TUBERCULOSIS:

DRUG RESISTANCE IN CANADA 2015

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

AK	Amikacin
Alta.	Alberta
B.C.	British Columbia
BCG	Bacillus Calmette-Guérin
CCDIC	Centre for Communicable Diseases and Infection Control
CI	Confidence interval
CLSI	Clinical and Laboratory Standards Institute
CM	Capreomycin
CTBLSS	Canadian Tuberculosis Laboratory Surveillance System
CTLTN	Canadian Tuberculosis Laboratory Technical Network
EMB	Ethambutol
ETH	Ethionamide
INH	Isoniazid
KM	Kanamycin
LIN	Linezolid
M. africanum	*Mycobacterium africanum*
M. bovis	*Mycobacterium bovis*
M. canetti	*Mycobacterium canetti*
M. caprae	*Mycobacterium caprae*
M. microti	*Mycobacterium microti*
M. pinnipedii	*Mycobacterium pinnipedii*
M. tuberculosis	*Mycobacterium tuberculosis*
Man.	Manitoba
MDR-TB	Multidrug-resistant tuberculosis
MOX	Moxifloxacin
MTBC	*Mycobacterium tuberculosis* complex
N.B.	New Brunswick
N.L.	Newfoundland and Labrador
NRCM	National Reference Centre for Mycobacteriology
N.S.	Nova Scotia
Nvt.	Nunavut
N.W.T.	Northwest Territories
OFL	Ofloxacin
Ont.	Ontario
PAS	*Para*-aminosalicylic acid
P.E.I.	Prince Edward Island
PHAC	Public Health Agency of Canada
ProvLab	Provincial Laboratory of Public Health (Alberta)

PZA	Pyrazinamide
Que.	Quebec
RBT	Rifabutin
RMP	Rifampin
Sask.	Saskatchewan
SM	Streptomycin
TB	Tuberculosis
XDR-TB	Extensively drug-resistant tuberculosis
Y.T.	Yukon

INTRODUCTION

Drug-resistant strains of tuberculosis (TB) pose a threat to Canadian TB prevention and control efforts. Although drug-resistant TB is not a major problem in Canada, it has the potential to become one because Canadians frequently travel abroad and many individuals immigrate to Canada from countries with high TB rates and associated drug resistance.

The Canadian Tuberculosis Laboratory Surveillance System (CTBLSS) was created in 1998 as part of Canada's response to a growing worldwide concern about TB drug resistance. It was established by the Health Canada Division of Tuberculosis Prevention and Control in collaboration with the Canadian Tuberculosis Laboratory Technical Network (CTLTN) and participating laboratories. The CTBLSS was designed to monitor emerging trends and patterns in TB drug resistance in Canada and is currently managed by the Centre for Communicable Diseases and Infection Control (CCDIC) within the Public Health Agency of Canada (PHAC).

This report is part of an annual surveillance report series that describes data collected through the CTBLSS. Specifically, this report provides details on TB drug resistance in Canada for the period 2005 to 2015, with a focus on 2015.

The data presented in this report are intended to inform public health action as well as policy and program development and assessment.

BACKGROUND

PATTERNS OF DRUG RESISTANCE

TB drug resistance is identified through susceptibility testing of clinical specimens collected from individuals with culture-positive TB.[1] People with TB are said to have drug-resistant TB if the strain of *Mycobacterium tuberculosis* causing their disease is resistant to one or more of the four first-line drugs: isoniazid, rifampin, pyrazinamide or ethambutol. The following resistance patterns are described in this report:

- *Monoresistance*—defined as resistance to one first-line anti-tuberculosis drug only (isoniazid, rifampin, ethambutol or pyrazinamide).
- *Polyresistance (other patterns)*—defined as resistance to more than one first-line anti-tuberculosis drug, not including the isoniazid and rifampin combination.
- *Multidrug-resistant tuberculosis (MDR-TB)*—defined as resistance to isoniazid and rifampin with or without resistance to other anti-tuberculosis drugs.
- *Extensively drug-resistant TB (XDR-TB)*—defined as resistance to isoniazid and rifampin and any fluoroquinolone and at least one of the three injectable second-line drugs (amikacin, capreomycin or kanamycin).[2]

TB DRUG RESISTANCE TESTING STANDARDS IN CANADA

The mission of the CTLTN is to promote excellence, standardization and quality assurance in mycobacteriology services. The CTLTN is a pan-Canadian network of technical and scientific heads of provincial and territorial TB laboratories (see Appendix I: Participating Laboratories of the Canadian Tuberculosis Laboratory Technical Network (CTLTN)).

The goals of the CTLTN are to:

- standardize laboratory methodologies;
- improve biosafety operational practices and physical requirements;
- implement biosafety guidelines;
- participate in national surveillance and proficiency programs; and
- exchange services and information about new technologies.

Laboratory testing methods in Canada, including drug selection and the critical concentrations used for routine drug susceptibility testing, follow recommended laboratory standards.[i,3,4] Participating CTLTN laboratories perform routine susceptibility testing of *Mycobacterium tuberculosis* complex (MTBC) isolates against first-line anti-tuberculosis drugs using fluorometric proportion method BACTEC® MGIT 960. **Table 1** provides a list of recommended first-line and second-line anti-tuberculosis drugs and the recommended critical concentrations to be used for testing.[3,4]

Second-line drug susceptibility testing varies across jurisdictions. Typically, however, isolates are tested for resistance to amikacin, kanamycin, capreomycin, ethionamide, linezolid, ofloxacin, moxifloxacin, *para*-aminosalicylic acid and rifabutin.

METHODS

OVERVIEW OF THE CANADIAN TUBERCULOSIS LABORATORY SURVEILLANCE SYSTEM

The CTBLSS is an isolate-based surveillance system designed to collect data on TB drug resistance from across Canada. Each year, drug susceptibility test results for isolates tested in the previous calendar year are voluntarily submitted to PHAC by provincial TB laboratories for inclusion in the CTBLSS. Not all provinces and territories, however, have the capacity to perform drug susceptibility testing. Those without the capacity prepare the isolates and forward them to other provincial laboratories for testing. In some instances, the laboratory that tests the sample sends the results to PHAC on behalf of the originating province or territory. For further details on provincial/territorial laboratory drug susceptibility testing capacity, please refer to Appendix II.

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[i] The Clinical and Laboratory Standards Institute (CLSI) offers practical operating guidelines that lead to consistent laboratory practices, precision and efficient use of resources. The CLSI recommends that, once drug-resistance testing against first-line anti-tuberculosis agents is complete, isolates found to be monoresistant to rifampin or to any two of the first-line anti-tuberculosis drugs be tested against a panel of second-line drugs. When fluoroquinolones are added to the drug regimen for cases monoresistant to isoniazid, second-line antimicrobial drug resistance testing is recommended.

Data are submitted to PHAC either through the manual completion of a standard reporting form (Appendix III: *M. tuberculosis* Complex Antimicrobial Susceptibility Reporting Form) or electronically. Standardized data recoding procedures are applied to all data to create a national dataset. The following information is submitted to PHAC:

- the date the isolate or specimen was received at the laboratory;
- the isolate or specimen identification number provided by the laboratory;
- the province where the isolate was tested;
- the province/territory from which the isolate originated;
- the sex of the individual from whom the isolate was collected;
- the date of birth or age at time of testing of the individual from whom the isolate was collected;
- the name(s) of the drug(s) tested;
- the concentration at which the drug(s) was (were) tested; and
- drug susceptibility result (sensitive/resistant/not done).

Data are submitted for confirmed cases of MTBC demonstrated on culture, including *M. tuberculosis, M. africanum, M. canetti, M. caprae, M. microti, M. pinnipedii* or *M. bovis*. Results may be submitted at the species level or for MTBC only without species identification. Some laboratories also submit results for the *M. bovis* Bacillus Calmette-Guérin (BCG) strain, a complication of TB vaccination often found in immunocompromised patients. These results are excluded from this report because this strain is not infectious.

All participating laboratories test for resistance to the first-line antibiotics isoniazid, ethambutol and rifampin. Although the *Canadian Tuberculosis Standards* (7th edition) recommends that laboratories perform drug susceptibility testing to pyrazinamide,[1] British Columbia does not routinely test for resistance to this drug. If resistance to any first-line drug is detected, British Columbia will subsequently test the isolate for resistance to pyrazinamide.

Results of second-line drug susceptibility testing are submitted for isolates showing resistance to isoniazid and rifampin. To rule out XDR-TB, laboratories are asked to report results for at least one of the fluoroquinolones (ofloxacin, moxifloxacin or levofloxacin) and at least one of the injectable agents (amikacin, kanamycin and capreomycin).

TABULATION AND PRESENTATION OF RESULTS

This report provides an overview of TB drug resistance in Canada for the period 2005 to 2015. Data are presented by province/territory and by age group and sex where feasible. Data from 2015 (the most recent reporting year for which data are available) are highlighted as are important trends over time.

The data presented in this report were extracted from the CTBLSS database on February 28, 2016 and have been validated by the reporting laboratories. Results from cultures that grow in a given year are included in the statistics for that calendar year; otherwise the results are reflected in the subsequent year's report. For example, if a specimen was received by the laboratory on December 20, 2015 and the culture did not grow *M. tuberculosis* until January 2016, these results would be reflected in the 2016 report.

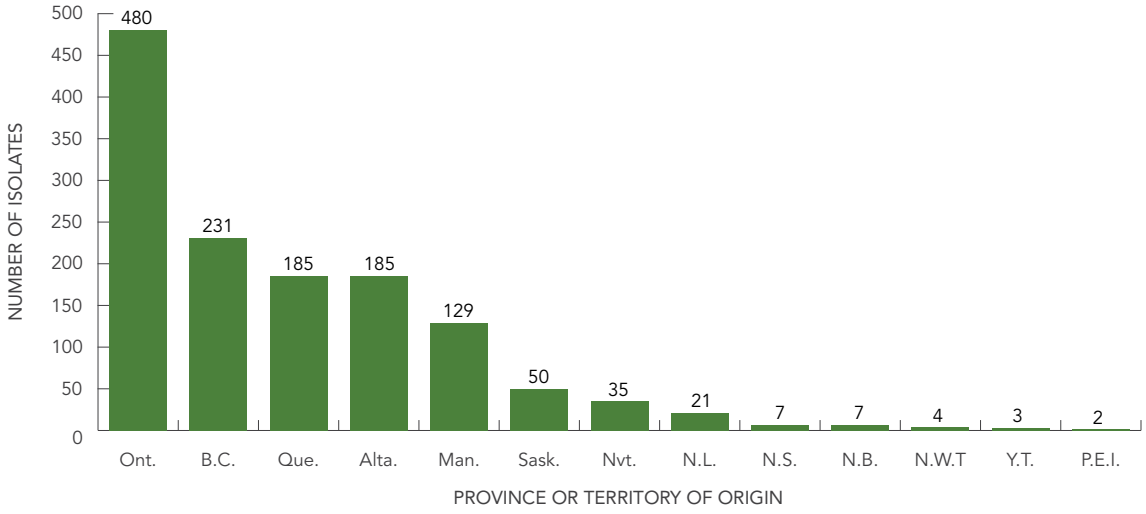
Samples submitted to the laboratory for drug susceptibility testing may be collected at the time of the individual's diagnosis or at any time during treatment. Depending on the treatment duration, an individual may be tested multiple times over several years until cured or until the prescribed treatment is completed. If two specimens are confirmed to be from the same individual in a given calendar year, only the most recent susceptibility result is retained. Therefore, the number of isolates described in this report is not equal to the number of culture-positive cases reported through the case-based surveillance system over the same time period where each individual with culture-positive TB is only reported once in the year of diagnosis.

