A COMPARATIVE STUDY ON THE INCIDENCE OF TUBERCULOSIS AMONG STATUS INDIANS AND OTHER SELECTED GROUPS IN MANITOBA. CANADA.

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A thesis

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To Ed

For all your help and support.

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ABSTRACT

This historical prospective study describes the epidemiology of tuberculosis of Status Indians and other selected populations in Manitoba. The study covers 20 years. 1975 through 1994. to show trends in TB: it can serve a baseline for future epidemiologicals studies.

Statistical analysis of the data compares and contrasts treds in TB among the Status Indian. immigrant. and total populations of Manitoba. Within-population description and statistical analysis is used to highlight high risk subgroups of the populations.

The efficacy of continued BCG innoculation of on-reserve newborns is examined. using criteria from the International Union Against TB and Lung Disease (IUATLD) for discontinuation of BCG. The possibe interaction and complication of HIV infection in the on-reserve population is considered.

A descriptive look at tuberculosis in Manitoba prisons is used to centre on the possible implications of the prison system in the spread of TB in Manitoba.

CHAPTER 1

BACKGROUND

1.1 Introduction

Status Indians* in Manitoba, as well as in the rest of Canada, have higher a incidence of tuberculosis (TB) than the general population.[1,2,3] In 1972, the Status Indian TB incidence rate in Manitoba was 181.2 per 100,000,[4,5] decreasing to 43.5 in 1991;[6] the overall Manitoba general population incidence rate was 23.5 in 1972[7] and 9.2 in 1991.[8] Although incidence rates have diminished in both populations, the 1991 rate ratio, Status Indian compared to the general Manitoba population, was 4.7. The incidence of tuberculosis is now increasing throughout most of the developed world.[9,10,11,12,13,14]

The relatively high incidence of TB in the Manitoba Status Indian population reflect the presence of risk factors for infection and disease in this population. These risk factors include poverty,[3,15,16,17,18] substance abuse - including alcohol,[3] previous TB,[3,16] and diabetes.[3,16,19,20,21]

The use of Bacille Calmette-Guerin (BCG) vaccination for Aboriginal children was introduced in Canada in the 1940's and became policy in the 1960's.[3] The vaccine is used primarily in order to prevent meningitis and miliary TB in infants and young children, who are more likely to have disseminated tuberculosis.[14,16,22,23,24,25,26,27] However, the vaccine is not without rare cases of death from disseminated BCG infection.[22,24,28] BCG is a live vaccine so should be used with

*The term "Status Indian" refers to Native Canadians identified under the Indian Act of Canada who are registered with the Department of Indian and Northern Affairs Canada. This term is also used interchangeably with "Registered Indian". (Indian Act)

caution in populations that are immunosuppressed.[29] In addition, children, who are more likely to have disseminated tuberculosis.[14,16,22,23,24,25,26,27] However, the vaccine is not without rare cases of death from disseminated BCG infection.[22,24,28] BCG is a live vaccine so should be used with the tuberculin skin test as a diagnostic tool is compromised by the use of BCG vaccination.[28] If risk of infection in a population is low, then the complications of BCG may outweigh the beneficial effect.[27,28]

The epidemiology of tuberculosis in Manitoba has changed since the policy of BCG vaccination for Status Indian infants was introduced, suggesting that the efficacy of continued BCG vaccine should be re-evaluated. Although many studies have examined TB among the Manitoba Status Indian population, none have included an analysis of the prison system. Status Indians, compared to the general population in Manitoba, have disproportional high rates of incarceration.[30] A study of the New York prison system suggests that their prisons are an important "amplification point" for TB.[31] Therefore, any TB study that concerns Status Indians should include the prison population.

The objectives of this study are:

1. Compare the incidence and trends in incidence of TB, within and among Manitoba Status Indians, the Manitoba general population, and other selected populations, over 20 years (January 1/75 to December 31/94).

2. Describe the TB incidence and TB risk factors among Manitoba Status Indians, the Manitoba general population, and other selected groups over the 20-year study period. Describe TB incidence within the Status Indian population.
3. Determine the efficacy of continued BCG vaccination of Manitoba Status Indian newborns, using the calculated rates of smear-positive TB and TB meningitis, and through estimates of TB infection.
4. Determine the relative proportion of TB cases occurring in Status Indians and others in Manitoba prisons, and compare the demographic and microbiological features in these two groups. Determination of incidence rates will depend on availability of denominator inmate population data, by ethnic status.
5. Describe the measures presently in place to detect, treat, and control TB in Manitoba's Federal and Provincial prisons.

The background will review the established data on TB in Canada, including Manitoba, and in the Status Indian population. As well, it will review the established data on TB in the prison system in Canada and Manitoba.

1.2 Burden of illness

Brancker et al.,[1] in the Statistics Canada Health Reports, define a high-risk group for tuberculosis as one with an incidence of more than eight times that of the general Canadian

population, or 16 times that of the non-Aboriginal Canadian-born population. From 1978 to 1988, the rate ratio of TB incidence for Canadian Registered Indians, compared to the general Canadian population, ranged from 9.0 to 14.7.[6,8] By this definition, Registered Indians are considered to be a high-risk group in Canada.

Although national rate ratios are useful to determine burden of illness, TB tends to occur in specific geographic locations where high-risk groups reside. Studies of these geographic locations and their populations (e.g. institutions such as prisons,[31,32,33,34] neighbourhoods of urban poor,[1,35,36] the elderly,[20] and immigrants from high incidence countries[1,37,38] can help in gaining a better understanding of the epidemiology of TB.

Northern Canada and the Prairie provinces have the highest incidence of TB, and the largest relative populations of Aboriginal people.[39] In the period 1980-1991, Manitoba was consistently among the four highest regions for tuberculosis incidence, following the Northwest Territories and Yukon, and with rates similar to those in Saskatchewan.[8]

The elderly are at higher risk for TB than younger people, due to greater exposure to infection in earlier years, and greater risk of disease due to waning immunity. In Manitoba, the proportion of the population over 65 years old was 10.2% in 1975; 12.1% in 1984, and 13.5% in 1994.[40,41] In the Status Indian population, this proportion was 3.8% in 1975, 3.7% in 1984, and 3.4% in 1994.[42]

The proportion of Status Indians in the Manitoba population is increasing. It was 4.0% in 1975, 4.8% in 1984, and 7.7% in 1994.[40,41,42] In Canada, Manitoba has the fourth largest proportion of Registered Indian, behind that of Saskatchewan, the Northwest Territories*, and the Yukon.[43]

It is possible that increases in TB incidence rates could be due to over-diagnosis of the disease. However, a study by Enarson and Grzybowski, 1970 to 1981,[2] found that over-diagnosis did not occur in the Registered Indian population. No significant difference was found in the proportion of bacteriologic confirmations of reported disease between ethnic groups. Registered Indians had 85.4% of cases confirmed on culture, Inuit 78.5%, and Non-Aboriginal 79.5%.[2] In the same study by Enarson and Grzybowski,[2] the Canadian Registered Indian population was not found to be more extensively screened than the Inuit or non-Aboriginal population.

The proportion of tuberculosis cases occurring by age reflects patterns of disease transmission within a population. Cases occurring in young children usually reflects exposure to infectious pulmonary disease, often in older relatives or caretakers, whereas cases in older individuals are frequently due to reactivation of disease.[20,44] In the Manitoba, analysis of the proportion of TB cases occurring within age groups has the potential to be inaccurate due to the small numbers involved.

*The study period examined predates the division of the Northwest Territories into two separate territories.

However, the available data indicate that there is no significant change in the proportion of TB in the younger or older age groups.[6]

The mortality rate due to tuberculosis in Canada has decreased significantly over the past six decades, with a steeper decline following the introduction of antituberculous drugs after World War II.[45] and a levelling of mortality rates since the late 1980s to the present.[8] This is true for all regions of Canada.[45] Mortality rates (per 100,000) due to tuberculosis in Canada were 84 in 1926 (excluding Newfoundland, Yukon and Northwest Territories).[45] 2 in 1972,[8] and 0.6 in 1993.[8] The Manitoba TB mortality rates were 2.3 in 1972, and 0.9 in 1993.[8] The TB mortality rate for Manitoba Registered Indians was 820 in 1932.[46]

Northern Canada (Yukon and Northwest Territories), with a high Aboriginal proportion of the population, had much higher rates of mortality in the past, with a steeper decline in rates.[1] Although the gap between mortality rates in the north and other parts of Canada has narrowed, rates in the north remain at six times that of the total Canadian population.[1]

1.3 Etiology and risk factors

In Manitoba, Status Indians have risk factors for tuberculosis that differ from the general population. The risks of infection with *Mycobacterium tuberculosis* and of progression of infection to disease are dependant on: a) amount and duration of exposure to bacillus;[1,47,48,49,50] b) susceptibility of the

host:[1,47,50,51,52] c) virulence of the bacilli:[50] d) adequacy of treatment.[47]

Risk of exposure

The higher rates of TB in Status Indians result from relatively higher exposure to cases of infectious TB occurring primarily in individuals with smear-positive respiratory disease. Approximately 5% of people exposed to TB will develop disease within 1 year, and another 5% subsequently (10% risk over a lifetime).[53] Across Canada, approximately 75% of cases are respiratory, with the exception of Asian immigrants and those with HIV infection, whose proportion of respiratory TB is lower.[39]

Crowded housing directly affects the amount and duration of exposure to *Mycobacterium tuberculosis*. The bacterium is spread by droplet infection when a person with respiratory tuberculosis coughs, sneezes, speaks, or sings.[48,53] Overcrowding, poor ventilation, and air recirculation increase the density of *Mycobacterium tuberculosis* in the air.[47,48] People living in the same household with an active case are considered to have the highest risk for tuberculosis.[54]

The Status Indian population has been increasing rapidly, particularly on reserves, due to high birth rates,[55] while availability of housing has not kept up with demand.[56] A study of Canadian children[18] found that in 1986, 29% of Indians living on reserves and 11% living off reserves lived in crowded housing, compared to 2% of the overall Canadian population. Hull[56] found that in Manitoba, Status Indians had three times the proportion

of people living in crowded and substandard housing, compared to the rest of the province, 21% versus 7%.[56]

Elderly Canadians (age 65+) are considered to be a high-risk group for tuberculosis due to high rates of exposure to infection in the past and increased risk of reactivation due to lowered resistance with age.[3,57,58] This is especially true for Aboriginal populations with past TB incidence and prevalence rates much greater than that of the general population. A study done by Johnson et al.[58] in Manitoba (1976 to 1981) revealed that Registered Indian origin was highly correlated with reactivation ($p < 0.001$, odds ratio 4.0), especially when the initial disease was advanced. Although Status Indians in Manitoba and Canada have a smaller proportion of elderly in their populations, crowded housing and the practice of extended families living together in one household create a situation where young children who are highly susceptible live in close and constant proximity to these elderly individuals.

Studies in the United States have shown that incidence rates of TB are lower for females than males and that incidence rates are declining faster in females than in males.[20] This has not been linked to a lower risk of disease once infected but lower risk of infection.[20]

Susceptibility of the host

Increased host susceptibility may be defined as a higher risk of disease at any given prevalence of infection. Status Indians have risk factors that are known to be associated with increased susceptibility to tuberculosis. Hopewell (1993)[59]

considers TB to be an opportunistic infection in the setting of malnutrition, diabetes mellitus, end-stage renal disease, and HIV infection:[59] high rates of some of these conditions exist in the Status Indian population of Manitoba.

Poverty is a "catch-all" term for several factors that negatively affect a person's resistance to disease, and Status Indians in Manitoba have a disproportionately high level of poverty.

Poverty is found to be highly correlated with tuberculosis and with general poor health in both developing and developed countries.[1,17,35,46] Studies conducted across Canada have demonstrated this correlation.[60,61,62] In a 1989 study by Enarson et al.[62] in British Columbia, tuberculosis was found to have a high negative correlation with socioeconomic level. While illness is a risk factor for poverty, poverty is a risk factor for illness. Those living in poverty are more likely to be sick, and sick people are more likely to be poor.[63]

Poverty rates, as measured by income, are higher among Status Indians than in the general population, in both Manitoba and Canada.[3,15,18] It is difficult to quantify the actual extent of poverty among Status Indians, because of differences in demographics and cost of living by region. Poverty is negatively correlated with level of education and with employment. In Manitoba in 1981, 42% of Status Indians had less than a grade 9 education, compared to 19% of the rest of the population.[56] In Canada, people with less than Grade 9 education are considered "functionally illiterate".[56]

Indians (Status and non-Status) have much higher rates of unemployment than the general Canadian population.[15,56,64] On Manitoba Indian Reserves, which have 67% of the province's Status Indian population,[42] the unemployment figure for 1992 was estimated to be 65% in summer and 85% to 90% in winter.[65]

A study conducted by Enarson and Grzybowski[2] between 1970 and 1981 found that TB incidence among Status Indians was higher in the Canadian Territories and the Prairies provinces than among Status Indians in other parts of Canada. Geographic region may be a confounding factors here: Indians from the north and from the Prairies have generally lower living standards and education levels than those in central Canada.[43]

Poor nutrition, which may result from poverty, affects both directly and indirectly the ability of the host to resist infection. Inadequate nutrition may cause direct breakdown physical barriers such as skin, and inhibiting antibody production and function. Indirectly, poor nutrition may lead to loss of appetite and food intolerance.[65] These influences on tuberculosis are well documented.[3,59,66]

Vitamin A deficiency, has been associated with increased morbidity from respiratory disease,[66] possibly through keratinization of the epithelium of the respiratory tract.[67] These effects have been well documented in children. TB mortality related to vitamin A deficiency was found to be doubled among children in Tanzania.[68] Respiratory disease was found to be four times greater with vitamin A deficiency in north-east Thailand,[69] and two times greater in south India[71] and rural Indonesia[71] with

vitamin A deficiency. A study by Solon et al.[72] showed a negative relationship between vitamin A and tuberculosis and vitamin A and whooping cough. No effect of vitamin A deficiency and respiratory disease was found on a study conducted in Guatemala City.[73]

Diabetes mellitus is another condition associated with an increased susceptibility to disease.[74] The incidence of diabetes is disproportionately high in the Status Indian population of Manitoba.[21] Estimates of the burden of disease have been based on its burden on the health care system and on the services used because of the disease, therefore the true burden of disease is likely to be under represented.[75] In a study by Young et al.[76] in northeast Manitoba/northwest Ontario region, 1978 to 1982, the estimated prevalence of diagnosed cases among Indians (Registered and non-Registered) of this area was found to be 2.8% overall, 4.6% for the 15 to 64 years population, and 9.6% for those over 65 years. In his second study in the population of Manitoba - excluding Status Indians and those under 25 years old (1980 to 1984), Young[78] found the estimated annual prevalence of diagnosed cases to be 0.8% for the 25 to 44 years age group, 3.5% for 45 to 64 years, and 7.6% for those over 65 years.

In the first study by Young,[76] the ratio of female to male diabetes among Indians was 2.5 to 1, while in the non-Indian population in the second study[77] the ratio was 0.97 to 1. The difference between these two ratios may be explained in part by more aggressive oral glucose tolerance screening of pregnant women in the Indian population (because of their high incidence

of gestational diabetes).[78] combined with a higher birth rate in that population.[43,79]

Diagnosis of diabetes among Manitoba Indians has been steadily increasing since the 1960s.[76] Diabetes in this population is predominantly non-insulin-dependant diabetes mellitus (NIDDM).[80] In a study in Manitoba among Indian children under 15 years of age, 1984 to 1990, Dean et al.[80] found that NIDDM did exist in this population but was rare - only 20 children for the period of the study. Family history of NIDDM and obesity were risk factors. NIDDM has appeared in this adult population after 1940, and it is now believed that NIDDM is becoming a problem of children in this population.[80]

Diabetes is widely recognized as a risk factor for tuberculosis. However, there may be a synergistic effect between the two diseases. A literature review by Mugusi et al.[81] suggests that rates of glucose intolerance are increasing in tuberculosis patients and that glucose tolerance improves with treatment of TB. These findings suggest a reciprocal relationship between the two diseases.

Renal failure and haemodialysis have also been found to be associated with increased risk of tuberculosis.[20,26,82,83,84] due to impaired immunity.[84] In a Canadian survey by Young et al.,[85] 1981 to 1986, Status Indians were shown to have a 2.5 to 4.0 times greater rate of end-state renal disease than the general population. Diabetes is associated with a high proportion of end-stage renal disease in the Registered Indian population, and this

proportion is higher than in the end-stage renal disease in total population, with an incidence rate ratio of 5.3.[85]

In the past, it has been suggested that North American Indian populations had a genetic predisposition to TB.[86] Human leucocyte antigen (HLA) types A11-B15 and DR2 have be implicated as a genetic risk factor for tuberculosis, but association between HLA types and TB have been inconsistant.[20] and have not been found in the Indian populations of North America.[86]

Enarson and Grzybowski, in their study "Incidence of active tuberculosis in the native population of Canada".[2] make reference to a hypothesis that Aboriginal people of the north and of the west had later exposure to TB from Europeans and therefore may have less herd immunity than Indians living in eastern and central Canada, which may be partly responsible for the higher incidence rates in the former regions.

Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) have emerged in the United States and other parts of the world as an important risk factor for tuberculosis. However, there are no data at present to support a significant role for HIV in the epidemiology of TB among the Status Indian or general population of Manitoba.[3,56] HIV infected people are more likely to progress from infection to disease:[59,87] the breakdown rate is estimated to be 8% per year, compared to 10% over a lifetime in non-HIV infected individuals.[87] Tuberculosis associated with HIV is characterized by a shift of TB from older to younger age groups.[59]

Other variables that have been associated with TB in some populations are fibrotic lesions, carcinoma of the head and neck, heavy smoking, silicosis, immunosuppressive treatment, underweight, gastrectomy, and jejunoileal bypass.[16,20] The extent to which these variables are important in the Status Indian population is unclear at this time.

Virulence of the bacilli

Strains of *Mycobacterium tuberculosis* differ in their virulence - their ability to cause disease in their host. This is related to differences in biochemical properties among strains.[88] In a study of M. tuberculosis strains in guinea pigs, Zhang et al.[88] revealed genetic abnormalities of the enzyme superoxide dismutase found in low-virulence, isoniazid-resistant strains of the bacteria. The study raises the possibility that these genetic changes affect the virulence of the bacilli. While drug resistance is most often created by a series of mutations, resistance has occurred with one mutation in the case of resistance to streptomycin and rifampicin.[89]

The pathogenicity of the tuberculosis bacillus is measured not only by its ability to cause disease, but also by its ability to resist treatment of the disease. One factor in bacillus virulence and drug resistance is the ability of the organism to withstand low pH environments found in cavities and abscesses. Jackett[90] in a study of *Mycobacterium tuberculosis* in guinea pigs, found virulence positively correlated with resistance to H_2O_2, with a synergistic effect in a low pH environment. Sareen and Khuller[91] found changes in the cell wall and membrane of

Mycobacterium tuberculosis $H_{37}Ra$ was associated with ethambutol resistance probably through altered permeability.

The tuberculosis bacillus infecting a person may be resistant to one or more antibiotics: bacilli that are resistant to certain antibiotics may be present in the host before coming into contact with the antibiotic.[89] Acquired primary drug resistance occurs when a patient is infected with a drug-resistant strain of *Mycobacterium tuberculosis*.[92] Drug resistance may also occur spontaneously. Tubercle bacilli mutate continuously, with an estimated drug resistance ratio of $1:10^6$ of the bacterial population: a resistant mutation to two drugs is estimated to be $1:10^{12}$ of the bacterial population.[93] Thus the larger the bacterial population, the greater probability there is of antibiotic-resistant mutations.[93,94]

Cross-resistance is the transferring of genetic material coding for resistance from one bacteria to another. A review of the literature by Mitchison[93] found partial cross-resistance between thiacetazone and ethionamide, and among various other anti-tuberculin drugs that are less commonly used. However, cross-resistance is rarely a cause of drug resistance.[93]

Adequacy of chemotherapy

Treatment and cure of TB infection and disease are highly effective if the condition is accurately diagnosed and correctly treated over a sufficient period of time.[3,58,95] Lifetime cure of the tuberculosis is the objective of antituberculous therapy, and chemotherapy is the only effective treatment of the disease.[96]

Chemotherapy treatment has two forms, treatment of active disease and treatment of infection.

