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Tuberculosis in First Nations Communities, 1999

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1. Executive Summary

The Tuberculosis (TB) Elimination Strategy was implemented in 1992, with the goal of reducing incidence of the disease to 1 per 100,000 by the year 2010. The creation of this program was motivated by consistently higher TB rates in First Nations communities, and global concerns over rising incidence, HIV/TB co-infection, and the emergence of drug resistence.

Over the past 10 years, case finding and directly observed therapy (DOT) have allowed FNIHB and its partners to control TB, and disease incidence would likely have increased over time without a dedicated national program. However, rates have not decreased as rapidly as planned. The notification rates of active TB disease among First Nations communities in 1992 and 1999 were 74.8 and 61.5 per 100,000, respectively. There are a number of factors contributing to the persistence of TB, which are discussed in this report.

TB is highest in Saskatchewan Region, where the age-standardized TB notification rate in 1998 was 104.3 per 100,000. However, the incidence of pulmonary, infectious TB between 1997 and 1999 was similar in Alberta, Saskatchewan and Manitoba. A consistent, downward trend in TB notifications was observed in Pacific Region, where the rate dropped from 76.2 to 32.3 per 100,000 between 1991 and 1998, and the gap between First Nations and provincial rates decreased. Rates were lower in the eastern Regions, and the majority of cases in Ontario occured in the northwestern part of the Region.

Repetitive TB outbreaks in endemic communities contribute substantially to the national TB notification rate. In 1999, 40% of Aboriginal, on-reserve cases occurred in only 5 First Nations communities. Analyses show TB is much more likely to occur in communities with higher levels of household crowding, and in communities located in remote areas far from physician services. It is recognized that improvements in social conditions would contribute enormously to the elimination of TB.

It is estimated that 20-60% of adults in communities from western Ontario to British Columbia have latent tuberculous infection (LTBI). This means they are infected with the bacteria that causes TB, but have not developed active TB disease. People who were recently infected, or who have one or more risk factors in addition to LTBI, are at higher risk of developing disease.

The annual risk of infection appears to be decreasing over time. This is due to improved case finding and treatment, which shortens the period of infectiousness in persons with disease, and reduces transmission of the bacteria to others. Compliance with therapy is over 90% in all Regions but one, an excellent indicator of program effectiveness in the area of treatment. DOT completion was over 90% in all Regions experiencing a major outbreak in 1999.

Despite high compliance with DOT, adherence to treatment of LTBI (chemoprophylaxis) tends to be quite low in most Regions, particularly among adults. Pulmonary, infectious TB occurs almost exclusively in adults above the age of 15 years. Enhanced screening of high-risk adults in endemic communities, and improved compliance with treatment of latent infection, would likely have a significant impact on transmission.

Pediatric TB rates in the First Nations population have decreased throughout the 1990s. The notification rate in the 0-15 age group dropped from 139 to 57 per 100,000, between 1990 and 1999. The majority of pediatric TB cases occurred in Saskatchewan Region, where rates dropped from 626 to 241 per 100,000 over the ten-year period. At the national level, active TB rates appear to be stable over time in other age groups.

Another important issue identified by the program is the need for improvements in community-level capacity to manage TB outbreaks, and preventive activities such as screening and health education. The continuing transfer of health services and programs to the control of First Nations makes this a very high priority.

2. Tuberculosis Elimination Strategy

In the early decades of the twentieth century, the death rate from TB was extremely high in First Nations communities, and adequate drug therapies for the disease did not exist. Many people were treated in sanitoria, and many passed away far from their families and communities. Although TB was endemic in North America prior to the arrival of Europeans, the TB epidemic among Aboriginal people in this country did not begin until recently. A combination of malnutrition, confinement on crowded reservations with poor sanitation, and lack of immunity to the TB bacillus created the ideal conditions for a terrible epidemic, which at one time led some to believe that TB would wipe out the entire Aboriginal population. Indeed, death rates from TB were in excess of 700 per 100,000 in the earlier part of this century, and at one point as high as 8,000 per 100,000 among Aboriginal children in residential schools (Wherrett, 1977).

Fortunately, TB death rates declined dramatically after the introduction of an effective chemotherapy, and a similar drop in morbidity occurred although considerably delayed. After a steady decrease throughout the 1950s, 60s and 70s, TB incidence began to level off in the 1980s, and Aboriginal Canadians living on reserve were still 10 times more likely to have TB than non-Aboriginal Canadians in 1990. At the global level, the emergence of drug resistance and HIV/AIDS contributed to increased rates of TB in many countries, and motivated national TB programs around the world to acknowledge the urgent need for increased efforts to control and prevent the disease. These factors led the First Nations and Inuit Health Branch (FNIHB) of Health Canada, the Centre for Infectious Disease Prevention and Control (CIDPC)[1] of Health Canada, and the Assembly of First Nations (AFN) to work together in developing a strategy for TB elimination in First Nations communities. The result of this collaboration, published in 1992, was the "National Tuberculosis Elimination Strategy for Aboriginal Peoples of Canada."

The epidemiologic definition of elimination is reduction of disease incidence in a population to 1 per million. The goal of the TB Elimination Strategy was to reduce the incidence of TB disease in the First Nations on-reserve population to 1 per 100,000 by the year 2010, although the results of this report clearly indicate this will not likely occur. It has been decided to derive a new, more evidence-based target, based on modeling the dynamics of the disease in First Nations communities, and the effects of FNIHB program interventions. The ultimate goal of the program remains the elimination of TB.

FNIHB is responsible for the delivery of primary health services in First Nations, "on-reserve" communities. Funding of the National Tuberculosis Program remains centralized at the national level, to prevent the loss of dedicated funding to Regional TB programs, and to allow for changes in funding allocations to Regions as trends in TB

[1]FNIHB formerly known as the Medical Services Branch (MSB), and CIDPC formerly known as the Laboratory Centre for Disease Control (LCDC), before the Health Canada realignment in 2000.

epidemiology change over time. Components of TB control such as clinical management, a TB registry, and a controlled system for TB drug supply and procurement, are centralized at the Regional level. This centralized direction supports a decentralized implementation through primary health care services in First Nations communities, where case finding and directly observed therapy (DOT) are done.

The following are considered elements of all Regional TB programs:

- Case finding and case holding
- Contact tracing and directly observed treatment of latent tuberculous infection (LTBI)
- Surveillance, at the community, Regional, and National levels
- Bacille Calmette-Guérin (BCG) immunization, in communities where use of the vaccine has been recommended
- Health education and training
- Research

Rapid finding of active TB disease cases is essential to prevent the transmission of TB to contacts of infectious cases. Persons with persistent cough, fever, and/or weight loss, and/or individuals in high-risk groups, are considered possible disease cases, and active cases are confirmed using sputum microscopy and culture, radiology, and other diagnostic tools. The objective of case holding is to ensure a proper course of treatment for all patients, and to maintain a central registry with records of treatment outcomes, contact follow-up, etc. DOT is the standard of care in all FNIHB Regions, meaning a health care worker or designate must be present to observe the patient take all medication doses.

It is now recommended by FNIHB that HIV testing, along with pre-test and post-test counseling, be routinely offered to all TB patients in all Regions. This is extremely important, given our lack of information on co-infection, and the potential consequences of HIV/AIDS on TB control in the future.

The investigation of all contacts must immediately follow diagnosis, especially if the case is considered infectious. Assessment of contacts may include skin testing, chest radiography, sputum culture, symptom inquiry, and TB history. All contacts with TB infection should be given directly observed prophylaxis (DOP), which is now also referred to as "treatment of LTBI." Both of these terms are used interchangeably in this report. Capacity building at the community level to improve response to TB outbreaks and conduct these kinds of investigations has been identified as a high priority.

Surveillance refers to the ongoing, routine collection, analysis, and timely dissemination of health information to those who need it. This activity is vital for effective disease control and prevention. In the National Tuberculosis Program, surveillance of TB trends is needed at the community, Regional, and National level, to evaluate and plan programs, target resources, and develop appropriate policies. Data should be analyzed routinely by the FNIHB Regions, and reported to Headquarters annually. The data should then be compiled into an annual, national report on TB in First Nations communities. The lack of an information system for surveillance of TB and other communicable diseases at the community level has been identified. Such a system is needed to improve community access to information, and to enhance surveillance capacity at the local and Regional levels.

Despite the directions given by FNIHB and the National Advisory Committee on Immunization (NACI) in the past, it has become clear that many communities and health professionals are confused about whether to offer the BCG vaccine to First Nations infants. The decision to use or discontinue the use of BCG in a specific area or community should be made by the FNIHB Regional Director, based on recommendations of the community, TB consultant, Regional Medical Officer, and/or appropriate TB program staff. BCG immunization is recommended in areas with a rate of new infections higher than 1%, or with a high incidence of infectious TB disease, because of the protective effect of the vaccine against TB meningitis and miliary TB. In an effort to improve policy-making capacity for BCG, the development of a decision analysis model was funded by FNIHB. Although this may be useful in the future, some work must still be done to validate and improve the model.

Education programs are essential in increasing the awareness and understanding of health professionals, patients, community members and leaders about the control and prevention of TB infection and disease. Efforts to increase awareness among these groups of people, and enhance the skills needed for TB control among community health nurses and TB program staff, are ongoing.

Research plays a key role in the evaluation of program effectiveness, and our understanding of TB epidemiology, in First Nations communities. In the future, the FNIHB TB Working Group will decide what research priorities need to be addressed, and target funding to these areas.

3. Epidemiology of TB among First Nations persons living on-reserve

3.1. Active TB

"Active TB" refers to TB disease, which may or may not occur in people who are infected with *Mycobacterium tuberculosis*. The epidemiology of latent tuberculous infection (LTBI) is described in section 3.2. All rates for the First Nations population[2] were calculated using TB data from the FNIHB Regions and CIDPC, and population figures from the FNIHB Community Workload Increase System (CWIS). A detailed description of how the on-reserve population was estimated is provided in Appendix B. Unfortunately, it was not possible to accurately determine the total number of on-reserve TB cases by age and sex in Quebec, and therefore Quebec was not included in the calculation of national age-standardized TB notification rates (Table 3.1). The notification rate and age-specific rates for Quebec Inuit communities from 1995 to 1999 are provided elsewhere in this section, as well as the total number of First Nations (on and off reserve) cases between 1995 and 1998 in the province.

Table 3.1 National age-standardized TB notification rate (per 100,000) in First Nations communities (1990-1999) and Canada (1990-1997), with standardized morbidity ratios[a]

Year	First Nations	Canada	SMR (%)[b]
1990	69.4	7.2	960
1991	59.5	7.2	830
1992	74.8	7.4	1010
1993	54.3	7.0	780
1994	56.3	7.1	790
1995	53.4	6.5	820
1996	49.0	6.3	780
1997	53.3	6.6	810
1998	41.6	n/a	n/a
1999	61.5	n/a	n/a

[a]all rates standardized to 1996 Canadian population; rate calculations do not include Quebec figures
[b]SMR = First Nations rate / Canadian rate * 100; e.g. if SMR = 200%, First Nations rate is two times higher

[2]The terms "First Nations population" and "First Nations communities" in this report refer to people living "on reserve," because of the mandate of FNIHB, and the national TB program.

Numerator data for rate calculations were obtained from Tuberculosis Prevention and Control at CIDPC, and reports from the FNIHB Regions. The number of cases by age and sex were used to calculate standardized notification rates. This was done because TB is influenced by age, and age distributions in the First Nations population are not comparable to those of the entire Canadian population. The rates presented in Table 3.1 refer to all cases of TB disease, both new and relapsed in the First Nations, on-reserve population, and in the entire Canadian population. The standardized morbidity ratio (SMR) is the First Nations rate divided by the overall Canadian rate, expressed as a percentage.

According to the results, TB appeared to decrease after the implementation of the Tuberculosis Elimination Strategy in 1992, from a 3-year incidence of 67.8 per 100,000 person-years (1990-1992), to 54.6 per 100,000 (1993-1995). However, the rate stabilized in the mid-1990s. In 1997, the TB rate was 8 times (810%) that of the entire Canadian population. No appreciable difference between the sexes was observed. Despite an encouraging dip in 1998, by the following year the rate climbed to the high levels experienced at the start of the decade. The 1999 figure was 61.5 per 100,000, due in part to large outbreaks in several Regions. Forty percent of the total TB cases in First Nations communities occurred in 5 communities that year. A section of this report is dedicated to describing these outbreaks, and their contribution to high TB rates in First Nations communities.

Because all Regional and provincial rates were standardized to the 1996 Canadian population, inter-population and inter-Regional comparisons are appropriate. TB rates were clearly highest in Saskatchewan throughout the 1990s, decreasing from 155.7 to 104.3 per 100,000 over 10 years. Alberta and Manitoba tend to experience higher rates than national figures, while on-reserve TB in Pacific Region appears to be dropping. The eastern provinces consistently report fewer TB cases than the western provinces. Some concern exists in

Table 3.2 First Nations, on-reserve TB cases (new and relapsed) by FNIHB Region (1990-1999)[a]

Region	Year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Pacific	20	15	57	19	17	14	11	18	13	9
Alberta	15	10	57	17	20	17	13	19	17	28
Saskatchewan	143	103	56	64	51	65	55	68	47	72
Manitoba	14	25	15	20	35	27	21	19	28	62
Ontario	6	9	22	15	12	8	23	4	12	12
Atlantic	2	0	0	2	0	1	1	1	4	0
Total	**200**	**162**	**207**	**137**	**135**	**132**	**124**	**129**	**121**	**183**

[a]data for 1990-1998 were supplied by CIDPC, except for Ontario. Data for that Region was obtained from the First Nations and Inuit Health Information System (FNIHIS). All 1999 data were obtained from the FNIHB Regions. CIDPC and Regional reports for 1991-1998 were compared as a validation exercise. It should be stated that these reports often differ slightly, usually because of problems in distinguishing whether a First Nations person lives on or off reserve.

Table 3.3 Three-year moving, age-standardized, Regional TB notification rates, per 100,000 (1991-1998)[a]

Year	Region					
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic
1991	76.2	88.9	155.7	67.0	20.5	5.6
1992	65.0	83.9	125.1	71.5	27.3	9.9
1993	64.1	94.2	102.9	69.3	28.9	9.6
1994	38.4	72.4	112.3	68.0	24.1	18.7
1995	37.5	65.3	104.5	68.2	25.2	11.9
1996	37.5	71.8	108.4	63.8	20.0	15.5
1997	35.2	61.1	95.1	60.4	20.6	20.4
1998	32.3	76.2	104.3	74.0	15.9	18.1

[a]all rates standardized to 1996 Canadian population

eastern provinces regarding the misclassification of on vs. off reserve status, due to diagnosis of the disease off reserve. This may contribute to under-reporting, and an underestimation of incidence.

Standardized TB notification rates for First Nations were higher than those of the rest of the population for all Regions and all years between 1991 and 1997 (Table 3.4). The gap between populations was reduced over time in Pacific, while in all other Regions that gap was constant or widening. Presentation of the data in this way ignores variations within Regions, meaning the SMR may be quite large for one part of a Region, while risk of TB for First Nations communities may be similar to the rest of the province in another part. Morbidity ratios ranged from 9 to 15 times difference in Alberta. In Saskatchewan, it should be noted that the First Nations population represents a larger proportion of the total provincial population than in other Regions, meaning the overall provincial rate is influenced more by Aboriginal figures. This may result in a smaller ratio than one might expect, given the very high TB notification rates generally experienced among Saskatchewan First Nations communities.

It is important to note that TB is not uniformly distributed across Ontario, and 76 % of TB cases in Ontario between 1996 and 1999 occurred in one northwestern Zone. TB is not homogenous even within this Zone, as most cases there occurred in five hyperendemic communities. Over half of the communities in the Zone had at least one case in the 1990s. If these communities were excluded from the calculation of a Regional TB rate for Ontario, that rate – and corresponding SMRs – would be quite low. Even with the hyperendemic communities, the SMR is lowest of all Regions, ranging between 200-400%.

The rates in Atlantic Region include only First Nations communities in New Brunswick and Nova Scotia. No active cases occurred in Labrador in 1997 and 1998, and two cases were reported in 1999. The morbidity ratios for Atlantic Region should be interpreted keeping in mind that the total number of cases

Table 3.4 Standardized morbidity ratios (%) of Regional First Nations TB notification rates to corresponding provincial rates (1991-1997)[a]

Year	Region					
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic
1991	930	1190	920	740	280	220
1992	710	920	1,020	930	350	520
1993	690	1,500	720	710	410	510
1994	440	1,030	810	670	320	1,170
1995	460	1,310	700	710	370	990
1996	460	1,330	990	730	290	910
1997	350	970	830	720	310	2,550

[a]all rates used to calculate SMRs are standardized to 1996 Canadian population

in Atlantic Region has ranged from 0 to only 4 in the past ten years, and rates fluctuate widely due to the relatively small First Nations population in the Region. However, the persistence of TB in this small population over time probably indicates that TB is still a problem. Cases tend to occur in the same communities, which likely have a high underlying prevalence of latent infection in the older age groups.