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 ($n \leq 5$) were not suppressed, since disclosure is not deemed to pose any risk of identifying individuals. These procedures are consistent with PHAC's *Directive for the collection, use and dissemination of information relating to public health*.[5]

RESULTS

In 2015, anti-tuberculosis drug susceptibility test results for 1,352 isolates were reported to PHAC. Of these, 13 (1.0%) isolates were identified as *M. bovis* BCG and were excluded from further analyses. Of the remaining 1,339 isolates analyzed, 788 (58.8%) were reported as MTBC where the species was known (772 were *M. tuberculosis*, ten were *M. africanum* and six were *M. bovis*) and 551 (41.2%) were MTBC of an unknown species (data not shown). **Figure 1** shows the number of MTBC isolates tested by province or territory of origin. **Table 2** provides a breakdown of the number of isolates by reporting and originating province or territory.

FIGURE 1: Number of *Mycobacterium tuberculosis* complex isolates tested by province or territory of origin, 2015



For the period 2005 to 2015, drug susceptibility test results were reported for 14,776 isolates (**Table 3**). Of the results received during this period, 1,402 (9.5%) were resistant to one or more of the first-line drugs, 178 isolates (1.2%) were identified as multidrug-resistant and 7 (< 0.1%) were identified as extensively drug-resistant (**Table 3**).

ANY FIRST-LINE DRUG RESISTANCE

In 2015, rifampin and ethambutol sensitivity results were available for all 1,339 isolates tested, isoniazid sensitivity results were available for 1,336 of the 1,339[ii] isolates tested and 1,111 (83.0%) isolates were tested for resistance to pyrazinamide (**Table 4**). As a percentage of the isolates tested, 110 (8.2%) were resistant to isoniazid, 38 (3.4%) were resistant to pyrazinamide 24 (1.8%) were resistant to rifampin, and 10 (0.7%) were resistant to ethambutol (**Figure 2**).

[ii] Isoniazid results were invalid for 3 isolates. For two of these isolates, the culture was mixed with *M. avium*, and for one the isoniazid tube was contaminated by other bacteria. All three of these isolates were sensitive to rifampin, ruling out MDR-TB.

FIGURE 2: Percentage of isolates tested with any resistance to isoniazid, pyrazinamide, rifampin and ethambutol, 2015

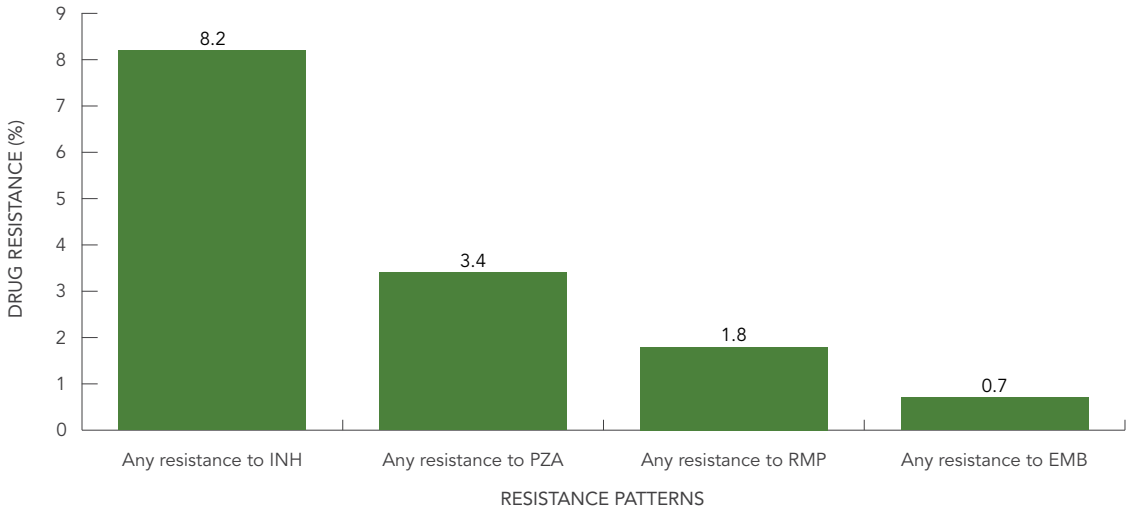
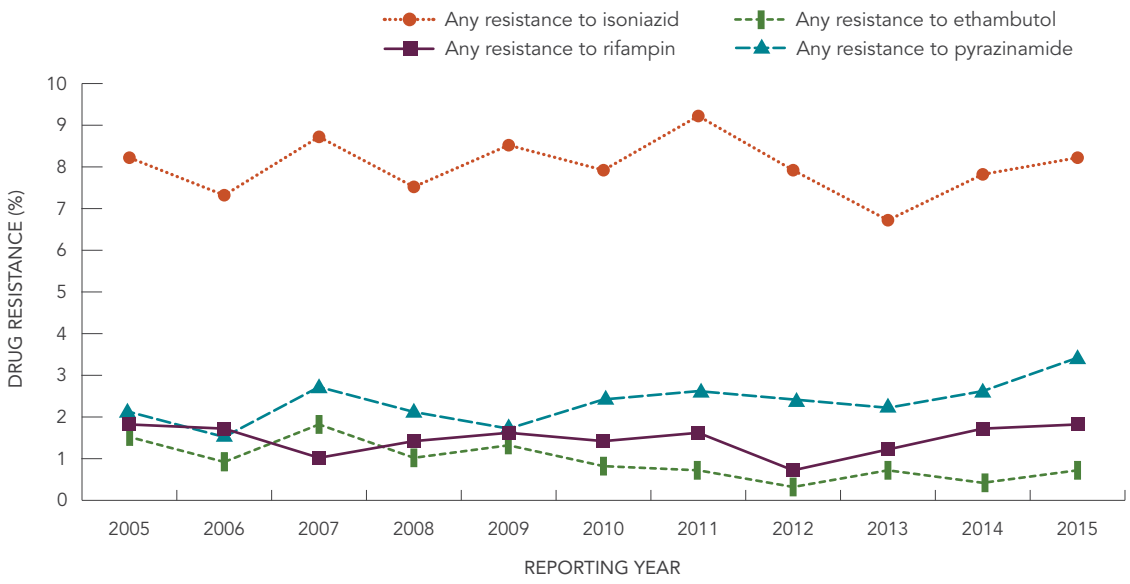


Figure 3 shows the changes over time in the percentage of isolates resistant to each of the first-line drugs for the period 2005 to 2015. During this period of time, 8.0% (range: 6.7% to 9.2%) of all isolates tested were resistant to isoniazid (**Table 4**) whereas resistance shown to ethambutol, rifampin and pyrazinamide resistance has remained below 4% (**Figure 3**).

FIGURE 3: Percentage of isolates tested with any resistance to isoniazid, pyrazinamide, rifampin and ethambutol, 2005 to 2015



MONORESISTANCE

In 2015, of the 139 TB isolates (10.4% of all isolates tested) reported to be resistant to at least one of the four first-line drugs (**Table 4**), the majority (n = 114; 82.0%) were monoresistant. Of these, 85 (74.6%) were isoniazid monoresistant, 27 (23.7%) were pyrazinamide monoresistant and 2 (1.8%) were rifampin monoresistant. No isolates were ethambutol monoresistant (**Table 5** to **Table 17; data not tabulated across tables**).

For the period 2005 to 2015, 7.9% of all isolates tested were monoresistant, ranging from a high of 9.1% in 2012 to a low of 6.7% in 2013 (**Table 4**). During this time, 30 isolates (0.2% of all isolates tested) were identified as rifampin-monoresistant, which is an uncommon resistance pattern[1]. Of these, 16 (53.3%) originated from British Columbia; six (20.0%) from Ontario, three (10.0%) from Quebec, two (6.7%) from Alberta, and one (3.3%) each from Saskatchewan, Northwest Territories and Nunavut. On average, one to three rifampin-monoresistant isolates were reported each year from 2005 to 2015 (**Table 5** to **Table 17; data not tabulated across tables**).

POLYRESISTANT, MULTIDRUG-RESISTANT AND EXTENSIVELY DRUG-RESISTANT TB

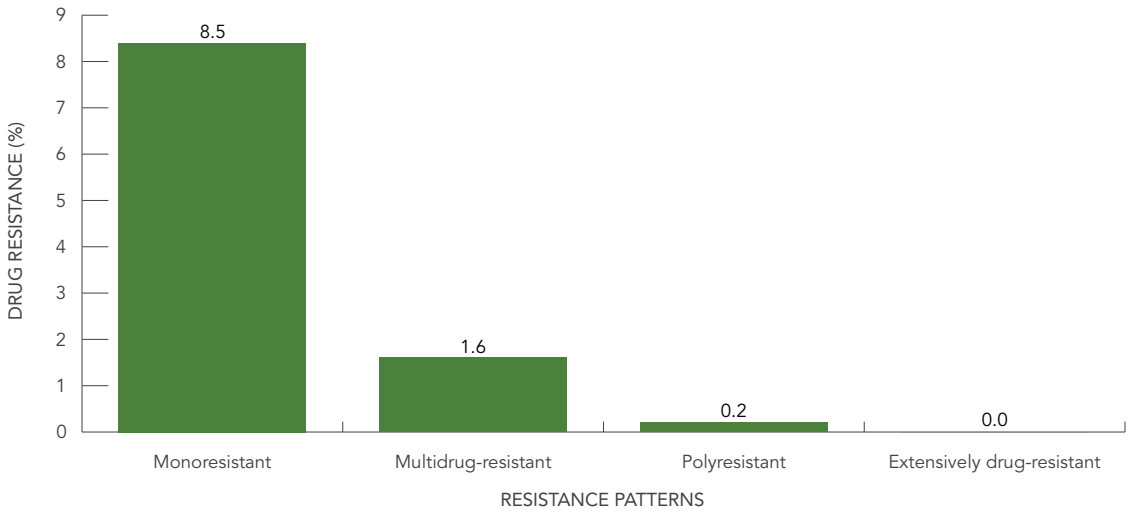
In 2015, after excluding isolates resistant to both isoniazid and rifampin, three isolates (0.2%) were resistant to two or more of the first-line drugs and were therefore classified as polyresistant (**Table 4**). Two of these were resistant to isoniazid and ethambutol and one was resistant to isoniazid and pyrazinamide.