With treatment of disease, three and sometimes four drugs are used.[23,96] In the first phase, known as the initial or intensive phase, the objective is to rapidly reduce the number of bacilli: the second or continuation phase objective is to destroy resistant bacteria over a longer period of time.[23,96]

First-line drugs include: isoniazid (INH), rifampin, pyrazinamide, streptomycin, and ethambutol, all of which are bactericidal.[26,96] In the first phase of treatment, three or four of the first-line drugs are used until sputum is no longer smear-positive and elimination of symptoms is achieved, usually within two months.[96] In the second phase, usually two drugs are used, INH and rifampin; they are given until presumably all TB bacilli are killed, usually another 4 to 7 months.[96]

People who have recent tuberculosis infection are at greater risk for developing active tuberculosis disease than those who do not harbour the infection.[97] Approximately 5% of those exposed to TB will develop disease within 1 year, and another 5% later, for 10% over a lifetime.[53] To reduce this risk, the antituberculous drug INH is given to eradicate the infection.[23,97] INH, the only proven effective prophylactic TB treatment, is not taken without risk.[23,97] The most prominent adverse effect is hepatic damage, which must be weighed against the possibility of developing active TB.[23,97]

The factors in deciding to give prophylactic treatment are: a) extent of contact with active cases; b) suspicion of previous

untreated or improperly treated TB; c) immune suppressing condition (e.g. HIV infection, chronic renal failure, diabetes); d) being a member of a high-risk group (e.g. Aboriginal); e) tuberculin skin test conversion from negative to positive in the past 1 to 2 years; f) age of patient (people over 35 years old are at higher risk of developing INH induced hepatitis).[23,97]

Poor compliance is the main reason for treatment failure,[47,98,99] leading to relapse of disease and to drug resistance.[3,58,98] Noncompliance is known to be high in tuberculosis treatment, due to the extended nature of the treatment.[9,10,99] Compliance with prophylactic treatment may be difficult to justify to a patient who does not have symptoms of tuberculosis.[47]

In a study by Weis et al.[98] in the United States, age, sex, religion, education, race, and socioeconomic status were not associated with compliance. However, psychiatric disorder, substance abuse - including alcoholism and drug addiction, and homelessness were positively associated with noncompliance.

Personal and cultural factors may also contribute to non-compliance with treatment.[100,101,102] In Manitoba, most individuals with active smear-positive tuberculosis are treated in Winnipeg until they are noninfectious);[78] this could be as long as two months.[96] People from remote communities (most of which are Indian reserves) may feel lonely and isolated when away from their families, many have responsibilities at home such as small children. Alienation may result the health care system

which is predominantly administered by health care workers from a non-Native culture.

Directly Observed Therapy (DOT) is a process where the treatment provider observes the patient taking every dose of antituberculous drug over the entire course of treatment;[92] at the same time, the health care worker observes the patient for complications of tuberculosis and drug toxicity.[103] In Canada, DOT is recommended for all TB disease chemotherapy.[96] DOT is initially more labour intensive than self-administered medication, but may save time by having cure achieved sooner and with greater certainty.

DOT has been shown to decrease rates of primary and acquired drug resistance, and of relapse.[98] In a study by Weis et al.[98] in Texas, when DOT was introduced, primary drug resistance dropped from 13.0% to 6.7% over the 6 year and ten month period; acquired drug resistance decreased from 14.0% to 2.1%; relapse rates decreased from 20.9% to 5.5% ($p<0.001$ for all). This was despite higher rates of tuberculosis, intravenous drug use, and increased homelessness.

In Manitoba, drug resistance is not widespread at this time.[104,105] In a study of all tuberculosis cases in Manitoba (1980 to 1989), Long et al.[105] found that drug resistance was not associated with age, sex, disease status or type of disease. The risk of drug resistance was significantly higher among immigrants than among the established Canadian population, odds ratio 4.0. Status Indians had a risk similar to the general Canadian-born Manitoba population, however, Status Indians were over

represented in the group that was noncompliant with treatment. Most drug resistance was found in immigrants coming from countries with high drug resistance.[105,106] No outbreaks of multidrug-resistant TB occurred over the study period.

In a study of primary drug resistance in Canada, 1963 to 1964, Armstrong[104] found Canadian resistance rates to be comparable to other developed countries and that primary drug resistance was not a major TB problem at that time. In Manitoba, resistance to one or more of streptomycin, isoniazid, and para-aminosalicylic acid was found in 5.1% of case. Overall Canadian drug resistance to one drug was 3.8%, to two drugs 0.9%, and to three drugs 0.3% of cases. Streptomycin was the most common drug to which cases were resistant. Only the very old showed more drug resistance than other age groups.[104]

Drug resistance has become an increasing problem throughout the world. In the first three months of 1991, the Centre for Disease Control (CDC) found that in the United States there were 14.4% of TB cases resistant to at least one antibiotic, and 3.3% of cases resistant to both isoniazid and rifampin, while between 1982 and 1986 drug resistance was estimated to be only 0.5%.[16] In a study done by Sepkowitz et al.,[107] it was shown that in a period of five years, 1987 to 1991, drug resistance in 44 New York City hospitals rose dramatically. Resistance to one drug rose from 19% to 28% of total cases; resistance to isoniazid used for routine prophylaxis rose from 13% to 23%; with isoniazid and rifampin, the two most widely used drugs, resistance rose from 6% to 14%.

The primary mechanism of drug resistance is through selection pressure.[89] Suboptimal use of antibiotics encourages the development of resistance through eradication of susceptible bacilli but not the more drug-resistant ones, thus allowing the more resistant bacilli to proliferate. Drug resistance is a function of pathogen virulence factors, potency of the antituberculous drugs used, and human factors - those related to choices made by people.

There are various reasons for low potency of antibiotics. For example, to be effective, antibiotics that are bacteriostatic (e.g. thiacetazone), must be kept in tissue concentrations at a constant optimal level; a drop in concentration results in growth of the bacilli.[93] Other drugs, such as ethambutol, ethionamide, and kanamycin, are too toxic to body tissues to be given in optimal doses.[93] Pyrazinamide is effective only at pH lower than 5.6, and streptomycin is not effective in the acid environment often found in areas of acute inflammation.[93]

Subtherapeutic use of antibiotics - a human factor - may promote the development of antibiotic drug resistance. The use of antibiotics in veterinary and farming practices has resulted in low doses of antibiotics ingested over extended periods of time, giving resistant bacteria the opportunity to proliferate. Antibiotics used as growth promoters in animal feeds are given in doses that are subtherapeutic for destroying bacteria.[108] Large numbers of animals given small amounts of antibiotic create a large reservoir of potential antibiotic resistance.[108]

In a study by Levy et al.,[108] increased rates of tetracycline-resistant organisms were found in the stool of farmers who fed chickens with tetracycline supplemented feed, while no increase was found in the stool of their neighbours. Within six months, 31.3% of the farmers' stool specimens had greater than 80% tetracycline-resistant bacteria, while the neighbours' had 6.8% ($p < 0.001$). No traces of tetracycline was found in the eggs of the chickens and no increases in tetracycline-resistant bacteria was found in stool of the people who ate the eggs.

The past decline in the incidence of tuberculosis in Europe and North America has resulted in a reduction of expertise in treating this disease among health care workers in some regions.[99,109,110] However, in Manitoba tuberculosis control is coordinated through the Respiratory Centre in Winnipeg, and the coordinator of the Centre is the information resource person for health care personnel. Health care personnel working with Aboriginal people traditionally have had a high level of suspicion of TB because of high rates of disease in the population.

The Medical Services Branch (MSB) of Health Canada, through Indian Health Services, is responsible for communicable disease control on Indian reserves in Manitoba. Tuberculosis control and prevention is included in their mandatory program.[111] Most First Nations communities (Indian reserves) of Manitoba are now in the process of transfer of Indian Health Services from the Federal Government to the First Nations. The Federal Government will

maintain a residual role in health care, for exceptional events such as outbreak of communicable disease.[112] Tuberculosis control protocol is based on the Canadian Tuberculosis Standards, written by the Canadian Thoracic Society.

Tuberculosis surveillance guidelines for the province of Manitoba have not changed significantly over the 20-year study period.[113] Surveillance is dependant on the epidemiology of an individual TB cases (e.g. infectiousness of disease, number of contacts, susceptibility of contacts) and on TB incidence in some high risk groups (e.g. immigrants from areas with a high prevalence of TB, some health care workers, Aboriginal communities with high rates of TB).[113,114]

Tuberculosis control includes treatment, prevention measures, and screening.[78] Treatment is prescribed by local medical staff in each community, in consultation with the coordinator of the Respiratory Centre.[111]

Prevention includes Bacille Calmette-Guerin (BCG) vaccination (discussed in detail below), contact tracing, and education - on prevention, detection of disease, and recovery.[111] (MSB manual: 23-26) Education is usually carried out on an individual basis, except in case of a community TB outbreak where it is given at a community level. BCG vaccination is recommended for all newborns living on reserves (Status Indian or Other).[78] The Manitoba Immunization Monitoring System (MIMS) which has been in effect in First Nations communities since 1990, will include records of all BCG vaccinations in 1996.[115]

Screening for tuberculosis infection is done through intradermal injection of a purified protein derivative (PPD); if the person has previously acquired TB infection, induration and redness at the site of injection will occur because of previously developed cell-mediated immunity; if the person manifests little or no reaction to the injection, TB infection is not considered to be present.[116] After newly acquired infection, cell-mediated immunity takes two to ten weeks to develop.[116] In Manitoba, the Mantoux skin test is used to diagnose infection.[78] and is considered by the Canadian Thoracic Society to be the most accurate, consistent, and reliable of the skin tests available.[116]

There are however, several reasons for a false result of the skin test. No reaction in the presence of infection (false negative) may occur in the case of suppression of the immune system (e.g. HIV infection, malnutrition), advanced tuberculosis, viral illness, or vaccination with live virus (e.g. measles).[47,116] A skin reaction may occur when there is no infection (false positive), in the case of previous BCG vaccination, or in the presence of non-tuberculosis Mycobacteria, which is a rare occurrence among the Canadian-born population.[116]

Mantoux skin testing is used in the screening of those with risk of exposure to tuberculosis infection. A second Mantoux test is recommended within two months of the first one for those with a history of exposure to an active case, but with a negative or small induration (5 to 10 mm) because of the lag time for cell-mediated immunity to develop[23] Medical Services policy is to skin

test school children in high-risk areas: this decision is based on the history of TB in the community (e.g. in case of TB outbreak).[78] Only those children with no history of a positive (> 10mm induration) Mantoux or of tuberculosis are skin tested.[78] (MSB manual: 24) BCG is repeated if the Mantoux is negative, if there is no history of previous conclusive BCG, if there is no presence of viral disease, or if there is no history of live vaccine given within the prior 30 days.[78]

If the Mantoux outcome has converted from a previous negative result to a later positive result, or if the result has increased by > 18mm induration, then the person is suspect of having tuberculosis and is screened for disease by chest X-ray.[78] Chest X-ray is also used for diagnosis in the case of a person with symptoms of TB, in which case the clinical, BCG, and Mantoux history, and bacterial specimens, are all components of the diagnosis.[78] Chest radiographs identify people with active or inactive pulmonary TB, but do not identify infection.[117]

Status Indians have risk factors that place them at increased risk for tuberculosis. Demographics, socioeconomic conditions, and culture make them unique from the general population of Manitoba in respect to TB control.

1.4 Prison risk

Risk factors for TB infection and disease exist in the prison environment. The high rates of incarceration of Status Indians in Manitoba, high rates of pre-incarceration infection, crowded conditions within prisons, and existence of co-morbid

conditions such as HIV infection, promote the spread of TB within the prison.

TB has been a public health concern in American prisons for several decades, with TB rates 3 to 6.5 times higher than in the general population.[31,34,118,119] Studies done in American prisons have shown that a prison environment poses a significant risk of acquiring TB infection.[31,32,34,118,119] A case-control (within a prospective cohort) study conducted in the New York City jail system[31] demonstrated an association between jail time or jail admission and development of tuberculosis. Most people within the prison population return to the community. This suggests that the prison system studied was an "amplification point" for tuberculosis within the community at large.

Substance abuse and HIV infection, both known risk factors for TB, are higher in the prison population than in the general population.[120,121,122] In the general population of Manitoba, the main risk factor for HIV/AIDS is unprotected male homosexual sex,[123] while in the Federal prison population the primary risk factor is injection drug use.[124,125]

Rothon et al.[124] (1992) estimate a prevalence of HIV to be 5 to 10 times higher in the British Columbia prisons than in the province's general population: Calzavara et al.[125] (1993) found the prevalence to be 6 times higher. In both studies, HIV infection was linked to injection drug use. Rothon found no association between HIV and Indian status. Calzavara did not elicit that information.

The impact of AIDS on TB depends on how, when, and how often the two diseases coincide in a population. Status Indians in Manitoba have high rates of TB infection. The injection drug addicted population has high rates of HIV/AIDS. Both groups come together in the prison system.

In spite of what is known about the risk factors for tuberculosis associated with incarceration, no data has been published to my knowledge on TB in Manitoba prisons.

1.5 BCG

Health Canada, the Federal Government's health agency responsible for Aboriginal health, has a mandatory program of TB prevention and control,[111] including: BCG, screening and monitoring of high-risk populations, contact tracing, and TB education.

BCG is not given universally across Canada. It is recommended for on-reserve newborns in Manitoba; it is not used in Labrador; and used at the discretion of health care workers in Alberta. Reasons for re-evaluation of BCG policy for Aboriginal people in Canada are a perceived decreased risk of tuberculosis and uncertainty regarding BCG effectiveness. Young[126] in his epidemiology assessment of TB in the Canadian Aboriginal population concluded that TB is still a serious health problem, that BCG is effective but the degree of effectiveness is unknown, and that BCG may be partly responsible for the reduction in TB morbidity. Also, the second generation benefits of BCG, the

future cases that are prevented by reducing TB and therefore transmission of TB at present, are difficult to quantify.

The American Thoracic Society strongly recommends BCG for infants and children with negative skin tests who are at risk of intimate or prolonged exposure to infectious TB, or when they are exposed to people who have resistance to both isoniazid and rifampin.[26] The Canadian Thoracic Standards is still recommending BCG for Aboriginal children.[97] The World Health Organization recommends BCG vaccine for infants of high-risk groups, especially when there is a high risk of spread of TB within the family unit.[127] This is the case among Manitoba's Aboriginal population who tend to live in extended family situations where young children are exposed to elderly family members who have a high incidence of TB.

The International Union Against TB and Lung Disease criteria for discontinuation of BCG are: average annual recorded rate of smear-positive TB is 5 cases or less per 100,000 population during the previous 3 years, or average recorded rate of TB meningitis in children under 5 years old be less than one case per 10 million population over the previous 5 years, or the average annual risk of TB infection is less than 0.1%.[128] These criteria were developed by a consensus conference of TB experts, not based on clinical data.

Considerations are: Is there a well-functioning TB control program in place? Is there a reliable reporting system in place for demographics, microbiology, etc.? Is there due consideration for the possibility of increase in TB resulting from HIV/AIDS?

Additional considerations include cost in human suffering due to disease, cost of treatment, and adverse reactions to the vaccine.[128]

BCG is not recommended if risk of infection in the community is less than 0.1% per year, as the complications from BCG could outweigh the beneficial effect.[27] BCG should not be given to symptomatic individuals, because of local reactions and disseminated disease (BCG is a live vaccine); it should be used with caution in populations with high incidence of HIV.[12] Latent TB may be considered an opportunistic disease which is more pathogenic than many other opportunistic diseases.[12]

The effectiveness of BCG, measured by its ability to prevent tuberculosis disease, is found to be highly variable, from 0% to 80%.[27,129] In a case control study of Manitoba Registered Indians living on Indian Reserves, 1979 to 1983, Young[130] found that those who received BCG at birth had only 40% the risk of developing TB compared to those who did not receive BCG. A review of the literature by Clemens[131] found BCG to have efficacy of 56% to 80%; Rouillon and Waaler found it to be 14% to 80%.[28]

The length of time that BCG offers protection is also uncertain; it is commonly expected to last from 10 to 15 years.[132] BCG limits complications of tuberculosis and it is generally accepted that BCG helps prevent meningitis and miliary TB in children.[14,25,29,133] The present World Health Organization (WHO) policy, Expanded Programme of Immunization, is to vaccinate newborns with BCG, because BCG is known to offer protection against childhood TB.[132] However, because BCG is most effective

in tuberculosis that is not smear positive (non-contagious), and smear positive TB is uncommon in children. BCG may be more an individual preventative health measure than a public health measure. Therefore, BCG is most effective as one component of a TB control program.

BCG is considered to be very safe,[24,28,126] with a lower proportion of complications than that of other vaccines.[29] Complications, when they do occur, range from mild to lethal: scar formation, long-lasting ulcer, suppurated adenitis, osteitis, and death.[24,28,29] An additional negative aspect is loss of the tuberculin test as a diagnostic tool.[28]

Widespread use of BCG impairs the detection of infection.[128] The best indicator for assessing the trend and magnitude of the tuberculosis problems is the incidence or risk of TB infection.[134] Also, BCG does not have a significant impact on reactivation of TB.[14]

Immunogenicity is not the same as efficacy. Research in human populations has not shown that just because a BCG vaccination "takes" (tuberculin positive), it will necessarily give TB protection.[129]

CHAPTER 2

DESIGN AND METHODS

2.1 Objectives

1. Compare the incidence and trends in incidence of TB, within and among Manitoba Status Indians, the Manitoba general population, and other selected populations, over the 20-years period, January 1/75 to December 31/94.
2. Describe the TB incidence and TB risk factors among Manitoba Status Indians. The Manitoba general population, and other selected groups over the 20-year study period. Describe TB incidence within the Status Indian population.
3. Determine the efficacy of continued BCG vaccination of Manitoba Status Indian newborns, using the calculated rates of smear-positive TB and TB meningitis, and estimates of TB infection.
4. Determine the relative proportion of TB cases occurring in Status Indians and others in Manitoba prisons, and compare the demographic and microbiological features in these two groups. Determination of incidence rates will depend on availability of denominator inmate population data, by ethnic status.
5. Describe the measures presently in place to detect, treat, and control TB in Manitoba's Federal and Provincial prisons.

2.2 Study design

The study describes and analyzes the TB epidemiology of Status Indians in Manitoba, in the context of the overall TB

control program for that group. Registered Indians (Status Indians) are an identifiable group known to have a relatively high rate of tuberculosis.

The study encompasses a 20 year period from 1975 to 1994 inclusive. This 20 year period was chosen in order to detect long-term trends in incidence, as well as clinical and microbiological features in the Status Indian population.

This was a period of relative stability in the treatment and control of tuberculosis (after the introduction of anti-tuberculous drugs and modern public health measures). During this period, causes of an increase in TB rates and severity found in other parts of North America e.g. increased prevalence of HIV/AIDS[3] and multi-drug resistant strains of the bacteria[105] were not present on a large scale. Information from this period can serve as a baseline for future epidemiological studies.

The evaluation of continuing the current policy of BCG vaccine for newborns living on Indian reserves will follow the criteria of the International Union Against Tuberculosis and Lung Disease (IUATLD) for discontinuation of BCG vaccine in countries with low prevalence of tuberculosis. The criteria for discontinuation are:[128]

1) The average annual notification rate of sputum smear-positive pulmonary tuberculosis should be 5 cases/100,000 population or less during the previous three years.

or

2) The average annual notification rate of tuberculosis meningitis in children under five years of age should be less than one case per ten million general population over the previous five years.

or

3) The average annual risk of tuberculosis infection should be 0.1% or less.

TB occurs in geographic groups of people[52] (e.g. prisons, individual communities, certain urban areas); and within these pockets, in groups of people with similar characteristics, (e.g. age, sex, ethnic origin, lifestyle). Although macro data is useful when looking at trends, micro data may be even more useful for evaluating and targeting control measures, as it enables the fine-tuning of control measures to local conditions.

2.3 Confidentiality and ethical issues

Permission to use the Central Tuberculosis Registry was obtained through Dr. E. Hershfield, Director of Tuberculosis Services for the Province of Manitoba. Dr. Hershfield also negotiated access to the Federal prison. The study was approved by the Human Ethics Committee, Faculty of Medicine, at the University of Manitoba.

Initially, names of clients (TB cases) were noted, to avoid omissions and duplications. Computerized data from the Registry were then analyzed without including names. The study analyzed population data and not specific cases.

2.4 Sources of data

2.4.1 Central Tuberculosis Registry for Manitoba

The primary source of data is the computer and paper files kept by The Central Tuberculosis Registry. Under the Public Health Act, all cases of tuberculosis are reportable to the Registry. There files are maintained for each individual, so that multiple reporting does not result in multiple files for the same person.

The Central Tuberculosis Registry, is a division of the Tuberculosis Control Program of Manitoba,[135] under the legislated control of the Sanatorium Board of Manitoba. The *Sanatorium Board of Manitoba Act 1904.*[136] set up a third party delivery system for TB control.[136,137] The Board is funded by the Federal and Provincial governments, and private donations.[135] The Registry is responsible for a centralized province wide system of TB control recording.[135] Anti-tuberculin drugs are distributed free of charge through the TB Registry.[138] The Respiratory Clinic is the referral centre for all TB cases and suspected TB cases for Manitoba.[138] The TB Registry documents 100% of TB cases diagnosed in Manitoba.[138]

The TB Registry form "Notification of a New Active or Reactive Tuberculosis Case" contains demographic, as well as clinical and microbiological data. The form was revised in 1990, to include: date treatment started, drugs presently prescribed, if the patient was a resident of a long-term care facility, if a Registered Indian patient lives on a reserve most of the time,

method of detection, current chest X-ray results, and antibiotic resistance data. (See Appendix A and B).

2.4.2 Indian and Northern Affairs Canada

The Registered Indian or "Status Indian" designation refers to individuals listed in the Indian Registry, as specified by the *Indian Act*[139] maintained by Indian and Northern Affairs Canada. The category of "Status Indian", is confirmed by a registered treaty number which is listed on the TB Registry form.