Although some information on TB in Quebec Region is available, it is not currently possible to separate on vs. off reserve cases to estimate standardized notification rates. Between 1995 and 1998, 28 First Nations cases were reported in Quebec, 10 of which were in Cree communities. Published results from tuberculin skin testing in Cree communities are included in this report. A small minority of Aboriginal communities in Quebec actually receive TB control services from FNIHB. However, the Region does cooperate with provincial and First Nations-controlled health authorities when necessary. An outbreak of 3 cases was reported in one transferred community in 1999.

Data provided by the Nunavik Regional Board of Health and Social Services shows that TB is still endemic among the Inuit of northern Quebec. Between 1995 and 1999, there were 33 active cases, and the incidence density over 5 years was 73.0 per 100,000 (standardized to the 1996 Canadian population). Table 3.5 contains age-specific case totals and rates for this population.

Pediatric TB rates decreased from 1990 to 1999, while rates among other age groups were relatively stable (Fig. 3.1). TB among the elderly was consistently higher than among younger age groups. It is apparent that Saskatchewan Region contributes disproportionately to the national rate of pediatric TB (Fig. 3.2), and to the proportion of primary TB cases at the national level (Fig. 3.3). As Figure 3.4 demonstrates, the distribution of TB by diagnostic site in the other FNIHB Regions is not unlike that of the rest of the Canadian population. A high percentage of TB cases in Saskatchewan can be attributed to pediatric, primary TB. This is a result of efficient school-based screening in the Region, and an aggressive contact and clinic review process for

Table 3.5 Age-specific TB notification rates among the Inuit of northern Quebec (1995-1999)[a]

Age Group	Person-years[a]	Cases	Incidence
0-4	4,930	1	20.3
5-9	6,520	1	15.3
10-14	5,570	3	53.9
15-19	4,785	10	209.0
20-24	3,800	5	131.6
25-29	3,680	4	108.7
30-34	3,305	3	90.8
35-39	2,885	3	104.0
40+	8,095	3	37.1

[a]population estimates provided by the Ministère de la santé et des services sociaux in Quebec

finding the primary form of the disease. Some argue these are not true cases of TB disease, because many of these children resolve and are detected as LTBI at a later date. If this occurred, such children would receive treatment of LTBI, rather than treatment for active disease. However, the Region is concerned that some of these children will develop progressive, primary disease during the following five years, although it is impossible to know which ones. Therefore, all cases of pediatric, primary TB receive treatment for active disease following diagnosis.

Figure 3.1 Age-specific TB notification rates (per 100,000) in First Nations communities (1991-1998)

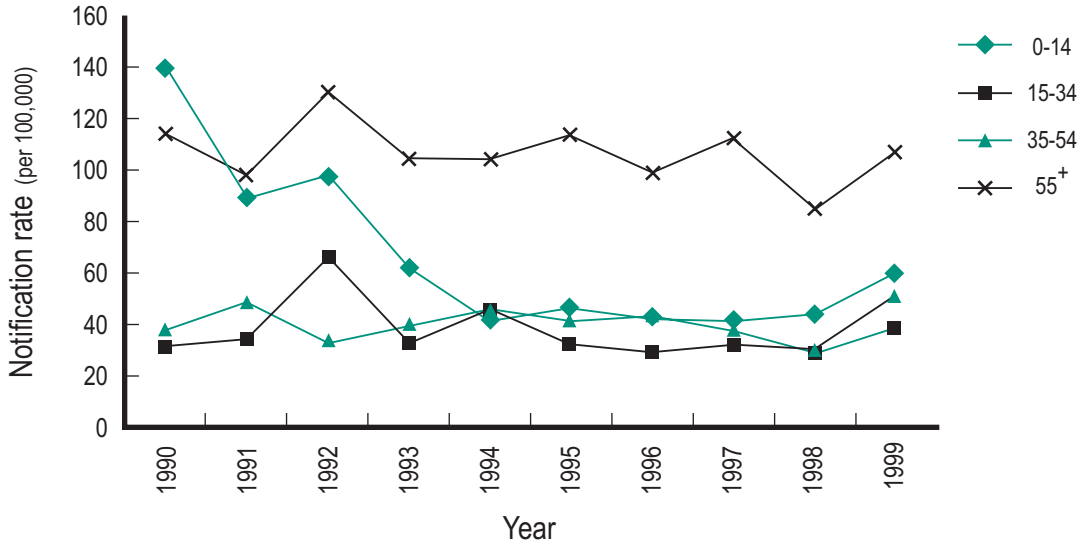


Figure 3.2 Three-year moving pediatric TB notification rate (0-14 years), by Region (1990-1999)

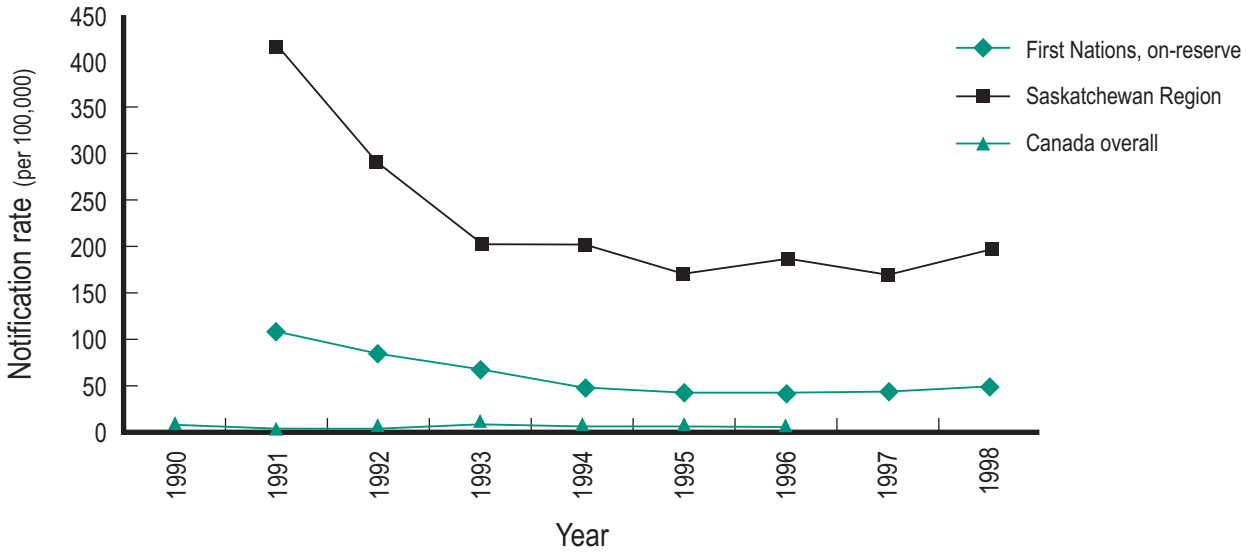


Figure 3.3 TB cases by diagnostic site (1990-1998)

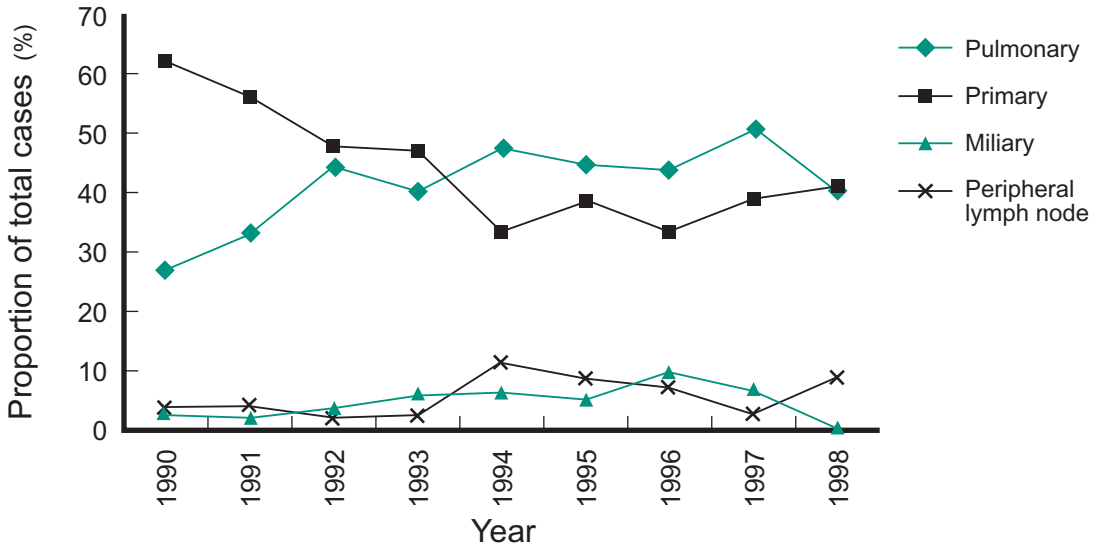
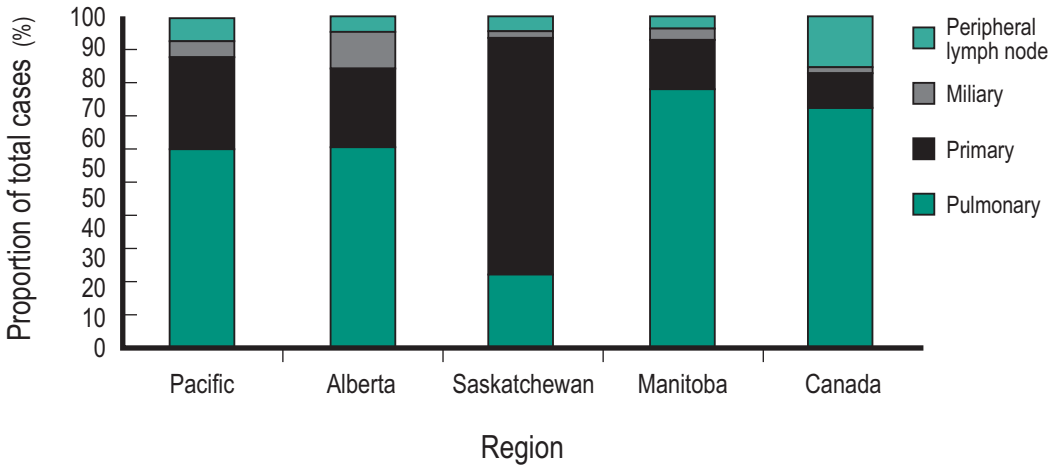


Figure 3.4 Distribution of TB cases by diagnostic site, by Region (1990-1998), compared to entire Canadian population (1990-1996)



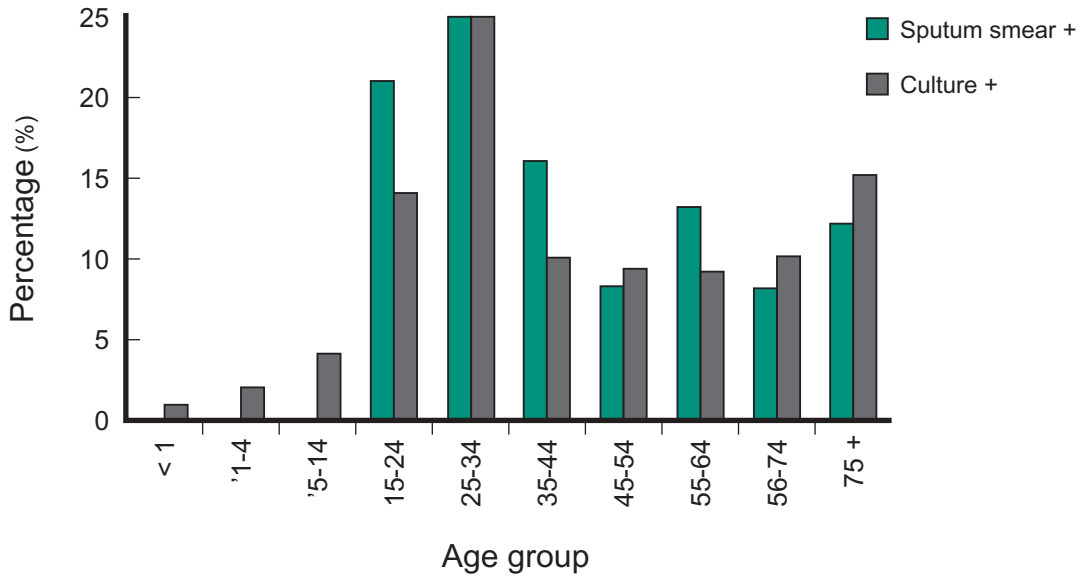
People with pulmonary TB have their sputum examined for TB bacteria. If the test is positive ("sputum smear positive"), the case is considered highly infectious. Among those with negative smears, the bacteria may grow in culture. These individuals are considered less infectious than those who are smear positive, although they are still regarded as infectious cases.

The reported incidence of bacteriologically confirmed, pulmonary TB is similar in Alberta, Saskatchewan and Manitoba, despite higher overall rates in Saskatchewan (Table 3.6). The proportion of total cases (all forms of TB disease) attributed to this form of the disease ranged from 24% in Saskatchewan to 64% in Alberta. Since individuals with pulmonary, bacteriologically proven TB infect others through airborne transmission, it is extremely important to target case finding activities towards this group. Furthermore, preventive activities that target people who are more likely to develop this form of the disease can impact on TB incidence in the population. Figure 3.5 shows the age distribution of smear positive and culture positive cases between 1997 and 1999. The graph suggests that people

Table 3.6 Bacteriologically confirmed, pulmonary TB notifications, by Region (1997-1999)

Region	Number of cases	Proportion of total cases (%)	Person-years	Three-year, crude notification rate (per 100,000)
Pacific	24	60	18,1027	13.3
Alberta	44	64	16,3845	26.9
Saskatchewan	43	24	15,3252	28.1
Manitoba	44	40	20,3532	21.6
Total	**155**	**39**	**70,1656**	**22.1**

Figure 3.5 Age distribution of pulmonary, bacteriologically confirmed cases (1997-1999)



between 15 and 34 years of age are at highest risk, and that pediatric cases are seldom infectious. People aged 15-24 may infect others, and the risk of transmission to others from people aged 25-34 is especially high. Many people aged 35 and over also developed bacteriologically confirmed, pulmonary TB.

3.2. Latent tuberculous infection (LTBI)

People with LTBI are infected with the bacteria that causes TB, but have not developed active TB disease. Individuals who were recently infected, or who have one or more risk factors in addition to LTBI, are at higher risk of developing disease. For this reason, it is important to analyze both the incidence and prevalence of LTBI in a population.

The annual risk of infection (ARI) is considered one of the best indicators of TB control in a population over time (Sutherland, 1991). It is derived using estimates of the prevalence of infection in specific cohorts with known age, and represents the incidence – or "force" – of LTBI. The formula for calculating ARI values is provided in Appendix A of this report.

Tuberculin skin test (TST) screening data from the FNIHB Regions and a recently published paper (Smeja and Brassard, 2000) were used to estimate the ARI for five Regions in 1991, and for Pacific and Saskatchewan Regions over time. The influence of BCG vaccination on the TST has been widely debated, and investigated in several studies (Comstock et al., 1971; Horwitz and Bunch-Christensen, 1972; Menzies and Vissandjee, 1992). Although some studies have shown that BCG given before age one has no effect on TST results in children after the age of 2-3 years, the World Health Organization (WHO) uses only TST results from people with no history of BCG to estimate ARI (Cauthen et al., 1988). For this reason, BCG-negative data were preferred. All results from Pacific, Alberta and Saskatchewan were based on cohorts with known age, and no history of BCG. However, the majority of children included in the Ontario and Quebec estimates had received BCG.

The 1991 ARI in Pacific, Alberta, and one northern Ontario Zone appear to be similar, while it is over two times higher in Saskatchewan (Table 3.7). The ARI decreased significantly over time both in Pacific (Fig. 3.6) and Saskatchewan (Fig. 3.7) Regions, during the periods of 1982-1995 and 1979-1993, respectively. The drop in both Regions was probably associated with improvements in case finding and treatment in the early 1990s. Finding active cases and treating them effectively decreases the number of infectious cases in the population, and their period of infectiousness. Case finding and case holding reduces transmission, and thus the incidence of LTBI goes down.