For the period 2005 to 2015, 54 (0.4%) isolates were identified as polyresistant (**Table 4**). Of these, 26 (48.1%) were resistant to isoniazid and ethambutol, 21 (38.9%) were resistant to isoniazid and pyrazinamide, and one was resistant to ethambutol and pyrazinamide. The remaining six isolates were resistant to isoniazid, ethambutol, and pyrazinamide (**Table 5** to **Table 17; data not tabulated across tables**).

With respect to first-line drug resistance, 22 (1.6%) isolates were isoniazid and rifampin resistant (identifying them as at least MDR-TB) in 2015. Of these, 11 (50.0%) were resistant to only isoniazid and rifampin. In addition to being isoniazid and rifampin resistant, three were also resistant to pyrazinamide, and one to ethambutol. Seven isolates were resistant to all four of the first-line drugs (**Table 18**).

To rule out XDR-TB, all 22 isolates resistant to both isoniazid and rifampin were subsequently tested for resistance to select second-line drugs. Of these, three isolates were resistant to at least one of the injectable agents (amikacin, capreomycin or kanamycin) but susceptible to the fluoroquinolones, and one isolate was resistant to a fluoroquinolone but susceptible to all of the injectable agents (**Table 5** to **Table 17; data not tabulated across tables**). Because none of the 22 isoniazid- and rifampin-resistant isolates were resistant to both an injectable agent and a flouroquinolone, all 22 were classified as MDR-TB and none were classified as XDR-TB (**Table 18**). **Figure 4** presents patterns of TB drug resistance as a percentage of all isolates tested in 2015.

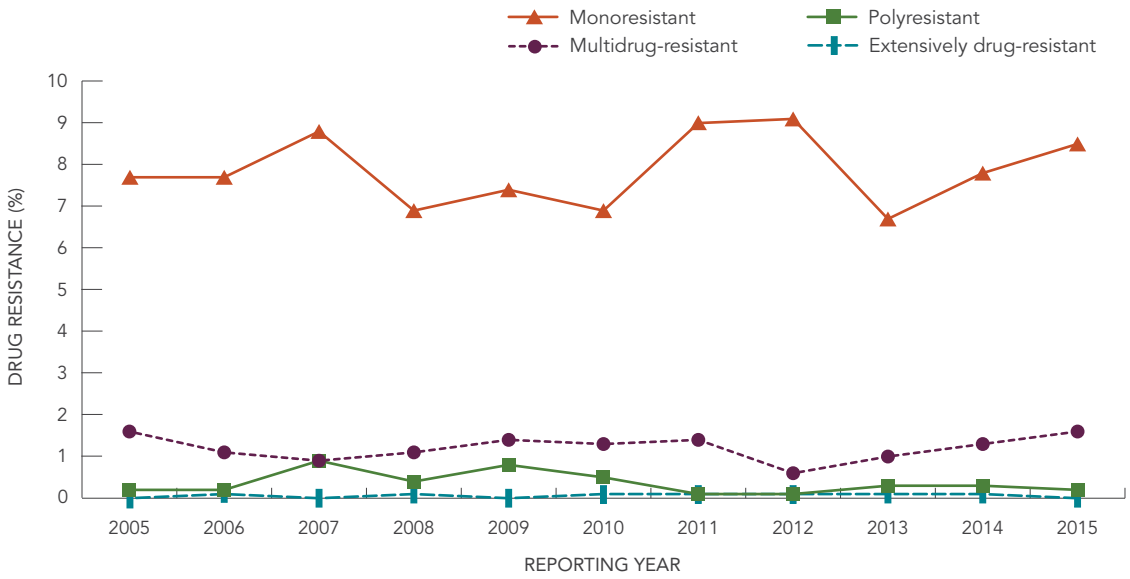
FIGURE 4: Tuberculosis drug resistance patterns as a percentage of isolates tested, 2015



For the period 2005 to 2015, 178 isolates were classified as MDR-TB, representing 1.2% of isolates tested over this time (**Table 4**) and seven isolates were classified as XDR-TB, representing less than 0.1% of the isolates tested. An average of 16 MDR-TB isolates were reported each year, ranging from a low of eight in 2012 (0.6% of all isolates tested in 2012) to a high of 22 in 2005 and in 2015 (1.6% of all isolates tested in each respective year).

Figure 5 shows the overall pattern of reported TB drug resistance as a percentage of isolates tested for the period 2005 to 2015. While there have been small fluctuations in the percentage of isolates showing various resistance patterns, there has been no notable change during this time.

FIGURE 5: Tuberculosis drug resistance patterns as a percentage of isolates tested, 2005 to 2015



GEOGRAPHICAL DISTRIBUTION

In 2015, the majority (90.4%) of isolates originated from five provinces: Ontario, British Columbia, Quebec, Alberta and Manitoba. Saskatchewan accounted for fewer than 4% of reported isolates while the northern territories (Northwest Territories, Nunavut and Yukon) and the Atlantic provinces (New Brunswick, Newfoundland and Labrador, Nova Scotia and Prince Edward Island) together accounted for 5.9% of reported isolates (**Table 2**).

In 2015, all isolates from the Northwest Territories, Yukon, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island were susceptible to all first-line drugs tested. Of the 22 MDR-TB isolates, 14 originated from Ontario, two from each Alberta, British Columbia, and Quebec and one from each Manitoba and New Brunswick (**Table 19**).

For the period 2005 to 2015, all 178 MDR-TB isolates originated from seven provinces: Alberta, British Columbia, Manitoba, New Brunswick, Ontario, Quebec and Saskatchewan. Of the seven isolates identified as XDR-TB, five originated from Ontario, one from Manitoba and one from Quebec (**Table 19**).

Table 5 through **Table 17** present complete resistance profiles for all the isolates tested for the period 2005 to 2015, by province and territory.

DEMOGRAPHIC INFORMATION

In 2015, age and/or date of birth was reported for all 1,339 individuals from whom isolates were collected (**Table 20**). Of the 139 drug-resistant isolates, none were from individuals under the age of 15 years. The majority of isolates with any resistance were collected from individuals between 15 and 34 years of age. Of the 22 MDR-TB isolates, 36.4% (n = 8) were collected from individuals between 25 and 34 years of age.

In 2015, sex was known for 1,331 (99.4%) of the 1,339 individuals from whom isolates were collected (**Table 20**). Males accounted for 55.1% of all reported isolates. Females accounted for 54.0% of isolates showing any resistance, and males accounted for 54.5% of MDR-TB isolates.

DISCUSSION

In many parts of the world, drug resistance is a major challenge to preventing and controlling TB. Eastern Europe and Central Asia continue to have the world's highest proportion of MDR-TB cases.[6]

Tuberculosis strains that are resistant to both isoniazid and rifampin pose a considerable challenge to treatment and prevention efforts because effective anti-tuberculosis drugs are limited. Data published by the World Health Organization show that, globally, in 2014 about 3.3% (95% CI: 2.2%–4.4%) of new TB cases and 20% (95% CI: 14%–27%) of previously treated TB cases were MDR-TB.[6] Although the data captured through the CTBLSS do not distinguish between isolates from new versus previously treated cases of TB, the fact that only 1.6% of isolates tested in 2015 were MDR-TB is a considerably lower finding than global estimates. In addition, the fact that only seven XDR-TB cases were identified over the period 2005 to 2015 indicates that XDR-TB in Canada is rare.

STRENGTHS AND LIMITATIONS

The CTBLSS is the result of a successful collaboration between federal, provincial and territorial governments and the CTLTN. The primary objective of the CTBLSS is to monitor emerging trends and patterns in resistance to anti-tuberculosis drugs in Canada. This report presents detailed data on the extent of first- and second-line TB drug resistance in Canada, disaggregated by province/territory and, where feasible, by sex and/or age group. As the primary source of national data on TB drug resistance in Canada, the data within this report provide timely information for public health action, as well as policy and program development and assessment.

Prior to analysis and report preparation, all data were reviewed for errors, inconsistencies and completeness. Submitting laboratories were provided with a summary report of their data for review. Following validation by the reporting laboratories, the data were integrated into the CTBLSS database. Nevertheless, like most surveillance data, the data in this report are subject to possible coding, reporting and processing errors.

Previously published data may be updated based on late reporting or revisions from participating laboratories. Any revisions to previously reported data are reflected in subsequent reports. Therefore, the data presented in this report are considered the most up-to-date and replace those previously published in this report series.

Although efforts are made to ensure that multiple records for any one individual in a given year are removed, given the minimal identifying information available for each isolate (age and sex), it is possible that multiple records from one individual are included in the database. This bias is likely minimal given the validation process with the data providers.

Demographic and clinical data collected through the CTBLSS are limited. No data are collected on the ethnic origin, diagnostic/clinical status or the treatment outcome of the individual from whom the sample was collected. Additional demographic and clinical information would facilitate a more in-depth epidemiological assessment of drug resistance patterns in Canada. What's more, differentiation between primary and acquired drug resistance and differing resistance patterns among new cases in comparison to re-treatment cases are not possible based on data collected through this surveillance system. However, the *Tuberculosis in Canada* report, which provides an overview of the overall number of reported active TB cases and corresponding incidence rates in Canada by select demographic and clinical characteristics, presents case-based (vs. isolate-based) data on primary and acquired drug resistance in Canada that are not presented here. Together, these two reports provide a more comprehensive overview of TB case and drug resistance surveillance data from a national perspective.

Typically, only MDR-TB isolates or other extensive resistance patterns will undergo select second-line drug sensitivity testing. Although the Clinical and Laboratory Standards Institute (CLSI) recommends that isoniazid-monoresistant isolates as well as other polyresistant, non-MDR isolates be tested for second-line drug resistance, this is not universally reported in Canada. Other isolates that are not MDR-TB may be resistant to fluoroquinolones because of the widespread use of these antibiotics for other respiratory infections. To some extent, this limits our understanding of the emergence of second-line drug resistance within Canada.

CONCLUSION

TB drug resistance is an important global public health concern, but it is not a significant problem in Canada. In 2015, 10.4% of all isolates tested were resistant to at least one of the four first-line drugs; the majority were resistant to only one drug (82.0%), and 1.6% were identified as MDR-TB and none as XDR-TB. TB drug resistance levels have been stable over the past 10 years and have remained below the global average since national surveillance began. However, with growing worldwide concern about resistance and the emergence of XDR-TB, the CTBLSS remains vital to the monitoring of TB drug resistance in Canada.