Population statistics for Status Indians were obtained from Indian and Northern Affairs Canada.[42] Their population data include all Manitoba Indians registered under the *Indian Act*. The number of Status Indians living on-reserve is counted by their own Manitoba band.[140] This is updated every year.

It is unlikely that someone eligible for the Status Indian category would not be registered as such, because of supports offered to this group. These include uninsured health benefits (e.g. glasses, prescription drugs, dental work)[141] and financial assistance with post secondary education.

In 1985, *Bill C-31* amended the *Indian Act*, to reinstate Registered Indian status to certain individuals who had previously lost this status. The classification of Registered Indian was extended to some individuals who had previously been denied registration.[142] This increased the Status Indian population beyond the natural rate of increase, thus increasing denominator data in the calculation of incidence rates.[143] (See Table 1)

Table 1
Impact of Bill C-31 on the Status Indian population of Manitoba

year	Original population (a)	Bill C-31 population (b)	Combined population	% increase (b/a * 100)
1985	53172	1114	54286	2.10
1986	52663	2644	56421	5.02
1987	54614	2546	60918	4.66
1988	56204	1806	64314	3.21
1989	57042	1466	66618	2.57
1990	61242	861	71679	1.41
1991	64366	1013	75815	1.57
1992	67632	701	79783	1.04
1993	69943	848	82942	1.21
1994	85893	1090	86982	1.27
mean	62277.1	1408.9	63686.0	2.26

Source: INAC population statistics;[42] *Bill C-31* population statistics. Indian and Northern Affairs Canada.[143]

2.4.3 Statistics Canada

Population statistics for the general Manitoba population were obtained from the Census of Canada. Statistics Canada.[41] Actual counts of the population were done by census in the years 1976, 1981, 1986, and 1991. In the years between the Census counts, population is estimated annually, using information from the previous Census, Revenue Canada tax files, Citizenship and Immigration Canada, and various other sources.[40]

Socioeconomic indicators were assigned to individual cases through the use of data gathered by Statistics Canada, 1991

Census. These indicators were used to evaluate data for the years 1990 through 1994 only. Socioeconomic data are averaged for each enumeration unit in Manitoba: these units correspond approximately with postal code areas. Postal code grouping shows a more accurate socioeconomic picture than large groupings such as health regions or districts.[144]

Counts of cases of tuberculosis meningitis, identified through International Classification of Disease (ICD-9) code 013.0.[145] were obtained from the Health Statistics Division of Statistics Canada. This was used for assessing the appropriateness of continued BCG vaccine, under the second IUATLD criteria.

2.4.4 Manitoba Health

Manitoba Health Services Commission (MHSC), the provincial health insurance agency, provides free of charge to all residents of Manitoba those health care services defined under the *Medical Care Act.*[146] and supplementary services approved by the Province.[147] Virtually all residents of Manitoba are registered with this plan. MHSC is a major tabulator of population statistics in Manitoba. Counts are updated yearly, by noting of migration, births and deaths.[148]

2.4.5 Federal Prisons

Correctional Services Canada (CSC) is responsible for Federal prisons throughout Canada. Manitoba has two Federal Correctional institutions, both located at Stony Mountain.[149]

Personal inspection was made of the on-site medical treatment facilities. Policies and procedures used in tuberculosis control for CSC were obtained from the Acting Chief of Health Care. through the Office of the Deputy Warden. Stony Mountain Penitentiary.[149]

The number of person-days by ethnic origin is not available through Correctional Services Canada computerized information system. only through paper records.[150] Determination of person-days by ethnic origin was too labour intensive for this study. As well. North American Indian status is documented according to self-identified ethnic background and not by registration under the *Indian Act.*[150] therefore the prison population statistics may not be accurate under the criteria of Status Indian used for this study.

2.4.6 Provincial Prisons

Information regarding TB control programs and inmate population statistics for Provincial prisons were obtained by telephone interviews with personnel in the Department of Justice for the Province of Manitoba. Adult Corrections. and individual correctional institutes.

Two Provincial correctional facilities were excluded from this study because of high turn over of the inmate population. making TB control programs difficult to maintain. The Manitoba Centre for Youth with approximately 200 inmates. houses short term juvenile offenders: the Remand Centre with approximately 300 inmates houses short term adult offenders. Both facilities are

located in Winnipeg. Female adult short term offenders are housed at the Portage Correctional Institute and these have been included in the Portage population counts: the number of inmates is approximately 15 out of the total population of approximately 50.[151]

2.5 Data management

2.5.1 Population Statistics

Indian and Northern Affairs Canada (INAC), Statistics Canada, and Manitoba Health Services Commission (MHSC) population estimates were investigated as possible denominator data to calculate rates and proportions of TB cases in this study.

Considerations when selecting population counts for denominator data used for calculating TB incidence rates and proportions for both Status Indian and the general population were: a) accuracy; b) accessibility; c) compatibility.

Statistics Canada

The Statistics Canada Census is conducted every five years, when every household is polled. In recent years, accuracy of population counts were estimated to be as high as 99%.[152] The census can be considered the gold standard for population counts. Post-census populations are estimated using several highly reliable government sources of information.

Although Census population statistics may be considered the gold standard for the general population, it cannot be considered so for the Registered Indian population. Starting in 1981, the categories of Status Indian and other Aboriginal groups were

documented according to self-identified ethnic background.[153] In 1981, the Census Canada count of Status Indians in Canada was 82.4% of the INAC count. Response to the census was recorded from all Manitoba reserves.[153] Although this method of determining who is an Indian may be more accurate than registration number, for the purpose of this study only Registered Indians are considered.

In the Statistics Canada 1991 Census, several First Nations were not (for various reasons) included either in part or in total.[154] (MSB-education) These were: Cross Lake (19C), Gambler (63), Gillam, Highrock (199), Lizard Point (62), Long Plain (part 6), Nelson House (170A and 170B), Roseau Rapids (2A), Roseau River (2), Shoal Lake (part 40), The Pas (21B and 21C), Valley River (63A).[154]

There is an overlap of unknown proportion between the Registered Indian population and the self-identified Métis population. Statistics Canada Census population counts were used for the Métis population. Although these statistics may not be highly accurate they were used because they are the only population statistics available for the Métis population.

Statistics Canada population data was used to calculate incidence rates for the general population because it used a census which is considered to be highly accurate. The information is published in detailed form and is compatible with the data needed for this study.

Indian and Northern Affairs Canada (INAC)

When determining Status Indian origin, this study used the criteria for Registration under the *Indian Act*, the same as used by INAC for their population data.

A contentious aspect of the INAC data is that it does not consistently count Status Indians from other provinces who live in Manitoba, or delete Manitoba Status Indians living outside of this province. INAC on-reserve population statistics are dependant on Band membership counts conducted by each individual Band. Local enumerators may know if a Band member has left the reserve, and they may not know if a new community member is from another reserve.[140]

Despite these issues, the INAC population statistics were used as denominator data when calculating TB incidence rates of Status Indians. This data is compatible with the study, and it is considered the most representative of population statistics available because it includes all Indian Bands in Manitoba. INAC population statistics are calculated and published on an annual basis. Error in counts is considered to be random.

Manitoba Health Services Commission

Manitoba Health Services Commission (MHSC) covers virtually everyone who is a resident of Manitoba. The population registers with this program because of the free health care it provides.

MHSC population statistics are calculated yearly taking into consideration numbers for migration in and out of the province, and for births and deaths. MHSC counts are usually higher than actual numbers, because they hold records of people who have left

the province. An audit between 1979 and 1981 removed 27.000 names from the registry. Presently, if there is no MHSC activity in 2 years, an enquiry by mail is sent; if no answer is received, the person is considered not to be in the province,[148] while in fact they may just not have had any need for medical service and could not be reached by mail.

The MHSC population counts were not used, because they showed the highest potential for inaccuracy, but were considered as denominator data for completeness of examination of all available pertinent data bases.

The possible exception to this may be the population counts for Status Indians in the age group 0 through 4 years. Most babies in Manitoba are born in hospital, and they will likely be documented as Status Indians if one or both of their parents are Registered. These babies are not, however, automatically registered with INAC, and must be registered by a parent, sometimes years after they are born.[140]

The impact of this late registration of babies is unknown, therefore MHSC population statistics for this age group were not considered.

2.5.2 TB Registry forms

Not all of the information found on the "Notification of New Active and Reactive Tuberculosis Case" form for the TB Registry was used. Emphasis was on demographic data related to possible risk factors, microbiological data, drug resistance because of

its implication on TB control, and BCG status - to evaluate that aspect of TB control.

Of the demographic information, ethnic origin, sex, age, postal code, and geographic location were selected. Clinical data include site of disease and BCG status. Bacteriological data includes bacillary status, and drug resistance.

The Manitoba Central Tuberculosis Registry uses the definition of a tuberculosis case as set out by The Canadian Tuberculosis Reporting System. It is as follows:[155]

1) cases with *Mycobacterium tuberculosis* complex demonstrated on culture.

or

2) cases with significant symptoms even without bacterial proof (preferably with a significant tuberculin reaction), such as:
   a) chest X-ray change compatible with active tuberculosis, including idiopathic pleurisy with effusion
   b) clinically active non-respiratory tuberculosis (meningeal, bone, kidney, etc.)
   c) pathologic or post-mortem evidence of active tuberculosis.

An incidence case is any case of tuberculosis diagnosed during the study period. Incidence rates per year will be based on cases diagnosed in that year. This will include cases not previously diagnosed (new active case) and previously diagnosed cases that were again diagnosed after a period of inactivity

(reactivated case). In each year, the portion of the population not diagnosed with TB in that year is deemed to not have TB.

For microbiological analysis of sputum, the classifications of "pulmonary" was examined. They are as follows[145]:

011 pulmonary tuberculosis

011.0 of lung, infiltrate

011.1 of lung, nodular

011.2 of lung with cavitation

011.3 of bronchus (excludes 012.2)

011.4 fibrosis of lungs

011.5 bronchiectasis

011.6 pneumonia (any form)

011.7 pneumothorax

011.8 other specified pulmonary

Drug resistance is defined as antibiotic resistance to one or more anti-tuberculin drugs, as shown on an initial positive culture.[156]

Demographic

On the TB Registry forms ethnic origin included Registered Indian, Unregistered Indian or Métis, Inuit, and Other.

Sex stratified by male and female is self explanatory.

The age groups at time of diagnosis are: 0-4, 5-14, 15-34, 35-64, 65+. The rationale for this grouping is as follows.

The age category of children under 5 years (0-4) was selected for the BCG analysis. It is generally accepted that BCG helps prevent meningitis and miliary TB in children.[29] and

children < 4 years are more likely than those > 4 years to have disseminated disease.[26]

The second age category of 5 through 14 years (5-14) was selected because young people tend to have a low incidence of tuberculosis: they now live through time when there is less TB around, and in the few years of their life had relatively low risk of exposure to TB. In the United States, 1963-1986, this age group showed the highest average percentage annual decline in TB incidence.[20]

The 15 to 34 years age group (15-34) is considered a marker for TB associated with HIV/AIDS infection. An increase in TB relative to the foreign-born, or a shift of older to younger cases, may be associated with HIV.[20,59] In Manitoba, young adults have had the highest numbers of documented HIV infection.[123]

In Manitoba, the 20 to 39 years age group (20-39) shows the highest prevalence of HIV/AIDS. This age group was also analyzed to determine a possible association between the spread of HIV/AIDS and tuberculosis.[123]

The age of over 65 years (65+) was arbitrarily chosen as an elderly population, because this is an age commonly designated as "senior citizen". Old age is a risk factor for tuberculosis, because these Canadians have lived during a time when TB was more prevalent than now and therefore there was more risk of exposure.[3,58] Also, with old age there is lowered resistance to disease.[3]

The 35 to 64 year age group (35-64) is a remaining group, added for completeness, to cover all age groups.

Age at diagnosis is obtained by subtracting date of birth from date of diagnosis. Months are expressed as a portion of a year. Missing month variables were dealt with as if the subject was born in June.

Comparison between Status Indians living on Indian reserves (on-reserve) and those not living on a reserve (off-reserve) was also made, to see whether geographic location and health care agency made a difference in incidence of tuberculosis. Those Status Indians designated by INAC as living "On Crown Lands" were included in the on-reserve category, because most in this category are overflow from reserve land, or have created a community without official reserve status.[157] These comparisons were done for the time period 1990 through 1994 only; on/off reserve data was not gathered before this time.

The on-reserve Status Indian population was stratified by Federal primary care treatment services and Provincial primary care treatment services. Federal service includes Medical Services Branch (MSB) Nursing Stations, Band run health care facilities, and two Federal hospitals. Provincial service includes Health Stations, which supply public health and first aide, run by Manitoba Health, and Provincially run hospitals. Status Indians living in a community with primary care service provided by the Federal Government are considered to use Federal Government primary care; those living in communities with Provincial service are considered to be users of Provincial service. (See Appendix C).

Medical Services Branch categories for location are as follows: Type I - remote isolated (no road access, minimum communication service); Type II - isolated (no road access); Type III - semi isolated (road access to nearest physician service is greater than 90 km); Type IV - non isolated (road access to physician service less than 90 km).[158] Type I and Type II were considered to be remote. Type III and Type IV were considered to be non-remote.

2.6 Estimation of TB infection

The incidence of TB infection is difficult to determine in the Status Indian population, as tuberculosis skin testing is no longer performed in Manitoba. When skin testing is used, BCG renders the results difficult to interpret.

The incidence of TB infection was estimated using the following formula:[50]

annual incidence of new TB infection	x	annual rate of progression from primary infection to disease	=	annual incidence of primary TB cases (disease)
(a)		(b)		(c)

Therefore: a = c/b

For determination of variable c, the mean number of primary TB cases per year, per 10,000 population, averaged over a 5-year period was used.

2.7 Statistical methods

The Number Cruncher Statistical System (NCSS) software was used for all statistical analysis. The Central Tuberculosis

Registry ASCII text files were imported into the NCSS format. In all cases, significance was assessed at the 0.05 level.

CHAPTER 3

RESULTS AND DISCUSSION

3.1 Comparison of TB incidence and trends between and within populations

3.1.1 Overall TB incidence rates by population

Over the study period 1975 through 1994, the TB incidence rates in Manitoba have decreased significantly. Using simple least squares linear regression analysis, the total Manitoba population rate decreased by 0.6 cases/100,000 people per year ($p<0.000$). TB rates in the two high risk populations for TB also decreased, the Status Indian population by 5.0 ($p=0.001$) per year and the immigrant population by 0.6 per year ($p<0.000$). (See Table 1).

Using linear regression analysis with incidence rate ratios as the dependant variable, the gap between the incidence rates of the Status Indian versus the total Manitoba population has not changed significantly over the 20-year period. However, with a $p=0.0522$, the gap was estimated to have narrowed by a rate of 0.09 per year. Given the small n (20) this may be suggestive of a narrowing of the incidence rate gap between the two populations, with a relatively greater decrease in the Status Indian incidence rate. The gap between the immigrant versus the total Manitoba population incidence rates has increased by 0.04 per year ($p=0.0025$), due to a slower decline in TB incidence in the immigrant population. (See Table 2).

Mean annual tuberculosis incidence rates for the total Manitoba population was 13.7/100,000, for the Status Indians

population 87.9/100,000, and for immigrants 25.8/100,000 over the study period. (See Table 2).

The Registered Indian population of Manitoba has more than doubled over the 20 year study period, from 41,187 in 1975 to 86,982 in 1994.[42] Part of this growth is due to the impact of Bill C-31, an amendment to the Indian Act in 1985 that allowed registration of people not previously eligible for registration, and reinstatement of registration under the Act[142]. This resulted in the sudden increase in the baseline population and along with a higher birth rate, has resulted in an increase in the proportion of Registered Indians (a high-risk group for tuberculosis) in the Manitoba population (4.01% in 1975, 7.69% in 1994).

Over the same time period, the non-Aboriginal population has increased only 6%, from 985,713 in 1975 to 1,044,118 in 1994[40]. The immigrant population has decreased in number and in proportion to the total Manitoba population over the same period, from 147,308 (14.34% of the Manitoba population) in 1975 to 138,595 (12.25%) in 1994.[41]

Table 2
TB cases, incidence rates+ and rate ratios, for Status Indian, immigrant, and total Manitoba population, 1975-1994.

	Total *		Status Indian **			Immigrant*		
year	case	rate+	case	rate+	RR	case	rate+	RR
1975	195	19.0	53	128.7	6.8	43	29.2	1.5
1976	202	19.8	53	125.3	6.3	44	29.9	1.5
1977	172	16.5	50	115.3	7.0	46	31.2	1.9
1978	176	16.9	50	112.0	6.6	38	25.8	1.5
1979	181	17.4	63	137.3	7.9	46	31.2	1.8
1980	172	16.6	46	97.2	5.9	43	29.4	1.8
1981	149	14.5	39	80.1	5.5	49	33.5	2.3
1982	153	14.6	54	108.1	7.4	35	24.0	1.6
1983	208	19.6	93	181.0	9.3	42	28.8	1.5
1984	181	16.9	60	115.3	6.8	40	27.4	1.6
1985	147	13.6	45	82.9	6.1	39	27.4	2.0
1986	133	12.5	38	67.3	5.3	39	27.4	2.2
1987	126	11.4	44	72.2	6.3	32	22.5	2.0
1988	112	10.1	31	48.2	4.8	33	23.2	2.3
1989	97	8.8	29	43.5	5.0	32	22.5	2.6
1990	92	8.3	25	34.9	4.4	27	19.5	2.4
1991	101	9.2	34	44.8	5.0	34	24.5	2.7
1992	88	7.9	30	37.6	5.0	28	20.2	2.6
1993	107	9.5	48	57.9	6.4	21	15.2	1.6
1994	115	10.1	60	69.0	6.9	31	22.4	2.2
mean	145.4	13.7	47.3	87.9	6.2	37.4	25.8	2.0

+ Incidence rates per 100,000 population
* Total population and immigrant population incidence rates based on Statistics Canada population statistics.
** Status Indian incidence rates based on INAC population statistics.

3.1.2 TB incidence rates and trends by age group

TB incidence may not change at the same rate in all age groups. TB rates were stratified by age group and analyzed.

Table 3
Total TB incidence rates+ in Manitoba,
by age group, 1975-1994

year	0-4	5-14	15-34	35-64	65+	total	20-39
1975	16.6	13.4	14.5	23.5	32.6	19.0	18.5
1976	18.2	9.3	18.0	21.9	37.5	19.8	23.0
1977	8.5	7.8	14.5	20.1	32.6	16.5	18.5
1978	8.6	7.4	17.9	20.0	25.6	16.9	17.6
1979	17.5	13.6	15.4	18.7	24.9	17.4	17.4
1980	5.1	7.3	16.2	19.6	29.3	16.6	16.3
1981	9.1	8.7	12.9	15.5	27.9	14.5	13.3
1982	7.7	3.7	14.5	13.5	36.1	14.6	13.3
1983	6.3	23.6	18.1	18.1	30.7	19.6	17.5
1984	10.0	14.3	15.3	17.2	27.8	16.9	16.2
1985	11.2	7.5	13.1	14.6	20.3	13.6	12.8
1986	5.0	5.1	11.5	16.1	19.4	12.5	12.7
1987	2.4	2.5	11.7	14.8	18.0	11.4	12.6
1988	2.4	3.1	8.1	11.7	24.1	10.1	10.0
1989	6.0	1.9	9.3	9.8	14.0	8.8	10.7
1990	4.8	0.6	7.8	10.0	15.8	8.3	9.7
1991	6.1	0.6	10.2	9.4	17.7	9.2	10.4
1992	3.6	0.6	4.8	9.4	20.7	7.9	5.9
1993	4.8	1.2	7.5	13.6	17.2	9.5	10.9
1994	4.8	6.2	10.8	7.4	24.9	10.1	10.1
mean	7.9	6.9	12.6	15.2	24.8	13.7	13.9

+cases per 100.000 population

Table 4
Status Indian TB Incidence Rates+ in Manitoba,
by age group, 1975-1994

year	0-4	5-14	15-34	35-64	65+	total	20-39
1975	132.5	127.3	96.5	193.1	128.5	128.7	116.4
1976	101.4	117.7	126.4	86.4	380.0	125.3	120.2
1977	34.5	72.2	120.7	238.6	123.3	115.3	132.3
1978	101.0	57.1	121.0	177.2	243.9	112.0	109.5
1979	115.9	106.4	103.2	263.6	239.7	137.3	112.4
1980	31.8	49.5	121.3	127.1	294.3	97.2	114.4
1981	61.8	42.5	82.7	61.0	519.6	80.1	86.3
1982	76.8	35.5	110.5	210.9	280.7	108.1	102.4
1983	60.0	212.2	166.2	202.7	442.2	181.0	181.0
1984	83.0	105.9	125.5	140.8	52.5	115.3	134.8
1985	77.2	41.8	91.8	103.1	153.4	82.9	92.1
1986	14.7	40.7	55.7	114.1	286.4	67.3	59.4
1987	0	19.6	79.3	127.2	261.6	72.2	96.6
1988	17.7	18.7	40.6	91.9	163.8	48.2	44.2
1989	18.6	6.1	46.1	71.2	152.8	43.5	45.8
1990	17.0	6.1	31.4	61.4	186.9	34.9	40.7
1991	36.7	5.9	50.6	57.0	209.4	44.8	44.7
1992	0	0	16.4	101.9	258.7	37.6	24.9
1993	31.6	5.5	51.3	137.8	184.8	57.9	85.6
1994	28.4	30.3	64.8	84.4	371.1	69.0	72.7
mean	52.0	55.1	85.1	132.6	246.7	87.9	90.8

+cases per 100,000 population

There is variability in the TB incidence rates from year to year. This could be due to delayed case reporting, causing cases from one year to be reported in the following year. Another possibility is the small population in each age group (small denominator) allows for a high variability.