Table 3.7 TST positivity among children by Region (1997), and associated annual risk of infection (1991)

Region	Age	n screened	n infected (> 10 mm)	% positive	Annual risk of infection (1991)
Pacific	12[a]	315	4	1.3	0.11
Alberta	12	205	4	2.0	0.16
Saskatchewan	9.5[a]	2,050	47	2.3	0.41
northwestern Ontario	12	217	4	1.8	0.15
Quebec Cree[b]	12	222	22	9.9	0.87

[a]midpoint of age range, as recommended by Cauthen et al., 1998, for ARI calculations
[b]Quebec figures adapted from Smeja and Brassard, 2000

Figure 3.6 Trend in the annual risk of infection in Pacific Region (1982-1995)

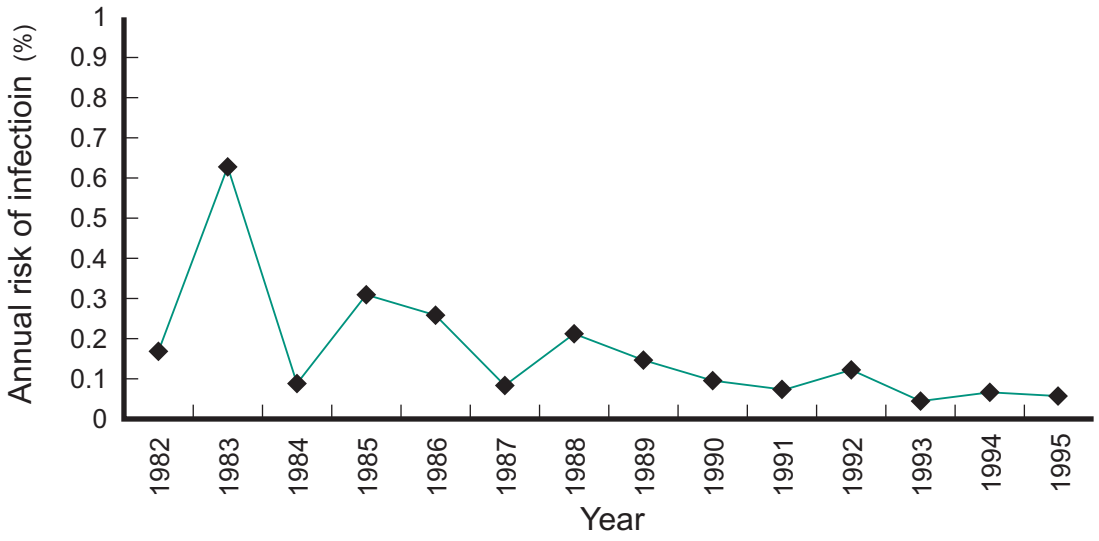


Figure 3.7 Trend in the annual risk of infection in Saskatchewan Region (1979-1993)

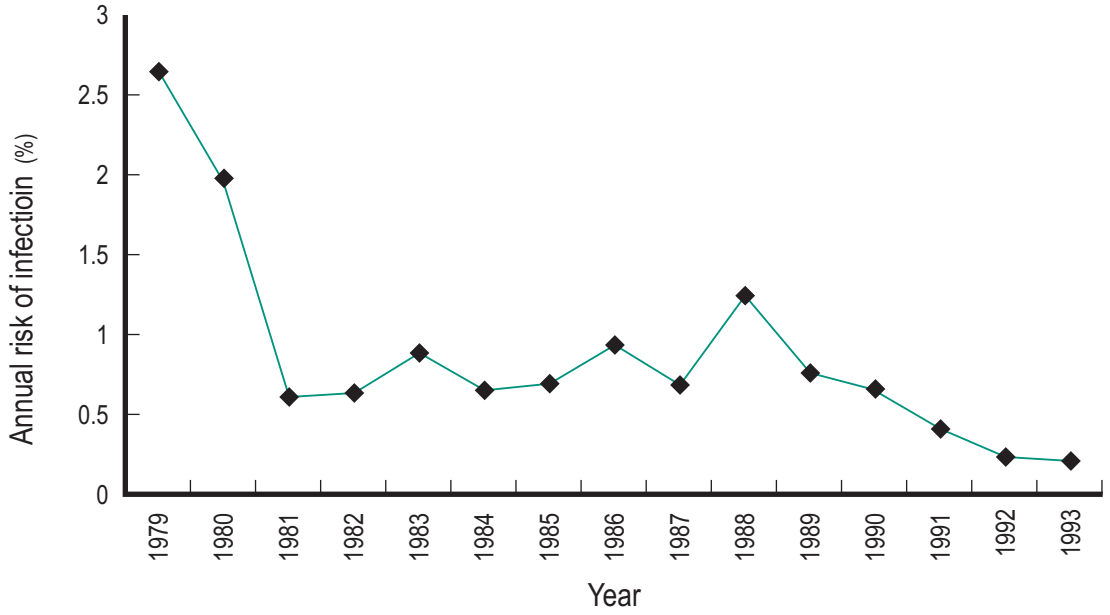


Figure 3.8 shows clearly that the prevalence of LTBI increases with age in Pacific Region, which is expected. The gap appears to be narrowing over time, and prevalence in older age groups is decreasing. In Saskatchewan, prevalence of infection has decreased markedly among those aged 15-30 years throughout the 1990s, while it remains relatively constant among people over 30 years (Fig. 3.9).

Figure 3.8 TST positivity by age group in Pacific Region (1991-1999)

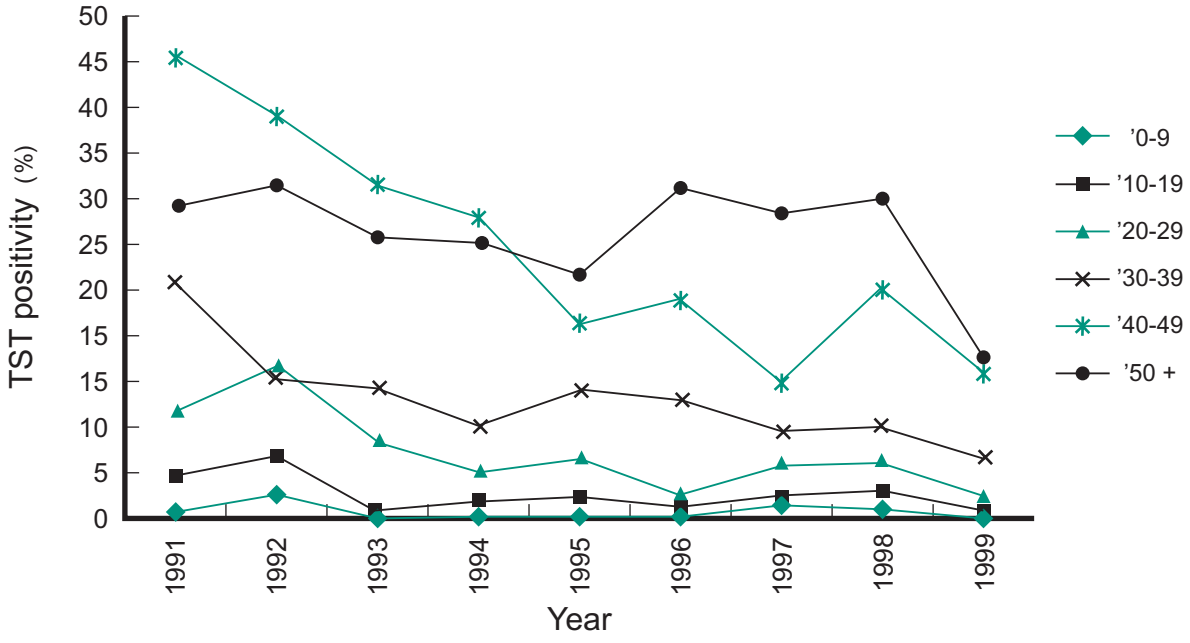
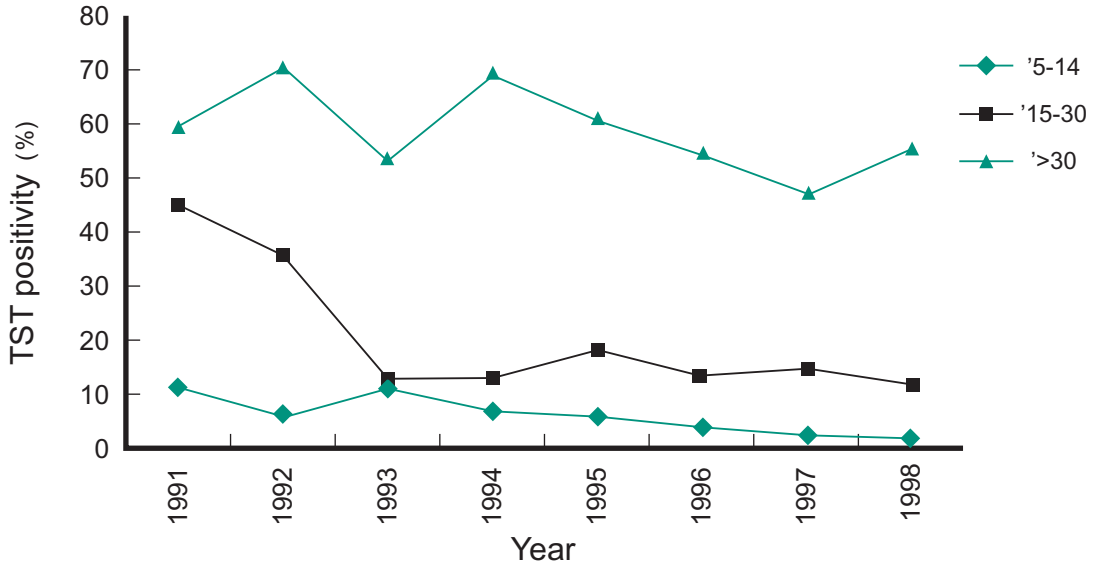


Figure 3.9 TST positivity by age group in Saskatchewan Region (1991-1998)



Results of contact investigations and TST surveys from three western Regions were used to estimate the prevalence of LTBI in those Regions. One limitation of these data is that contact investigations occur in communities where one or more infectious cases have been found, and those with LTBI may include both recent convertors and people who have been infected for many years. This can limit the generalizability of the results, due to the presence of convertors. However, contact investigations in First Nations communities often involve the entire community, because community size and degree of isolation may result in most – if not all – people being a contact. Furthermore, since many of these communities are considered TB endemic, and cases may be reported in the same community from year to year, the prevalence of LTBI recorded during a contact investigation may be an accurate estimate of the true prevalence in TB endemic areas.

Table 3.8 suggests a high prevalence of infection in many First Nations communities, particularly in the adult population. From 1995 to 1999 in Pacific Region, this figure ranged from 12% to 22 % in the >30 age group, although data from the entire decade shows a decreasing trend. Prevalence of infection in those more than 30 years of age in Saskatchewan appears to be very high (47%-61%). In Manitoba, the figure for all people tested during contact investigations ranged from 23% to 42%. The trend towards higher infection in older age groups and lower infection in younger age groups reflects that of many industrialized countries in which the burden of latent infection is still high. The World Health Organization has estimated roughly 80% of infected individuals in industrialized countries are aged 50 years or more (Kochi, 1991).

Table 3.8 Results of tuberculin surveys and contact investigations in 3 Regions (1995-1999)

Region and age group	Year	n tested	n infected (> 10 mm)	% positive	95% C.I.
Pacific (> 30 years)	1995	445	82	18.4	14.8, 22.0
	1996	586	126	21.5	18.2, 24.8
	1997	416	74	17.8	14.1, 21.5
	1998	851	187	22.0	19.2, 24.8
	1999	359	43	12.0	8.6, 15.3
Saskatchewan (> 30 years)	1995	119	73	61.3	52.6, 70.1
	1996	111	61	55.0	45.7, 64.2
	1997	148	70	47.3	39.3, 55.3
	1998	165	91	55.2	47.6, 62.7
Manitoba (all ages)	1995	205	87	42.4	35.6, 49.2
	1996	223	62	27.8	21.9, 35.4
	1997	336	78	23.2	18.7, 27.7
	1998	358	113	31.6	26.8, 36.4
	1999	489	187	38.2	33.9, 42.5

School-based screening results indicate that infection rates among children in most Regions are low at this time, while the results of screening, contact tracing and tuberculin surveys show a high prevalence of infection among adults. In the 1960s, TB rates among Inuit people exceeded all other rates reported worldwide, and were among the highest ever reported in a human population (Grzybowski et al., 1976). The response was aggressive screening, treatment, BCG vaccination, and chemoprophylaxis, which resulted in one of the fastest rates of decline in TB incidence ever recorded (Enarson, 1998a). The role of screening and providing effective prophylaxis to adults in this population – in addition to children – should not be forgotten.

3.3. Mortality, HIV co-infection, and drug resistance

Mortality from TB in this report will be defined as deaths caused directly by TB, and cases in which TB contributed to the death but was not the underlying cause. Mortality rates from TB are very low in First Nations communities, mostly due to aggressive case finding and effective treatment of the disease. Nonetheless, deaths continue to be reported each year in almost all western Regions. Throughout the 1990s, 34 TB-related deaths were reported in Pacific, Alberta, and Saskatchewan (Table 3.9). These deaths usually occur in the older age groups.

Table 3.9 Mortality from active TB in First Nations communities, by Region (1991-1999)[a]

Region / Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	Total
Pacific	0	0	0	2	1	2	0	0	3	**8**
Alberta	3	1	1	4	2	0	1	2	1	**15**
Saskatchewan	1	1	1	1	1	2	2	1	1	**11**
Manitoba	0	0	0	0	1	2	0	1	n/a	**n/a**
Ontario	0	1	0	1	1	0	n/a	n/a	n/a	**n/a**

[a]includes deaths caused directly by TB, and cases in which TB contributed to the death but was not the underlying cause

In 1996, it was estimated the proportion of TB cases tested for HIV in the FNIHB Regions ranged from 1% to 70%. The TB Working Group has approved a national recommendation of testing all TB cases for HIV, meaning this figure should be increased to 100% in all Regions.

Although it appears TB/HIV co-infection remains low in First Nations communities, it is currently impossible to assess this situation properly. More accurate information on co-infection in the First Nations population – as well as the entire Canadian population – is needed. For example, HIV status was unknown in 94% of reported TB cases across the country in 1997 (Health Canada, 2000a). Reporting of TB disease among AIDS patients is more accurate. From 1983 to 1996, 4.2% of overall reported AIDS cases in Canada had active TB, and from 1997 to 1999 that proportion has increased to 6.3% (personal communication with the Bureau of HIV/AIDS, STD and TB, CIDPC, 2000). The proportion of new HIV infections with TB remains unknown. These figures show a strong need both in First Nations communities and in the rest of the population for more accurate information.

The enormous impact of HIV on the spread of TB in other countries should not be ignored, and Regional TB programs should monitor HIV trends. The proportion of new AIDS cases and positive HIV test reports attributed to Aboriginal persons in Canada is increasing

Table 3.10 Reported HIV infection in active TB cases, by Region (1991-1999)

Region	Reported HIV infection in active TB cases
Pacific	2 (1993;1998)
Alberta	0 (data n/a for 1997-1999)
Saskatchewan	0
Manitoba	2 (1996; 1999)
Other Regions	unknown

(Health Canada, 2000b). It is also important to remain aware of HIV trends in the urban, off-reserve Aboriginal population, which could affect on-reserve communities as well due to patterns of migration to and from the city. In some large Canadian cities, risk factors for HIV/AIDS and seroprevalence of HIV among Aboriginal people are a significant problem (Elliott and Blanchard, 1999; Rekart, 1998).

The reported rate of drug resistance among TB isolates tested is quite low in the First Nations, on-reserve population. Saskatchewan appears to have the most consistent pattern of resistance over time (Table 3.11). Despite this, Regional comparisons of drug resistance are discouraged, given the lack of data for 1997 to 1999 from Manitoba and Ontario, and the complete lack of data for Quebec and Atlantic Regions. Improved reporting of drug resistance from these Regions in the future will be encouraged.

The Canadian Tuberculosis Laboratory Surveillance System was implemented in 1998 to monitor patterns of drug resistance across the country. In 1998, resistance to one or more TB drugs was reported for 11.9% of isolates, and by 1999 that proportion had risen to 12.2%. The percentage of isolates for which multi-drug resistance was reported (defined as resistance to at least isoniazid and rifampin) was 1.2% for both years (Health Canada, 2000c).