APPENDIX I: PARTICIPATING LABORATORIES OF THE CANADIAN TUBERCULOSIS LABORATORY TECHNICAL NETWORK (CTLTN)

ALBERTA Provincial Laboratory of Public Health Edmonton/Calgary	Cary Shandro Technologist Mycobacteriology Dr. Greg Tyrrell Clinical Microbiologist Dr. Graham Tipples Medical/Scientific Director
BRITISH COLUMBIA British Columbia Centre for Disease Control Public Health Microbiology and Reference Laboratory Vancouver	Dr. Mabel Rodrigues Mycobacteriology/TB Laboratory, Team Lead Dr. Mel Krajden Medical Microbiologist / Director, Laboratory Services
MANITOBA Diagnostics Services Manitoba Health Sciences Centre Winnipeg	Assunta Rendina Charge Technologist, Mycobacteriology Doug Swidinsky Senior Technologist Dr. Heather Adam Clinical Microbiologist
NEW BRUNSWICK Department of Laboratory Medicine Saint John Regional Hospital Saint John	Hope MacKenzie MLT3-Supervisor CL3 Lab Dr. Duncan Webster Medical Microbiologist / Infectious Disease Dr. Tarek Rahmeh Laboratory Director
NEWFOUNDLAND AND LABRADOR Newfoundland and Labrador Public Health Laboratory St. John's	Sherry Baird Tech II Dr. George Zahariadis Director and Divisional Chief of the Public Health Laboratory and Microbiology Services
NORTHWEST TERRITORIES Stanton Territorial Hospital Yellowknife	Sherrill Webber Tech II, Microbiology Carolyn Russell Laboratory Supervisor Cheryl Case Manager, Therapeutic and Diagnostic Services

NOVA SCOTIA Department of Pathology and Laboratory Medicine Queen Elizabeth II Health Sciences Centre Halifax	Darlene McPhee (MLTC/temporary supervisor) Division of Medical Microbiology Dr. David Haldane, Director, Provincial Public Health Laboratory Network and Special Pathogens Dr. Todd Hatchette Director, Pathology and Laboratory Medicine
NUNAVUT Qikiqtani General Hospital Iqaluit	Sonia Marchand Laboratory Health
ONTARIO Public Health Ontario Laboratories Public Health Ontario Toronto	Kevin May Operational Lead, Mycobacteriology Dr. Frances Jamieson Medical Microbiologist-TB and Mycobacteriology Kirby Cronin Laboratory Liaison Technical Officer (PHAC) Alex Marchand-Austin Manager, Laboratory Surveillance and Data Management
QUEBEC Laboratoire de santé publique du Québec Institut national de santé publique du Québec Sainte-Anne-de-Bellevue	Hafid Soualhine Head, Mycobacteriology and Aerobic Actinomycetes Dr. Jean Longtin Director
SASKATCHEWAN Saskatchewan Disease Control Laboratory Regina	Rita Thomas Technologist, TB/Bacteriology Dr. David Farrell Director of Bacteriology / Associate Clinical Director Dr. Paul Levett Clinical Director Dr. David Alexander Microbiologist Dr. Greg Horsman Medical Director
FEDERAL National Microbiology Laboratory Public Health Agency of Canada Winnipeg	Joyce Wolfe Senior Expert Program Delivery Kym Antonation Chief, Bioforensics Assay Development and Diagnostics National Microbiology Laboratory

APPENDIX II: PROVINCIAL/TERRITORIAL LABORATORY DRUG SUSCEPTIBILITY TESTING CAPACITY

- The British Columbia Public Health Microbiology and Reference Laboratory at the British Columbia Centre for Disease Control tests and reports first-line susceptibility results for British Columbia and Yukon.
- The Provincial Laboratory of Public Health (ProvLab) in Alberta tests and reports results for Alberta and Northwest Territories.
- Public Health Ontario Laboratories test and report results for Ontario and Nunavut.
- The National Reference Centre for Mycobacteriology (NRCM)[iii] located in Manitoba does first-line susceptibility testing for Newfoundland and Labrador, Manitoba, New Brunswick, Nova Scotia and Prince Edward Island. In this case, the NRCM returns test results to the originating province and the originating province submits their results to PHAC.
- All the remaining provinces conduct their own first-line testing and do not routinely report results for any other jurisdiction.
- Four laboratories in Canada conduct second-line drug susceptibility testing: the ProvLab in Alberta, the Public Health Ontario Laboratories, the Laboratoire de santé publique du Québec and the NRCM.
- The NRCM tests the susceptibility of isolates to second-line drugs for all provinces and territories that do not conduct such testing at their laboratories. Upon request, the NRCM also tests isolates submitted by any provincial laboratory to confirm resistance patterns. Results from testing done by NRCM are returned to the provincial laboratory that submitted the isolates and the provincial laboratory then reports the results to PHAC.

[iii] For more information about the NRCM please see: www.nml-lnm.gc.ca/eb-be/myco-eng.htm

APPENDIX III: *M. TUBERCULOSIS* COMPLEX ANTIMICROBIAL SUSCEPTIBILITY REPORTING FORM

Public Health Agency of Canada / Agence de la santé publique du Canada

The Canadian Tuberculosis Laboratory Surveillance System
M. TUBERCULOSIS COMPLEX ANTIMICROBIAL SUSCEPTIBILITY REPORTING FORM

Système de surveillance des laboratoires de tuberculose au Canada
RAPPORT SUR LA SENSIBILITÉ DES SOUCHES DU COMPLEXE M. TUBERCULOSIS AUX ANTIMICROBIENS

Unique Source Laboratory ID No.:
Identificateur unique du laboratoire déclarant:

Date specimen / culture received at laboratory:
Date de réception échantillon / culture au laboratoire: Y / A | M | D / J

Species: / **Espèce :**
☐ M. tuberculosis complex (species known)* / Complexe M. tuberculosis (espèce connue)*
☐ M. bovis
☐ M. bovis BCG
☐ MTB Complex (species unknown) / Complexe MTB (espèce inconnue)

Have susceptibility test results been previously reported for this patient? - Des résultats d'antibiogramme ont-ils déjà été fournis pour ce patient?

☐ No / Non
☐ Yes / Oui → What is the **previous** Unique Source Laboratory ID No.? / Identificateur **antérieur**?
→ What is the **previous** Form No.? (If known) / N° de formulaire **antérieur**? (Si connu)

Note: Only DRUG TESTING RESULTS OF ONE ISOLATE are to be reported. No subsequent drug testing results for the same patient are to be reported unless the sensitivity pattern changes.

Note: Ne fournir que les RÉSULTATS POUR UN SEUL ISOLAT par patient à moins d'un changement du profil de sensibilité.

1 Province / territory from which this report originates: / Province / territoire qui soumet ce rapport : (see code list) / (voir liste de codes)

2 Province / territory from which specimen originates: / Province / territoire d'où provient l'échantillon : (see code list) / (voir liste de codes)

3 Patient's date of birth: / Date de naissance du patient : Y / A | M | D / J (CCYY/MM/DD) (SSAA/MM/JJ) ☐ Unknown / Inconnu

4 Patient's gender: / Sexe du patient : ☐ Male / Masculin ☐ Female / Féminin ☐ Unknown / Inconnu

PROV / TERR CODES PROV / TERR

10 = N.L. / T.N.-L.	46 = Man.
11 = P.E.I. / Î.-P.-É.	47 = Sask.
12 = N.S. / N.-É.	48 = Alta. / Alb.
13 = N.B. / N.-B.	59 = B.C. / C.-B.
24 = Que. / Qc	60 = Y.T. / Yn
35 = Ont.	61 = N.W.T. / T.N.-O.
	62 = Nvt. / Nt

5 **LABORATORY RESULTS / RÉSULTATS DE LABORATOIRE**

Antituberculous Drugs/Antituberculeux	**Concentration** (if different from on file) **Concentration** (si autre que spécifiée)	**Results** (check appropriate box for every drug) **Résultats** (cocher la case pertinente pour chaque antibiotique) Sensitive / Sensible	Resistant / Résistant	Other (specify) / Autre (préciser)
INH (Isoniazid/Isoniazide)	mg / L	☐	☐	
RMP (Rifampin/Rifampicine)	mg / L	☐	☐	
EMB (Ethambultol/Éthambutol)	mg / L	☐	☐	
PZA (Pyrazinamide)	mg / L	☐	☐	
2nd line drugs/Antituberculeux mineurs				
AK (Amikacin/Amikacine)	mg / L	☐	☐	
CM (Capreomycin/Capréomycine)	mg / L	☐	☐	
CIPRO (Ciprofloxacin/Ciprofloxacine)	mg / L	☐	☐	
CF (Clofazamine)	mg / L	☐	☐	
CS (Cycloserine/Cyclosérine)	mg / L	☐	☐	
ETH (Ethinoamide/Éthionamide)	mg / L	☐	☐	
KM (Kanamycin/Kanamycine)	mg / L	☐	☐	
LEV (Levofloxacin/Lévofloxacine)	mg / L	☐	☐	
MOX (Moxifloxacin/Moxifloxacine	mg / L	☐	☐	
OFL (Ofloxacin/Ofloxacine)	mg / L	☐	☐	
PAS (Para-Aminosalicylic Acid/Acide Para-aminosalicylique)	mg / L	☐	☐	
RBT (Rifabutin/Rifabutine)	mg / L	☐	☐	
SM (Streptomycin/Streptomycine)	mg / L	☐	☐	
Other/Autre (specify/préciser)				
1.	mg / L	☐	☐	
2.	mg / L	☐	☐	
3.	mg / L	☐	☐	
4.	mg / L	☐	☐	
5.	mg / L	☐	☐	

6 **Comments - Commentaires**

* include/inclus: M. tuberculosis, M. africanum, M. canetti, M. caprae, M. microti, M. pinnipedii.

PHAC/ASPC 9061
(01-2010)

APPENDIX IV: DATA TABLES

TABLE 1: Critical concentrations for routine testing of anti-tuberculosis drugs

	ANTI-TUBERCULOSIS DRUGS	CRITICAL CONCENTRATIONS* (mg/L) BACTEC® 960	COMMENTS
FIRST-LINE	Isoniazid (INH)	0.1	When resistance to INH is 0.1 mg/L, tests are repeated with INH 0.4 mg/L to determine the level of resistance. Nevertheless, the isolate is reported as resistant using the 0.1 mg/L cut-off level.
	Rifampin (RMP)	1.0	
	Ethambutol (EMB)	5.0	
	Pyrazinamide (PZA)	100.0	Routine testing is not performed for isolates from British Columbia
SECOND-LINE	Amikacin (AK)	1.0	
	Capreomycin (CM)	2.5	
	Ethionamide (ETH)	5.0	
	Kanamycin (KM)	2.5	
	Linezolid (LIN)	1.0	
	Moxifloxacin (MOX)	0.3	
	Ofloxacin (OFL)	2.0	
	Para-amino salicylic acid (PAS)	4.0	
	Rifabutin (RBT)	0.5	
	Streptomycin (SM)	1.0	

* Critical concentrations: the lowest concentration of drug that will inhibit 95% of wild strains of *Mycobacterium tuberculosis* that have never been exposed to drugs while not inhibiting strains of *Mycobacterium tuberculosis* that have been isolated from patients who are not responding to therapy and that are considered resistant.