A relatively low incidence rate in one year followed be a relatively high incidence rate in the next year is suggestive of delayed recording of TB cases to the following year. This did occur in some years. Arbitrarily, a greater than two fold change in incidence rate from one year to the next was examined. This greater than two fold increase occurred in age group 5-14, year 1982 (3.7) to 1983 (23.6) and 1993 (1.2) to 1994 (6.2). (See Table 4).

However, more often, a greater than two fold decrease in incidence rate was seen from one year to the next. This occurred twice in the 0-4 age group, twice in the 5-14 age group, and once in the 15-34 age group. It is unlikely that this could be due to a case being recorded in the previous year (TB case recorded before it happens). (See Table 4).

Greater variability was shown in the two youngest age groups which had the lowest and third lowest mean populations: 81,387 (7.6% of total population) for the 0-4 age group and 164,842 (15.3% of total population) for the 5-14 age group. It is likely the variability in incidence rates is due to actual variability in cases per year and possibly due to the relatively small populations in these age groups.

In the Status Indian populations a greater than two fold difference in TB incidence rates from one year to the next was seen 20 times in the data as opposed to seven times in the total Manitoba populations. In 10 out of the 20 incidence there was a greater than two fold increase: in 10 out of 20 times the change was a decrease. The Status Indian populations in each age group

are smaller than the total populations in the corresponding age groups (smaller denominator) which is the more likely reason for the variability. In the total Status Indian population there were no greater than two fold changes from one year to the next.

To analyze within population incidence rates, by age group, over time, a linear regression model was used. The results are summarized in Table 5.

Table 5
Linear regression analysis of TB incidence rates
Status Indian and total Manitoba population,
by age group, 1975 through 1994.

	total population				Status Indian			
age group	intercept	p	slope for year	p	intercept	p	slope for year	p
0-4	13.4	<.001	-.58	<.001	98.9	<.001	-4.93	<.001
5-14	12.4	<.001	-.58	.007	110.9	<.001	-5.87	.002
15-34	17.7	<.001	-.54	<.001	132.5	<.001	-4.99	<.001
35-64	22.1	<.001	-.71	<.001	189.9	<.001	-6.04	.008
65+	33.4	<.001	-.91	<.001	260.5	<.001	-1.46	.754
Total	19.5	<.001	-.61	<.001	135.4	<.001	-4.96	<.001

TB incidence rates decreased significantly in the total Manitoba population, in all age groups. In the Status Indian population, incidence rates decreased significantly in all age groups with the exception of the oldest age group (65+). This indicates that TB incidence rates in the oldest people, in the Status Indian population, are not changing. With an intercept (incidence at year 1975) of 260.50 (p=0.0001), it almost two

times greater than the intercept for the total Status Indian population (135.4, $p<0.000$). This indicates that the oldest people in the Status Indian population are a high risk age group within a high risk population.

TB incidence rate proportions by age group.

TB cases occurring in young children is a marker for new transmission within a community, because young children are unlikely to develop reactivated disease from previous infection. Conversely, communities where the burden of disease is found primarily in older age groups may indicate little new transmission, if cases represent reactivated disease in older people and if they are diagnosed and treated prior to becoming significantly infectious to others.

HIV/AIDS infection has been well documented as a risk factor for TB reactivation and progression from primary infection to disease.[9] An increase in tuberculosis in the young adult age group may be considered a sentinel marker for HIV/AIDS in the population.[20] Young adults have the highest recorded incidence rates of HIV/AIDS infection in Manitoba,[123] as well as in the rest of Canada and the United States.[159,160,161,162] In Manitoba, documented HIV infection and AIDS has its concentration in the 20 through 39 year age group.[123]

Population incidence rates in these four age groups compared to all age groups were analyzed by linear regression, with the rate ratio, age group/all ages, as the dependant variable. The results are summarized in Table 6.

Table 6
Linear regression analysis of TB incidence proportion by age group, within populations, 1975 through 1994.

	total population				Status Indian			
Age group total	inter cept	p	Slope for year	p	inter cept	p	slope for year	p
0-4	.70	<.001	.01	.014	.77	<.001	.02	.035
15-34	.92	<.001	-.01	.861	1.02	<.001	-.01	.289
20-39	1.01	<.001	.00	.818	1.00	<.001	.00	.589
65+	1.67	<.001	.02	.145	1.64	.017	.17	.007

The TB incidence rate in the youngest age group (0 through 4 years) has increased significantly, compared to the total rate, over the 20-year study period for both the total Manitoba population (slope 0.014, p=0.014) and the Status Indian (slope 0.024, p=0.035). This indicates the possibility of increased new transmission in both populations. The mean incidence rate ratio for this age group by population was 0.562 for total Manitoba and 0.543 for Status Indians.

The TB incidence rate in the oldest age group (65+ years) has not changed significantly, compared to the total rate, over the 20-year study period for the total Manitoba population. In the Status Indian population, the incidence in this age group has increased significantly compared to the total (slope 0.171, p=0.0065). This may indicate a increase in reactivated disease. However, the population count in this age group is small (mean 2116) and the trend is over only 20 years. The mean incidence rate ratio for the 65+ age group, for the total Manitoba

population was 1.853, for the Status Indian population it was 3.267.

A communal lifestyle as practiced in the Aboriginal population, where extended family live together in the same household, may provide an environment in which TB is more easily transmitted, compared to the non-Aboriginal Manitoba population where nuclear families are more common.

The TB incidence rate for the young adult age group (15 through 34 years) has not changed significantly, compared to the total rate, over the 20-year study period for the total Manitoba population or the Status Indian population. The mean TB rate ratio (15 through 34 years/all ages) for this period was 0.923 for the total Manitoba population and 0.952 for the Status Indian population.

The TB incidence rate for the young adult age group which has the highest incidence of AIDS/HIV (20 through 39 years) has not changed significantly, compared to the total rate, over the 20-year study period for the total Manitoba population or the Status Indian population. The mean TB rate ratio (20 through 39 years versus all ages), for this period was 1.033 for the total Manitoba population and 1.021 for the Status Indian population. This suggests that HIV/AIDS may not have been a major factor in the epidemiology of tuberculosis in Manitoba over the study period.

It is unknown how many TB cases had HIV or vice versa because HIV was not reportable until 1999, not all TB cases were

tested for HIV, and if they were tested the result may not have been recorded by the TB Registry.

3.1.3 TB rates and trends by age group and sex

To analyze within population incidence rates for each sex, by age group, over time, a linear regression model was used. The results are summarized in Table 7 and Table 8.

Table 7
Linear regression analysis of TB incidence
by sex, within the total Manitoba population, 1975 through 1994.

	male		female	
age group	slope for year	p value	slope for year	p value
0-4	-0.69	0.004	-0.43	0.011
5-14	-0.43	0.018	-0.73	0.011
15-34	-0.41	0.002	-0.70	<0.001
35-64	-0.82	<0.001	-0.62	< 0.001
65+	-1.44	<0.001	-0.47	0.035
total	-0.62	<0.001	-0.60	<0.001

Table 8
Linear regression analysis of TB incidence by sex, within the Status Indian population, 1975 through 1994.

	male		female	
age group	slope for year	p value	slope for year	p value
0-4	-6.02	0.002	-3.89	0.009
5-14	-4.84	0.003	-6.96	0.010
15-34	-5.29	0.002	-4.86	<0.001
35-64	-4.19	0.092*	-7.92	0.003
65+	-2.82	0.706*	-0.27	0.955*
total	-4.64	<0.001	-5.25	<0.001

*not significant

The TB incidence rates have been decreasing significantly in the total Manitoba population, for both males and females, in all age groups. (See Table 7).

In the Status Indian population there was no significant decrease in incidence rates in the 35-64 years age group males; and the 65+ years age group, males and females. This indicates that the TB incidence rates for the oldest people in the Status Indian population, both male and female have not significantly changed over time. (See Table 8) Within population comparison of TB incidence, female versus male, by age group, were analyzed over time, using a linear regression model. The dependant variable is the rate ratio of female/male incidence rate. The results are summarized in Table 9.

Table 9
Linear regression analysis of TB incidence rate ratios, female/male, within population, 1975 through 1994.

female/male	total population		Status Indian	
age group	slope for year	p value	slope for year	p value
0-4	0.06	0.264	-0.05	0.422
5-14	-0.07	0.127	-0.09	0.080
15-34	-0.02	0.211	0.03	0.042
35-64	<0.01	0.807	-0.03	0.153
65+	0.01	0.163	0.07	0.099
total	<-0.01	0.768	<-0.01	0.909

In the total Manitoba population, the ratio of female to male TB incidence rates, have not changed significantly, in any age group, over the 20-year study period.

In the Status Indian population, this incidence rate ratio has not changed significantly in any age group, with the exception of the age group 15 through 34 years. In this age group the female incidence rates are increasing significantly relative to male incidence. (See Table 9).

Between population comparison of TB incidence by age group and sex were analyzed over time, using a linear regression model. The dependant variable is the incidence rate ratio of Status Indian/total Manitoba, by sex and age group. (See Table 10).

Table 10
Linear regression analysis of incidence rate ratios by sex. between population. by age group 1975 through 1994.

Status Indian /total	male		female	
age group	slope for year	p value	slope for year	p value
0-4	-0.30	0.136	-0.24	0.134
5-14	-0.22	0.075	-0.25	0.071
15-34	-0.24	0.006	-0.06	0.241
35-64	0.12	0.301	-0.12	0.450
65+	0.18	0.317	0.39	0.096
total	-0.08	0.064	-0.09	0.116

Between population comparison of TB incidence rates by sex. have not changed significantly. over the 20-year study period. with the exception of males in the 15 through 34 years age group. In this case the Status Indian male rate has decreased significantly faster than the total male incidence rate in this age group.

3.1.4 TB incidence rates on-reserve versus off-reserve.

TB incidence rates based on DIAND population statistics indicate lower TB incidence rates on-reserve than off-reserve for the period 1990 through 1994. Mantel Haenszel Chi square 13.96. 1 df. $p < 0.001$. with a mean rate ratio. on-reserve versus off-reserve. 0.59. (See Table 11). Prior to 1990. on-reserve and off-reserve designations for Status Indians had not been recorded by the TB Registry.

Table 11
Comparison of Status Indian TB rates+
on-reserve versus off-reserve, 1975 through 1994.

	On-reserve			Off-reserve			RR	M-H
Year	cases	pop	rate	cases	pop	rate	On/ off	Chi
1990	11	52013	21.15	14	19666	71.19	0.30	0.001
1991	23	51019	45.08	11	24796	44.36	1.02	0.965
1992	17	53239	31.93	13	26544	48.98	0.65	0.242
1993	20	55617	35.96	28	27325	102.47	0.35	0.001
1994	38	58364	65.11	22	28618	76.87	0.85	0.535
Mean	21.5	54050	39.85	16.5	25390	68.77	0.59	

+cases per 100,000 population

The population counts (denominator data) are submitted to DIAND by individual Bands. Local recorders of these counts may not know if someone has left the community or returned to the community. It is probable that these counts would err on the side of overestimation of on-reserve numbers, because funding for some reserve services is calculated on a per capita basis.[163]

A deflation of on-reserve population counts by 17% (and a corresponding increase in off-reserve counts) would result in a convergence of incidence rates in the two groups (mean rate ratio 1.00). Thus it seems likely that TB rates off-reserve are higher than on-reserve presuming that possible inflation of on-reserve population statistics is less than 17%.

Trends in TB incidence rates for both on-reserve and off-reserve Status Indian populations were not noted because of the short time period (1990 through 1994) of the data.

On-reserve versus off-reserve TB incidence comparisons may be considered as rural versus urban comparisons. Most Status Indians living off-reserve live in urban areas, while all of the reserves are considered to be rural. (See Methods).

The difference between on-reserve and off-reserve (urban and rural) TB incidence rates may reflect the migration of those with greater risk factors to urban areas. As an example, people with end stage renal disease (a risk factor for tuberculosis) may move from a remote area where dialysis treatment is not available to an urban area where it is available and therefore increase TB incidence rates in urban areas. However, the lower mean annual TB incidence rate, 1990 through 1994, of the non-remote reserves (18.18 cases/100,000 population) compared to the remote reserves (64.83 cases/100,000 population), does not support this theory. (See Table 11). All of the non-remote reserves are within three and a half hours drive to a secondary or tertiary hospital (The Pas, Thompson, Brandon, or Winnipeg) where they can receive specialized care and still be able to live in their non-remote reserve home. Status Indians from remote reserves with special treatment needs would have to relocate to have these needs met.

3.1.5 On-reserve Status Indian TB incidence rates by location and primary health care agency

Geographic location is a risk factor for exposure to tuberculosis and may be a risk marker for development of disease.

Tuberculosis spreads in locations where people with infectious TB come into personal contact with those who are susceptible. Many remote Indian reserves in northern Manitoba are characterized by risk factors for tuberculosis infection and disease.

The type of primary health care services may affect access to treatment for tuberculosis and case finding efforts may vary with health care provider.

The Registered Indian population living on-reserve was further stratified by major primary health care provider - Federal versus Provincial, and by location - remote versus non-remote. (See Methods section for definition of remote and non-remote reserves). There is considerable overlap between these two variables. Most reserves that are considered to be remote have primary health care provided by the Federal Government, while those that are considered to be non-remote are usually serviced by Provincial agencies. The most prominent exception to this is the large Peguis reserve (on-reserve population in 1994 was 2406) which is not remote, but has a Federal Government hospital.

Status Indians living in a community with primary care service provided by the Federal Government are considered to use Federal Government primary care; those living in communities with Provincial service are considered to be users of Provincial service.

There was a significant difference between the proportion of the population serviced by Federal primary health care versus

Provincial primary health care. (Chi^2 1695.6. 19 df. p< 0.001). There was no significant change however. in these proportions over the 20-year period (1975 through 1994). The mean proportion of Federal Government primary health care was 55.6%; for the Provincial Government it was 44.4%. (See Table 12).

There was a significant difference between the population proportion for remote versus non-remote reserves. (Chi square 435.9. 19 df. p< 0.001). The mean proportion for the 20-year period was 51.9% for remote location; 48.1 for non-remote. (See Table 12).

There was a small but significant decrease. in the proportion of population living in remote reserves and a corresponding increase in the proportion living in non-remote reserves. A linear regression model was used to analyze this. with the dependant variable as remote/non-remote proportion of population. The proportion ratio increased on average by 0.1135 per year (p=0.0046). (See Table 12).

Table 12
Status Indians population, on-reserve,
by primary health care provider and location, 1975 through 1994.

	Health care agency		Location	
year	Federal health care (%)	Provincial health care n (%)	remote n (%)	non-remote n (%)
1975	17385 (55.4)	13997 (44.6)	16043 (51.1)	15339 (48.9)
1976	17751 (55.9)	14004 (44.1)	16443 (51.8)	15312 (48.2)
1977	18130 (55.9)	14298 (44.1)	16825 (51.9)	15603 (48.9)
1978	18580 (56.5)	14302 (43.5)	17266 (52.5)	15616 (47.5)
1979	19025 (56.8)	14464 (43.2)	17682 (52.8)	15807 (47.2)
1980	19698 (56.9)	14948 (43.1)	18295 (52.8)	16351 (47.2)
1981	20164 (57.1)	15138 (42.9)	18725 (53.0)	16574 (47.0)
1982	20755 (57.1)	15580 (42.9)	19279 (53.1)	17056 (46.9)
1983	21400 (57.0)	16123 (43.0)	19881 (53.0)	17642 (47.0)
1984	21765 (57.0)	16394 (43.0)	20236 (53.0)	17923 (47.0)
1985	22689 (56.8)	17228 (43.2)	21115 (52.9)	18802 (47.1)
1986	23519 (57.1)	17692 (42.9)	21821 (52.9)	19390 (47.1)
1987	24098 (56.5)	18574 (43.5)	22221 (52.1)	20451 (47.9)
1988	24289 (55.4)	19575 (44.6)	22426 (51.1)	21438 (48.9)
1989	24640 (55.2)	20006 (44.8)	22811 (51.1)	21835 (48.9)
1990	30460 (58.6)	21553 (41.4)	24471 (51.0)	23477 (49.0)
1991	28098 (55.1)	22921 (44.9)	26096 (51.1)	24923 (48.9)
1992	29204 (54.9)	24035 (45.1)	27021 (50.8)	26218 (49.2)
1993	29943 (53.8)	25674 (46.2)	27680 (49.8)	27937 (50.2)
1994	31285 (53.6)	27079 (46.4)	28938 (49.6)	29426 (50.4)
mean	**23144 (56.1)**	**18179 (43.9)**	**21264 (51.9)**	**19856 (48.1)**

Since 1990 on/off-reserve designations for Status Indians have been recorded by the TB Registry. The mean annual TB incidence rates were significantly higher in the communities with Federal primary health care than Provincial care (Mantel Haenszel Chi square 34.6, 1 df, $p<0.001$) and higher with remote location compared to non-remote (Mantel Haenszel Chi square 40.4, 1 df, $p<0.001$). Again, there is considerable overlap between these two variables.

The mean annual TB incidence rates for the five year period 1990 through 1994, by primary care agency, was 59.47/100,000 for the population served by Federal agencies and 16.56/100,000 served by Provincial. By location, mean annual incidence in remote communities was 64.26/100,000; non-remote communities 15.92/100,000. (See Table 13).

Table 13
On-reserve Status Indian TB cases and incidence rates+, by primary health care provider and location, 1990-1994.

	Primary health care agency				Location			
	Federal		Provincial		remote		non-remote	
year	case	rate	case	rate	case	rate	case	rate
1990	7	22.98	4	18.56	7	28.61	4	17.04
1991	21	74.74	2	8.73	21	80.47	2	8.02
1992	11	37.67	6	24.96	11	40.71	6	22.89
1993	15	50.10	5	19.47	14	50.58	6	21.48
1994	35	111.87	3	11.08	35	120.95	3	10.20
mean	17.8	59.47	4	16.56	17.6	64.26	4.2	15.92

+cases per 100,000 population

3.1.6 TB incidence rates - Status Indian versus Métis

The Métis are an ethnic group identified on the Manitoba TB Registry notification forms since 1990: they are included in this analysis for completeness. (See Methods for a definition of Métis). Their TB incidence rates were analyzed for the 1990 through 1994 period.

The Manitoba Métis have a distinctly different geographic distribution from the Status Indian population. The Métis have a greater proportion of urban dwellers (mean 81.5%) than Status Indians (mean 37.9%).[164] In the Status Indian population, urban location (off-reserve) is associated with greater incidence of tuberculosis. (See Table 11).

There is an overlap of unknown proportion between the Registered Indian population and the self-identified Métis population (see Methods). Statistics Canada Census population counts were used for the Métis population. Although these statistics may not be highly accurate they were used because they are the only population statistics available for the Métis population.

The mean annual TB incidence rates for the total Manitoba population, for the 5-year period, was 9.0/100,000: for the Status Indian population it was 50.0: for the Métis it was 18.1. (See Table 13). Trends in TB incidence rates were not noted, because of the short time period (1990 through 1994) of the data.

Table 14
TB incidence rates+, by population, 1990 through 1994.

	total population	Status Indian population	Métis population		
Year	rate	Rate	case	1991 pop	rate
1990	8.3	34.9	13	33,230	39.1
1991	9.2	44.8	4	33,230	12.0
1992	7.9	37.6	3	33,230	9.0
1993	9.5	57.9	6	33,230	18.1
1994	10.1	69.0	4	33,230	12.0
mean	9.0	50.0	6	33,230	18.1

+ incidence rates expressed per 100,000 population.

3.1.7 Clinical and microbiological comparisons

Site

From a public health prospective only pulmonary tuberculosis is considered to be contagious. Non-pulmonary tuberculosis is not considered to be contagious, therefore may be considered an individual health concern rather than a public health concern, although it is a notable cause of TB related morbidity.

The mean pulmonary incidence rate (1975-1994) for Status Indians was 6.8 times greater than that of the rest of the population. However, the proportion of pulmonary TB cases in the Status Indian population was significantly lower than the proportion for the rest of the population (Cochran-Mantel-Haenszel 11.236, df 19, p = 0.001). This relationship has not changed over the 20-year period. The mean proportion of pulmonary TB for the Status Indian population was 55.5% (mean cases 25.5):

for the rest of the population it was 60.3% (mean case 59.3). (See Tables 15 and 16).

Although the proportion of contagious TB is lower in the Status Indian population the incidence rates are higher. This indicates a continuous higher level of contagious TB in the Status Indian population.