Lower reported resistance among First Nations, on-reserve cases could be due to effective DOT in the Regions. However, it is also influenced by the fact that most drug resistent isolates of *M. tuberculosis* are found among people born in other countries, meaning the bacteria probably entered Canada recently. Studies have shown the rate of TB drug resistance among First Nations cases is similar to that of the Canadian-born, non-Aboriginal population (Long et al., 1993; 1997). Resistent strains found in the foreign-born are unlikely to be found in First Nations communities – particularly remote communities, where the disease is more prevalent – although the possibility of this occurring due to migration should not be ignored.

Table 3.11 Reported drug resistance in the First Nations, on-reserve population (1991-1999)[a]

Region	Details on resistant isolates
Pacific	1 RMP (1994)
Alberta	1 SM (1991); 1 EMB (1994); 1 MDR-TB (1996); 1 MDR-TB (1997)
Saskatchewan	1 INH and SM (1991); 1 INH (1992); 1 INH (1993); 2 INH (1994); 5 INH (1996); 1 INH and EMB (1997); 1 EMB (1998)
Manitoba	1 SM (1994); data n/a for 1997-1999
Ontario	1 INH (1992); 1 INH (1996); data n/a for 1997-1999
Other Regions	Unknown

[a]RMP = rifampin; SM = streptomycin; EMB = ethambutol; MDR-TB = multi-drug resistent TB (resistance to at least INH and RMP); INH = isoniazid

4. Regional TB Control Programs

The following data related to TB program performance was requested from the Regions for 1997 to 1999:

- DOT completion rate
- Total number of contacts identified
- Total number of contacts per case
- Completion rate for treatment of LTBI
- BCG coverage
- Reported adverse reactions to the BCG vaccine

For similar information on performance from 1991 to 1996, Regional questionnaires used for the last FNIHB TB report (Medical Services Branch, 1999) were used.

The DOT completion rate refers to the proportion of patients cured plus the proportion of patients who completed treatment by DOT, where the denominator consists of all reported cases, including patients who died, experienced treatment failure, defaulted, or transferred out (World Health Organization, 2000). DOT completion rates are generally quite high in the on-reserve population, and are likely higher than those for the rest of the population (FitzGerald et al., 2000). Reported adherence to DOT in 1999 ranged from 92 to 100% in four provinces, and was 33% in Pacific Region. The latter was not typical of Pacific Region, although DOT completion tends to be slightly lower than other Regions. Alberta, Saskatchewan, and Manitoba Regions were able to achieve very high compliance with DOT in 1999 despite large outbreaks and considerable logistic difficulties.

Considering the WHO recommends a cure rate of 95% in industrialized countries (Kochi, 1991), this element of the TB Elimination Strategy has been implemented with a high degree of success. Although treatment success is important in curing the patient and reducing their risk of mortality, it is also essential for effective control of the disease in the population. Finding and treating cases – in particular, those cases with infectious, pulmonary TB – lowers the risk of transmission to contacts, and therefore impacts on TB incidence over time.

The completion rate for treatment of LTBI – directly observed prophylaxis (DOP) – is the proportion of those recommended treatment who complete their prescribed course of chemoprophylaxis. However, there are some major limitations to this value, as presented in this report. Those given treatment of LTBI include contacts of active cases, in addition to persons with LTBI identified through screening. Data on completion among both these groups will be collected in the future, in order to evaluate contact investigations and screening programs separately. Furthermore, the percentage of individuals with positive tuberculin skin tests (TSTs) who are recommended treatment of LTBI varies greatly between Regions, meaning high compliance in a Region may hide the fact that few individuals with positive TSTs were actually recommended chemoprophylaxis. Compliance with treatment of LTBI has been recognized as a problem in several Regions, and strategies to improve screening and DOP effectiveness are needed.

4.1. Pacific Region

Table 4.1 Treatment completion, Pacific Region (1991-1999)

Outcome	Year								
	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. of reported active cases	15	57	19	17	14	11	18	13	9
DOT completion (%)	100	96	94	71	83	50	83	78	33

Table 4.2 Contacts, treatment of LTBI, and BCG coverage, Pacific Region (1996-1999)

Outcome	Year			
	1996	1997	1998	1999
Contacts per case	24	21	10	34
Number of individuals recommended treatment of LTBI	13	85	52	8
Completion of treatment of LTBI (%)	69	59	50	50
BCG coverage (%)[a]	90	35	31	25

[a]coverage for 1996 reported by Region; coverage for 1997-1999 estimated by dividing total number of infants receiving vaccine by total population < 1 year in Pacific Region

TB control services in Pacific Region are administered by the B.C. Centre for Disease Control (CDC). The on-reserve TB notification rate in Pacific Region decreased from 76.2 to 32.3 per 100,000, and from 9 times to 3.5 times the provincial rate between 1990 and 1999. These achievements are noteworthy, although a high prevalence of infection remains in many communities, and TB cases continue to be reported in 2000. Another concern in Pacific Region is the urban Aboriginal TB problem. The CDC is also responsible for TB control in this population, which is at high risk of developing TB, and more likely to have risk factors for HIV infection. The potential for migration of individuals with TB from urban areas to First Nations communities should be monitored closely in all Regions.

From 1997 to 1999, 8.8% of contacts of active TB cases were household ("first circle"), 52.8% were non-household ("second circle"), and 38.4% were casual ("third circle") contacts. Data on treatment of LTBI outcomes from Pacific Region were also analyzed. From 1997 to 1999, 55% of individuals given DOP completed therapy. Of those who did not complete therapy, 46% were uncooperative, 38% experienced side effects to INH, and 11% were classified as "other." The latter individuals were likely taken off treatment of LTBI by private physicians, without consulting the TB control program. Recognizing the need to address low compliance with DOP among adults, control program staff in this Region are developing a module to educate people on the importance of treatment of LTBI.

Table 4.1 shows an unusually low DOT compliance rate (33%) for 1999. This can be attributed to a total of only 9 on-reserve cases in the Region, three of which died within days of diagnosis, and 2 of which were discovered on autopsy. The other person whose completion remains unknown did not receive DOT, due to the refusal of community health staff to provide it.

4.2. Alberta Region

Table 4.3 Treatment completion, Alberta Region (1991-1999)

Outcome	Year								
	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. of reported active cases	10	57	17	20	17	13	19	17	28
DOT completion (%)	77	93	76	70	61	85	85	100	92

Table 4.4 Contacts, treatment of LTBI, and BCG coverage, Alberta Region (1996-1999)

Outcome	Year			
	1996	1997	1998	1999
Contacts per case	138	29	35	17
Number of individuals recommended treatment of LTBI	81	245	237	294
Completion of treatment of LTBI (%)	45	33	24	n/a
BCG coverage (%)	60	54	49	n/a

In May, 2000, Alberta Region began working with a core group of community health nurses (CHNs) to increase the skills, knowledge and networking among health professionals at the community level. This group, called "CHNs for the Elimination of Tuberculosis," has three main objectives: 1) to facilitate increased community involvement in TB elimination activities through mentor-ship; 2) to strengthen standards and skills related to the TB program through continuing education and skill dissemination; and 3) to increase community TB program evaluation through participation in research.

BCG coverage in Alberta Region varies widely by treaty area in Alberta Region.[1] An analysis of BCG vaccination in 1998 revealed coverage in the Treaty 6 area ranged from 16% to 88%, and in Treaty 7 from 54.5% to 88%. In those

[1]First Nations communities in Alberta can be divided into three main Treaty areas: Treaty 6, 7 and 8.

communities offering BCG, coverage ranged from 21% to 100%, with an average of 48.8% for the entire Region. Thirteen communities did not offer BCG at all.

It has been recognized that DOP completion is a major concern in Alberta Region. A research study on the socio-cultural factors influencing TB prevention and treatment has been funded by FNIHB, in order to obtain information that may help to design more effective intervention strategies in the future. Interviews are being conducted with patients with active TB, people receiving treatment of LTBI, and people who have refused treatment of LTBI. The results from the interviews are analyzed for themes, to identify knowledge, attitudes, and beliefs related to TB infection and disease, and TB control activities. Preliminary results indicate that more information on TB is needed at the community level, to educate people on the importance of treatment and prophylaxis. It appears that side effects of medications, and the inconvenience of taking the regimens for long periods of time, are the main deterrents to completion of therapy. Individuals who complete therapy do so because they believe in the efficacy of the medication, meaning they have an understanding of TB, and the need to treat the disease, as well as latent infection (Cave, 2000). The latter finding underlines the need to educate people on why they are taking medications, particularly among those who receive DOP and do not feel sick.

Data from school-based screening activities show that skin test positivity among children is low, and not many TB cases are found through screening. Despite this, 26 cases occurred in the 0-14 age category between 1990 and 1999. This has led the Region to evaluate the need for school-based screening, and determine that more enhanced screening is needed among adults in high-risk communities.

4.3. Saskatchewan Region

Table 4.5 Treatment completion, Saskatchewan Region (1991-1999)

Outcome	Year								
	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. of reported active cases	103	56	64	51	65	55	68	47	72
DOT completion (%)	96	98	96	92	95	96	84	95	93

Table 4.6 Contacts, treatment of LTBI, and BCG coverage, Saskatchewan Region (1996-1999)

Outcome	Year			
	1996	1997	1998	1999
Contacts per case	22	22	29	n/a
Number of individuals recommended treatment of LTBI	233	205	247	173
Completion of treatment of LTBI (%)	96	95	96	91
BCG coverage (%)[a]	32	48	46	48

[a]BCG coverage among infants < 1 year

Direct TB services are now delivered by three central authorities in Saskatchewan Region, which cover the northern, central, and southern areas of the province. This change led to some instability at first, such as a significant decrease in screening activities in 1998. Functions such as drug procurement and supply, case management, and TB registry and surveillance activities remain centralized at the Regional level. The program works in collaboration with FNIHB Region, the University of Saskatchewan, and Saskatchewan Health.

In the northern area, the TB nursing program was transferred to a tribal authority in 1998-99, and a TB coordinator has been hired. Although it was difficult for central TB control in the Region to let go of many functions it previously had, the reorganization has been relatively successful.

In Saskatchewan Region, there is a heavy emphasis on school-based screening activities, largely due to very high pediatric TB rates in the late 1980s and early 1990s. The program has become very efficient in detecting TB infection and primary disease among First Nations children, and achieves a very high rate of compliance with chemoprophylaxis in this group.

4.4. Manitoba Region

TB control services are delivered almost exclusively by the Sanitorium Board of Manitoba in this Region. In recent years, several large outbreaks have occurred, particularly in northern, remote communities. These outbreaks have necessitated extensive chest x-ray surveys and contact investigations, in 4-5 communities per year from 1995 to 1999. This places a great strain on time and resources, both of which are currently limited.

Detailed data on treatment of LTBI and BCG coverage were not provided by the Region. However, it was reported that 95% of infected contacts of active TB cases given DOP in 1999 have completed treatment.

The need to develop a strategy for targeted screening and treatment of latent infection in northern endemic communities has been recognized, and a blueprint for elimination in these areas is being developed. In the past, school-based screening has not been done in Manitoba First Nations communities. The Region is currently planning a pilot screening project in several endemic communities, to address this issue.

Table 4.7 Treatment completion and contacts, Manitoba Region (1991-1999)

Outcome	Year								
	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. of reported active cases	25	15	20	35	27	21	19	28	62
DOT completion (%)	68	n/a	78	51	81	63	93	96	95
Contacts per case	n/a	n/a	n/a	n/a	n/a	12	97	78	62

4.5. Ontario Region

TB control in Ontario Region is decentralized to the Zone level, and control programs currently operate in Siouz Lookout Zone, Thunder Bay Zone, and Southern Ontario Zone. Unlike the western provinces, provincial services are not relied upon in a systematic way. If an individual who lives primarily on reserve is diagnosed by a physician off reserve, a FNIHB or First Nations nurse in the community is generally notified by the physician or local public health authorities. The community health nurse then notifies the Zone TB nurse who plans DOT and contact investigation activities. All case management is done by one physician, who speaks with local physicians to ensure proper drug regimens are prescribed.

A very high proportion of First Nations TB cases in Ontario occur in one Zone (76% between 1996 and 1999), and most cases in that Zone have occurred in only five communities. The need to organize enhanced screening, treatment and education in these communities is currenly being addressed. Data from this area indicates that adherence to DOP is quite high, when compared to other Regions that regularly give DOP to adults in addition to children.

As indicated in Table 4.9, there was a significant decline in BCG immunization of infants from 1998 to 1999 in northwestern Ontario. This can be attributed to several factors, including the closure of obstetrical services at Sioux Lookout Zone hospital. The closing led to the diversion of clients to different area hospitals, only one of which administers BCG to First Nations and Inuit infants. The next destabilizing factor has been the exodus of experienced community health nurses from Zone communities, who were diligent about post-natal follow-up to ensure vaccination in the past. A remarkably high rate of nursing staff turnover has occurred in northwestern Ontario in recent years.

Table 4.8 Treatment completion, Ontario Region (1991-1999)

Outcome	Year								
	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. of reported active cases	9	22	15	12	8	23	4	12	12
DOT completion (%)[a]	78	85	92	42	43	96	100	100	100

[a]figures for 1997-1999 are from Sioux Lookout Zone only

Table 4.9 Contacts, treatment of LTBI, and BCG coverage, Ontario Region (1996-1999)[a]

Outcome	Year			
	1996	1997	1998	1999
Contacts per case	17	11	17	18
Number of individuals recommended treatment of LTBI	222	n/a	n/a	n/a
Completion of treatment of LTBI (%)	79	71	67	77
BCG coverage (%) in northwestern Ontario	98.5	95	85	45

[a]figures for 1997-1999 are from one Zone (in northern Ontario) only

4.6. Quebec Region

TB control services in most Quebec First Nations and Inuit communities are delivered by provincial or transferred health authorities. However, the Region does work with these authorities when necessary, and remains responsible for TB control in several non-transferred communities.

An outbreak of 3 cases occurred in a transferred community in 1999. All cases received adequate treatment, and a contact investigation was done. Quebec Region is currently supporting a school-based screening initiative in the Inuit communities of northern Quebec. Prophylaxis will be given to children with latent infection, and the annual risk of infection in this cohort will be estimated.

4.7. Atlantic Region

As shown in section 3, TB incidence in Atlantic Region appears to be quite low, although the Region has sporadic reported cases of active TB. Most of the cases occur in the same communities over time, and most are older adults who have relapsed TB due to inadequate treatment in the past. BCG has not been given in the Region since the 1970s, and it is believed the risk of infection in children is very low.

The Region has decided to develop a model protocol for elimination in communities where TB remains endemic. This protocol will be tested in one community this year, and implemented in another next fiscal year. Chart reviews of individuals born before 1960 will be conducted to identify former cases, and targeted screening for LTBI among older adults in the community will be done. A fair amount of education of community members and health professionals will be needed, because TB is rare and people may not understand the need for skin testing and DOP, etc. The concept of elimination must be understood by all those involved.

Because a centralized system for TB drug supply is not feasible in Atlantic Region, a system has been developed to notify the Region of TB drug claims payed by FNIHB non-insured health benefits (NIHB). Claims for single drugs, and combinations of drugs, by age and band number, will be reported to Headquarters and the Region, so that community health nurses in the area can be notified. No personal information will be made available by NIHB, to ensure confidentiality. This system will help find patients diagnosed and treated by physicians off reserve, and serve to identify those patients who may be receiving inappropriate drug regimens. The information is required by the Region, because FNIHB

and First Nations health authorities are responsible for communicable disease control on reserve, and must know about all cases of disease.

4.8. Method of detection

Figure 4.1 shows clearly the majority of individuals with active TB are found by presenting themselves to clinicians with symptoms of the disease. However, more cases proportionately are found through contact investigations in First Nations communities than in the rest of the population. This likely reflects the greater frequency of outbreak situations in First Nations communities, and the ability to make links between cases and contacts in small, isolated communities. The percentage of total cases found through routine screening is quite low in most Regions, with the exception of Saskatchewan.

Table 4.10 contains Regional policies for screening children and high risk groups. Some school-based activities have changed since the last report in 1999 (Medical Services Branch, 1999). Policies were taken from Regional and provincial TB control manuals.