TABLE 2: Total number of *Mycobacterium tuberculosis* complex isolates by reporting and originating province/territory, 2015

REPORTING PROVINCE/ TERRITORY	CANADA	ORIGINATING PROVINCE/TERRITORY												
		N.L.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Y.T.	N.W.T.	Nvt.
N.L.	21	21	0	0	0	0	0	0	0	0	0	0	0	0
N.S.	9	0	2	7	0	0	0	0	0	0	0	0	0	0
N.B.	7	0	0	0	7	0	0	0	0	0	0	0	0	0
Que.	183	0	0	0	0	183	0	0	0	0	0	0	0	0
Ont.	517	0	0	0	0	2	480	0	0	0	0	0	0	35
Man.	129	0	0	0	0	0	0	129	0	0	0	0	0	0
Sask.	50	0	0	0	0	0	0	0	50	0	0	0	0	0
Alta.	190	0	0	0	0	0	0	0	0	185	1	0	4	0
B.C.	233	0	0	0	0	0	0	0	0	0	230	3	0	0
TOTAL	1,339	21	2	7	7	185	480	129	50	185	231	3	4	35

ABBREVIATIONS: Alta. = Alberta; B.C. = British Columbia; Man. = Manitoba; N.B. = New Brunswick; N.L. = Newfoundland and Labrador; N.S. = Nova Scotia; Nvt. = Nunavut; N.W.T. = Northwest Territories; Ont. = Ontario; P.E.I. = Prince Edward Island; Que. = Quebec; Sask. = Saskatchewan; Y.T. = Yukon.

TABLE 3: Total number of *Mycobacterium tuberculosis* complex isolates and number and percentage identified with any resistance, as multidrug and as extensively drug resistant in Canada, 2005 to 2015

REPORTING YEAR	TOTAL NUMBER OF REPORTED MTBC ISOLATES	RESISTANT TO ONE OR MORE FIRST-LINE DRUGS		MULTIDRUG-RESISTANT TB*		EXTENSIVELY DRUG-RESISTANT TB†	
		NUMBER	PERCENT (%)	NUMBER	PERCENT (%)	NUMBER	PERCENT (%)
2005	1,335	128	9.6	22	1.6	0	0.0
2006	1,389	126	9.1	15	1.1	1	0.1
2007	1,267	133	10.5	11	0.9	0	0.0
2008	1,356	116	8.6	15	1.1	1	0.1
2009	1,331	127	9.5	18	1.4	0	0.0
2010	1,279	112	8.8	17	1.3	1	0.1
2011	1,319	139	10.5	18	1.4	1	0.1
2012	1,404	139	9.9	8	0.6	1	0.1
2013	1,381	112	8.1	14	1.0	1	0.1
2014	1,376	131	9.5	18	1.3	1	0.1
2015	1,339	139	10.4	22	1.6	0	0.0
TOTAL	14,776	1,402	9.5	178	1.2	7	<0.1

ABBREVIATION: MTBC = *Mycobacterium tuberculosis* complex.

* Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

† Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second-line drugs (amikacin, capreomycin and kanamycin).

TABLE 4: Overall pattern of reported tuberculosis drug resistance in Canada, 2005 to 2015

	REPORTING YEAR																							
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		TOTAL	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Total number of isolates tested	1,335	100.0	1,389	100.0	1,267	100.0	1,356	100.0	1,331	100.0	1,279	100.0	1,319	100.0	1,404	100.0	1,381	100.0	1,376	100.0	1,339	100.0	14,776	100.0
Isolates tested that were susceptible	1,207	90.4	1,263	90.9	1,134	89.5	1,240	91.4	1,204	90.5	1,167	91.2	1,180	89.5	1,265	90.1	1,269	91.9	1,245	90.5	1,200	89.6	13,374	90.5
Isolates showing any resistance to first-line drugs																								
Any resistance to isoniazid	109	8.2	101	7.3	110	8.7	102	7.5	113	8.5	101	7.9	122	9.2	111	7.9	93	6.7	107	7.8	110	8.2	1,179	8.0
Any resistance to rifampin	24	1.8	24	1.7	13	1.0	19	1.4	21	1.6	18	1.4	21	1.6	10	0.7	17	1.2	24	1.7	24	1.8	215	1.5
Any resistance to ethambutol	20	1.5	12	0.9	23	1.8	13	1.0	17	1.3	10	0.8	9	0.7	4	0.3	10	0.7	6	0.4	10	0.7	134	0.9
Any resistance to pyrazinamide*	22	2.1	16	1.5	27	2.7	22	2.1	18	1.7	25	2.4	28	2.3	33	2.8	26	2.2	30	2.6	38	3.4	285	2.4
Total number isolates resistant to one or more first-line TB drugs	128	9.6	126	9.1	133	10.5	116	8.6	127	9.5	112	8.8	139	10.5	139	9.9	112	8.1	131	9.5	139	10.4	1,402	9.5
Monoresistant	103	7.7	107	7.7	111	8.8	94	6.9	98	7.4	88	6.9	119	9.0	128	9.1	93	6.7	108	7.8	114	8.5	1,163	7.9
Multidrug resistant†	22	1.6	15	1.1	11	0.9	15	1.1	18	1.4	17	1.3	18	1.4	8	0.6	14	1.0	18	1.3	22	1.6	178	1.2
Polyresistant	3	0.2	3	0.2	11	0.9	6	0.4	11	0.8	6	0.5	1	0.1	2	0.1	4	0.3	4	0.3	3	0.2	54	0.4
Extensively drug resistant‡	0	0.0	1	0.1	0	0.0	1	0.1	0	0.0	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	0	0.0	7	<0.1

* Not all isolates were tested for resistance to pyrazinamide. The percentage shown with any resistance is based on the number tested by year: 2005 = 1,063; 2006 = 1,080; 2007 = 991; 2008 = 1,048; 2009 = 1,042; 2010 = 1,042; 2011 = 1,197; 2012 = 1,175; 2013 = 1,187; 2014 = 1,143; 2015 =1,111.

† Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

‡ Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second–line drugs (amikacin, capreomycin and kanamycin).

TABLE 5: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Alberta, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA*	129	100.0	104	100.0	98	100.0	134	100.0	159	100.0	107	100.0	156	100.0	163	100.0	154	100.0	181	100.0	185	100.0
Isolates susceptible to all first-line TB drugs	115	89.1	95	91.3	92	93.9	123	91.8	145	91.2	96	89.7	133	85.3	148	90.8	140	90.9	165	91.2	164	88.6
Monoresistant TB																						
INH	10	7.8	7	6.7	5	5.1	8	6.0	8	5.0	6	5.6	14	9.0	10	6.1	9	5.8	11	6.1	15	8.1
RMP	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
EMB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	0	0.0	1	1.0	1	1.0	0	0.0	3	1.9	0	0.0	2	1.3	3	1.8	4	2.6	0	0.0	3	1.6
Subtotal—Monoresistant TB	10	7.8	8	7.7	6	6.1	8	6.0	12	7.5	6	5.6	16	10.3	13	8.0	13	8.4	12	6.6	18	9.7
Polyresistant																						
INH and EMB	0	0.0	0	0.0	0	0.0	1	0.7	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, EMB and PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0
INH and PZA	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	1	0.9	0	0.0	1	0.6	0	0.0	0	0.0	1	0.5
Subtotal—Polyresistant	0	0.0	0	0.0	0	0.0	1	0.7	2	1.3	2	1.9	0	0.0	1	0.6	1	0.6	0	0.0	1	0.5
Multidrug-resistant TB†																						
INH and RMP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP and EMB	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB and PZA	1	0.8	0	0.0	0	0.0	1	0.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
INH, RMP, EMB, PZA and SM	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, OFL and MOX	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
INH, RMP, EMB, PZA, SM, OFL, MOX, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
INH, RMP, EMB, PZA, SM and RBT	0	0.0	0	0.0	0	0.0	1	0.7	0	0.0	1	0.9	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB and SM	0	0.0	1	1.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP and ETH	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5
INH, RMP, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.3	0	0.0	0	0.0	1	0.6	0	0.0
INH, RMP, PZA, SM and ETH	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, PZA, SM, OFL and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, PZA, SM and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.9	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP and SM	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, SM, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
INH, RMP, SM and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0
Subtotal—Multidrug-resistant TB	4	3.1	1	1.0	0	0.0	2	1.5	0	0.0	3	2.8	7	4.5	1	0.6	0	0.0	4	2.2	2	1.1
Extensively drug-resistant TB‡																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number isolates resistant to one or more first-line TB drugs	14	10.9	9	8.7	6	6.1	11	8.2	14	8.8	11	10.3	23	14.7	15	9.2	14	9.1	16	8.8	21	11.4

ABBREVIATIONS: AK = amikacin; EMB = ethambutol; ETH = ethionamide; INH = isoniazid; KM = kanamycin; MOX = moxifloxacin; OFL = ofloxacin; PAS = *para*-aminosalicylic acid; PZA = pyrazinamide; RBT = rifabutin; RMP = rifampin; SM = streptomycin.

* Includes *Mycobacterium africanum* isolate: 1 in 2011, 2013, 2014 and 2015, 2 in 2007 and 2009, and 3 in 2010; *Mycobacterium bovis*: 1 in 2012, 2 in 2009, 2011 and 2013, 3 in 2015.

† Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

‡ Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second–line drugs (amikacin, capreomycin and kanamycin).