Table 15
Status Indian population. pulmonary TB 1975-1994.

	total TB cases			pulmonary					
	pulmonary			smear +		culture only +		Clinical diagnosis	
year	rate*	case	%	case	%	case	%	Case	%
1975	46.1	19	35.8	7	36.8	7	36.8	5	26.3
1976	54.4	23	43.4	13	56.5	7	30.4	3	13.0
1977	57.7	25	50.0	22	88.0	2	8.0	1	4.0
1978	56.0	25	50.0	19	76.0	4	16.0	2	8.0
1979	58.9	27	42.9	17	63.0	7	25.9	3	11.1
1980	67.6	32	69.6	23	71.9	7	21.9	2	6.3
1981	51.4	25	64.1	16	64.0	3	12.0	6	24.0
1982	62.1	31	57.4	13	41.9	13	41.9	5	16.1
1983	87.6	45	48.4	18	40.0	20	44.4	7	15.6
1984	51.9	27	45.0	18	66.7	8	29.6	1	3.7
1985	49.7	27	60.0	17	63.0	6	22.2	4	14.8
1986	43.5	25	65.8	12	48.0	10	40.0	3	12.0
1987	44.3	27	61.4	13	48.0	12	44.4	2	7.4
1988	34.2	22	71.0	13	59.1	5	22.7	4	18.2
1989	18.0	12	41.4	5	41.7	7	58.3	0	0
1990	27.8	19	76.0	10	52.6	5	26.3	4	21.1
1991	20.4	15	44.1	8	53.3	5	33.3	2	13.3
1992	26.1	20	66.7	11	55.0	6	30.0	3	15.0
1993	31.6	25	52.1	11	44.0	11	44.0	3	12.0
1994	44.9	38	64.4	22	57.9	12	31.6	4	10.5
mean	46.7	25.5	55.5	14.4	56.4	7.9	31.0	3.2	12.6

*per 100.000 population

Table 16
Other than Status Indian population, pulmonary TB 1975-1994.

	total TB cases (%)			Pulmonary and other respiratory (%)					
	Pulmonary			Smear +		culture only +		clinical diagnosis	
year	rate*	case	%	case	%	case	%	case	%
1975	8.7	73	51.4	43	58.9	18	24.7	12	16.4
1976	9.9	82	55.0	49	59.8	22	26.8	11	13.4
1977	9.3	79	64.8	43	54.4	14	17.7	22	27.8
1978	10.0	84	67.5	53	63.1	19	22.6	12	14.3
1979	7.9	66	56.8	31	47.0	13	19.7	22	33.3
1980	8.9	74	59.5	20	27.0	25	33.8	29	39.1
1981	8.7	71	65.5	24	33.8	20	28.2	27	38.0
1982	8.1	69	69.7	34	49.3	22	31.9	13	18.8
1983	8.5	73	64.3	25	34.2	23	31.5	25	34.2
1984	8.7	76	62.8	26	34.2	27	35.5	23	30.3
1985	7.3	64	63.7	34	53.1	13	20.3	17	26.5
1986	6.8	59	62.1	29	50.0	12	20.7	17	29.3
1987	5.2	47	57.3	24	51.1	10	21.3	13	27.7
1988	5.7	50	63.0	18	36.0	12	24.0	20	40.0
1989	3.8	34	50.0	20	58.8	5	14.7	9	26.5
1990	5.1	45	68.7	15	33.3	13	28.9	17	37.8
1991	5.0	43	65.7	12	27.9	11	25.6	20	46.5
1992	3.7	33	56.9	11	33.3	11	33.3	11	33.3
1993	3.7	33	57.6	9	27.3	11	33.3	13	39.4
1994	3.4	31	56.4	18	58.1	5	16.1	8	25.8
mean	6.9	59.3	60.3	26.9	44.5	15.3	25.5	17.1	29.9

Bacteriology

In Manitoba all case finding is passive. A person with TB or suspected TB presents themselves to a primary health care worker and from there they are investigated for disease.[165] Screening is carried out on contacts of TB cases only (focused case finding).[165]

Even with passive case finding, differences in reported tuberculosis rates between populations may be due to differences in case finding, including use of screening and varying diagnostic criteria.

A population with a high proportion of pulmonary smear-positive (secretions diagnosed by microscopy) TB cases or cases diagnosed clinically would be expected to have a high rate of transmission of tuberculosis. Smear-positive secretions are associated with more advanced disease and large numbers of bacilli.[166] Cases diagnosed clinically are likely to quite ill and have a history of contact with tuberculosis. A high proportion of these cases may indicate delayed diagnosis.

A high proportion of TB cases with secretions that are smear-negative/culture-positive pulmonary cases may indicate early diagnosis of disease related to more intense screening (in this case of contacts), and/or earlier case finding.

Using Cochran-Mantel-Haenszel analysis, the relationship between the proportion of smear-positive pulmonary TB cases Status Indian versus the rest of the population is not constant over time, indicating that no conclusions can be drawn from this relationship with regard to case finding. (See Figure 1).

Using Cochran-Mantel-Haenszel analysis, the relationship between the proportion of culture-positive/smear-negative pulmonary TB cases Status Indian versus the rest of the population is not constant over time. (See Figure 2), suggesting that no conclusions can be drawn from this relationship with regard to case finding. The proportion of culture-positive/smear-negative cases was constant over time for the rest of the population, mean proportion 25.5%. (See Table 16).

Using Cochran-Mantel-Haenszel analysis, the relationship between the proportion of clinically diagnosed (without laboratory confirmation) pulmonary TB cases among Status Indians versus the rest of the population is not constant over time. (See Figure 3). No conclusions can be drawn from this relationship with regard to case finding. The proportion of clinically diagnosed cases was constant over time for the population that was other than Status Indian (mean proportion 29.9%). (See Table 16).

Figure 1
Proportion of smear-positive pulmonary TB cases, by population, 1975 1994.

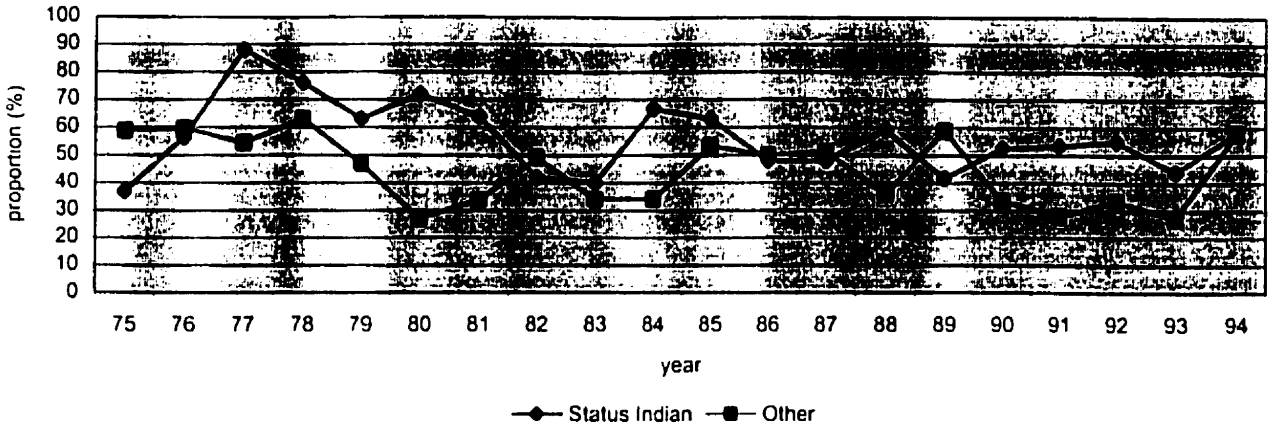


Figure 2
Proportion of culture-positive/smear-negative pulmonary TB cases, by population, 1975-94.

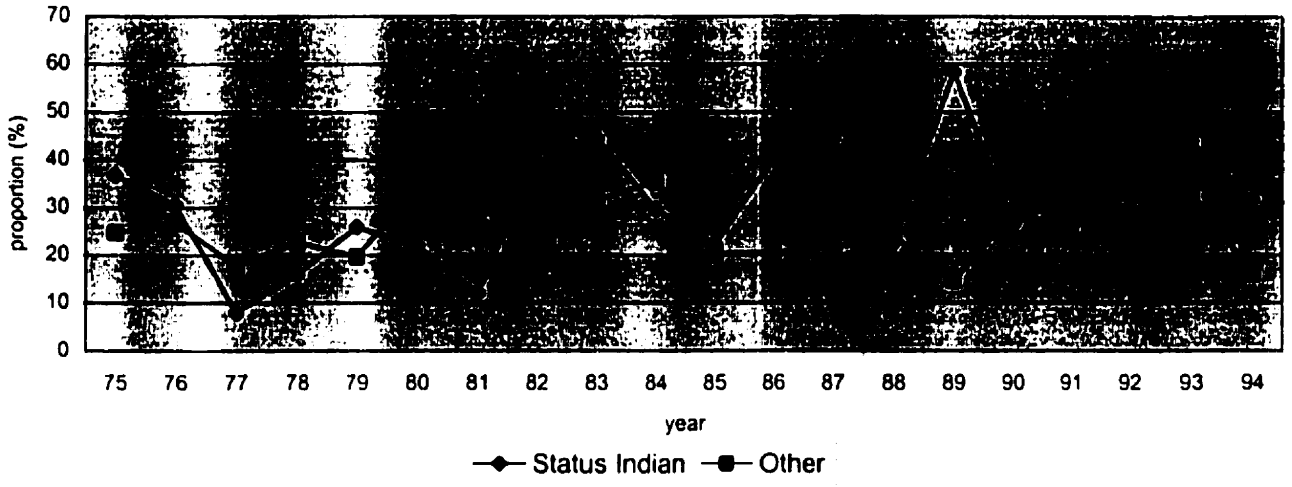
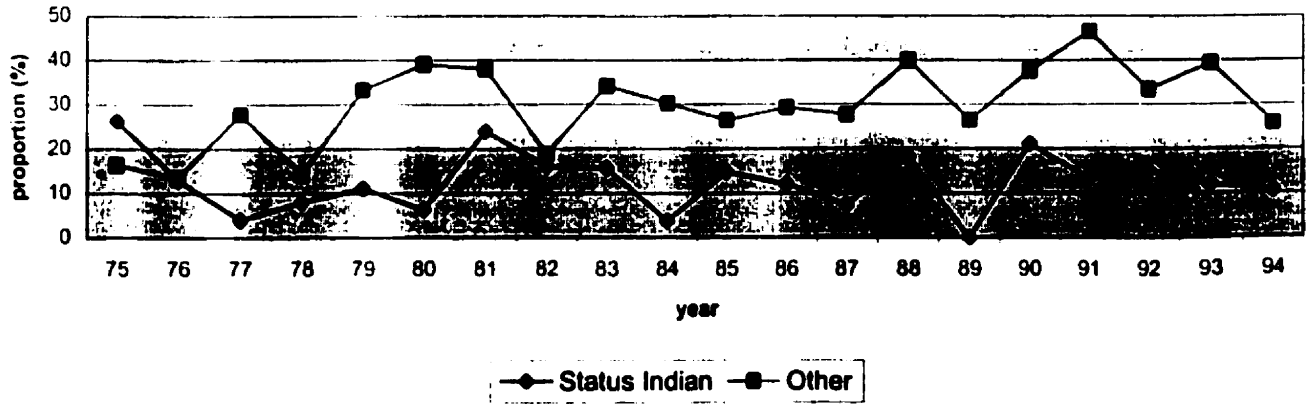


Figure 3
Proportion of clinically diagnosed pulmonary TB cases, by population, 1975-94.



The analysis of proportion of sputum characteristics indicates that the higher incidence of TB in the Status Indian population, compared to the rest of the population, is related to higher rates of transmission of disease rather than differences in case finding and screening. Status Indians have higher rates of pulmonary tuberculosis than the rest of the population. This indicates contagia is greater in this population. The proportions of smear-positive, culture-only-positive, and clinically diagnosed cases, show no pattern over time. This indicates that case finding and screening follow diagnosis of an active case, not the other way around. disease is not greater in one population versus the other. Higher TB incidence rates in the Status Indian population is not because of greater case finding and screening.

Tuberculosis surveillance guidelines for the province of Manitoba have not changed significantly over the 20-year study period.[113]

Drug resistance

Drug resistance is defined as antibiotic resistance to one or more anti tuberculin drugs, as shown on an initial positive culture.[156]

In Manitoba, 1980 through 1989, drug resistance was not found to be widespread.[104,105] Drug resistance was not associated with age, sex, disease status or type of disease. The risk of drug resistance was significantly higher among immigrants than among the established Canadian population, odds ratio 4.0.[105] Most drug resistance was found in immigrants coming from

countries with high drug resistance.[105,106] No outbreaks of multi-drug-resistant TB occurred over the study period.

Prior to 1990, drug resistance to anti-tuberculin medication was not recorded on the TB Registry case form.

TB cases with drug resistance "unknown", documented by the TB Registry, 1990 through 1994, was overall 9.9% of cases; in the Status Indian population this portion was 12.2%; in the immigrant population it was 5.7%. (See Table 17).

Five years of data was not enough to show any trends in drug resistance; however, documented drug resistance (15 cases) indicates that drug resistance was not widespread in this 5-year period. Again, immigrants had a higher proportion of drug resistance. Drug resistance in the total population was 3.0%, in the Status Indian population 0.5%, and in the immigrant population 9.2%. (See Table 17).

Table 17
Drug resistant TB cases and proportion of cases,
in Manitoba, 1990 through 1994.

	Total Population		Status Indian		Immigrant	
year	Resist cases (%)	unknown cases (%)	Resist cases (%)	unknown cases (%)	resist cases (%)	unknown cases (%)
1990	0(0)	4(4.3)	0 (0)	2(8.0)	0(0)	1(3.7)
1991	5(5.0)	1(1.0)	0 (0)	0(0)	5(14.7)	0(0)
1992	2(2.3)	0(0)	0 (0)	0(0)	2(7.1)	0(0)
1993	2(1.9)	18(16.8)	0 (0)	9(18.8)	2(9.5)	1(4.8)
1994	6(5.2)	27(23.5)	1(1.7)	13(21.7)	4(12.9)	6(19.4)
total	15(3.0)	50(9.9)	1(0.5)	24(12.2)	13(9.2)	8(5.7)

3.2 Description of TB between populations and within the Status Indian population.

3.2.1 Socioeconomic level among cases by population.

Low socioeconomic status is highly correlated with tuberculosis in both. developing and developed countries. including Canada.[1,17,35,46,60,61,62] Socioeconomic status was compared among the Status Indian. immigrant. and total Manitoba cases using socioeconomic indicators compiled by Statistics Canada. from the 1991 Census.[164] Socioeconomic status was not compared among the populations because population counts (denominator data) was not available by socioeconomic grouping.

Socioeconomic level is stratified on an ordinal scale by quintile. The enumeration units are in ascending order - Quintile 1 representing 20% of the Manitoba enumeration units with the lowest average reported socioeconomic level. and Quintile 5 representing 20% of the enumeration units with the highest average reported socioeconomic level.[167] As outlined in the Methods section unrankable cases resulted when a postal code was not successfully assigned to an enumeration unit.

Table 18
TB cases and proportion, by income quintile, 1990 through 1994

	Total Manitoba		Status Indian*		Immigrant	
Income quintile	cases	%	Cases	%	cases	%
Unrankable	67	13.4	26	13.3	18	12.8
Low (1)	153	30.5	48	24.6	52	36.9
Low-medium (2)	66	13.2	13	6.7	29	20.6
Medium (3)	129	25.7	84	43.1	7	5.0
High-medium (4)	52	10.4	8	4.1	26	18.4
High (5)	34	6.8	16	8.2	9	6.4

As expected, the Status Indian, immigrant, and total Manitoba populations (1990 through 1994), all had a large proportion of TB cases in the lowest average income quintile, Quintile 1. The immigrant and total Manitoba populations having the largest proportion of cases in Quintile 1 and the Status Indian population having the second largest proportion of cases in Quintile 1. (See Table 18). There was no linear relationship between proportion of TB cases and income level by quintile. Both the total Manitoba population and the Status Indian population showed a second peak in proportion of cases in the mid quintile range. (See Table 18).

Status Indian TB cases by socioeconomic level.

The relationship between socioeconomic quintile and tuberculosis cases was examined further for the Status Indian population. The Status Indian socioeconomic quintile distribution comparison between the on-reserve and the off-reserve cases was

similar to the quintile distribution of rural versus urban. (See Table 19). This was to be expected, because most off-reserve Status Indians live in urban areas, while all of the reserves are considered to be rural.

Table 19
Status Indian TB cases, by income quintile and location, 1990 through 1994.

	on-reserve		off-reserve		Rural		urban	
quint	case	%	case	%	Case	%	case	%
unrank	12	11.0	14	16.3	12	10.3	14	17.9
1	5	4.6	43	50.0	5	4.3	43	55.1
2	8	7.3	5	5.8	10	8.5	3	3.8
3	68	62.4	16	18.6	72	61.5	12	15.4
4	4	3.7	4	4.7	6	5.1	2	2.6
5	12	11.0	4	4.7	12	10.3	4	5.1

In the Status Indian population, the distribution of TB cases over the five income quintiles shows two peaks, in Quintile 1 and Quintile 3. (See Table 19). When the population is stratified by on-reserve/rural and off-reserve/urban, there is one peak in each of these stratum. In the on-reserve/rural category the majority of cases were in Quintile 3, while in the off-reserve/urban category the majority of cases were in Quintile 1. (See Table 19).

The differences between the on-reserve/rural and off-reserve/urban Status Indian income quintile distributions may be due to differences in the epidemiology of TB within the two

groups, or perhaps due to the use of socioeconomic quintiles rather than actual socioeconomic status.

Socioeconomic level is based on household income rather than on individual income; the on-reserve Status Indian population has on average more people per household, therefore may have a higher average household income (but lower individual income) than the off-reserve population. In this scenario, some on-reserve TB cases included in the mid income level (Quintile 3) may actually be closer to the socioeconomic level of the off-reserve individual TB cases found in the lowest income level (Quintile 1).

The second peak in proportion of overall TB cases in Quintile 3 may be partly due to crowding. Because of the scarcity of on-reserve housing, an increase in household (or individual) income - without an increase in availability of housing - may not reduce exposure to TB and indirectly the incidence of TB. In the off-reserve group, where housing is more available, an increase in household (or individual) income is more likely to reduce crowding. This would indicate that in the on-reserve group, crowding may be a more important risk factor for tuberculosis than household socioeconomic level.

Rural household densities were higher on average than urban household densities, in both the Status Indian and other than Status Indian populations. In Quintile 5 the mean Status Indian rural household density is more than double the urban density; in the non-Indian population this ratio was 1:1.3. (See Table 20).

Table 20
Mean number of people per household (1991), in households which had TB cases, by income quintile, ethnic origin, and location, 1990 through 1994.

	non-Indian population		Status Indian population	
quint	rural	Urban	rural	urban
1	2.87	2.20	2.84	2.17
2	2.50	2.53	3.25	2.43
3	4.09	2.55	4.82	2.42
4	3.00	3.14	2.97	3.40
5	3.00	2.83	6.92	3.20
mean	3.30	2.51	4.68	2.32

Of the 11 rural Status Indian TB cases in Quintile 5, 7 were from Little Grand Rapids/Pauingassi with a housing density of 8.3 people per house hold, the highest in all of Manitoba. It is unlikely that Quintile 5 accurately reflects the socioeconomic category of Little Grand Rapids/Pauingassi individuals.

On-reserve Status Indian TB cases by socioeconomic level, and by health care agency and location.

For the on-reserve Status Indian population, the distribution of TB cases over the socioeconomic quintiles was further stratified by location (remote and non-remote) and by primary care provider (Federal and Provincial). The on-reserve socioeconomic quintile distributions of TB cases for remote location and Federal primary health care were similar: the distributions for non-remote location and Provincial primary

health care were similar: the distribution of unrankables was also similar. (See Table 21).

Table 21
On-reserve Status Indian TB cases by income quintile.
by primary health care agency and location. 1990 through 1994.

	Health care agency		Location	
quintile	Federal (%)	Provincial (%)	remote (%)	non-remote (%)
unrankable	9 (10.1)	3 (15.0)	9 (10.2)	3 (14.3)
1	0 (0)	5 (25.0)	0 (0)	5 (23.8)
2	2 (2.2)	6 (30.0)	1 (1.1)	7 (33.3)
3	65 (73.0)	3 (15.0)	65 (73.9)	3 (14.3)
4	1 (1.1)	3 (15.0)	1 (1.1)	3 (14.3)
5	12 (13.5)	0 (0)	12 (13.6)	0 (0)

The highest proportion of TB cases were found in Quintile 1 of the Provincial/non-remote category. (See Table 21). This peak is likely related to household poverty. In non-remote communities, with an increase in socioeconomic level, housing may be available off-reserve, but close to the home reserve.

The highest proportion of TB cases were found in Quintile 3 of the Federal/remote category. (See Table 21). Again, this peak may be related to higher housing density in remote areas where housing is not available at any price.