Figure 4.1 Method of detection of TB cases (1990-1998)

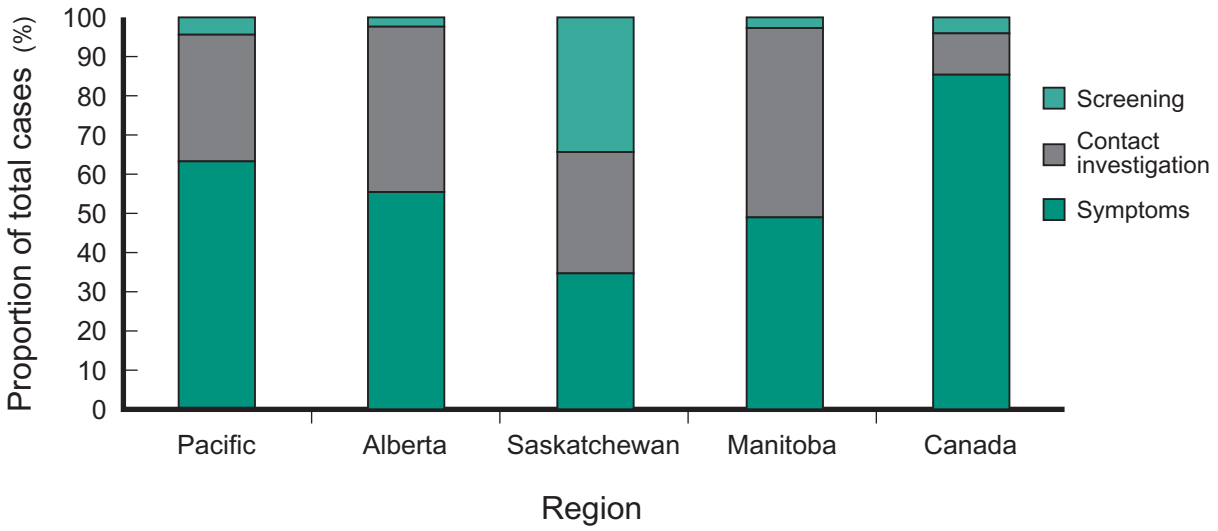


Table 4.10 Current Regional screening activities for schoolchildren and high-risk groups

Region	Groups screened
Pacific	Grades 1 and 6, every 2 years; detox centre residents, after admission; school staff in select areas of high incidence; patients and employees in licensed community care facilities
Alberta	Grades 1 and 6, annually; health care workers, annually; alcohol and drug counselors, teachers, daycare workers, and social workers; detox and rehabilitation centre residents, pre-admission; long-term care facilities; targeted testing of community members with HIV, diabetes, renal failure, and other high-risk medical conditions
Saskatchewan	Baseline at 2-3 years; kindergarten; grades 2, 4 and 6, annually; long-term care facilities, on admission and annually; occasional chest x-ray surveys in communities with clusters and outbreaks
Manitoba	Chest x-ray surveys in endemic communities; school-based screening pilot project beginning next year
Ontario	Age 4 and 14 years; screening of homeless in Sioux Lookout Zone; persons with diabetes, renal failure, and other high-risk medical conditions considered for chemoprophylaxis
Quebec	Region is funding school-based screening project in Nunavik
Atlantic	No screening currently; planned chart reviews and targeted testing of adults in endemic communities

4.9. Contact investigations

In 1996, positive TST results among contacts of active TB cases varied widely between Regions, as Table 4.11 shows. The proportion of positive contacts was particularly high in Saskatchewan (57%). DOP completion ranged between 56% and 94%. However, the proportion of individuals with positive skin tests who were given DOP was low in some Regions, and very low in Saskatchewan. This does not necessarily reflect the number of positive contacts given chemoprophylaxis in Saskatchewan, as DOP is primarily given to individuals aged less than 15 years, while those aged 15 years or more usually take their medications self-administered. The ability to give DOP to adults during a large contact investigation is limited by available resources and commitment of adults to complete treatment of LTBI. However, the implications of not providing DOP to such a high number of positive adult contacts should be considered, as an adult convertor has a 5-14% probability of breaking down to TB disease within one year of infection, and adults who break down are much more likely to develop infectious, pulmonary TB (Sutherland et al., 1982; Vynnycky and Fine, 1997; Dye et al., 1998). The problems with adult DOP compliance which may discourage its use present a major challenge to all Regional TB programs.

Table 4.11 Results of contact investigations, by Region (1996)

Outcome	Region					
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Total
Contacts	191	1,796	1,103	226	342	**3,658**
Contacts per case	24	138	22	12	17	**32**
Tested n	186	1,726	905	207	272	**3,093**
Positive TSTs	34	421	514	54	55	**1,055**
Positivity (%)	18	24	57	26	20	**34**
Number given DOP	13	81	16	9	46	**165**
Proportion of positives given DOP (%)	38	19	3	17	84	**16**
DOP completion (%)	69	56	94	89	91	**72**
Active TB	1	7	3	0	4	**15**

4.10. Adverse reactions to BCG

Policies on BCG use were reviewed after three infants were diagnosed with disseminated BCG infection between 1993 and 1996. Two of the infants were born with genetic immunodeficiencies, and the other with HIV. Since BCG is a live vaccine, there is a risk of disseminated infection in children who are immunocompromised. All three infants died, although two had multiple pathogens and the extent of BCG-related morbidity terminally was unknown in one (Scheifele et al., 1998).

The protective effect of BCG against TB meningitis and miliary TB in children makes it difficult to recommend discontinuing the use of the vaccine in areas of high disease incidence (Rodrigues et al., 1993).

Table 4.12 Adverse reactions to the BCG vaccine, by type of reaction, in Pacific, Alberta, Saskatchewan, and Ontario (1996-1999)[a]

Reaction	Year			
	1996	1997	1998	1999
Adenitis	4	6	6	6
Ulceration / swelling / abscess at injection site	2	1	0	2
Marked lymphadenitis	12	2	2	2
Suppurative adenitis	0	0	0	1
Disseminated BCG infection	0	1	0	0
Other	0	2	0	0

[a]data for Manitoba Region unavailable

5. TB outbreaks

The term "outbreak" refers to a greater than expected number of active TB cases in a given area over a defined time period. TB outbreaks in First Nations communities occurred in all of the FNIHB Regions during the 1990s (FitzGerald et al., 1996; Medical Services Branch, 1999; Raftery et al., 2000, personal communication with FNIHB Atlantic Region, 2000). These outbreaks contribute substantially to the high incidence rates experienced in some Regions. For example, 40% of the total cases occurring in 1999 occurred in only 5 communities. Furthermore, outbreaks in endemic areas often recur in the same communities over time. These communities, and these endemic areas, should be targeted in the future with aggressive screening, DOT, and treatment of LTBI.

Many factors contribute to hyperendemicity of TB in a community, and to the eventual occurrence of large outbreaks. Smear positive incidence, frequency of communal events, quality of housing conditions, community size, and delays in diagnosis are all possible factors affecting the likelihood of a TB outbreak in a community.

5.1. Molecular epidemiology

Patterns of transmission in a TB outbreak can be evaluated using genetic fingerprinting. This process, called restriction fragment length polymorphism (RFLP) analysis, identifies which cases in an outbreak were infected by the same strain of *M. tuberculosis*, indicating highly probable epidemiological links between individuals (Kulaga et al., 1999). "Clusters" of TB cases have been defined as 2 cases with the same RFLP fingerprint. Results from an evaluation of positive TB cultures from western Canada show that clustering tends to occur more among Aboriginal people than in the rest of the population. It was found that 42% of cases among Aboriginal people are due to the effects of clustering, whereas the proportion in the non-Aboriginal population is less than 12% (FitzGerald et al., 1997; FitzGerald et al., 2000). Although it is possible that Aboriginal people are genetically predisposed to clustering, the multiple risk factors for outbreaks in many First Nations communities makes this almost impossible to confirm.

In Alberta, one community alone had 13 cases in 1998 and 17 cases in 1999. Fourteen isolates were analyzed from this community from 1998 to 2000, using RFLP. Results showed that 11 of 14 cultures had the same fingerprint, and were all linked to the index case in the outbreak. Another isolate was linked to a case reported in another community, and one had a previously unidentified pattern. Because this community was remote, the provision of DOT and contact tracing presented many challenges. For example, the nearest medical facility equipped for radiographic screening was an hour and a half away by vehicle (Raftery et al., 2000). This community is classified as "semi-isolated" by FNIHB, meaning there is road access, but the nearest physician services are more than 90 km away.

5.2. Remoteness

Analyses at the national level indicate that active TB is more prevalent in remote First Nations communities (Table 5.1). Significantly higher TB rates were experienced in remote isolated, isolated, and semi-isolated communities than in non-isolated communities. Although this is not sample data, 95% confidence intervals were calculated to estimate whether differences were significant. The following criteria are used to categorize communities into the four isolation types identified in Table 5.1:

- Remote isolated (type 1): no scheduled flights, minimal telephone and radio, no road access
- Isolated (type 2): flights, good telephone service, no road access
- Semi-isolated (type 3): road access greater than 90 km to physician services
- Non-isolated (type 4): road access less than 90 km to physician services

The fact that active TB occurs more often in remote communities puts a considerable strain on program resources, as treatment, contact tracing, and other control activities involve a great deal of traveling, and transport of equipment. Furthermore, health facilities in these communities are often more likely to experience a high rate of staff turnover, thereby increasing the probability of late diagnosis of TB, and predisposing the community to spread of the disease and an outbreak situation.

In 1999, 2 communities alone contributed to 53% of TB cases in Manitoba Region. Both of these communities are isolated, meaning they have no road access. An outreach nurse and DOT worker were hired to deal with the larger of the two outbreaks, which involved 22 cases. Only 2 of the cases were pulmonary, smear positive cases, and 96% of the cases were between the ages of 13 and 38. Three people, including the two index cases and an individual with TB meningitis, were medically evacuated to a hospital. DNA fingerprinting indicated the strain from this outbreak is identical to one that caused a smaller outbreak of 4 cases in 1994.

Table 5.1 Active TB notification rates by degree of isolation (1997-1999)

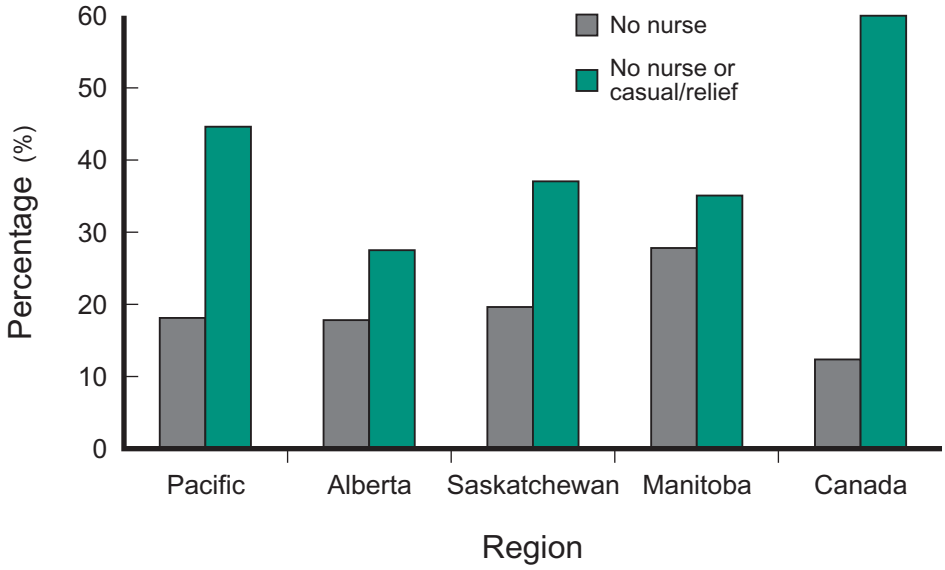
Outcome	Remote isolated	Isolated	Semi-isolated	Non-isolated
Total number of cases	12	180	79	136
Total person-years	18,993	200,910	88,689	678,786
TB notification rate (per 100,000)	63.2	89.6	89.1	20.0
95% C.I.	27.4, 98.9	76.5, 102.7	69.4, 108.7	16.7, 23.4

5.3. Health worker shortages

FNIHB vacancy reports indicate that vacancy rates for nursing positions in remote First Nations communities in Manitoba ranged from 24% to 32% from January to May, 2000 (Fig. 5.1). If the vacancy rate were to include communities serviced by casual or relief nurses, who often remain in the community 2 to 3 weeks at a time, vacancy becomes 29% to 40%. These figures are extremely important, considering the very high potential for delays in case finding and reporting in communities lacking a community health nurse.

If an adequately trained health professional is not present in a community to make an initial diagnosis and report the case, the disease can be spread to others before a sufficient preventive intervention is even considered. It can take a year or more of visits and phone calls from TB program staff before a community health nurse is comfortable and competent with the Regional program. Therefore, adequate protection of the health of a community is extremely difficult to achieve if the turnover rate for nursing positions in the community is high.

Figure 5.1 Nursing shortages in remote communities, expressed as percentages (January – May, 2000)



5.4. Transfer

Transfer is a process that gradually moves control of resources and responsibility for community health services and programs into the hands of First Nations and Inuit communities. This process involves the transfer of knowledge, capacity and funds so that communities can manage and administer their own resources. Although this is a necessary and positive development, it can impact on the effectiveness of mandatory programs such as communicable disease control at the community level.

In Pacific Region, many new nurses in transferred communities lack a community health background, and are at the same time isolated geographically. With new facilities being built, considerable time is needed for stocking basic supplies. Four instances have recently occurred in which patients on TB medications

lived in communities with no community health nurse. Other concerns include mixed messages given to clients by nurses regarding DOP and BCG vaccination. If a nurse is unaware of what TB program policies are, and why they exist, a client may be misinformed or become confused. In Pacific Region, this has resulted in the rejection of INH chemoprophylaxis.

Many positive aspects of transfer have been observed as well. For example, although transfer of services in Saskatchewan has been a challenging process, many aspects of TB control have been implemented effectively by First Nations-controlled health authorities. The process of transfer is happening to some degree in most First Nations communities, meaning FNIHB must make an effort to ensure the integrity of TB control at the community level is maintained.

5.5. Housing and socio-economic conditions

Since TB is primarily spread from person to person through respiratory droplets, it is logical to assume that poor, overcrowded housing conditions would increase the probability of transmission. The association between overcrowded housing and TB incidence, pediatric TB, and TB mortality has long been recognized (Reinhard et al., 1997; Elender et al., 1998; Hawker et al., 1999).

Major housing problems have been identified in First Nations communities in Canada. In 1997/98, only 54% of housing units on reserve were considered "adequate," meaning they did not require any minor or major renovations or replacement (Department of Indian Affairs and Northern Development, 1999). Given these housing problems, and higher rates of TB in the Aboriginal population, it was decided to analyze the relationship between community housing densities and TB incidence. Housing densities from the 1996 census were obtained from Indian and Northern Affairs Canada, and TB cases by community and year were provided by the FNIHB Regions for the period 1997-1999. TB data was available from 95% of First Nations communities in the 7 Regions, including 12 communities in Quebec. Of these 602 communities, housing data was available for 474 (79%).

Figure 5.2 shows a relatively normal distribution of population by housing density, and a clear "dose-response" relationship between density and active TB incidence. Simple linear regression with housing density as a predictor of TB incidence was highly significant ($p < 0.001$). Notification rates and 95% confidence intervals were calculated for different strata of housing densities. The association was first analyzed for 1997 alone, because this is the year immediately after the year for which housing data is available (Table 5.2). TB by housing density was then analyzed for the full period of 1997 to 1999 (Table 5.3). All of these results indicate that TB is far more likely to occur in communities with higher levels of crowding. It is recognized that overcrowded communities may also be more likely to suffer from other risk factors for TB, such as poverty, substance abuse, remoteness, and various underlying medical conditions.