TABLE 6: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for British Columbia, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA*†	204	100.0	275	100.0	231	100.0	254	100.0	239	100.0	204	100.0	194	100.0	254	100.0	223	100.0	270	100.0	231	100.0
Isolates susceptible to all first-line TB drugs	182	89.2	257	93.5	210	90.9	230	90.6	215	90.0	185	90.7	170	87.6	231	90.9	204	91.5	235	87.0	199	86.1
Monoresistant TB																						
INH	11	5.4	7	2.5	13	5.6	18	7.1	22	9.2	16	7.8	21	10.8	21	8.3	19	8.5	25	9.3	27	11.7
RMP	2	1.0	6	2.2	0	0.0	3	1.2	1	0.4	0	0.0	1	0.5	0	0.0	0	0.0	2	0.7	1	0.4
EMB	4	2.0	3	1.1	4	1.7	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
Subtotal—Monoresistant TB	17	8.3	16	5.8	17	7.4	21	8.3	23	9.6	18	8.8	22	11.3	21	8.3	19	8.5	27	10.0	29	12.6
Polyresistant																						
INH and EMB	1	0.5	0	0.0	2	0.9	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
INH and PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	2	0.7	0	0.0
Subtotal—Polyresistant TB	1	0.5	0	0.0	2	0.9	0	0.0	1	0.4	0	0.0	1	0.5	0	0.0	0	0.0	2	0.7	1	0.4
Multidrug-resistant TB‡																						
INH and RMP	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, KM, CM, ETH and RBT	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA and PAS	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA and RBT	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, ETH, RBT and PAS	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, KM and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
INH, RMP, EMB, PZA, SM, OFL, ETH, RBT and PAS	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM and RBT	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, SM, AK, KM, CM, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
INH, RMP, EMB, SM, ETH and RBT	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0
INH, RMP, EMB, SM, ETH, RBT and PAS	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4	1	0.4
INH, RMP, PZA and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0
INH, RMP, PZA, SM and RBT	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0
INH, RMP, PZA, SM, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP and RBT	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.7	0	0.0
INH, RMP, SM and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0
Subtotal—Multidrug-resistant TB	4	2.0	2	0.7	2	0.9	3	1.2	0	0.0	1	0.5	1	0.5	2	0.8	0	0.0	6	2.2	2	0.9
Extensively drug-resistant TB																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	22	10.8	18	6.5	21	9.1	24	9.4	24	10.0	19	9.3	24	12.4	23	9.1	19	8.5	35	13.0	32	13.9

ABBREVIATIONS: CM = capreomycin; EMB = ethambutol; ETH = ethionamide; INH = isoniazid; KM = kanamycin; MOX = moxifloxacin; OFL = ofloxacin; PAS = *para*-aminosalicylic acid; PZA = pyrazinamide; RBT = rifabutin; RMP = rifampin; SM = streptomycin.

* Includes *Mycobacterium bovis* isolates: 1 in 2006, 2007 and 2015; *Mycobacterium africanum*: 1 in 2008, 2009 and 2014; 4 in 2015; 5 in 2012 and 2013.

† Routine testing for PZA not conducted in British Columbia.

‡ Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

TABLE 7: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Manitoba, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA*	94	100.0	119	100.0	84	100.0	116	100.0	106	100.0	113	100.0	97	100.0	123	100.0	148	100.0	125	100.0	129	100.0
Isolates susceptible to all first-line TB drugs	92	97.9	113	95.0	75	89.3	111	95.7	99	93.4	99	87.6	90	92.8	113	91.9	144	97.3	120	96.0	125	96.9
Monoresistant TB																						
INH	2	2.1	6	5.0	7	8.3	4	3.4	4	3.8	10	8.8	5	5.2	10	8.1	4	2.7	5	4.0	3	2.3
RMP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
EMB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	0	0.0	0	0.0	1	1.2	0	0.0	1	0.9	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Monoresistant TB	2	2.1	6	5.0	8	9.5	4	3.4	5	4.7	11	9.7	5	5.2	10	8.1	4	2.7	5	4.0	3	2.3
Polyresistant																						
INH and EMB	0	0.0	0	0.0	1	1.2	0	0.0	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH and PZA	0	0.0	0	0.0	0	0.0	0	0.0	1	0.9	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Polyresistant TB	0	0.0	0	0.0	1	1.2	0	0.0	2	1.9	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Multidrug-resistant TB†																						
INH and RMP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, AK, KM, CM, ETH and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, PZA, SM and RBT	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, SM and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8
Subtotal—Multidrug-resistant TB	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	1	0.9	2	2.1	0	0.0	0	0.0	0	0.0	1	0.8

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Extensively drug-resistant TB‡																						
INH, RMP, EMB, PZA, KM, OFL, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	2	2.1	6	5.0	9	10.7	5	4.3	7	6.6	14	12.4	7	7.2	10	8.1	4	2.7	5	4.0	4	3.1

ABBREVIATIONS: AK = amikacin; CM = capreomycin; EMB = ethambutol; ETH = ethionamide; INH = isoniazid; KM = kanamycin; MOX = moxifloxacin; OFL = ofloxacin; PAS = *para*-aminosalicylic acid; PZA = pyrazinamide; RBT = rifabutin; RMP = rifampin; SM = streptomycin.

* Includes *Mycobacterium bovis* isolates: 1 in 2006 and 2007; *Mycobacterium africanum*: 1 in 2008.

† Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

‡ Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second–line drugs (amikacin, capreomycin and kanamycin).

TABLE 8: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for New Brunswick, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA*	5	100.0	3	100.0	5	100.0	3	100.0	10	100.0	9	100.0	5	100.0	4	100.0	3	100.0	6	100.0	7	100.0
Isolates susceptible to all first-line TB drugs	4	80.0	3	100.0	5	100.0	3	100.0	10	100.0	7	77.8	5	100.0	3	75.0	2	66.7	6	100.0	5	71.4
Monoresistant TB																						
INH	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
RMP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
EMB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	1	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0	1	14.3
Subtotal—Monoresistant TB	1	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	1	33.3	0	0.0	1	14.3
Polyresistant																						
Subtotal—Polyresistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Multidrug-resistant TB																						
INH, RMP, PZA, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	14.3
Subtotal—Multidrug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	14.3
Extensively drug-resistant TB																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	1	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	1	33.3	0	0.0	2	28.6

ABBREVIATIONS: EMB = ethambutol; ETH = ethionamide; INH = isoniazid; PZA = pyrazinamide; RBT = rifabutin; RMP = rifampin.

* Includes 1 *Mycobacterium africanum* isolate for 2007.

TABLE 9: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Newfoundland and Labrador, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA	6	100.0	11	100.0	5	100.0	5	100.0	10	100.0	9	100.0	5	100.0	5	100.0	11	100.0	6	100.0	21	100.0
Isolates susceptible to all first-line TB drugs	5	83.3	11	100.0	5	100.0	5	100.0	10	100.0	9	100.0	5	100.0	5	100.0	11	100.0	6	100.0	21	100.0
Monoresistant TB																						
INH	1	16.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
RMP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
EMB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Monoresistant TB	1	16.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Polyresistant																						
Subtotal—Polyresistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Multidrug-resistant TB																						
Subtotal—Multidrug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extensively drug-resistant TB																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	1	16.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

ABBREVIATIONS: EMB = ethambutol; INH = isoniazid; PZA = pyrazinamide; RMP = rifampin.

TABLE 10: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Northwest Territories, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA	6	100.0	4	100.0	14	100.0	13	100.0	10	100.0	5	100.0	8	100.0	6	100.0	3	100.0	2	100.0	4	100.0
Isolates susceptible to all first-line TB drugs	6	100.0	3	75.0	14	100.0	13	100.0	9	90.0	4	80.0	8	100.0	6	100.0	3	100.0	2	100.0	4	100.0
Monoresistant TB																						
INH	0	0.0	1	25.0	0	0.0	0	0.0	0	0.0	1	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
RMP	0	0.0	0	0.0	0	0.0	0	0.0	1	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
EMB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Monoresistant TB	0	0.0	1	25.0	0	0.0	0	0.0	1	10.0	1	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Polyresistant																						
Subtotal—Polyresistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Multidrug-resistant TB																						
Subtotal—Multidrug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extensively drug-resistant TB																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	0	0.0	1	25.0	0	0.0	0	0.0	1	10.0	1	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

ABBREVIATIONS: EMB = ethambutol; INH = isoniazid; PZA = pyrazinamide; RMP = rifampin.

TABLE 11: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Nova Scotia, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA*	7	100.0	8	100.0	5	100.0	3	100.0	7	100.0	8	100.0	7	100.0	9	100.0	9	100.0	8	100.0	7	100.0
Isolates susceptible to all first-line TB drugs	6	85.7	8	100.0	5	100.0	3	100.0	7	100.0	5	62.5	7	100.0	9	100.0	8	88.9	5	62.5	7	100.0
Monoresistant TB																						
INH	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	12.5	0	0.0	0	0.0	1	11.1	3	37.5	0	0.0
RMP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
EMB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	1	14.3	0	0.0	0	0.0	0	0.0	0	0.0	1	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Monoresistant TB	1	14.3	0	0.0	0	0.0	0	0.0	0	0.0	2	25.0	0	0.0	0	0.0	1	11.1	3	37.5	0	0.0
Polyresistant																						
INH and PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Polyresistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Multidrug-resistant TB																						
Subtotal—Multidrug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extensively drug-resistant TB																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	1	14.3	0	0.0	0	0.0	0	0.0	0	0.0	3	37.5	0	0.0	0	0.0	1	11.1	3	37.5	0	0.0

ABBREVIATIONS: EMB = ethambutol; INH = isoniazid; PZA = pyrazinamide; RMP = rifampin.

* Includes 1 *Mycobacterium bovis* isolate for 2010.

TABLE 12: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Nunavut, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA	28	100.0	37	100.0	25	100.0	51	100.0	50	100.0	71	100.0	64	100.0	65	100.0	42	100.0	66	100.0	35	100.0
Isolates susceptible to all first-line TB drugs	28	100.0	37	100.0	24	96.0	51	100.0	49	98.0	70	98.6	62	96.9	65	100.0	42	100.0	66	100.0	33	94.3
Monoresistant TB																						
INH	0	0.0	0	0.0	1	4.0	0	0.0	1	2.0	1	1.4	1	1.6	0	0.0	0	0.0	0	0.0	2	5.7
RMP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.6	0	0.0	0	0.0	0	0.0	0	0.0
EMB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Monoresistant TB	0	0.0	0	0.0	1	4.0	0	0.0	1	2.0	1	1.4	2	3.1	0	0.0	0	0.0	0	0.0	2	5.7
Polyresistant																						
Subtotal—Polyresistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Multidrug-resistant TB																						
Subtotal—Multidrug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extensively drug-resistant TB																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	0	0.0	0	0.0	1	4.0	0	0.0	1	2.0	1	1.4	2	3.1	0	0.0	0	0.0	0	0.0	2	5.7

ABBREVIATIONS: EMB = ethambutol; INH = isoniazid; PZA = pyrazinamide; RMP = rifampin.

