculate the proportion of susceptible cases that are on a RIPE (Isoniazid, Ethambutol, Rifampin, Pyrazinamide) treatment regime, data on treatment and drug resistance were required (total number of susceptible cases on RIPE/total number of susceptible cases). However, TB cases were placed on RIPE despite resistance and all cases were included in the calculations, which created an underestimation. In addition, for a number of jurisdictions, data on treatment regime was not available, thus, the proportion of cases on a RIPE treatment regime may have been under or overestimated. Furthermore, drug sensitivity data was not available for a portion of cases, thus, the total number of susceptible cases may have been under or overestimated.

Drug resistance

In order to calculate the proportion of cases in the ICS jurisdictions with drug-resistant strains of TB (mono-drug resistance, MDR-TB and XDR-TB), the denominator used in the analysis was the total number of cases with a drug sensitivity test with a known result (positive or negative). This analysis did not take into account cases that did not have a mycobacterial culture present for testing or cases with an unknown sensitivity test. In a number of jurisdictions, data was provided on the results of drug sensitivities; however, data on culture methods and results were missing. Furthermore, drug sensitivity data was not available for some cases, thus, the calculated proportion of cases with drug resistance may be underestimated. In addition, not all jurisdictions use or test for the same first-line drugs. For example, streptomycin is not tested in Canada, which may underestimate the actual resistance of streptomycin in the circumpolar jurisdictions.

TB-related deaths

In order to calculate the distribution of causes of death among the proportion of cases who had died (TB contributed to death or TB did not contribute to death), the total number of deaths for each jurisdiction was derived from the “treatment outcome” variable which indicates if cases had been cured/completed treatment, had died or had another treatment outcome. In one jurisdiction, data on treatment outcomes were not available at the time of data analysis and thus, the total number of deaths could not be determined based on this variable. However, jurisdictions did provide data on cause of death, despite data not being available for treatment outcomes. To approximate the total number of deaths (denominator), totals for “TB contributed to death”, “death not related to TB” and “unknown” were tallied. This may not be completely representative of the total number of deaths.

CONCLUSION

Overall, TB remains a serious public health issue in the circumpolar region. The International Circumpolar Surveillance (ICS) project contributes to a more comprehensive understanding of TB in the north. As the epidemiology of TB in circumpolar regions evolves and changes, members of the International Circumpolar Surveillance – Tuberculosis Working Group will continue to share expertise to improve upon existing knowledge of the epidemiology of TB and will work collaboratively to reduce the burden of TB in the circumpolar region and across the world.

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APPENDIX 1 – LIST OF CORE DATA ELEMENTS

Main category	Data elements	Sub-data elements
Identification	Unique case identifier (jurisdiction specific for reference purposes only)	
	ICS-TB case identifier (assigned by ICS-TB)	
Demographics	Country reporting the case	
	Region reporting the case (<i>future prospective analysis may include uniform data element indicating region where diagnosed</i>)	
	Geocode or sub-region identifier (e.g. province or state - specific to country)	
	Sex	
	Month and year of birth and/or age at diagnosis (which ever is available)	
Diagnosis	Date of diagnosis (or other date used by the jurisdiction to define in the case in the context of time)	
	New or re-treatment case	
	Diagnostic site: 'pulmonary', 'extrapulmonary' or 'both'	
	Clinically-confirmed or culture-confirmed case	
	Bacterial (microscopy) status or smear results	Type and source of specimen Method of microscopy
	Culture results	Type and source of specimen Method of culture
	Final antibiotic resistance pattern (for culture-positive only)	Type of drug
		Concentration used
		Method of drug sensitivity testing
Treatment	Initial date of treatment	
	Final date of treatment	
	Final treatment outcome	
	Cause of death (if the case died)	

APPENDIX 2 – LIST OF DRUGS TESTED BY THE ICS-TB JURISDICTIONS

Country/jurisdiction	Use*	First-line drugs				
		Isoniazid (INH)	Rifampin (RMP)	Ethambutol (EMB)	Pyrazinamide (PZA)	Streptomycin (SM)
Canada (Northwest Territories, Nunavik, Nunavut, Yukon)	Standard regimen	X	X	X	X	
	Routine testing	X	X	X	X	
Finland	Standard regimen	X	X	X	X	
	Routine testing	X	X	X	X	X
Greenland	Standard regimen	X	X	X	X	
	Routine testing	X	X	X	X	
Norway	Standard regimen	X	X	X	X	
	Routine testing	X	X	X	X	X
Sweden	Standard regimen	X	X	X	X	
	Routine testing	X	X	X	X	
Russian Federation (Arkhangelsk)**	Standard regimen	X	X			
	Routine testing	X	X			
United States (Alaska)	Standard regimen	X	X	X	X	
	Routine testing	X	X	X	X	

* Standard therapy refers to a first-line drug that is normally used in the treatment of fully sensitive TB strains. Routine testing is a drug that is normally tested through routine drug susceptibility testing to determine the resistance to antituberculosis drugs.

** Before 2010 in Arkhangelsk, drug sensitivity testing was performed for EMB, SM and PZA. However, tests for those drugs have been discontinued as SM was no longer recommended by the WHO as a first-line drug in the standard regimen for new TB patients.