Figure 5.2 Total population and TB notification rate by community housing density (1997-1999)

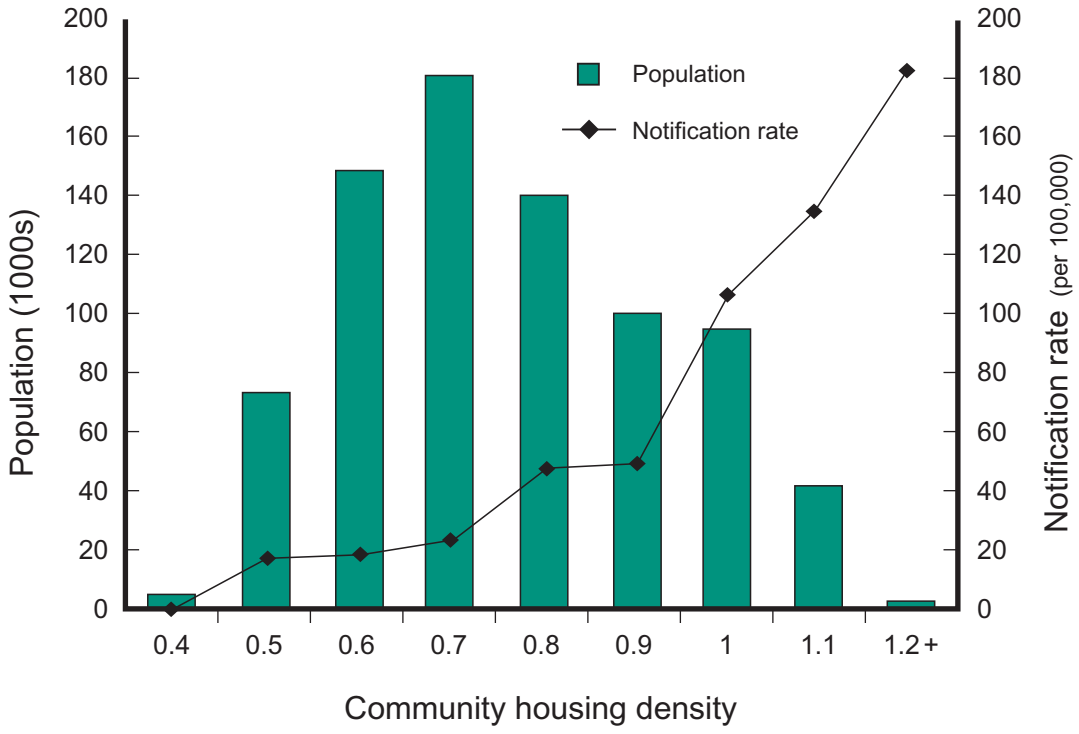


Table 5.2 TB notification rates by community housing density categories (1997)

Community housing density in 1996 (mean persons per room)	Population	Notification rate (per 100,000)	95% C.I.
0.4-0.6	75,805	23.7	12.8, 34.7
0.7-0.9	140,022	30.0	20.9, 39.1
1.0-1.2	46,911	83.1	57.0, 109.2
1.3+	3,691	433.5	221.1, 645.9

Table 5.3 TB notification rates by community housing density categories (1997-1999)

Community housing density in 1996 (mean persons per room)	Person-years	Notification rate (per 100,000)	95% C.I.
0.4-0.6	227,415	18.9	13.3, 24.6
0.7-0.9	420,066	39.0	33.1, 45.0
1.0-1.2	140,733	113.0	95.4, 130.5
1.3+	11,073	225.8	137.3, 314.3

In the Northwest Territories (NWT), transient lifestyle, overcrowding, unemployment, and other social conditions were found to influence the transmission of TB, and contribute to an ongoing outbreak of 50 active cases and 146 converters in 1995. This large outbreak also led to one case and 8 reactors/converters outside the NWT (White and Heinzig, 1998).

In Ontario, five communities have had repeated outbreaks throughout the 1990s. These hyperendemic communities, all located in northwestern Ontario, have driven the on-reserve TB rate in Ontario Region upwards. Together, they represent only 4.2% of the total on-reserve population of Ontario. The persistence of TB in these communities provides a reservoir for spread to others as people migrate to Manitoba and other parts of Ontario. Although many risk factors for TB disease progression are present in these communities, they do not seem to differ substantially from other parts of northern Ontario in that regard. The reason for this hyperendemicity needs to be further investigated.

These analyses, along with anecdotal information from the Regions, show strongly that hyperendemic communities exist, in which a large pool of infection and multiple risk factors contribute to a cycle of TB outbreaks over time. It is also apparent that TB rates vary considerably in different areas within the same Region, and analyzing the local epidemiology of TB in each Region is necessary. Hyperendemic communities must be the focus of intense efforts to control and prevent TB in the future, including enhanced case finding, treatment, screening of high-risk groups, and treatment of LTBI. In the coming fiscal year, the process for Regions to request budget allocations from National Headquarters will be standardized. As part of this standard request, each Region will be required to submit a work plan. In Regions with high incidence, a clear plan for eliminating TB infection and disease in endemic communities will be required. The magnitude of funding allocations to a particular Region will be dependent upon both the epidemiologic situation, and the Region's plan for elimination.

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Appendix A. Screening: a framework for discussion

A.1. Background

The following recommendation was made at the National Consensus Conference on Tuberculosis in 1997:

> "Because of high rates of tuberculosis among Aboriginal peoples, regionally appropriate screening guidelines must be developed, implemented, and evaluated" (Health Canada, 1998).

Similar recommendations were made by the MSB Advisory Group for the Elimination of Tuberculosis (MAGET):

(A) It is recommended that MSB through MAGET develop screening guidelines to determine when screening for TB should be utilized in Aboriginal communities, and preferred methods for screening, the appropriate age and risk groups to be tested and the optimal interval for screening.

(B) It is recommended that Regional screening programs be evaluated on a regular basis and include a review of the following: compliance with screening, rates of positivity and conversion, rates of case finding and compliance with treatment including chemoprophylaxis (Medical Services Branch, 1999).

These recommendations have led to considerable discussion among members of the TB Working Group about screening policies in the FNIHB Regions. It has been recognized that Regions with similar TB problems may have different screening policies, and that more evidence-based thinking is required to implement and evaluate screening activities. The information and recommendations included in this section are intended to assist in the development of Regionally appropriate screening guidelines for use in the field.

Screening for a disease involves the examination of asymptomatic individuals in order to classify them as likely or unlikely to have the disease. The objectives of this activity are to call attention to those individuals likely to have disease before symptoms appear, provide early treatment to these people, and reduce morbidity and mortality from the disease (Morrison, 1998).

Mass screening is not recommended in populations with a low prevalence of TB. Results from a WHO-sponsored study evaluating mass screening in Czechoslovakia (Styblo et al., 1967) in the 1960s indicated definitively that mass screening is neither sufficiently accurate nor cost-efficient, and that the majority of infectious TB cases presented themselves to health services during the interval between regular screening examinations (Enarson, 1998b). Furthermore, costly screening activities may divert limited program resources from essential TB control activities, such as case finding and treatment.

It is for these reasons that screening is recommended for high-risk groups only. The tendency of TB disease to be concentrated in younger age groups in the First Nations population indicates a high rate of recent transmission from infectious adults. Although

continued screening of children at risk is needed for this reason, the infectious adults who spread the disease must also be considered. Adults in the high-risk groups described below, particularly those living in communities where TB is endemic and where cluster outbreaks have occurred, should be actively sought and screened for TB.

A.2. High-risk groups in First Nations communities

The following groups should be considered for systematic screening in First Nations communities:

- Close contacts of individuals with known or suspected active TB;
- Persons with HIV infection;
- Persons with a history of active TB who have not received adequate therapy;
- Persons who are poor, especially the homeless;
- Staff and residents of long-term care facilities and lodges;
- Those at risk for occupational exposure, especially health care workers;
- Those with the following medical conditions: diabetes mellitus; chronic renal failure; immunosuppression; and silicosis;
- Those at risk for TB who work in settings where they may infect infants or immunosuppressed individuals;
- Alcoholics and injection drug users

A.2.1. Close contacts

A contact investigation should always follow the diagnosis of TB. All contact tracing should begin within 7 days of the index case report. Among individuals whose tuberculin status is unkown or previously recorded as negative, a tuberculin skin test (TST) should be done. Those with positive tests should undergo chest radiography and sputum culture within 30 days of the index case report (Health Canada, 1998).

A.2.2. Persons with HIV infection

The risk of developing TB among persons with HIV/TB co-infection is very high. It has been estimated that 36-80% of HIV-positive individuals with TB infection will develop progressive, primary TB within one year of infection, compared to 5-14% of HIV-negative individuals with TB infection (Dye et al., 1998). Screening is therefore strongly recommended for all HIV-positive individuals. Tuberculin skin tests (TSTs) and/or chest x-rays should be done as early as possible in the course of the HIV infection, due to possible interference with the sensitivity of both these methods by HIV-related immunosuppression.

Although the limited data available suggest a low rate of on-reserve co-infection, the proportion of new AIDS cases and positive HIV test reports attributed to Aboriginal persons in Canada is increasing (Health Canada, 2000b). Community health nurses, TB nurses, TB workers, and other TB program staff should be aware of the HIV trend in their Region and community. It is also important to inform health care workers involved in HIV/AIDS control of the need to screen seropositive individuals for TB.

A.2.3. The homeless and underhoused

The homeless in First Nations communities may frequently spend time outside the community, making it difficult for the TB program to track them if they are infected with TB. Because many of these individuals are likely to return to the community, possibly with infectious TB, they can impact on the health of that community whether or not they are within the boundaries of FNIHB service delivery. It is therefore important to either make an effort to track these persons outside the community and provide preventive therapy, or to ensure that the provincial TB program is doing so.

A.2.4. Long-term care facilities and lodges

Detailed procedures for screening patients for TB in long-term care facilities are provided in the Canadian Tuberculosis Standards (CLA et al., 2000).

A.2.5. Occupational exposure

Community health nurses, TB nurses, TB workers, and other TB program staff who have regular direct patient contact in TB endemic communities, and/or work in a facility where patients with active TB are admitted, must be screened for TB regularly using a TST. Housekeepers, clerks and maintenance staff working in facilities with increased rates of TST conversion should also be screened.

Results from a study on tuberculin reactivity among health care workers (HCWs) servicing Aboriginal communities in British Columbia, Alberta and Saskatchewan indicate the rate of positive TST results is high (Fanning et al., 1998). The study found that 48.5% of HCWs participating in the study were skin test positive (≥ 10 mm induration), although BCG was strongly associated with positivity ($p < 0.001$). Seventy-five of the 97 reactors had received BCG. It was found that those HCWs aged 35 years or more, and those who were Aboriginal, were more likely to be positive. Univariate analyses showed that "years worked with the Medical Services Branch" was associated with positivity, although this did not appear in the results of logistic regression analyses. The positivity rate was particularly high in Saskatchewan (60.5%), and lowest in British Columbia (38.5) (Fanning et al., 1998). Despite the confounding effects of BCG on these results, this study provides evidence of the need for screening of HCWs in First Nations communities where TB is endemic.

A.2.6. Diabetes mellitus and renal failure

It has long been known that diabetes mellitus is a risk factor for progression to active TB (Root, 1934). In fact, it was recently estimated that risk for TB associated with diabetes was as high as that for HIV among Hispanics aged 25 to 54 in the United States (Pablos-Méndez et al., 1997). Due to the high prevalence of type 2 diabetes among First Nations people, HCWs providing services to persons with this disease should be made aware that these individuals are at increased risk for TB. The age-adjusted prevalence of diabetes in First Nations communities is 3.3 times higher among males and 5.3 times higher among females than the corresponding values for the entire Canadian population (Young et al., 1999). The prevalence of diabetes in TB endemic areas should be assessed by Regional TB programs, and systematic screening should be considered in high-risk communities.

Chronic renal failure/hemodialysis is a risk factor for the development of active TB among persons with TB infection. Unfortunately, it is also a complication of diabetes. One study has reported a relative risk of 25.3 (95% C.I. 22.9-31.5, $p < 0.0001$) for active TB in dialysis patients, compared to the general population

(Chia et al., 1998). Although this analysis was done with a total of only nine cases of TB in the dialysis patient cohort, these results should not be overlooked. Community health nurses, TB nurses, TB workers, and other TB program staff should actively seek patients with renal failure, particularly in TB endemic communities, and strongly recommend TB screening for these individuals.

A.2.7. Adults in endemic communities

In communities where TB is endemic, and cases of infectious, pulmonary TB are reported regularly from year to year, screening of adults should be considered. This is particularly important among adults who have been treated inadequately for TB in the past, and among adults who have one or more of the above risk factors for progression to active disease.

A.3. Components of screening

The following components of screening were adapted from the Canadian Tuberculosis Standards (CLA et al., 2000):

- Education and community outreach;
- Informed consent;
- Relevant history taking: history of BCG; contact with active TB; results of previous skin tests; previous TB treatment; symptom inquiry; and immunocompromising illness;
- Referral for clinical evaluation of clients who have positive skin tests or are immunocompromised;
- Directly observed preventive therapy (DOP), (or "directly observed treatment of LTBI") for all positive reactors who have not previously completed an adequate course of therapy, along with appropriate testing for isoniazid (INH) toxicity;
- Complete and accurate record keeping;
- Compilation of summary data for program evaluation;
- Ongoing staff training

A.4. Screening methods

A.4.1. The tuberculin skin test (TST)

A.4.1.1. Technique

The TST, also known as the Mantoux test, is used to diagnose LTBI. It consists of an intradermal injection of purified protein derived from *M. tuberculosis* bacilli, and will induce delayed-type hypersensitivity in persons who have developed cell-mediated immunity to these antigens. The reaction causes localized swelling and induration of the skin at the injection site within 48-72 hours. All tests should be read and interpreted by a health professional at 48-72 hours after administration.

A.4.1.2. Contraindications

The following individuals should not undergo tuberculin testing:

- Patients with severe blistering from tuberculin reactions in the past;
- Patients with documented active TB or a clear history of treatment for LTBI or active TB in the past;
- Patients with extensive burns or eczema;
- Patients with severe viral infections or live-virus vaccines (e.g. MMR) in the past month (patients with common cold may be tested)

Pregnancy, immunization with vaccines other than live-virus vaccines, and a history of BCG are not contraindications to tuberculin skin testing.

False negative reactions may also occur. Factors causing these are immunosuppression, human error (improper storage and preparation of antigen, poor injection technique, errors in reading and recording), and infections (especially viral infections).

A.4.1.3. Interpretation

Table A.1 Interpretation of a tuberculin skin test

Reaction size (mm induration)	Setting in which reaction indicates probable TB infection
<5	HIV infection AND expected risk of tuberculosis infection is high Should only be considered in the presence of immunosuppression
5-10	HIV infection Close contact with infectious TB case Abnormal chest x-ray with fibronodular disease
> 10	All other individuals

Adapted from CLA et al., 2000.

A.4.1.4. Positive predictive value

The positive predictive value (PPV) of a screening test is the proportion of people with a positive test result who actually have the disease. It is largely dependent upon the specificity of the test, and the prevalence of preclinical disease in the target population. The specificity of a test is the percentage of people without the condition who have a negative result, and false-positive tuberculin results reduce the specificity of the test. The TST is known to have a high specificity in populations with no other mycobacterial exposures or BCG vaccination. A decrease in specificity occurs in populations experiencing a high degree of cross-reactivity with other mycobacteria. The test is also influenced by the prevalence of tuberculosis infection, as indicated in Table A.2.

Table A.2 should be taken into account when deciding whether or not to screen using the TST. Prevalence of infection, BCG policies, and exposure to mycobacteria vary according to Region and community, meaning the PPV of tuberculin testing will likely differ across the country. Systematic screening using the TST should be reconsidered in areas in which the PPV is probably quite low.

Table A.2. Positive predictive value of a tuberculin skin test.[a]

Prevalence of infection (%)	Positive predictive value	
	Specificity of 0.95[b]	Specificity of 0.99[c]
90	0.99	0.99
50	0.95	0.99
25	0.86	0.97
10	0.67	0.91
5	0.5	0.83
1	0.16	0.49
0.1	0.03	0.1
0.01	0.002	0.09

[a]adapted from American Thoracic Society, 2000
[b]populations with high exposure to other mycobacteria
[c]populations with low exposure to other mycobacteria and no BCG

A.4.1.5. Booster phenomenon and two-step tuberculin testing

One week to a year after a TST is given, some individuals may have a reaction to a subsequent skin test in the absence of infection, due to recall of waned cell-mediated immunity. This phenomenon, known as the "booster effect," usually occurs in individuals exposed to other mycobacteria, or who have received BCG. The booster effect results in false-positive skin tests, if serial skin testing is done. A two-step method, in which individuals who test negative undergo a second TST one week later, may be considered in certain situations to prevent misinterpreting a boosted response as a conversion (Bass and Serio, 1981).

- The specificity of the TST is decreased by exposure to other mycobacteria and the use of BCG.
- Systematic screening using the TST should be reevaluated in populations with a very low prevalence of infection.

A.4.2. Chest x-ray

All persons over the age of 11 years applying for permanent residence in Canada must undergo chest radiographic screening for TB infection and disease. This method may be used to screen high-risk adults for TB in First Nations communities, particularly during a cluster outbreak.

Certain radiographic abnormalities have been associated with TB infection, although chest x-rays alone should not be used to diagnose TB infection or disease. One of the most significant problems associated with this method is that interpretation is highly variable among physicians.