TABLE 13: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Ontario, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA*	553	100.0	567	100.0	538	100.0	479	100.0	488	100.0	496	100.0	507	100.0	493	100.0	511	100.0	457	100.0	480	100.0
Isolates susceptible to all first-line TB drugs	487	88.1	504	88.9	466	86.6	427	89.1	428	87.7	456	91.9	454	89.6	429	87.0	458	89.6	407	89.1	421	87.7
Monoresistant TB																						
INH	44	8.0	39	6.9	50	9.3	33	6.9	39	8.0	27	5.4	39	7.7	45	9.1	27	5.3	30	6.6	30	6.3
RMP	0	0.0	1	0.2	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	2	0.4	1	0.2	0	0.0
EMB	0	0.0	0	0.0	1	0.2	1	0.2	1	0.2	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0
PZA	7	1.3	9	1.6	9	1.7	6	1.3	4	0.8	2	0.4	6	1.2	10	2.0	8	1.6	11	2.4	15	3.1
Subtotal—Monoresistant TB	51	9.2	49	8.6	61	11.3	40	8.4	44	9.0	29	5.8	45	8.9	57	11.6	37	7.2	42	9.2	45	9.4
Polyresistant																						
EMB and PZA	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH and EMB	2	0.4	3	0.7	1	0.2	2	0.4	3	0.6	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0
INH, EMB and PZA	0	0.0	0	0.0	0	0.0	2	0.4	2	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH and PZA	0	0.0	0	0.0	2	0.4	0	0.0	0	0.0	1	0.2	0	0.0	1	0.2	2	0.4	1	0.2	0	0.0
Subtotal—Polyresistant TB	2	0.4	3	0.5	4	0.7	4	0.8	5	1.0	1	0.2	0	0.0	1	0.2	3	0.6	1	0.2	0	0.0
Multidrug-resistant TB†																						
INH and RMP	0	0.0	2	0.4	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, AK, CM and RBT	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, CM and RBT	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0
INH, RMP, EMB, PZA, AK, CM, ETH and RBT	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
INH, RMP, EMB, PZA, CM and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, ETH and RBT	0	0.0	0	0.0	2	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA and RBT	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.2
INH, RMP, EMB, PZA, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA and SM	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, AK, KM, CM, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2
INH, RMP, EMB, PZA, SM, ETH and RBT	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.2	0	0.0	1	0.2	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, ETH, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, OFL, MOX, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, OFL and RBT	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM and RBT	0	0.0	0	0.0	1	0.2	1	0.2	1	0.2	0	0.0	1	0.2	0	0.0	1	0.2	0	0.0	3	0.6
INH, RMP, EMB and RBT	0	0.0	2	0.4	1	0.2	1	0.2	2	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, SM, AK and CM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, SM, ETH and RBT	1	0.2	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, SM, ETH, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0
INH, RMP, EMB, SM, KM, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, SM, OFL, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
INH, RMP, EMB, SM, OFL, MOX, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, SM, OFL and RBT	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, SM and RBT	2	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.2	0	0.0
INH, RMP, ETH and RBT	0	0.0	1	0.4	0	0.0	1	0.2	1	0.2	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	1	0.2
INH, RMP, ETH, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, OFL, ETH, RBT and PAS	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, PZA, ETH and RBT	1	0.2	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, PZA, SM, AK, KM, CM, ETH, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2
INH, RMP, PZA, SM, ETH and RBT	0	0.0	0	0.0	1	0.2	1	0.2	1	0.2	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2
INH, RMP, PZA, SM, OFL, MOX and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0
INH, RMP, PZA, SM and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	1	0.2	1	0.2	0	0.0
INH, RMP and RBT	3	0.5	1	0.2	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	2	0.4	0	0.0	0	0.0
INH, RMP and SM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.2	0	0.0	0	0.0
INH, RMP, SM, CM and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0
INH, RMP, SM, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2
INH, RMP, SM, ETH, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0
INH, RMP, SM, KM, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0
INH, RMP, SM, OFL, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, SM and RBT	2	0.4	0	0.0	0	0.0	3	0.6	1	0.2	1	0.2	1	0.2	1	0.2	2	0.4	1	0.2	5	1.0
Subtotal—Multidrug-resistant TB	13	2.4	10	1.8	7	1.3	7	1.5	11	2.3	10	2.0	7	1.4	5	1.0	13	2.5	6	1.3	14	2.9

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Extensively drug-resistant TB‡																						
INH, RMP, AK, CM, OFL, ETH and RBT	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, CM, OFL, ETH, RBT and PAS	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, KM, OFL, MOX, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, KM, OFL, MOX, ETH, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, KM, OFL, MOX and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0
Subtotal—Extensively drug-resistant TB	0	0.0	1	0.2	0	0.0	1	0.2	0	0.0	0	0.0	1	0.2	1	0.2	0	0.0	1	0.2	0	0.0
Total number of isolates resistant to one or more first line drugs	66	11.9	63	11.1	72	13.4	52	10.9	60	12.3	40	8.1	53	10.5	64	13.0	53	10.4	50	10.9	59	12.3

ABBREVIATIONS: Abbreviations: AK = amikacin; CM = capreomycin; EMB = ethambutol; ETH = ethionamide; INH = isoniazid; KM = kanamycin; MOX = moxifloxacin; OFL = ofloxacin; PAS = *para*-aminosalicylic acid; PZA = pyrazinamide; RBT = rifabutin; RMP = rifampin; SM = streptomycin.

* Includes *Mycobacterium bovis* isolates: 1 isolate for 2004, 2014 and 2015; 2 for 2005, 2009 and 2010; 3 for 2011, and 4 for 2006.

† Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

‡ Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second–line drugs (amikacin, capreomycin and kanamycin).

TABLE 14: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Prince Edward Island, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA	1	100.0	0	–	0	–	0	–	1	100.0	1	100.0	3	100.0	0	–	0	–	2	100.0	2	100.0
Isolates susceptible to all first-line TB drugs	1	100.0	0	–	0	–	0	–	1	100.0	1	100.0	2	66.7	0	–	0	–	2	100.0	2	100.0
Monoresistant TB																						
INH	0	0.0	0	–	0	–	0	–	0	0.0	0	0.0	0	0.0	0	–	0	–	0	0.0	0	0.0
RMP	0	0.0	0	–	0	–	0	–	0	0.0	0	0.0	0	0.0	0	–	0	–	0	0.0	0	0.0
EMB	0	0.0	0	–	0	–	0	–	0	0.0	0	0.0	0	0.0	0	–	0	–	0	0.0	0	0.0
PZA	0	0.0	0	–	0	–	0	–	0	0.0	0	0.0	1	33.3	0	–	0	–	0	0.0	0	0.0
Subtotal—Monoresistant TB	0	0.0	0	–	0	–	0	–	0	0.0	0	0.0	1	33.3	0	–	0	–	0	0.0	0	0.0
Polyresistant																						
Subtotal—Polyresistant TB	0	0.0	0	–	0	–	0	–	0	0.0	0	0.0	0	0.0	0	–	0	–	0	0.0	0	0.0
Multidrug-resistant TB																						
Subtotal—Multidrug-resistant TB	0	0.0	0	–	0	–	0	–	0	0.0	0	0.0	0	0.0	0	–	0	–	0	0.0	0	0.0
Extensively drug-resistant TB																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	–	0	–	0	–	0	0.0	0	0.0	0	0.0	0	–	0	–	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	0	0.0	0	–	0	–	0	–	0	0.0	0	0.0	1	33.3	0	–	0	–	0	0.0	0	0.0

ABBREVIATIONS: EMB = ethambutol; INH = isoniazid; PZA = pyrazinamide; RMP = rifampin.

TABLE 15: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Quebec, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA*	226	100.0	201	100.0	200	100.0	210	100.0	171	100.0	197	100.0	205	100.0	209	100.0	205	100.0	186	100.0	185	100.0
Isolates susceptible to all first-line TB drugs	207	91.6	173	86.1	177	88.5	188	89.5	156	91.2	179	90.9	180	87.8	187	89.5	187	91.2	167	89.8	167	90.3
Monoresistant TB																						
INH	14	6.2	21	10.4	12	6.0	15	7.1	7	4.1	11	5.6	18	8.8	13	6.2	12	5.9	10	5.4	8	4.3
RMP	0	0.0	1	0.5	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5
EMB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	4	1.8	4	2.0	4	2.0	4	1.9	2	1.2	5	2.5	6	2.9	9	4.3	4	2.0	7	3.8	6	3.2
Subtotal—Monoresistant TB	18	8.0	26	12.9	17	8.5	19	9.0	9	5.3	16	8.1	24	11.7	22	10.5	16	7.8	17	9.1	15	8.1
Polyresistant																						
INH and EMB	0	0.0	0	0.0	3	1.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5
INH and PZA	0	0.0	0	0.0	1	0.5	1	0.5	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Polyresistant TB	0	0.0	0	0.0	4	2.0	1	0.5	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5
Multidrug-resistant TB†																						
INH, RMP, EMB, ETH and RBT	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB and PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5
INH, RMP, EMB, PZA and RBT	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM and ETH	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM, KM, ETH, RBT and PAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0
INH, RMP, EMB, PZA, SM and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
INH, RMP, EMB and RBT	0	0.0	0	0.0	1	0.5	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, EMB, SM and RBT	0	0.0	1	0.5	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5
INH, RMP, PZA, ETH and RBT	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, PZA and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0
INH, RMP, PZA, SM, AK, KM and CM	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, PZA, SM, KM, CM and ETH	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP and RBT	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP, SM and RBT	0	0.0	0	0.0	0	0.0	1	0.5	2	1.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0
Subtotal—Multidrug-resistant TB	1	0.4	2	1.0	2	1.0	2	1.0	6	3.5	1	0.5	1	0.5	0	0.0	1	0.5	2	1.1	2	1.1
Extensively drug-resistant TB‡																						
INH, RMP, EMB, PZA, SM, AK, KM, CM, OFL, MOX, ETH and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	19	8.4	28	13.9	23	11.5	22	10.5	15	8.8	18	9.1	25	12.2	22	10.5	18	8.8	19	10.2	18	9.7

ABBREVIATIONS: AK = amikacin; CM = capreomycin; ETH = ethionamide; KM = kanamycin; MOX = moxifloxacin; OFL = ofloxacin; PAS = *para*-aminosalicylic acid; RBT = rifabutin; RMP = rifampin; SM = streptomycin.

* Includes *Mycobacterium bovis* isolates: 1 in 2014; 2007, 2009, 2013 in 2014; 2 in 2004, 2006, and 2010; 3 in 2011; 4 in 2012; *Mycobacterium caprae*: 1 in 2006; *Mycobacterium africanum*: 1 in 2005, 2006, 2008, and 2014; 2 in 2007, 2012, and 2013; 3 in 2009 and 2011; 4 in 2010; and 5 in 2015.

† Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

‡ Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second–line drugs (amikacin, capreomycin and kanamycin).