3.2.2 Geographic risk

Status Indian on-reserve TB cases and incidence rates by community.

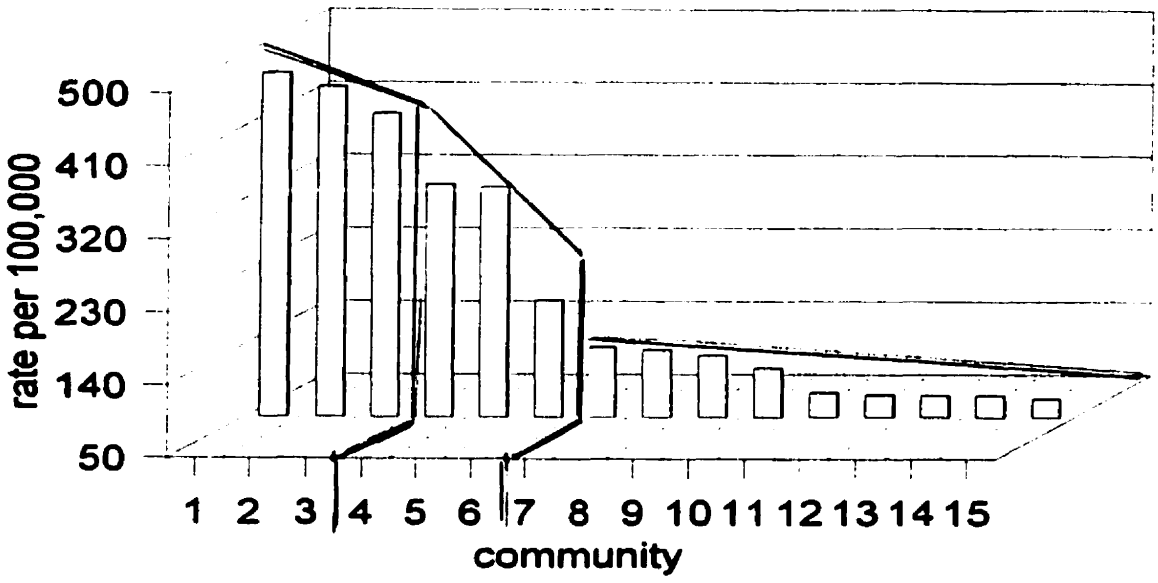
Tuberculosis is not evenly distributed over all First Nations communities. On-reserve TB incidence in Manitoba was disproportionately concentrated in a small number of communities over the five year period, 1990 through 1995. Almost half (29 reserves) of the 61 Manitoba reserves had no TB cases at all, while one reserve, God's Lake Narrows, had 29 cases. (See Table 22).

Table 22
Status Indian TB cases, on-reserve,
1990 through 1994.

number of cases per reserve	number (%) of reserves experiencing designated number of TB cases	total number (%) of cases during study period, n = 113
0	29 (47.5)	0
1	13 (21.3)	13 (12.6)
2	6 (9.8)	12 (15.5)
3	4 (6.6)	12 (11.7)
4	2 (3.3)	8 (11.7)
5	0 (0)	0 (0)
6	3 (4.9)	18 (17.5)
7	3 (4.9)	21 (6.8)
29	1 (1.6)	29 (24.3)

The 15 reserves with the highest TB incidence rates were divided into high, medium, and low incidence by visually estimating the break points from the distribution curve. (See Figure 4).

Figure 4
Mean annual on-reserve TB incidence rates,
1990 through 1994.



High incidence

1. God's Lake Narrows (mean annual incidence 457.4/100,000)
2. York Factory (424.0/100,000)
3. Pauingassi (336.7/100,000)

Medium incidence

4. Northlands (194.5/100,000)
5. Little Grand Rapids (136.5/100,000)
6. Birdtail Sioux (126.6/100,000)

Low incidence

7. Shamattawa (80.4/100,000)
8. Mathias Colomb (78.1/100,000)
9. Sayisi (76.9/100,000)
10. Lake St. Martin (71.7/100,000)
11. Roseau River (69.4/100,000)
12. Chemawawin (66.6/100,000)
13. Rolling River (65.6/100,000)
14. Nelson House (52.7/100,000)
15. Cross Lake (46.2/100,000)

In some cases the high mean annual incidence of TB in these communities was due to an outbreak of disease in a particular year. In other communities, the number of TB cases was consistently high during each year from 1990 through 1994. (See Table 23). TB incidence rates were highly variable between reserves, due to the small populations of the communities involved. (See Appendix A).

Table 23
Number of TB cases per year on the 15 reserves with the highest TB incidence rates, 1990 through 1994.

Community	1990	1991	1992	1993	1994
God's Lake Narrows	2	5	2	5	15
York Factory (York Landing)	0	6	0	0	0
Pauingassi	NA	0	0	2	2
Northlands (Lac Brochet)	1	1	1	0	4
Little Grand Rapids	0	1	0	2	3
Birdtail Sioux	0	0	1	1	0
Shamattawa	0	0	2	1	0
Mathias Colomb (Pukatawagan)	1	0	1	0	5
Sayisi (Tadoule Lake)	0	0	0	0	1
Lake St. Martin	0	0	1	2	0
Roseau River	0	0	0	2	1
Chemawawin (Easterville)	1	0	0	1	0
Rolling River	0	0	1	0	0
Nelson House	0	4	1	1	0
Cross Lake	2	2	2	1	0

Six of the 15 reserve communities (Pauingassi, Birdtail Sioux, Shamattawa, Lake St. Martin, Roseau River, Chemawawin) did not consistently have high numbers of TB cases throughout the five-year period.

Sayisi and Rolling River had only one case each, but due to their small populations their calculated TB incidence rate is high. (See Appendix D).

Cross Lake and Northlands had TB cases in four out of the five years, pointing to a chronic high level of endemicity of TB in the communities. Nelson House, Little Grand Rapids, and Mathias Colomb had TB cases in three of the five years examined. York Factory had an outbreak of TB in 1991 (6 cases). (See Table 23).

God's Lake Narrows had TB cases in 5 out of 5 years and the largest number of TB cases (29) from 1990 through 1994, indicating a chronic high level of endemicity, with 15 cases of tuberculosis in 1994. (See Table 23). God's Lake Narrows had 24.3% of all on-reserve TB cases. (See Table 22). Three of the 29 cases were reactivated within the five-year period: one of these people also had TB in 1985. Incomplete therapy due to noncompliance has been identified in individual cases and has been an issue in this community.[168]

14 of the 15 reserves communities with the highest TB incidence rates were further analyzed over the 20-year study period by incidence rate per 5-year period. Pauingassi was not included in the 20-year analysis, as it was created in 1991; it

appears as part of the Little Grand Rapids TB count. (See Table 24).

Table 24
Mean annual TB incidence rate* and mean number of cases on 14 reserves, by 5-year period.

Community	1975-79 (cases)	1980-84 (cases)	1985-89 (cases)	1990-94 (cases)
God's Lake Narrows	376.9(17)	415.4(20)	133.6(7)	457.4(29)
York Factory	0(0)	0(0)	64.9(1)	424.0(6)
Northlands	269.5(1)	479.6(10)	253.2(5)	194.5(7)
Little Grand Rapids	52.6 (2)	23.4(1)	86.1(4)	136.5(6)
Birdtail Sioux	0(0)	490.2(5)	0(0)	126.6(2)
Shamattawa	0(0)	0(0)	0(0)	80.4(3)
Mathias Colomb	135.8(7)	182.1(11)	188.8(13)	78.1(7)
Sayisi	1212.1(16	1481.5(18	76.6(1)	76.9(1)
Lake St. Martin	44.2(1)	41.8(1)	0(0)	71.7(3)
Roseau River	123.2(3)	0(0)	32.8(1)	69.4(3)
Chemawawin	382.5(7)	609.4(11)	47.7(1)	66.6(2)
Rolling River	0(0)	85.1(1)	73.0(1)	65.6(1)
Nelson House	146.2(12)	73.3(7)	54.6(6)	52.7(6)
Cross Lake	440.2(37)	92.3(9)	34.7(4)	46.2(7)

*cases per 100,000 population.

York Factory, Birdtail Sioux, Sayisi, and Chemawawin did not consistently have high incidence rates of TB but because of the small populations (less than 340 people), these cases resulted in a corresponding high incidence of TB. Rolling River had only three TB cases over the 20-year period. Lake St. Martin five cases, and Roseau River seven cases.

TB incidence in the Mathias Colomb band has dropped in the last five years of the study period, because of fewer TB cases and an increasing population. Shamattawa showed no cases of TB until 1991.

God's Lake Narrows, Northlands, Nelson House, and Cross Lake had consistently high TB incidence rates, indicating chronic endemicity of TB over the 20-year period.

There is considerable overlap in language and cultural groupings, and geographic location. Of the 15 reserve communities with the highest TB incidence rates, 11 were in remote locations. The Dene and Cree with nine of the 15 reserve communities live in the most remote parts of the province (north and west). The Oji-Cree and Ojibwa with five of the 15 communities have fewer remote communities in total. The Sioux communities of the south-west are not remote and one was included in the 15 reserve communities examined.

Total Manitoba TB incidence rates and cases, by community.

Province wide, the 15 communities with the highest TB incidence rates included nine Indian reserves and six Winnipeg neighbourhoods, comprising 1.88% of the total Manitoba population. Over the period of 1990 through 1994 these 15 communities experienced 31.0% of the total TB cases. (See Table 25).

Table 25
TB cases, population, and incidence rates in 15 communities with the highest TB incidence, 1990 through 1994.

communities	number of cases (% of all cases) n=503	1991 pop (% of total pop)*	average annual TB incidence**
South Point Douglas (Winnipeg)	9 (1.8)	380 (0.03)	473.7
God's Lake Narrows	29 (5.8)	1268 (0.12)	457.4
York Factory	6 (1.2)	283 (0.03)	424.0
Logan CPR(Winnipeg)	7 (1.4)	480 (0.04)	333.3
Pauingassi+	4 (0.8)	297 (0.03)	336.7
Northlands	7 (1.4)	617 (0.06)	194.5
Little Grand Rapids	6 (1.2)	879 (0.08)	136.5
Dufferin (Winnipeg)	1 (0.2)	150 (0.01)	133.3
Birdtail Sioux	2 (0.4)	316 (0.02)	126.6
Spence (Winnipeg)	43 (8.5)	4870 (0.45)	110.9
Shamattawa	3 (0.6)	746 (0.07)	80.4
West Broadway(Wpg)	21 (4.2)	5455 (0.50)	77.0
Mathias Colomb	7 (1.4)	1793 (0.16)	78.1
Sayisi	1 (0.2)	260 (0.02)	76.9
Centennial(Winnipeg	10 (2.0)	2740 (0.25)	73.0
Total	156 (31.0)	20534 (1.88)	

*total Manitoba population 1,091,945
**cases per 100,000 population
+Pauingassi was created in 1991.

These 15 communities were divided into high, medium, and low incidence by visually estimating the break points from the distribution curve. The nine Indian reserves with the highest TB

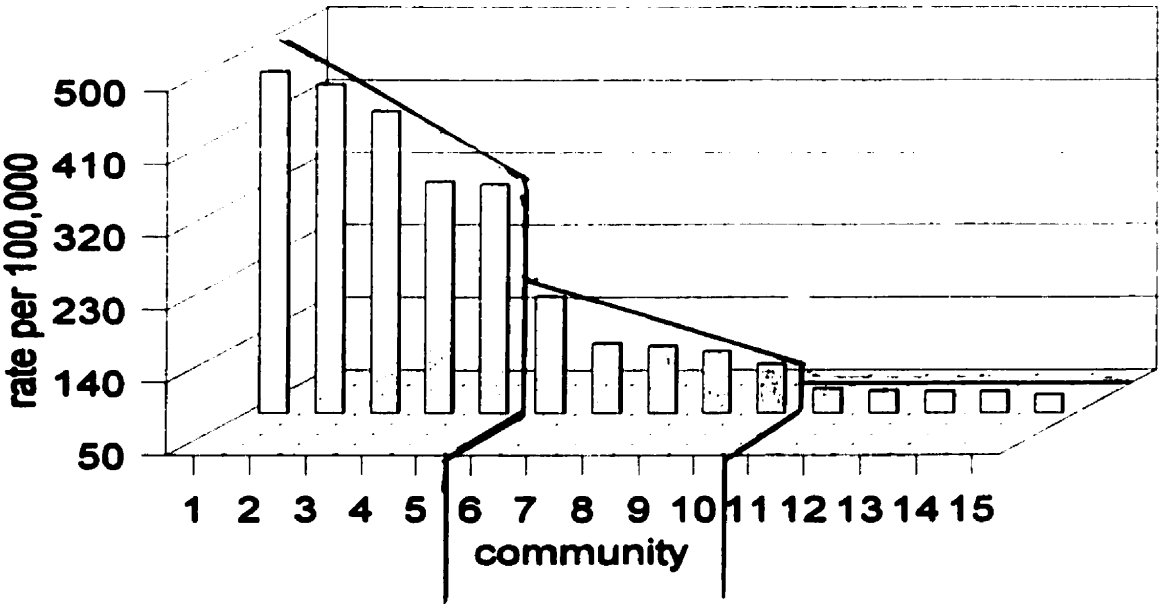
incidence rates were included in the 15 communities. All nine reserves remained in the same incidence category as they were when the reserve communities were analyzed separately. (See Figure 4).

All of the non-reserve communities were located in Winnipeg. As mentioned in the Methods section, the Winnipeg communities are defined by natural boundaries, homogeneity of housing, catchment area and community focus related to a common community institution.[170]

Table 26
Comparison of selected characteristics between reserve and non-reserve communities, by TB risk category, 1990 through 1994.

Characteristic	risk category					
	high		medium		low	
Community	non reserve	reserve	Non reserve	reserve	non reserve	reserve
Weighted mean TB incidence	395.3	373.2	111.6	133.9	75.7	78.6
Mean population (1991)	430	616	2510	597	4097	933
Weighted mean number of people per household (1991)	4.3	5.3	2.7	4.9	2.1	8.4
Male/female ratio (1991)	2.5	1.1	1.1	1.1	1.0	1.2
% of people > 65 years (1991)	19.8	4.7	17.6	4.5	14.6	3.4
% of people < 5 years (1991)	5.8	15.2	10.3	17.5	8.5	15.0

Figure 5
Mean annual TB incidence rates,
1990 through 1994.



High incidence

1. South Point Douglas - Winnipeg (mean annual TB incidence 473.7/100,000)
2. God's Lake Narrows (457.4/100,000)
3. York Factory (424.0/100,000)
4. Pauingassi (336.7/100,000)
5. Logan CPR - Winnipeg (333.3/100,000)

Medium incidence

6. Northlands (194.5/100,000)
7. Dufferin Industrial (133.3/100,000)
8. Little Grand Rapids (136.5/100,000)
9. Birdtail Sioux (126.6/100,000)
10. Spence - Winnipeg (110.9/100,000)

Low incidence

11. Shamattawa (80.4/100,000)
12. West Broadway - Winnipeg (77.0/100,000)
13. Mathias Colomb (78.1/100,000)
14. Sayisi (76.9/100,000)
15. Centennial - Winnipeg (73.0/100,000)

Selected characteristics associated with risk of TB were compared between the nine Indian reserves and the six non-reserve communities by incidence rate category. (See Table 26).

The populations of both the reserve communities and the Winnipeg communities in the high TB incidence range were small, less than 617 people, with the exception of the reserve community of God's Lake Narrows which had a population of 1268 people. The reserve communities in the medium and low TB incidence ranges were smaller on average than the Winnipeg communities (less than one fourth the size). (See Table 26). (See Appendix D and E).

The small communities of Dufferin Industrial (population 150 people) and Sayisi (260 people) had only one case each over the five year period (1990 through 1994). Higher variability in incidence rates occurs in the smaller populations.

The mean number of people per household was higher in the reserve communities than in the Winnipeg communities in each of the three incidence rate ranges. In the Winnipeg communities, mean number of people per household decreased, with decreasing mean TB incidence rates. This pattern was not shown in the reserve communities. (See Table 26).

The youngest members of a population (0 through 4 years) are more likely to develop disease due to tuberculosis infection. The reserve communities had proportionately higher numbers in this age group; in the high TB incidence communities, this age group held 15.2% for the reserve communities population and 5.8% of the non-reserve communities population. In the medium incidence communities 17.5% for reserve and 10.3% for non-reserve. In low incidence communities 15.0% reserve and 8.5% non-reserve. (See Table 26).

The elderly (65 years and over age group) are known to be at higher risk for tuberculosis than other age groups in the populations due to the prevalence of TB exposure in the past, and the waning of immunity with age.[3,57,58] The reserve communities

had proportionately less elderly than the urban communities - in the high TB incidence communities 4.7% reserve and 19.8% non-reserve: medium incidence communities 4.5% reserve and 17.6% non-reserve: low incidence 3.4% reserve and 14.6% non-reserve. (See Table 26).

In the reserve communities the oldest and youngest age groups have more close and prolonged exposure to each other because of crowded housing and the practice of extended families living together in one household.

No direct comparison of socioeconomic status was made between the reserve and non-reserve communities, because the urban Winnipeg communities included more than one postal code area and therefore were not eligible for analysis by socioeconomic quintile.

Eight of the nine reserves communities examined were in remote locations. The remote reserves are poorer than the reserves in non-remote locations, due to limited economic resources and great distance from markets. Some remote reserves have commercial fishing and commercial forestry. However, the main economic base of all eight remote reserves examined were hunter-gatherer activities, putting these reserves among the poorest of the poor.[170]

Birdtail Sioux in southern Manitoba was the only non-remote reserve community. Although Birdtail Sioux may be somewhat better off than these eight remote reserve communities because it has an economic base of agricultural production and residential

development, and road access to markets, like most Indian reserves in Manitoba it is poor by province-wide comparison.

Although Indian Reserves are not included in published unemployment rates, the unemployment figures in remote reserves of the province is estimated to be 65% in summer and 85% in winter.[171]

All six Winnipeg communities examined were poorer than the city-wide average. Mean household income in five of the six communities was less than half of the $42,169 total Winnipeg average.[173] The sixth community, South Point Douglas, with the highest TB incidence, had a the higher than average number of people per household, 5.8 compared to a mean of 2.7 people per household in the other five Winnipeg communities. South Point Douglas also had a household income of 59% of the city wide mean.[172]

Unemployment rates in the six urban communities ranged from 22.0% to 45.5%, compared with the Winnipeg rate of 8.8%.[172] There was no linear relationship between unemployment and TB incidence.

Risk of exposure is in part independent of individual risk behaviour (risk ecology).[173] An individual cannot be infected with TB if they are not exposed to aerosolized TB bacilli.

3.3 Efficacy of continued BCG use.

It has been the policy of Medical Services Branch to give BCG to Status Indian infants from Manitoba reserves, after birth, before leaving the hospital. Examination of the efficacy of

continued BCG vaccination is integral to a critical review of TB control among the Status Indian on-reserve population.

The International Union Against TB and Lung Disease criteria for discontinuation of BCG are as follows:[128]

a) the average annual risk of TB infection is less than 0.1%.

or

b) average recorded rate of TB meningitis in children less than 5 years old be less than one case per 10 million population over the previous 5 years.

or

c) average annual recorded rate of smear-positive TB is 5 cases/100,000 population or less during the previous 3 years.

These recommendations were made by IUATLD consultants, and were based on consensus opinion rather than evidence based criteria.

For criterion a), annual risk of infection can be calculated from average annual cases of primary TB, (see Table 27) using estimates of progression of infection to disease. This was estimated for the 0 through 4 years age group. In the age group all cases are considered to be primary; it is highly unlikely to have reactivated disease in this age group.

Table 27
Incidence* of TB disease in Status Indians, on and off-reserve, and the total Manitoba population, age 0 through 4 years, 1990 through 1994.

	On-reserve			Off-reserve			total population		
year	cases	pop	rate	cases	pop	rate	cases	pop	rate
1990	1	3821	2.62	0	2063	0	4	83400	0.48
1991	2	5892	3.39	1	2289	4.37	5	82140	0.61
1992	0	6521	0	0	2677	0	3	83500	0.36
1993	1	6810	1.47	2	2688	7.44	4	83900	0.48
1994	3	7533	3.98	0	3017	0	4	83800	0.48
mean	1.4	6115	2.29	0.6	2546	2.36	4	83348	0.48

*cases per 10,000 population.

It is unknown how many Status Indian newborns living off-reserve receive BCG vaccination, but there has not been a policy to vaccinate this group. Of the 7 0-4 years old TB cases on-reserve, 6 had received BCG; of the 3 off-reserve cases, 2 had received BCG.

Of TB cases in this age group, the on-reserve population showed 86% had received BCG (100% documentation); the off-reserve population showed 67% (100% documentation); and the general Manitoba population 40% (90% documentation).

The formula used to determine incidence of infection is as follows:[50]

annual incidence of new TB infection 0 through 4 years	x	annual rate of progression from primary infection to disease	=	annual incidence of primary TB cases (disease) 0 through 4 year
(a)		(b)		(c)

Therefore: a = c/b

Using an estimate of 5.1%[50] for the rate of progression of infection to disease (variable b) during the first 12 months following infection, the calculated mean annual incidence of infection was 0.45% for the Status Indian, 0 through 4 years on-reserve and 0.46% for the Status Indian the same age off-reserve and 0.09% for all Manitoba. By this estimation the on-reserve population, 0 through 4 years, does not fall into the IUATLD criteria for discontinuation of BCG (average annual risk of TB infection is less than 0.1%).