A.5. Screening children and adolescents

A.5.1. To screen or not to screen

Surveillance and analyses of screening data should provide Regional TB control programs with the information they need to make decisions about school-based screening. The prevalence of infection, annual risk of infection, pediatric TB rates, and overall TB incidence need to be assessed regularly.

A.5.1.1. Comparison

Consistently higher rates of pediatric TB in First Nations communities compared to non-Aboriginal children in Canada have warranted screening of these children in the past. Since high rates of TB among children indicate a high degree of recent transmission, screening may be considered among high-risk adults in the same population. If the prevalence of infection and/or rate of pediatric TB are higher than in the rest of the population, school-based screening should be considered. Recommendations cannot be made at the national level, nor at the Regional level, on whether to screen First Nations children, because infection and incidence vary so much across the country. Decisions to screen groups of children should be based on local epidemiologic data (Advisory Council for the Elimination of Tuberculosis, 1995).

A.5.1.2. Infection and incidence rates

A high degree of variability exists between different groups of children, according to both ethnicity and geography. This is illustrated by the summary of results from Canadian urban centres, First Nations communities, and one Region of Nunavut in Table A.3.

In the past, it has been recommended that TB screening be considered for groups in which the annual risk of infection among children under 5 years is greater than 1% (Standards Committee of the Canadian Thoracic Society, 1996). BCG has been recommended for groups with the same risk value (National Advisory Committee on Immunization, 1999). It has also been recommended that screening be implemented in First Nations communities where the use of BCG has been discontinued (Medical Services Branch, 1999). Although the efficacy of BCG has been widely debated, case-control studies assessing use of the vaccine among First Nations infants in Manitoba and Alberta have shown protective effects of 60% and 57%, respectively (Young and Hershfield, 1986; Houston et al., 1990). It is also recognized that BCG has a significant protective effect against TB meningitis and miliary TB, which are severe, often fatal forms of the disease in children (Rodrigues et al., 1993). It is therefore reasonable to recommend screening in TB endemic communities that discontinue the use of BCG, due to the combined possibilities of decreased immunity and severe forms of pediatric TB.

TB control programs should analyze screening data regularly to calculate annual risk of infection. In order to do this, a satisfactory estimate of TB infection prevalence P among a cohort of BCG-negative individuals is needed. The annual risk R refers to the risk at calendar time $b + x$, where b is the year the cohort was born, x is the midpoint between 0 and a, and a is the age of the cohort at calendar time $b + a$. The following formula estimates annual risk of infection at the midpoint between year of birth and the year screening occurred (Rieder, 1995):

$$R_{b+a/2} = 1 - (1-P_{b+a})^{1/a}$$

Table A.3 Results of published school-based screening evaluations in Canada, and this report.

Publication/report	Setting	n	Infection (%)
Rothman and Dubeski, 1993	Outbreak investigation in Scarborough, Ontario schools	707	6.8 (all children); 1.2 (Canadian-born); 14.6 (foreign-born); 4.4 (conversion)
Yuan et al., 1995	Students from TB endemic countries and Aboriginal students in Toronto	720	22.5
Adhikari and Menzies, 1995	Grade 6 and 10 students, first-year health professional students, and workers aged 18-25 in Montreal	7,669	10.2
Stewart and Sheldrick, 1996	Students entering Ottawa-Carleton school from TB endemic countries	887	9.8
Strader, 2000	Kindergarten and grade 6[a], Baffin Island (1999-2000)	798	7.4 (all children received BCG as infants)
This report	Children aged 12 years, Pacific Region (1997)	315	1.3
This report	Children aged 12 years, Alberta Region (1997)	205	2
This report	Children aged 5-14 years, Saskatchewan Region (1997)	2,050	2.3
This report	Children aged 12 years, Sioux Lookout Zone (1997)	217	1.8 (all children received BCG as infants)
Smeja and Brassard, 2000	Cree children aged 12 years, Quebec (1997)	222	9.9 (all children received BCG as infants)

[a]also grades 1, 3, 5, 8, and 11 in two communities, and grades 3 and 10 in another.

High smear positive incidence in a population may also warrant school-based screening, due to the increased risk of transmission of the disease to children.

Evaluation of a school-based screening program in California indicated that screening all children is cost saving only if the prevalence of infection is 20% or more (Mohle-Boetani et al., 1995). This study estimated a compliance rate of 60% with preventive therapy, a value based on completion cards mailed by parents and the proportion of children for whom INH prescriptions were filled for 6 months. Such an estimation would not be necessary for FNIHB programs, which measure DOP completion rates. It is possible that screening groups with a prevalence of infection lower than 20% may be cost-efficient, if adherence to preventive therapy is greater than 60%.

Screening is indicated for groups of children who are subjected to the following:

- annual risk of infection > 1%;
- living in a community/area with high smear positive, pulmonary TB incidence (>50 per 100,000);
- prevalence of TB infection is 10-20% in targeted group, and > 60% DOP completion can be achieved;
- living in TB endemic community in which the use of BCG has been discontinued

A.5.2. Appropriate age and optimal interval for screening

Although some Regions currently use similar screening methods, there is considerable variation between Regions in terms of screening age and intervals. When making decisions on when to screen, TB program staff should consider the effect of age on opportunity for effective intervention. For example, adherence to DOP is often difficult with children over the age of 12 years. Some programs screen at school exit, despite the possible difficulties in tracking children to administer DOP when they are no longer in school. Screening at school entry is done in four FNIHB Regions, and can be considered a minimum standard for areas in which screening is indicated. Compliance with DOP is generally very high in this age group. Decisions on screening in subsequent years should be made by Regions, taking into consideration the local epidemiology of TB in children.

- In communities where school-based screening is indicated, it is recommended that children be screened at school entry as a minimum standard

A.5.3. Suggested process

The following process is used for school-based screening in First Nations communities by FNIHB and the Tuberculosis Program in Saskatchewan (Saskatchewan Health and the First Nations/MSB TB Committee, 1999):

- Consult with Community Health Nurse and Band for project approval and set dates;
- Acquire school lists and research current tuberculin status of community;
- Obtain informed, written consent from parents;
- Do pre-test teaching with students;
- Conduct tuberculin tests;
- Read and record all results in 48 hours;
- Send all results to TB Control;
- Inform appropriate health care worker and parent of significant results and proposed follow-up

A.6. Directly observed prophylaxis (DOP), or "directly observed treatment of LTBI"

For both ethical reasons and program effectiveness, DOP should be strongly recommended for all individuals with TB infection, and DOT for all those found to have active TB disease. Indeed, screening would not have a role if a preventive action did not follow. DOP as a strategy was designed to combat poor compliance rates, by having a health care worker or designate present to observe the patient taking all medication doses (Kohn et al., 1996).

Clinical trials have shown that INH chemoprophylaxis for 6 months is associated with a 69% lower incidence of TB in those receiving the drug, and one year of INH is associated with 93-97% lower incidence (Ferebee, 1970; International Union Against Tuberculosis Committee on Prophylaxis, 1982). Upon further analyses of these data, it has been recommended that nine months of INH be given for optimal protection (Comstock, 1999). If an individual cannot tolerate INH, or is believed to be infected with an INH-resistant strain, 4 months of rifampin may be given.

Recent evidence suggests that 2 months of daily rimfampin and pyrazinamide has the same effectiveness as 12 months of INH in HIV seropositive patients with LTBI (Gordin et al., 2000). The American Thoracic Society (ATS) and the Centre for Disease Control (CDC) have since released a recommendation that this regimen be used for HIV infected people with LTBI (ATS/CDC Statement Committee on Latent Tuberculosis Infection, 2000). Clear evidence on the effectiveness of this regimen in HIV seronegative individuals is currently unavailable, although the ATS/CDC group has recommended it as an acceptable alternative to 9 months INH. Given the low compliance rates to DOP in many FNIHB Regions, a 2-month regimen would be very useful if equivalency of treatments is established. Research into this area should be considered.

- All individuals diagnosed with TB infection should receive DOP
- Nine months of INH should be given to individuals with LTBI
- A 2-month regimen of daily rifampin and PZA should be given to HIV seropositive individuals with LTBI, and the effectiveness of this regimen in HIV seronegative people should be researched further.

A.7. Evaluation of screening programs

A.7.1. Screening and preventive therapy practices

The first measure for evaluating screening programs is the participation rate. For example, results from an evaluation by Yuan et al. (1995) indicated that only 42.9% of eligible students, meaning those who were born in a TB endemic country or who were Canadian Aboriginal, agreed to participate in a Toronto screening program. The skin test positivity in this study was 22.5%. If this was the prevalence of infection among all children eligible for the program, it can be assumed that many children with latent infection were missed. The percentage of all participants who have their test result read at 48-72 hours should also be calculated.

The second criterion for evaluation is the percentage of positive reactors who are given DOP, and the third is the percentage of positive reactors who complete the chemoprophylaxis. It has been shown that a high degree of provider noncompliance can significantly reduce the effectiveness of screening (Adhikari and Menzies, 1995). Centralized case management by TB medical consultants in the FNIHB Regions should prevent this problem, and all positive reactors should be given DOP. DOP compliance must be calculated, and any barriers to adherence should be recorded. This will help to develop strategies to improve compliance with preventive therapy regimens in the future.

A high DOP compliance rate will contribute to a decrease in the prevalence of infection, and increase the cost-effectiveness of screening. Mohle-Boetani et al. (1995) estimated that a 20% increase in adherence to therapy, from 60% to 80%, would be associated with a

$9157 decrease in cost per case of TB prevented. DOP was not used in this program. Results from a school-based program in New York City showed that compliance was 87.6%, and an estimated $100,000 in health care expenditures were saved, as a result of implementing DOP (Kohn et al., 1996). A study in Alberta concluded that completion rates must approach 50% in order to have any significant effect on TB incidence as well as show any cost benefit. The study also found that 80% DOP completion would reduce the number of cases per year in Aboriginal communities by 70%, and save the province $2 million in health care costs (Melenka et al., 2000).

Screening programs should be evaluated using the following indicators:

- Participation rate among eligible people;
- Percentage of participants who return to have test results read;
- Percentage of positive reactors given DOP;
- Percentage of positive reactors who complete their drug regimen, with a target of 85%

A.7.2. The impact of screening

The annual risk of infection is now recognized as perhaps the best index of improvement or deterioration of TB in a population (Sutherland, 1991). However, the value may be meaningless in Regions where the prevalence of infection is low. These Regions should probably consider whether screening is indicated at all. Although an initial increase in incidence may be expected from screening activities, due to increased case finding, it is hoped that screening will contribute to a long-term decline in TB incidence. TB incidence in areas where screening has been implemented should be evaluated over time. The percentage of people screened who are found to have active TB, and the percentage of active case notifications in the population found by screening, should also be evaluated.

The impact of screening should be evaluated using the following indicators:

- temporal trends in the annual risk of infection and disease incidence;
- percentage of people screened who are found to have active TB;
- percentage of active case notifications in the population found by screening

A.7.3. Cost-effectiveness analyses

The possibility that screening activities may divert limited money and resources from essential TB control activities such as case finding and DOT should be assessed regularly, with cost-effectiveness analyses.

Decision analysis

A decision analysis should be done to estimate the effects of different options, such as no screening, screening all individuals, or targeted screening activities. Using baseline assumptions derived from various data sources, the dynamics of TB in a population with and without the intervention can be assessed. Data sources may include the study itself, or the TB program database. Other parameters may have to be estimated from the medical literature, such as TB reactivation rates and secondary transmission. These variables are needed to predict the number of TB cases prevented by screening, and the probable health and economic consequences of not screening.

Cost estimates

Cost estimates should be obtained from financial records of program costs, hospitals, lists of provincial costs for health care, manufacturers of medical products, and/or from other health service providers involved in TB control. It should be decided whether or not costs such as lost earnings due to time missed from work should be included in the analysis.

The following formula (adapted from Weinstein and Stason, 1977) can be used to estimate net health care costs from an intervention:

$$\Delta C = \Delta C_{Rx} + \Delta C_{SE} - \Delta C_{Morb}$$

The first component, with subscipt Rx, includes all direct medical and health care costs. These may include screening (TST and/or x-ray costs), prophylaxis, treatment of active cases, hospitalizations, physician time, laboratory analyses, contact tracing and outbreak management, etc. The second component, with subscript SE, refers to the costs associated with adverse side effects of treatment, such as those resulting from INH therapy. The third cost, with subscript Morb, is expressed with a minus sign, because it refers to the cost savings associated with preventive activities. For the option of no screening, this would be equal to 0.

This formula should be applied to each screening option. Using data from the decison analysis and cost estimates, the outcomes in the box below can be derived. For a more detailed description of cost-effectiveness analysis, refer to Weinstein and Stason, 1977, or Detsky and Naglie, 1990. For examples of such studies done on TB screening, refer to Mohle-Boetani et al., 1995, and Schwartzman and Menzies, 2000. The incremental cost-effectiveness of different options should be assessed, in order to maximize the preventive potential of screening activities. Intuitively, it is probable that a targeted approach will be the most cost-effective. Therefore, it is recommended that various targeted screening strategies be included in the analysis, such as screening children, screening adults, screening high-risk adults, screening individuals with HIV, screening hyperendemic communities, etc.

Outcomes

Benefits = money saved from the prevention of TB by screening

Cost-effectiveness = program cost per case of TB prevented

Benefit-cost ratio = benefits / program costs

A.8. Record keeping

The collection and analysis of screening data is extremely important, both to identify epidemiologic trends and to evaluate screening programs.

The following information should be collected from each individual screened for TB using a TST:

- Community name;
- School name, if school-based screening;
- Grade, if school-based screening;
- Informed, written consent;
- Date of skin test;
- Result (mm induration);
- Name of person (last, first, middle, and maiden name if applicable);
- Date of birth;
- Gender;
- Band and Treaty number;

- BCG history (including age of administration, if positive);
- Date and results of previous skin tests;
- Reason for screening (e.g. high-risk group; school-based; etc.)

Information on treatment outcomes should also be collected. All of this data should be entered into a database at the Regional level, and analyzed regularly. Annual reports on skin test positivity and treatment outcomes should be generated, to provide the following information:

- Total number of people eligible for screening, by age;
- Total number of people screened, by age and BCG history;
- Total number of individuals with LTBI, by age and BCG history;
- Total number of active TB cases identified from screening;
- Percentage of people who return to have skin tests read;
- Percentage of people with LTBI given DOP;
- Percentage of people given DOP who complete therapy;
- Number of people screened, by reason for screening

Appendix B. Demographics of the First Nations, on-reserve population

A new methodology has been developed to estimate the First Nations on-reserve population. Because FNIHB and its First Nations partners are responsible for TB control on-reserve, it is essential to enumerate this population properly. In the past, figures provided by Indian and Northern Affairs Canada (INAC) have been used to calculate incidence rates for TB and other diseases. However, it is widely accepted that these data suffer from late reporting of births and deaths, missed reporting of births and deaths, and incorrect categorization of the residency of First Nations persons. These factors cause the underestimation of the pediatric population, particularly infants and very young children, and an overestimation of age-specific totals for older age groups.

To solve these problems, it was decided to use figures from the Community Workload Increase System (CWIS) to enumerate the on-reserve population. CWIS was created to obtain accurate, up-to-date population numbers for First Nations communities, in order to set health priorities, assess the need for resource allocations, and develop health programs. Community population figures are updated annually, and the rate of growth is analyzed over time.