TABLE 16: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Saskatchewan, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA	74	100.0	58	100.0	60	100.0	81	100.0	77	100.0	54	100.0	66	100.0	72	100.0	71	100.0	63	100.0	50	100.0
Isolates susceptible to all first-line TB drugs	72	97.3	57	98.3	59	98.3	79	97.5	72	93.5	51	94.4	62	93.9	68	94.4	69	97.2	60	95.2	49	98.0
Monoresistant TB																						
INH	2	2.7	1	1.7	1	1.7	2	2.5	3	3.9	2	3.7	4	6.1	1	1.4	1	1.4	0	0.0	0	0.0
RMP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.6	0	0.0
EMB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	4.2	1	1.4	1	1.6	1	2.0
Subtotal—Monoresistant TB	2	2.7	1	1.7	1	1.7	2	2.5	3	3.9	2	3.7	4	6.1	4	5.6	2	2.8	2	3.2	1	2.0
Polyresistant																						
INH and EMB	0	0.0	0	0.0	0	0.0	0	0.0	1	1.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH and PZA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.6	0	0.0
Subtotal—Polyresistant TB	0	0.0	0	0.0	0	0.0	0	0.0	1	1.3	0	0.0	0	0.0	0	0.0	0	0.0	1	1.6	0	0.0
Multidrug-resistant TB†																						
INH, RMP and RBT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
INH, RMP and SM	0	0.0	0	0.0	0	0.0	0	0.0	1	1.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Subtotal—Multidrug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	1	1.3	1	1.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extensively drug-resistant TB*																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	2	2.7	1	1.7	1	1.7	2	2.5	5	6.5	3	5.6	4	6.1	4	5.6	2	2.8	3	4.8	1	2.0

ABBREVIATIONS: EMB = ethambutol; INH = isoniazid; PZA = pyrazinamide; RBT = rifabutin; RMP = rifampin; SM = streptomycin.

† Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

* Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second–line drugs (amikacin, capreomycin and kanamycin).

TABLE 17: Results for routine drug susceptibility testing of *Mycobacterium tuberculosis* complex isolates to anti-tuberculosis drugs for Yukon, 2005 to 2015

	REPORTING YEAR																					
	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Isolates tested for resistance to INH, RMP, EMB and PZA*	2	100.0	2	100.0	2	100.0	7	100.0	3	100.0	5	100.0	2	100.0	1	100.0	1	100.0	4	100.0	3	100.0
Isolates susceptible to all first-line TB drugs	2	100.0	2	100.0	2	100.0	7	100.0	3	100.0	5	100.0	2	100.0	1	100.0	1	100.0	4	100.0	3	100.0
Monoresistant TB																						
Subtotal—Monoresistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Polyresistant																						
Subtotal—Polyresistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Multidrug-resistant TB																						
Subtotal—Multidrug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extensively drug-resistant TB																						
Subtotal—Extensively drug-resistant TB	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total number of isolates resistant to one or more first line drugs	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

ABBREVIATIONS: EMB = ethambutol; INH = isoniazid; PZA = pyrazinamide; RMP = rifampin.

* Routine testing for PZA not conducted for Yukon.

TABLE 18: Multidrug-resistant tuberculosis and extensively drug-resistant tuberculosis isolates by province/territory of origin, 2015

		ORIGINATING PROVINCE												
	CANADA	N.L.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Y.T.	N.W.T.	Nvt.
INH and RMP	11	0	0	0	0	1	7	1	0	1	1	0	0	0
INH, RMP and PZA	3	0	0	0	1	0	2	0	0	0	0	0	0	0
INH, RMP and EMB	1	0	0	0	0	0	0	0	0	0	1	0	0	0
INH, RMP, EMB and PZA	7	0	0	0	0	1	5	0	0	1	0	0	0	0
Total number of Multidrug-resistant TB*	22	0	0	0	1	2	14	1	0	2	2	0	0	0
Extensively drug-resistant TB†	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ABBREVIATIONS: Alta. = Alberta; B.C. = British Columbia; Man. = Manitoba; N.B. = New Brunswick; N.L. = Newfoundland and Labrador; N.S. = Nova Scotia; Nvt. = Nunavut; N.W.T. = Northwest Territories; Ont. = Ontario; P.E.I. = Prince Edward Island; Que. = Quebec; Sask. = Saskatchewan; Y.T. = Yukon.

* Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

† Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second-line drugs (amikacin, capreomycin and kanamycin).

TABLE 19: Provincial/territorial breakdown by any resistance, multidrug-resistant tuberculosis and extensively drug-resistant tuberculosis in Canada, 2005 to 2015

ORIGINATING PROVINCE/TERRITORY	TOTAL NUMBER OF REPORTED MTBC ISOLATES	RESISTANT TO ONE OR MORE FIRST-LINE DRUGS		MULTIDRUG-RESISTANT TB*		EXTENSIVELY DRUG-RESISTANT TB†	
		NUMBER	PERCENT (%)	NUMBER	PERCENT (%)	NUMBER	PERCENT (%)
Ontario	5,569	632	11.3	103	1.8	5	0.1
British Columbia	2,579	261	10.1	23	0.9	0	0.0
Quebec	2,195	227	10.3	20	0.9	1	0.0
Alberta	1,570	154	9.8	24	1.5	0	0.0
Manitoba	1,254	73	5.8	5	0.4	1	0.1
Saskatchewan	726	28	3.9	2	0.3	0	0.0
Nunavut	534	7	1.3	0	0.0	0	0.0
Newfoundland and Labrador	94	1	1.1	0	0.0	0	0.0
Nova Scotia	78	8	10.3	0	0.0	0	0.0
Northwest Territories	75	3	4.0	0	0.0	0	0.0
New Brunswick	60	7	11.7	1	1.7	0	0.0
Yukon	32	0	0.0	0	0.0	0	0.0
Prince Edward Island	10	1	10.0	0	0.0	0	0.0
CANADA	14,776	1,402	9.5	178	1.2	7	0.0

* Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

† Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second–line drugs (amikacin, capreomycin and kanamycin).

TABLE 20: Tuberculosis drug resistance by sex and age group in Canada, 2015

AGE GROUP AND SEX		ISOLATES REPORTED		RESISTANT TO ONE OR MORE FIRST LINE DRUGS		MULTIDRUG RESISTANT*		EXTENSIVELY DRUG RESISTANT†	
		NUMBER	PERCENT (%)	NUMBER	PERCENT (%)	NUMBER	PERCENT (%)	NUMBER	PERCENT (%)
< 1	Male	2	0.1	0	0.0	0	0.0	0	0.0
	Female	1	0.1	0	0.0	0	0.0	0	0.0
	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Total	3	0.2	0	0.0	0	0.0	0	0.0
1 to 4	Male	3	0.2	0	0.0	0	0.0	0	0.0
	Female	2	0.1	0	0.0	0	0.0	0	0.0
	Unknown	1	0.1	0	0.0	0	0.0	0	0.0
	Total	6	0.4	0	0.0	0	0.0	0	0.0
5 to 14	Male	10	0.7	0	0.0	0	0.0	0	0.0
	Female	10	0.7	0	0.0	0	0.0	0	0.0
	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Total	20	1.5	0	0.0	0	0.0	0	0.0
15 to 24	Male	86	6.4	9	6.5	2	9.1	0	0.0
	Female	82	6.1	12	8.6	1	4.5	0	0.0
	Unknown	2	0.1	0	0.0	0	0.0	0	0.0
	Total	170	12.7	21	15.1	3	13.6	0	0.0
25 to 34	Male	119	8.9	9	6.5	3	13.6	0	0.0
	Female	122	9.1	17	12.2	5	22.7	0	0.0
	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Total	241	18.0	26	18.7	8	36.4	0	0.0
35 to 44	Male	95	7.1	5	3.6	1	4.5	0	0.0
	Female	99	7.4	12	8.6	1	4.5	0	0.0
	Unknown	2	0.1	0	0.0	0	0.0	0	0.0
	Total	196	14.6	17	12.2	2	9.1	0	0.0

AGE GROUP AND SEX		ISOLATES REPORTED		RESISTANT TO ONE OR MORE FIRST LINE DRUGS		MULTIDRUG RESISTANT*		EXTENSIVELY DRUG RESISTANT†	
		NUMBER	PERCENT (%)	NUMBER	PERCENT (%)	NUMBER	PERCENT (%)	NUMBER	PERCENT (%)
45 to 54	Male	107	8.0	13	9.4	4	18.2	0	0.0
	Female	69	5.2	7	5.0	2	9.1	0	0.0
	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Total	176	13.1	20	14.4	6	27.3	0	0.0
55 to 64	Male	94	7.0	10	7.2	0	0.0	0	0.0
	Female	62	4.6	4	2.9	1	4.5	0	0.0
	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Total	156	11.7	14	10.1	1	4.5	0	0.0
65 to 74	Male	82	6.1	8	5.8	1	4.5	0	0.0
	Female	64	4.8	10	7.2	0	0.0	0	0.0
	Unknown	2	0.1	2	1.4	0	0.0	0	0.0
	Total	148	11.1	20	14.4	1	4.5	0	0.0
75+	Male	135	10.1	9	6.5	1	4.5	0	0.0
	Female	87	6.5	12	8.6	0	0.0	0	0.0
	Unknown	1	0.1	0	0.0	0	0.0	0	0.0
	Total	223	16.7	21	15.1	1	4.5	0	0.0
Unknown	Male	0	0.0	0	0.0	0	0.0	0	0.0
	Female	0	0.0	0	0.0	0	0.0	0	0.0
	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Total	0	0.0	0	0.0	0	0.0	0	0.0
Total	Male	733	54.7	63	45.3	12	54.5	0	0.0
	Female	598	44.7	74	53.2	10	45.5	0	0.0
	Unknown	8	0.6	2	1.4	0	0.0	0	0.0
TOTAL		1,339	100.0	139	100.0	22	100.0	0	0.0

* Multidrug-resistant TB is TB that is resistant to isoniazid and rifampin, but does not meet the definition of extensively drug-resistant TB.

† Extensively drug-resistant TB is TB that is resistant to isoniazid and rifampin, any fluoroquinolone and at least one of three injectable second–line drugs (amikacin, capreomycin and kanamycin).

REFERENCES

1 Menzies R, Wong T (eds). Canadian Tuberculosis Standards, 7th Edition. Canadian Thoracic Society, Canadian Lung Association, Public Health Agency of Canada; 2013.

2 World Health Organization. Definitions and reporting framework for tuberculosis – 2013 revision (updated December 2014). Geneva: WHO Press; 2013 [cited 2016 Sep 22]. Available from: http://apps.who.int/iris/bitstream/10665/79199/1/9789241505345_eng.pdf

3 Woods GL, Brown-Elliott BA, Conville PS, et al. Susceptibility testing of mycobacteria, nocardiae, and other aerobic actinomycetes; approved standard – 2nd ed. Wayne, PA: Clinical and Laboratory Standards Institute; 2011.

4 Sharma M, Thibert L, Chedore P, et al. Canadian multicentre laboratory study for standardized second-line antimicrobial susceptibility testing of mycobacterium tuberculosis. J Clin Microbiol. 2011;49(12):4112–6.

5 Public Health Agency of Canada. Directive for the collection, use and dissemination of information relating to public health. Unpublished document. Ottawa, ON: Public Health Agency of Canada; 2013.

6 World Health Organization. Global tuberculosis report 2015. Geneva: WHO Press; 2015 [cited 2016 Sep 22]. Available from: http://apps.who.int/iris/bitstream/10665/191102/1/9789241565059_eng.pdf