The model allows for use of different estimates for variable b. In the Status Indian populations infecting dose of TB bacilli may be higher than expected due to crowded housing. Susceptibility of the host may also be higher than expected because of the high prevalence of diabetes and poor nutrition, possibly resulting in higher rates of progression than expected.

With increasing estimates of variable b, the estimated mean annual prevalence of TB infection (variable a) decreases. Even with an estimate of b = 20%, a) would still not be less than 0.1%. (See Table 28).

Table 28
Estimates of annual percent incidence of TB infection based on varying rates of progression from infection to disease. Status Indians. 0 through 4 years. on-reserve. 1990 through 1994.

	annual % rate of progression from infection to disease					
year	1%	2.5%	5%	7.5%	9%	20%
1990	2.62%	1.05%	0.52%	0.35%	0.29%	0.13%
1991	3.39%	1.36%	0.68%	0.45%	0.38%	0.17%
1992	0	0	0	0	0	0
1993	1.47%	0.59%	0.20%	0.20%	0.16%	0.07%
1994	3.98%	1.59%	0.80%	0.53%	0.44%	0.20%
mean	2.29%	0.92%	0.46%	0.31%	0.25%	0.11%

The second IUATLD criteria for discontinuation of BCG is: average recorded rate of TB meningitis in children less than 5 years old be less than one case per 10 million population over the previous 5 years.[128] The average recorded rate of TB meningitis in children less than 5 years. in both the Status Indian population and the total Manitoba population was 0. over the 5-year period of 1990 through 1994. Over the previous 5-year period (1985 through 1989) it was also 0. (See Table 29). This falls into the second IUATLD criteria for discontinuation of BCG vaccination.

For all ages. the Status Indian annual incidence of TB meningitis rate was 1.02 cases per 10 million population. for the total Manitoba population it was 0.36. (See Table 29).

Table 29
Annual incidence rate* and number of cases
of TB meningitis, by population, 1990 through 1994.

	total Manitoba population		Status Indian population	
year	all ages(cases)	0-4 years	all ages(cases)	0-4 years
1990	0.63 (7)	0	1.46 (1)	0
1991	0.37 (4)	0	0	0
1992	0.18 (2)	0	0	0
1993	0.44 (5)	0	1.27 (1)	0
1994	0.18 (2)	0	2.36 (2)	0
mean	0.36 (4)	0	1.02 (.8)	0

*per 10 million population

The third criteria for discontinuation of BCG is - average annual recorded rate of smear-positive TB is 5 cases/100,000 population or less during the previous 3 years.

The average annual recorded rate of smear-positive TB, in on-reserve Status Indians, over the period 1992 through 1994 is 14.83 cases per 100,000 population. (See Table 30). This does not meet the third IUATLD criteria for discontinuation of BCG vaccination.

Table 30
Annual incidence rates* and number of cases of smear-positive TB, Status Indian, on-reserve, by age group.

year	age groups (years)					
	0-4	5-14	15-34	35-64	65+	total
1992	0	0	10.60	41.76	53.79	13.15
1993	0	0	0	50.27	56.18	10.79
1994	0	0	39.09	27.12	51.26	20.56
mean	0	0	16.56	39.72	53.74	14.83

*per 100,000 population

3.5 TB in prisons

TB cases in prison

There were 18 cases of TB diagnosed in Manitoba prisons, over the 20-year study period. Of these 18 cases, 14 (78%) were Status Indian, 2 (11%) were Métis, and 2 (11%) were Canadian-born/non-Aboriginal. None were immigrants. All cases occurred in Provincial institutions.

One out of the 18 cases (5.6%) was female. The proportion of females in the Manitoba prison system is approximately 3.4%.

Prisons in Manitoba have a high proportion of Aboriginal inmates. This group includes Status Indians and Métis; it rarely includes Inuit, who are usually incarcerated in Alberta. The proportion of Manitoba prisoners who are Status Indian or Métis, was estimated to be greater than 50% by the Aboriginal Justice Inquire in 1991.[30] In Stony Mountain, the only Federal prison, the proportion of Aboriginal prisoners has remained stable over the 20-year study period at 35% to 50%. The proportion of self

identified Aboriginal inmates at the Stony Mountain facility, on May 13, 1996, was 35%.[149]

TB incidence rates were not calculated. Ethnic status by person-days would have to be calculated manually and this information was not available.[174] Status Indian designation is self reported.[174]

12 of the cases were in the 15 through 34 year age group, the other 6 cases were in the 35 through 64 years old age group. This is reflective of the larger numbers of incarcerated younger people.

Of the 14 respiratory cases, 11 (78.6%) were smear positive. This is higher than the 56.4% in the Aboriginal population and the 44.5% in the non-Aboriginal Manitoba population.

This indicates that risk of transmission may be higher in the prison population than in the total population.

Six TB cases occurred during the 1990 through 1994 5-year period. Socioeconomic information was available for this period. Of these 6 cases, 4 were Status Indian. 2 of the 4 Status Indian cases diagnosed after 1989 stated that they "lived on-reserve most of the time". One case was from God's Lake Narrows, the reserve with an annual TB incidence of 457.4/1000,000, which represents the highest TB incidence in a Manitoba reserve community, for the time period (1990 through 1994). One of the cases was from the Mathias Colomb Band, the reserve with an annual TB incidence rate of 78.1/100,000, ranking seventh highest for that time period. (See Table 24). Both reserves are considered to be poor relative to Manitoba as a whole, with

limited economic resources, a great distance to markets, and high rates of unemployment. (See socioeconomic data above).

One of the four Status Indian cases was from the core inner-city area of Winnipeg. This is one of the lowest socioeconomic areas of Winnipeg with a TB incidence rate of 40.5/100,000 people, an unemployment rate of 15.6% compared to the city-wide rate of 8.8%, and a family income of 57% of the city-wide average.

The fourth Status Indian case was from a rural area. The two remaining cases in this time period (1990 through 1994) were Canadian-born/non-Aboriginal and were from rural areas. Socioeconomic data was not gathered on the cases from rural areas because of problems with the validity of socioeconomic data for rural communities. (See Methods).

Cases of tuberculosis are not evenly distributed over all correctional facilities. Half of the institutions, with more than half of the inmate population (54.4%), had no cases of TB. Two prisons, The Pas and Headingly, with 27.3% of the total prison population, had 67% of TB cases. (See Table 31).

Table 31
Total prison TB cases. 1975 through 1994.

umber of cases per prisons	number of prisons experiencing designated number of TB cases (% of Manitoba prison population)	total number (%) of cases during study period. n = 18
0	9 (54.3%)	0 (0)
2	1 (8.2%)	2 (11%)
4	1 (10.2%)	4 (22%)
6	2 (27.3%)	12 (67%)

TB cases were not evenly distributed over the 20-year period. Two correctional institutions. The Pas and Brandon. had TB cases in three of the four 5-year periods. indicating a possible chronic level of endemicity in these two institutions. Prison TB cases may reflect the high TB incidence among the population served by this prison. The Pas had six TB cases in the three 5-year periods. It is likely that The Pas has the highest proportion of Status Indian inmates. because of its location. in northern Manitoba. (See Table 32).

Headlingly. the largest Provincial prison had all of its 6 cases in the 1985-1990 5-year period. This clustering of cases may indicate prison acquired disease. Milner Ridge had two cases in the most recent 5-year period. (See Table 32).

Table 32
Number of TB cases, by correctional institution, by 5-year period, 1975 through 1994.

Prison	1975-79	1980-84	1985-89	1990-94
The Pas	0	2	1	3
Headingly	0	0	6	0
Brandon	1	2	0	1
Milner Ridge	0	0	0	2

3.6 TB control measures in Manitoba prisons.

3.6.1 Federal

It is recognized by Corrections and Health Canada that TB in Federal prisons is a health hazard to those in prison and the community outside the prison.[175]

The Corrections Services of Canada components of TB control and prevention are a) education b) medical response to active TB c) measure TB infection status d) ongoing surveillance of inmates and staff e) ongoing monitoring of physical environment for TB transmission risk, as laid out in the current Canadian Tuberculosis Standards.[176] Curative or preventative therapy is provided in accodance with Canadian Tuberculosis Standards.[176]

The general responsibilityes for TB control for inmates rests with Corrections Services Canada.[176] with technical advice and service provided by Health Canada, Medical Services Branch. Corrections Canada "pays", Health Canada "provides".[175]

Diagnosis, cases reporting, and contact investigation as per Canadian Tuberculosis Standards Guidelines, are carried out on

site by nurses and a physician, in collaboration with the HSC Respiratory Clinic and the TB Registry.[176]

Education

Inmate education is conducted by on-site medical staff through the Choosing Health Care In Prison (CHIP) Federal initiative, started in July 1997. This program on choosing healthy behaviours includes information on tuberculosis and tuberculosis prevention.[177]

Staff education is in the form of training videos and inservice conducted in collaboration with the TB Registry. Tuberculosis inservice is not compulsory.[177]

Medical response to active TB

Prisoners with suspected tuberculosis are assessed at the Respiratory Clinic at the Health Sciences Centre (HSC) in Winnipeg. An isolation room with positive pressure is available on-site for inmates with tuberculosis or suspected tuberculosis.[177]

Screening

Screening for TB starts with a history which includes risk factors and symptoms. Screening is not compulsory but inmates with symptoms, reported by themselves or prison personnel, are considered to have TB and referred to the Respiratory Clinic at HSC.

2-step Mantoux skin testing is done on all inmates admitted or readmitted who have no previous documentation of skin test status or a previous negative skin test. Previous BCG vaccination is not a contraindication for Mantoux. Follow up Mantoux are done

annually for those with a negative skin test. Those with a positive Mantoux are evaluated annually.[178] Chemoprophylaxis for all new convertors, individuals who are immunosuppressed, those < 35 years old, who have fibronodular disease, or on oral steroid therapy are offered INH as per the Canadian Tuberculosis Standards.[178]

Pre-employment TB screening by chest x-ray and 2-step Mantoux is compulsory for all employees of the prison. Annual screening is encouraged but not compulsory and compliance is unknown.[177]

Surveillance

Information on TB cases, inmates and staff, is submitted to a national reporting system through Health Canada, in collaboration with the TB Registry.[177] Information on follow up screening and treatment, for inmates transferred to other correctional institutes, is the responsibility of prison medical staff. Inmates released to the community are followed by the TB Registry and local public health/medical personnel.[179]

Risk factors

Tuberculosis infection is likely to be high in the Status Indian prison population because of relatively high exposure to TB in the general Status Indian population. The prevalence of HIV infection in the prison population is unknown.

Crowding in the medium security Stony Mountain Penitentiary is not considered, by the administration, to be a problem.[149] Double bunking, when there is more than one inmate per cell, is considered to be physical and emotional crowding.[149] The prison

holds 500 inmates with no double bunking. 417 in the original building and 83 in the annex. 540 inmates is considered to be the maximum capacity of the prison. Cell size in the older section 2.1 x 2.7 x 2.4 meters. In the newer section the cells are "somewhat larger".[149] At present there are no plans to expand the facility. Stony Mountain Penitentiary is one of the oldest prisons in western Canada.

On 1996/May/13, the prison had 579 inmates, 40 were temporary inmates from a Provincial correctional institution which had just experienced a prison riot.[149] Stony Mountain Penitentiary had a prison riot in 1983 with one of the perceived problems among the inmates at that time was double bunking.

The minimum security Rockwood Institute has a capacity of 168 inmates. On 1996/May/13 it held 130 inmates.[149]

3.6.2 Provincial

TB control programs, for inmates and staff, were not consistent across all Provincial correctional institutions. No directives have been issued to the Provincial correctional institutions regarding TB control. TB control programs were implemented by individual jails, on an ad hoc basis, to reflect the needs of their catchment area and the limitations of their facilities.

Inmates are often held at the Winnipeg Remand Centre while waiting for trial; after convicted they are sent to Provincial jails if their sentence is less than two years.[180] Inmates with

sentences of two years or more are sent to a Federal correctional institution.[180]

The average length of stay at the Remand Centre is 2 to 4 weeks: range of stay is from a few hours to three years.[180] The Centre often holds 20 to 30 inmates more than its capacity of 300 to 310.[180] Single and double bunked cells will often hold an extra inmate with a mattress on the floor.[180] The 13 bed medical unit has held up to 22 inmates.[180]

There is no active TB screening implemented at the Remand Centre.[180] Inmates who are suspected of TB or who request TB screening, are seen by a physician. If they are diagnosed with TB they are treated according to the direction from the Director of Tuberculosis Services and the Central Tuberculosis Registry.[180] Screening of contacts (focused case finding) in the Remand Centre is instituted. Receiving correctional facilities are notified of inmates who are TB contacts and on treatment for disease or chemoprophylaxis. Inmates released back into the community are followed through the TB Registry. DOT is carried out for inmates with TB and those taking chemoprophylaxis.[180]

Education

No inmate education or staff inservice regarding, tuberculosis or tuberculosis control, was routinely given in any of the Provincial correctional institutes.[181,182,183,184]

The exception to this was at the Agassiz Youth Centre, where TB was briefly mentioned in a course called Medical Concerns, which is offered to new staff.[185]

Medical response to active TB

Inmates suspected of having TB are screened for the disease and if coughing they are isolated.[181,182,183,184,186] Confirmed cases are referred to the Respiratory Unit at Health Sciences Centre.[181] Treatment and follow-up is carried out in collaboration with the Respiratory Unit and TB Registry.[181,182,184,186] Directly Observed Therapy (DOT) is used for all treatment with medication.

Screening

Screening for TB is not part of the pre-admission process for inmates or pre-employment for staff.[187] The exception to this is The Pas Correctional Institute, which has a high incidence of tuberculosis in the catchment area. Here, screening for TB, done on-site, starts with a history which includes risk factors and symptoms. A chest x-ray is done on admission: this is not compulsory but has not been refused. No skin testing is done: the explaination for this policy was that a high proportion of the inmates have received BCG at birth.[186] Headingly screens kitchen staff for TB as a condition of employment.[181]

All facilities screen suspected cases and contacts of confirmed cases. This includes skin testing using the 2-step Mantoux, if applicable, chest x-ray, and sputum specimens if applicable. This is done in collaboration with the HSC Respiratory Clinic and the TB Registry.

Surveillance

Surveillance for TB of inmates or prison staff is not carried out on a routine basis.[187]

Risk factors

The prevalence of tuberculosis infection and the incidence of disease in Provincial jails reflect, in part, by the corresponding prevalence and incidence in their catchment area. However, rates of infection and disease may theoretically be higher in prison due to crowding and potential drug use.

Crowding, a major risk factor for TB, was not felt to be a problem in any of the Provincial jails. Two jails normally held one inmate per cell;[183,186] one jail held two per cell.[183]

Milner Ridge houses 4 to 5 inmates per room; these rooms have open windows and are used basically for sleeping only.[184] Milner Ridge is a work camp and inmates have to be considered healthy as a requirement for admission.[184] Most inmates enter the facility through the Remand Centre or the Headingly jail. It was assumed that inmates would already be screened for disease, prior to admission to Milner Ridge.[184] However, there is no routine screening at the Headingly facility or the Remand centre.

The Dauphin jail houses inmates in one dormitory, with 40 to 50 inmates, using bunk beds. The dormitory is used for sleeping only. There is an "open door policy" where inmates have jobs in the community and liberal freedom of movement.[183]

The Portage jail had a mixture of dorms with 5-6 inmates per dorm, a few double rooms, and a few single rooms. All rooms had high ceilings and big windows.[185] Agassiz had large rooms with individual cubicles for sleeping.[185]

Intravenous drug (IVD) use, documented in other Canadian prisons,[124,125] is a risk factor for HIV/AIDS and therefore for

tuberculosis. None of the Provincial correctional facilities felt that IVD use was a problem in there facility to their knowledge. Most facilities did not know of even one case of IVD use.[181,182,183,184,185] Prevalence of HIV infection in the prison population is unknown.

CHAPTER 4

CONCLUSION

4.1 Conclusion

4.1.1 Summary of epidemiology

The Manitoba Status Indian population TB incidence rate has remained significantly higher than that of total population. TB incidence rates in Manitoba are no longer decreasing.[188] and the trend of decline in tuberculosis is reversing in other parts of the developed world. [9,10,11,12,13,14] Incidence rates in immigrants to Manitoba have remained in the range of 20 to 33 per 100,000 population over the past 20 years.

However, the on-reserve Status Indian incidence rate has increased steadily between 1990 (21.2/100,000) and 1994 (65.1/100,000). Outbreaks of tuberculosis have occurred in communities with no previous TB. In some communities TB is endemic. The off-reserve incidence rate has remained steady in the same time period with the mean rate almost twice that of the on-reserve population. The Status Indian population is increasing in numbers (86,983 in 1994), more than double the 1975 count.[42] The Status Indian proportion of the population is also increasing from 4.0% in 1975 to 7.7% in 1994.[40,41,42]

When analyzed by age, TB incidence rates have decreased over the period of 1975 through 1994 in all age groups, in both the Status Indian and total Manitoba populations, with the exception

of Status Indians older than 64 years, where there was no significant change in incidence. (See Table 5).

A communal lifestyle as practiced in the Aboriginal population, where extended family live together in the same household, may provide an environment in which TB is more easily transmitted, compared to the non-Aboriginal Manitoba population where nuclear families are more common. Elderly Status Indians with a high incidence of TB live in close proximity to the very young who are highly susceptible.

The proportion of TB cases among Manitobans, in persons 0 through 4 years of age, has also significantly increased, suggesting a possible increase in new transmission.

In the total Manitoba population, males 65 plus years have a rate of tuberculosis that is almost twice that of women in the same age group (mean for males 33.43/100,000; for females 18.48/100,000). This points to elderly males as a possible high risk group for TB.

Analysis of infection site demonstrated that the incidence of pulmonary TB, is almost seven times higher in the Status Indian population (mean 46.7/100,000, 1975-1994) than the population which is not Status Indian (6.9/100,000). Pulmonary smear positive TB cases are associated with the highest rate of transmission[166] Of these pulmonary cases there is a greater proportion in the Status Indian population which are smear positive (mean 56.4%) than in the rest of the population (mean 44.5%). This indicates a higher level of disease transmission in the Status Indian population.

Several risk factors for TB infection and disease were discussed in this study. The Aboriginal population of Canada has higher rates of unemployment and lower levels of education than the general population.[15,56,64] Reserve communities of Manitoba have limited economic resources and costs of economic enterprise (including transportation, etc.) are higher. The risk factors of diabetes[21] and renal failure,[85] related to increased susceptibility to disease are more prevalent and increasing in the Status Indian population than in the general population.

Ecological or geographic risk for tuberculosis must also be considered. The risk of exposure may be independent of individual risk behaviour and susceptibility to disease. Aral[173] described ecological risk in a study of STDs and AIDS, geographic clustering of disease was observed that was independent of risk behaviour. In the case of air borne disease such as tuberculosis ecological risk may be even more important than poverty.

Indian reserves in Manitoba, considered to be poor by Manitoba standards, have a mean TB incidence, 1990 through 1994, that is almost four and a half times higher than the total population (on-reserve Status Indian 39.9/100,000: total Manitoba 9/100,000). However, 29 of these 61 reserves had no cases of TB in that time period. One reserve had almost one quarter (24.3%) of all on-reserve cases. Without the tuberculosis bacillus present in the environment it is not possible to contract the infection.

Two of the three IUATLD criteria for discontinuation of BCG were not met. The annual risk of TB infection was estimated to be

greater than 0.1% (0.45%) and the average annual rate of smear-positive TB was greater than 5 cases/100,000 population during the period 1992 through 1994 (14.83 cases/1000,000 population). If the Manitoba TB control program accepts the IUATLD criteria, continued use of BCG in the Status Indian population appears warrented. However, the possible overlap of BCG immunization and HIV infection in newborns is a cause for concern in the Status Indian population. BCG is contraindicated in newborns with immune system impairment and may result in systems damage and even death.[189]

The prevalence of HIV infection among Status Indian is unknown. HIV infection among the Aboriginal population of Canada follows a somewhat different pattern than the general population, with a higher proportion being females, heterosexual, younger age group, and having intravenous drug use risk,[189] indicating the potential for an increasing prevalence among Aboriginal females, who have the potential to transmit HIV to their babies.

As long as crowding housing remains a chronic problem on reserves and prisons, there will be increased risk of transmission from pulmonary cases of TB. The Manitoba Aboriginal population has high rates of incarceration and account for a high proportion of the prison population.[30,148] Most correctional facilities have reported periodic crowding. Inmates waiting for trial, are kept under chronically crowded conditions. These conditions are expected to be short term but may last for up to three years.

Risk factors for tuberculosis such as crowding and HIV/AIDS have been documented in Canada and other parts of North America.[120,121] Prevalence of TB and HIV infection, and intravenous drug use in Manitoba prisons is unknown. Incarceration in a Manitoba prison or employment in a Manitoba prison is a potential risk factor for TB.