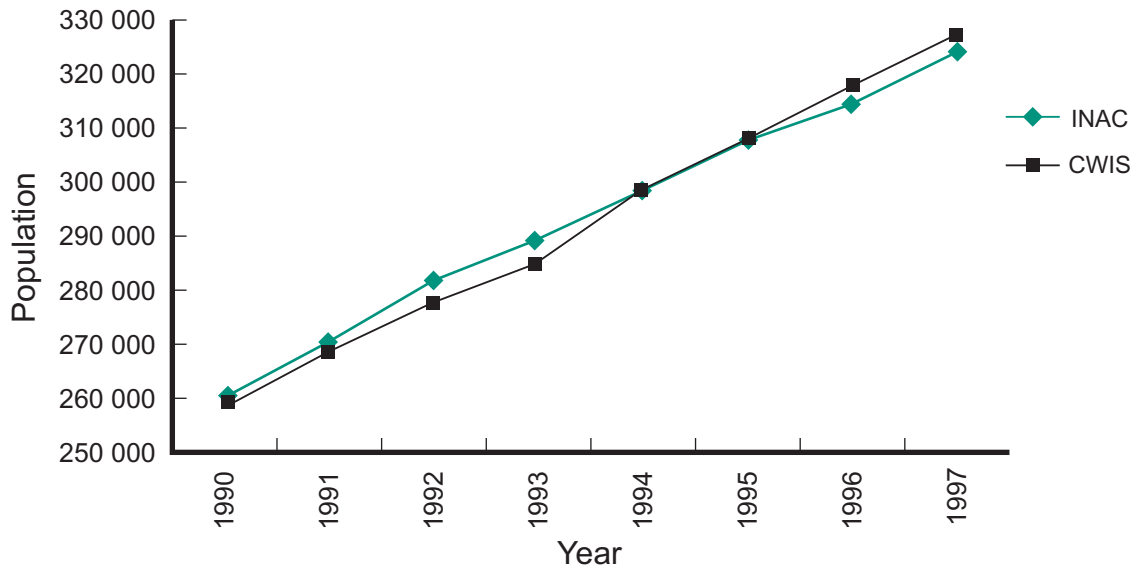
One of the benefits of CWIS is that estimates of the number of people aged <1 and 1-4 are accurate, because the figures are not affected by late reporting of births. It is necessary to know these numbers to plan for prenatal care services, immunization programs, and infant health programs. However, the age categories above 5 years are broad, as needs become more homogenous between groups. The other 3 groupings are 5-19, 20-64, and 65+. Although these are not sufficient for the calculation of age-specific rates, or the process of age-standardization, they are considered accurate estimates. Figure B.1 shows the overall difference between the total on-reserve population estimated by INAC, and the total estimated from CWIS, for the Regions included in the national incidence rates in this report.

Much as the population estimates for infants and young children do not suffer from the under-reporting of births, the estimates for the 20-64 and 65+ age groups do not suffer from the under-reporting of deaths. Therefore, it was decided to apply the proportions of people in different age groupings from INAC data to these broad CWIS totals, to obtain 5-year age groupings. The following equation illustrates what was done to derive the population of the 5-9 age group, for example:

$$\text{INAC population}_{(5\text{-}9)} / \text{INAC population}_{(5\text{-}19)} = X.$$

$$\text{Population}_{(5\text{-}9)} = X * \text{CWIS population}_{(5\text{-}19)}$$

Figure B.1 Comparison of INAC and CWIS total populations for six Regions



In order to demonstrate the effect of using CWIS numbers to derive age-specific population estimates, the CWIS figures were compared to INAC figures (Figures B.2 and B.3). The under-reporting of births and deaths in the INAC Indian Registered Population is evident, when expressed as both the CWIS total minus the INAC total, by age group, and the CWIS percentage of total population minus that of INAC, by age group.

Figure B.2 Difference between CWIS and INAC age-specific population estimates, by total age-specific populations

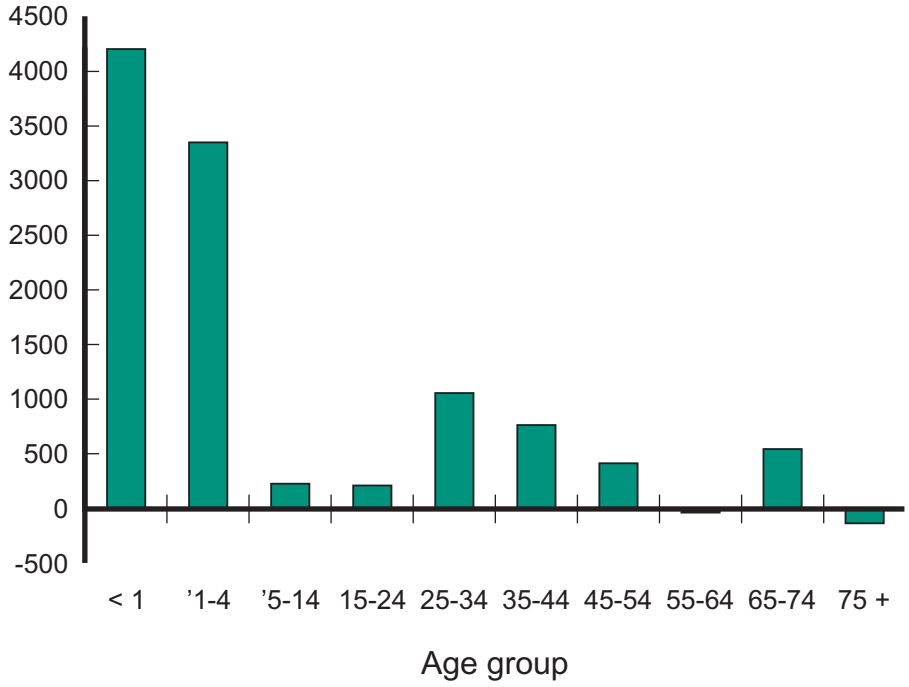
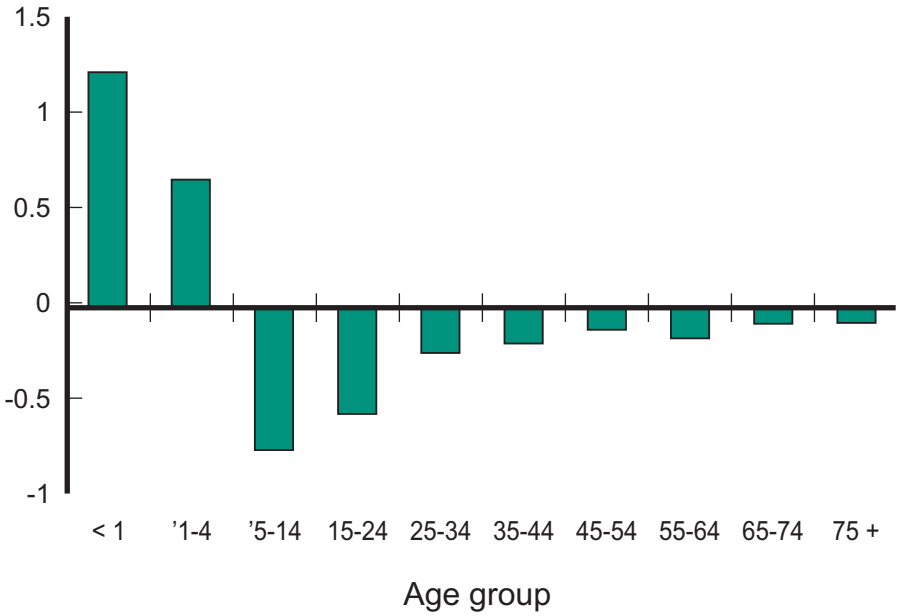


Figure B.3 Difference between CWIS and INAC age-specific population estimates, by percentage of total population



CWIS data was available from 1993 to 1997. Communities are currently providing more recent population counts, but this process is incomplete. Therefore, modeling was done to generate estimates for other years, using the exponential growth formula:

$$P_t = P_0 e^{rt},$$

where P_t is the age-specific population in year t, P_0 is the base year population (1997), and r is the annual rate of population growth. The latter was calculated for each Region and each age group by fitting a linear regression to the available data, using the following equation:

$$\text{In } P_t = \text{In } P_0 + rt$$

If the slope for a given age sratum was not significant ($p > 0.05$), it was assumed that $r = 0$, and therefore $e^{rt} = 1$. That is, $P_t = P_0$, and no growth is assumed.

It is recognized this is an imperfect method of estimating the on-reserve population by age grouping. However, there is no better option currently available. Tables B.1 to B.10 contain the on-reserve, First Nations population estimates, by age and Region, used to calculate rates in this report. Figures for Quebec were not included, because on-reserve numerator data for TB is not available from that Region. Therefore, the national, First Nations TB rates presented in this report include numerator and denominator information for all Regions minus Quebec.

Table B.1 On-reserve population, by age group and Region (1990)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	1,066	1,522	910	1,633	1,481	372	6,984
1-4	4,085	4,682	5,836	6,435	7,107	1,620	29,765
5-14	8,986	9,134	11,792	10,188	10,600	2,749	53,449
15-24	8,723	9,260	9,353	10,694	10,855	2,726	51,611
25-34	9,536	9,021	7,731	8,711	10,140	2,303	47,442
35-44	5,541	5,493	4,113	4,886	7,058	1,570	28,661
45-54	3,124	3,142	2,162	3,066	5,025	1,029	17,548
55-64	1,772	1,856	1,488	1,832	2,743	655	10,345
65-74	1,370	948	991	1,089	3,188	266	7852
75+	979	647	567	784	3,322	179	6477
Total	**45,182**	**45,705**	**44,943**	**49,318**	**61,518**	**13,469**	**260,135**

Table B.2 On-reserve population, by age group and Region (1991)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	1,066	1,522	910	1,633	1,481	372	6,984
1-4	4,182	4,971	5,836	6,435	7,107	1,620	30,151
5-14	9,447	9,650	11,941	10,871	10,981	2,870	55,759
15-24	8,884	9,260	9,353	10,694	10,855	2,726	51,772
25-34	9,536	9,021	7,731	9,022	10,443	2,387	48,140
35-44	5,918	5,493	4,250	5,197	7,489	1,652	30,000
45-54	3,360	3,142	2,255	3,206	5,138	1,048	18,149
55-64	1,905	1,856	1,488	1,911	2,905	655	10,719
65-74	1,438	960	1,002	1,120	3,188	275	7,984
75+	956	647	574	775	2,912	179	6,043
Total	**46,693**	**46,522**	**45,340**	**50,863**	**62,498**	**13,785**	**265,702**

Table B.3 On-reserve population, by age group and Region (1992)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	1,066	1,522	910	1,633	1,481	372	6,984
1-4	4,282	5,277	5,836	6,435	7,107	1,620	30,557
5-14	9,932	10,196	12,094	11,600	11,391	2,998	58,209
15-24	9,052	9,260	9,353	10,694	10,855	2,726	51,940
25-34	9,536	9,021	7,731	9,343	10,755	2,474	48,861
35-44	6,321	5,493	4,391	5,528	7,948	1,740	31,421
45-54	3,615	3,142	2,353	3,352	5,257	1,067	18,787
55-64	2,049	1,856	1,488	1,993	3,075	655	11,116
65-74	1,510	973	1,013	1,152	3,188	285	8,122
75+	938	647	582	769	2,595	179	5,710
Total	**48,301**	**47,387**	**45,750**	**52,499**	**63,653**	**14,117**	**271,707**

Table B.4 On-reserve population, by age group and Region (1993)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	1,066	1,522	910	1,633	1,481	372	6,984
1-4	4,384	5,602	5,836	6,435	7,107	1,620	30,984
5-14	10,441	10,772	12,251	12,378	11,833	3,131	60,807
15-24	9,226	9,260	9,353	10,695	10,855	2,726	52,114
25-34	9,536	9,021	7,731	9,676	11,077	2,565	49,607
35-44	6,752	5,493	4,538	5,880	8,435	1,832	32,929
45-54	3,889	3,142	2,455	3,506	5,383	1,088	19,463
55-64	2,204	1,856	1,488	2,079	3,257	655	11,538
65-74	1,586	986	1,024	1,185	3,188	297	8,267
75+	926	647	590	766	2,350	179	5,457
Total	**50,011**	**48,302**	**46,175**	**54,232**	**64,966**	**14,465**	**278,151**

Table B.5 On-reserve population, by age group and Region (1994)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	1,145	1,538	1,307	1,748	1,473	335	7,546
1-4	4,587	6,024	6,270	7,497	6,803	1,612	32,793
5-14	11,022	12,431	12,769	14,241	14,826	3,321	68,611
15-24	9,391	9,341	9,435	11,366	12,408	2,826	54,767
25-34	9,692	8,229	7,954	10,168	11,763	2,698	50,503
35-44	7,212	5,209	4,853	6,372	9,312	1,982	34,941
45-54	4,162	2,924	2,596	3,710	5,951	1,180	20,523
55-64	2,327	1,732	1,540	2,196	3,576	716	12,087
65-74	1,571	948	1,103	1,291	2,293	299	7,505
75+	909	593	595	788	1,720	176	4,781
Total	**52,018**	**48,969**	**48,422**	**59,378**	**70,125**	**15,145**	**294,057**

Table B.6 On-reserve population, by age group and Region (1995)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	948	1,528	1,356	1,603	1,358	371	7,164
1-4	4,715	6,420	5,644	7,828	6,748	1,648	33,003
5-14	11,938	12,984	12,823	15,269	15,253	3,386	71,653
15-24	9,766	9,507	9,156	11,670	12,525	2,860	55,484
25-34	9,987	8,433	7,843	10,581	11,873	2,827	51,545
35-44	7,862	5,548	4,898	6,903	9,730	2,137	37,079
45-54	4,477	3,080	2,644	3,932	6,190	1,277	21,600
55-64	2,501	1,793	1,519	2,362	3,736	754	12,665
65-74	1,696	1,032	1,081	1,261	2,333	311	7,714
75+	944	619	587	765	1,804	182	4,901
Total	**54,833**	**50,944**	**47,552**	**62,175**	**71,551**	**15,754**	**302,809**

Table B.7 On-reserve population, by age group and Region (1996)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	1,110	1,619	1,431	1,715	1,549	442	7,866
1-4	4,833	6,991	6,764	7,807	7,385	1,751	35,531
5-14	12,331	13,276	12,801	15,667	15,771	3,484	73,330
15-24	9,906	9,523	9,012	11,615	12,965	2,858	55,879
25-34	9,963	8,372	7,741	10,850	12,251	2,844	52,022
35-44	8,340	5,752	5,055	7,328	10,450	2,245	39,171
45-54	4,732	3,164	2,699	4,094	6,697	1,324	22,710
55-64	2,565	1,833	1,515	2,338	3,990	770	13,012
65-74	1,811	1,065	1,086	1,381	2,615	325	8,283
75+	900	617	582	807	1,646	183	4,735
Total	**56,491**	**52,213**	**48,687**	**63,603**	**75,318**	**16,226**	**312,538**

Table B.8 On-reserve population, by age group and Region (1997)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	1,115	1,466	1,252	1,664	1,438	358	7,293
1-4	4,805	7,012	6,005	7,888	7,040	1,714	34,464
5-14	12,682	13,724	13,907	16,334	16,400	3,804	76,851
15-24	10,152	9,877	9,732	12,127	13,581	2,939	58,407
25-34	9,377	8,455	7,994	11,162	12,587	2,991	52,566
35-44	8,739	6,073	5,240	7,465	10,730	2,232	40,479
45-54	5,256	3,129	2,974	4,179	6,458	1,282	23,278
55-64	3,027	1,883	1,720	2,489	4,109	736	13,964
65-74	1,890	1,133	1,126	1,383	2,716	380	8,627
75+	942	617	617	785	1,681	182	4,825
Total	**57,985**	**53,368**	**50,567**	**65,475**	**76,740**	**16,618**	**320,753**

Table B.9 On-reserve population, by age group and Region (1998)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	1,115	1,466	1,252	1,664	1,438	358	7293
1-4	4,920	7,444	6,005	7,888	7,040	1,714	35011
5-14	13,334	14,500	14,093	17,432	17,075	3,976	80411
15-24	10,360	9,877	9,732	12,127	13,581	2,939	58616
25-34	9,377	8,455	7,994	11,560	12,965	3,101	53453
35-44	9,338	6,073	5,415	7,940	11,392	2,352	42509
45-54	5,655	3,129	3,103	4,371	6,624	1,307	24189
55-64	3,258	1,883	1,720	2,596	4,353	736	14546
65-74	1,986	1,148	1,138	1,426	2,716	395	8809
75+	952	617	626	794	1,609	183	4781
Total	**60,294**	**54,591**	**51,078**	**67,798**	**78,794**	**17,060**	**329617**

Table B.10 On-reserve population, by age group and Region (1999)

Age	Region						
	Pacific	Alberta	Saskatchewan	Manitoba	Ontario	Atlantic	Total
<1	1,115	1,466	1,252	1,664	1,438	358	7,293
1-4	5,037	7,903	6,005	7,888	7,040	1,714	35,587
5-14	14,021	15,320	14,285	18,604	17,803	4,156	84,189
15-24	10,577	9,877	9,732	12,127	13,581	2,939	58,833
25-34	9,377	8,455	7,994	11,973	13,356	3,214	54,369
35-44	9,978	6,073	5,596	8,445	12,095	2,478	44,665
45-54	6,084	3,129	3,237	4,574	6,799	1,333	25,156
55-64	3,506	1,883	1,720	2,708	4,612	736	15,165
65-74	2,087	1,164	1,151	1,473	2,716	410	9,001
75+	966	617	635	804	1,554	183	4,758
Total	**62,748**	**55,886**	**51,607**	**70,259**	**80,994**	**17,522**	**339,015**