Prison inmates are a geographic subgroup of the general population, made up of various subgroups with relatively high risk factors for TB. Prison staff with direct contact with inmates are also at risk for TB.

Inmates and prison staff carry with them their risk of tuberculosis when they leave the prison environment. In the Provincial prisons, turn over of the inmate population is relatively high. Prison stay is less than two years, increasing the velocity of potential movement of TB from one sub group to another (prison to home community).

In the Provincial prison system, screening for TB is not part of the mandatory pre-admission process for inmates or pre-employment for staff.[187] Only one Provincial jail is doing this on a regular basis.[186] No inmate education or staff inservice regarding tuberculosis or tuberculosis control is routinely given in any of the Provincial jails. Surveillance for TB of inmates or staff is not carried out on a routine basis.[187]

4.1.2 Opportunities for prevention

Risk of infection is composed of the amount and duration of exposure to the tuberculosis bacillus. Primary prevention needs

to focus on improved quality and quantity of housing. especially on reserves. Funds for housing could be prioritized for communities with the highest rates of crowding. Crowding in prison is an issue to be addressed at all levels of the penal system. The possible need for more prison buildings or alternatives to incarceration may need to be addressed by the judicial system.

The risk of conversion of infection to disease is dependant on the susceptibility of host as well as the exposure dose of bacilli. Illness that influences susceptibility. such as diabetes and renal disease. are more prevalent in the Status Indians population than the Manitoba population as a whole. Manitoba Health. in conjunction woth Aboriginal groups in the Province. are attempting to improve diagnosis and treatment of diabetes mellitus and hypertension in order to prevent secondary sequelae including renal diseae.[190] It is unknownwhether these efforts will have an effect on secondary prevention of tuberculosis.

The main form of secondary prevention is finding out who are infected (by skin testing) and giving them INH chemoprophylaxis. Targeting high risk groups for secondary prevention may be most efficient. This would include some jails. high incidence reserve communities. the core area of Winnipeg. and possible immigrants from regions with high incidence of tuberculosis. The criteria for designation of a high risk group may include a mean TB incidence rate of for example greater than 175 cases per 100.000 population over the past five years: this would include the Manitoba communities designated as having "high" or "medium"

incidence shown above. This criteria could be adjusted to reflect available funding and the projected epidemiology of disease.

Screening for TB disease and infection among high risk subgroups may be efficient for high incidence rates and in the case of drug resistance. Data on prevalence of TB infection through skin testing would enable targeting of the most vulnerable individuals in a high risk group. Appropriate use of chemoprophylaxis could then be implemented.

An unpublished study by Jordan[189] among Canadian First Nation infants suggests that continued use of BCG inoculation is appropriate, given the present incidence of tuberculosis disease and recorded HIV, but should be evaluated by geographic region and particular population subgroup.

BCG vaccination of newborns from high risk populations may be beneficial, and may be offered to other groups besides the on-reserve population (e.g. off-reserve Status Indians and some high incidence communities of Winnipeg). Use of BCG will require close monitoring because of the changing epidemiology of TB and HIV. High rates of HIV testing of prenatal women in a population where BCG of newborns is conducted would be crucial to monitoring and evaluation of the BCG policy.

The stability of the public health system on Manitoba Indian reserves is unknown. There are shortages of public health personnel needed to carry out public health programs and the political authority over health care is in transition. At present, Manitoba has a well functioning BCG vaccination program in place with a reliable reporting system for adverse reactions.

It would be difficult to restart this program if it were ever discontinued.

Using the IUATLD criteria and given the present information on HIV in the population, the benefits of the policy of BCG outweigh the risks. However, because of the changing epidemiology of TB and HIV in the Manitoba Status Indian population this policy needs to be evaluated of a regular basis.

Provincial guidelines for TB control, with modifications to suit the prison/staff population are needed. Screening and case finding protocols for the pre-admission of inmates and pre-employment of staff, should be implemented and evaluated at regular intervals. This includes the appropriate use of 2-step skin testing and chest x-ray.

Surveillance for TB disease and infection needs to be ongoing. TB epidemiological studies in Manitoba prisons are needed to set up these guidelines and to facilitate evaluation. Basic definitions, such as what constitutes crowding, need to be addressed.

The risk of tuberculosis complications and possible death is dependant on effective treatment. The use of Directly Observed Therapy (DOT), shown to decrease rates of primary and acquired drug resistance, and of relapse,[98] are part of a comprehensive TB control program. This is a lobour intensive program, but one that is cost effected.

The ability to recognize active tuberculosis and complications of tuberculosis is a cornerstone of tertiary prevention. Education of front line workers such as primary

health care providers and prison workers is needed to develop a high level of suspicion for tuberculosis.

Primary health care providers need inservices to help develop their skills for detection and treatment of TB and disease complications, especially when working with high risk populations.

Public education for communities with a high incidence of TB are necessary to increase awareness of TB. Access can be accomplished through town hall meetings and through the school system. Small group discussion may be appropriate in the prison system.

Individuals that are not in the mainstream of society, such as the homeless, new immigrants, and rural Aboriginal people who have recently moved to urban areas, are often the most vulnerable to disease. One-on-one education from someone with a similar background may be useful.

Mass chest x-ray screening for active infiltrates, may be needed in communities of groups that have a high and chronic levels of TB.

4.2 Future studies

After the completion of this analysis, several research priorities are immediately obvious: The first of these is an analysis to estimate the rates of TB infection in Manitoba populations with a high risk of TB. This would include prison inmates, core area of Winnipeg, Status Indians, particularly in urban areas and from communities with a high incidence of TB, and

immigrants from countries with high TB incidence. This would enable a more clear picture of TB risk in these groups of people. and facilitate identification of the most vulnerable to TB within the group.

A model is needed for implementation of ongoing HIV monitoring in populations where BCG of infants is used. In Manitoba this involves the Status Indains on-reserve. particularly women of child bearing age. This would provide a valuable component to the evaluation of Medical Services policy of BCG innoculation of on-reserve newborns.

A thorough analysis of the epidemiology of TB and the the interaction of TB with HIV infection is needed at the Winnipeg Remand Centre. This is an entry point for most inmates into the prison system. crowding is chronic. and inmate turnoverm although high can be as long as three years with only 'temporary' shelter facilities. This indicates a possible point of augmentation for the spread of TB.

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Appendix A: TB notification form 1975 through 1989.

NOTIFICATION OF NEW ACTIVE OR REACTIVATED TUBERCULOSIS CASE

1. Reporting province: Manitoba 4 6

2. Name of patient: *(Surname)* *(Given names)* *(Maiden name)*

3. Register case No.:

4. Sex: M 1☐ F 2☐

5. Permanent residence: *(Number)* *(Street)* *(City, town, village)* *(County, division)* *(Province)*

6. Marital status (Mar.): Single 1☐ C.L. 2☐ Sep. 3☐ Wid. 4☐ Div. 5☐

7. Origin: Unreg. Ind. or Reg. Ind. 1☐ Metis 2☐ Inuit 3☐ Other 4☐

8. Date of diagnosis: *Month* *Year*

9. Date of birth: *Day* *Month* *Year*

10. Country of birth: 995☐ Canada ☐ Other (specify) _____

11. Year of arrival in Canada (omit if born in Canada) 19

12. Diagnosis (ICD) — Respiratory

☐ Pulmonary: 011.0, 011.1, 011.2, 011.3, 011.4, 011.5, 011.6, 011.7, 011.8, 011.9

☐ With associated silicosis (502)

Miliary	Primary	Pleurisy (tuberculous)
☐ 018.0, 018.8, 018.9	☐ 010	☐ 012.0

Tuberculous laryngitis	Other respiratory tuberculosis
☐ 012.3	☐ 012.1, 012.2, 012.8

Non-respiratory: 013.0 – 017.8

(specify)

13. (a) Patient on preventive chemotherapy before? 1☐ Yes 2☐ No 0☐ Unknown

(b) If yes, give duration in months .....

14. (a) Previous BCG vaccination(s)? 1☒ Yes 2☐ No 0☐ Unknown

(b) If yes, indicate year of last BCG vaccination if known . . 19

15. Bacillary status:

	Microscopy			Culture		
	Sputum	Other; (specify)		Sputum	Other (specify)	
Negative	☐	☐	☐	☐	☐	☐
Positive	☐	☐	☐	☐	☐	☐
Not done	☐	☐	☒	☐	☐	☐

16. (a) New active case? 1☐ } Check one
(b) Reactivated case? 2☐ } box only

(i) Year of first active episode 19

(ii) Country of first active episode _____

(iii) Antituberculosis drugs administered previously as treatment for more than 90 days:

1☐ INH 2☐ SM 3☐ PAS 4☐ EMB
5☐ ETA 6☐ RMP 7☐ PZA 8☐ CS
9☐ Other (specify) _____ 0☐ Unknown
☐ No drugs administered

17. Was this case discovered after death? 1☐ Yes 2☐ No

8-2300-86.1: 10-7-81 RETAIN THIS COPY COPY 2

lotification of a New Active or Reactivated Tuberculosis Case

Confidential when completed

PROVINCE/ TERRITORY/ PATIENT ID

1. Reporting province/ territory: [ ]
2. Register case number: [ ][ ][ ][ ][ ][ ]
3. Unique patient identifier *(if name not provided)*
4. Date of birth — Year [ ][ ][ ][ ] Month [ ][ ] Day [ ][ ]
5. Sex — M [ ] F [ ]

DIAGNOSIS/ TREATMENT

6. Date of diagnosis — Year [ ][ ][ ][ ] Month [ ][ ] Day [ ][ ]
7. Date treatment started — Year [ ][ ][ ][ ] Month [ ][ ] Day [ ][ ]
8. Drugs prescribed *(list all that apply)*: [ ] 1 INH [ ] 2 SM [ ] 3 EMB [ ] 4 RMP [ ] 5 PZA [ ] 6 Other *(specify)* _____ [ ] 7 No drugs prescribed [ ] 9 Unknown

NAME OF PATIENT

9. Surname _____ Given Names _____ Birth Surname _____

USUAL RESIDENCE

10. Number _____ Street _____ City/Town/Village _____ County and Health Unit or DSC _____ Province/Territory Manitoba Postal Code [ ][ ][ ][ ][ ][ ]

11. Resident of long-term care facility? [ ] 1 Yes [ ] 2 No [ ] 9 Unknown

Geo. Codes PR [ ][ ] CD [ ][ ] PR [ ][ ] HU/DSC [ ][ ][ ]

MARITAL STATUS

12. [ ] 1 Single [ ] 2 Married/Common Law [ ] 3 Separated [ ] 4 Divorced [ ] 5 Widowed [ ] 9 Unknown

ORIGIN

13. [ ] 1 Registered Indian → 14. Lives on reserve most of the time? [ ] 1 Yes [ ] 2 No [ ] 9 Unknown
[ ] 2 Unregistered Indian or Métis
[ ] 3 Inuit [ ] 4 Other
15. Medical Services Branch Number [ ][ ][ ][ ][ ][ ]

COUNTRY OF BIRTH

16. Birthplace
[ ] 1 Canada [ ][ ][ ]
[ ] 2 Other [ ][ ][ ]
(specify) _____

17. If other, year of arrival in Canada [ ][ ]
a) Placed on surveillance upon arrival in Canada? [ ] 1 Yes [ ] 2 No [ ] 9 Unknown
b) If yes, was surveillance complied with? [ ] 1 Yes [ ] 2 No [ ] 9 Unknown
c) Country of residence during the five years prior to entering Canada [ ][ ][ ]

DIAGNOSIS (ICD-9) *Check all boxes that apply and write ICD code, if known*

18. Respiratory [ ][ ]
- [ ] Pulmonary: 011.0; 011.1; 011.2; 011.3; 011.4; 011.5; 011.6; 011.7; 011.8; 011.9
  - [ ] with associated silicosis (502)
- [ ] Miliary: 016.0; 016.6; 016.9
- [ ] Primary: 010.0; 010.1; 010.6; 010.9
- [ ] Pleurisy: (tuberculous) 012.0
- [ ] Other respiratory: 012.1; 012.2; 012.3; 012.8; 137.0

Non-respiratory
- [ ] Central nervous system: 013.0; 013.1; 013.6; 013.9; 137.1
- [ ] Abdominal: 014
- [ ] Bone and Joint: 015.0; 015.1; 015.2; 015.7; 015.8; 015.9; 137.3
- [ ] Genitourinary 016.0; 016.1; 016.2; 016.3; 016.4; 016.9; 137.2
- [ ] Other: 017.0; 017.1; 017.2; 017.3; 017.4; 017.5; 017.6; 017.7; 017.8; 137.4

BACILLARY STATUS

	19. Microscopy: 1. Sputum	2. Bronchial washings	3. Gastric washings	4. Urine	Other positive specimen (specify)	20. Culture: 1. Sputum	2. Bronchial washings	3. Gastric washings	4. Urine	Other positive specimen (specify)
Negative	[ ]1	[ ]1	[ ]1	[ ]1		[ ]1	[ ]1	[ ]1	[ ]1	
Positive	[ ]2	[ ]2	[ ]2	[ ]2		[ ]2	[ ]2	[ ]2	[ ]2	
Not done	[ ]3	[ ]3	[ ]3	[ ]3		[ ]3	[ ]3	[ ]3	[ ]3	

DETECTION

21. Method of detection: [ ] 1 Symptoms [ ] 2 Contact investigation [ ] 3 Routine screening [ ] 4 Special Survey [ ] 5 Post-mortem [ ] 6 Other *(specify)* _____ [ ] 9 Unknown

CHEST X-RAY

22. Current chest x-ray results: [ ] 1 Normal [ ] 2 Abnormal → [ ] 3 Not done [ ] 9 Unknown
23. Abnormal results: [ ] 1 Cavitary [ ] 2 Non-cavitary [ ] 9 Not specified

ACTIVITY STATUS

24. New active case? [ ] 1 Reactivated case? [ ] 2

If reactivated case:
25. Year of last active episode: [ ][ ]
26. Province/territory or country of last active episode:
(I) Canada *(province or territory)*: _____ [ ][ ]
(II) Outside Canada *(country)*: _____ [ ][ ][ ]
27. List antituberculosis drugs administered previously as treatment for more than 90 days.
[ ] 1 INH [ ] 2 SM [ ] 3 EMB [ ] 4 RMP [ ] 5 PZA
[ ] 6 Other *(specify)*: _____
[ ] 7 No drugs administered [ ] 9 Unknown

28. Patient on preventive chemotherapy before?
[ ] 1 Yes → 29. Date started Year [ ][ ][ ][ ] Month [ ][ ] Day [ ][ ]
[ ] 2 No
[ ] 9 Unknown
30. Duration in months [ ][ ]

31. Previous BCG vaccination?
[ ] 1 Yes [ ] 2 No [ ] 9 Unknown
If yes, year of last vaccination, if known [ ][ ]

32. Antibiotic resistance? (see Manual)
[ ] 1 Yes, *(specify)* _____
[ ] 2 No [ ] 9 Unknown

DEATH

33. Patient died?
[ ] 1 Yes →
[ ] 2 No
[ ] 9 Unknown
34. If yes
[ ] 1 TB was the underlying cause of death.
[ ] 2 TB contributed to death but was not the underlying cause.
[ ] 3 TB did not contribute to death but was an incidental finding.
35. Date of death Year [ ][ ][ ][ ] Month [ ][ ] Day [ ][ ]

Appendix C: Classification of Manitoba reserves.

Reserve	Health care agency	Location status
Berren Lands	Federal	remote
Berens River	Federal	remote
Birdtail Sioux	Provincial	non remote
Bloodvein	Federal	remote
Brokenhead	Provincial	non remote
Buffalo Point	Provincial	non remote
Chemawawin	Provincial	non remote
Cross Lake	Federal	remote
Dakota Plains	Provincial	non remote
Dakota Tipi	Provincial	non remote
Dauphin River	Provincial	non remote
Ebb and Flow	Provincial	non remote
Fairford	Provincial	non remote
Fisher River	Provincial	non remote
Fort Alexander	Band	non remote
Fox Lake	Provincial	non remote
Gamblers	Provincial	non remote
Garden Hill	Federal	remote
God's Lake Narrows	Federal	remote
God's River	Federal	remote
Grand Rapids	Provincial	non remote
Hollow Water	Provincial	non remote
Indian Birch	Provincial	non remote
Jackhead	Provincial	non remote

Keeseekoowenin		non remote
Lake Manitoba	Provincial	non remote
Lake St. Martin	Provincial	non remote
Little Black River	Provincial	non remote
Little Grand Rapids	Federal	remote
Little Saskatchewan	Provincial	non remote
Long Plains	Band	non remote
Mathias Colomb	Federal	remote
Mosakahiken	Provincial	non remote
Nelson House	Federal	remote
Northlands	Federal	remote
Norway House	Federal	remote
O-chi-chak-ko-sipi	Provincial	non remote
Oak Lake	Provincial	non remote
Opaskwayak	Provincial	non remote
Oxford House	Federal	remote
Pauingassi	Federal	remote
Peguis	Federal	non remote
Pine Creek	Provincial	non remote
Poplar River	Federal	remote
Red Sucker Lake	Federal	remote
Rolling River	Provincial	non remote
Roseau River	Provincial	non remote
Sandy Bay	Band	non remote
Sapotaweyak	Provincial	non remote
Sayisi	Federal	remote
Shamattawa	Federal	remote

Sioux Valley	Provincial	non remote
Split Lake	Federal	remote
St.Theresa Point	Federal	remote
Swan Lake	Provincial	non remote
Tootinaowaziibeeng	Provincial	non remote
War Lake	Provincial	remote
Wasagamack	Federal	remote
Waterhen	Provincial	non remote
Waywayseecappo	Provincial	non remote
York Factory	Federal	remote

Source: DIAND pop stats

Appendix D

TB incidence rates* and cases by Indian reserve, in Manitoba, by 5-year period, 1975 through 1994.

reserve (post office)	1975-79 cases mean pop rate	1980-84 cases mean pop rate	1985-89 cases mean pop rate	1990-94 cases mean pop rate
Barren Lands** (Brochet)	2 557 71.8	2 307 130.3	0 324 0	1 372 53.76
Berens River (Berens River)	3 709 84.6	7 777 180.2	1 911 22.0	1 905 22.1
Bird Tail Sioux (Beulah)	0 181 0	5 204 490.2	0 245 0	2 336 119.0
Bloodvein (Bloodvein)	0 398 0	3 430 139.5	0 473 0	1 512 39.1
Brokenhead (Scanterbury)	0 183 0	0 191 0	0 223 0	0 315 0
Buffalo Point (Middleboro)	0 12 0	0 22 0	0 28 0	0 32 0
Chemawawin (Easterville)	8 358 446.9	11 375 586.7	1 474 42.2	2 650 61.5
Cross Lake (Cross Lake)	37 1734 426.8	9 1975 91.1	4 2335 34.3	7 3020 46.4
Dakota Plains (Edwin)	0 96 0	0 107 0	1 116 172.4	0 155 0
Dakota Tipi (Portage la Prairie)	0 68 0	0 56 0	0 126 0	0 145 0
Dauphin River** (Gypsumville)	2 74 901.0	6 98 1224.5	3 107 560.7	0 125 0
Ebb and Flow (Ebb and Flow)	2 382 104.7	1 428 46.7	3 593 101.2	1 677 29.5
Fairford (Fairford)	5 652 153.4	2 737 54.3	0 842 0	1 1017 19.7
Fisher River (Koostatak)	1 772 25.9	1 835 24.0	1 948 21.1	0 1234 0

Fox Lake** (Gillam)	0 234 0	0 269 0	0 260 0	0 331 0
Gamblers (Binscarth)	0 16 0	0 20 0	0 24 0	0 29 0
Garden Hill (Island Lake)	6 1417 84.7	5 1686 59.3	0 1946 0	4 2398 33.4
God's Lake Narrows** (God's Lake Narrows)	17 903 376.5	20 964 414.9	7 1048 133.6	29 1273 455.6
God's River** (God's River)	9 215 1046.5	0 257 0	0 310 0	0 404 0
Grand Rapids (Grand Rapids)	0 265 0	5 274 365.0	2 326 122.7	0 478 0
Hollow Water (Winipegow)	1 367 54.5	1 428 46.7	0 462 0	0 533 0
Jackhead (Dallas)	1 227 88.1	1 212 94.3	0 206 0	0 224 0
Keeseekoowenin (Elphinstone)	0 202 0	0 219 0	0 264 0	0 442 0
Lake Manitoba (Vogar)	1 420 47.6	0 487 0	0 565 0	0 698 0
Lake St. Martin (Gypsumville)	1 461 43.4	1 491 40.7	0 634 0	3 887 67.6
Little Black River (O'Hanley)	1 189 105.8	1 233 85.8	0 268 0	0 357 0
Little Grand Rapids** (Little Grand Rapids)	2 761 52.6	1 856 23.4	4 929 86.1	6 907 132.3
Little Saskatchewan** (Gypsumville)	3 203 295.6	0 211 0	0 288 0	0 381 0
Long Plains (Edwin)	0 450 0	0 508 0	0 667 0	1 888 22.5
Mathias Colomb (Pukatawagan)	7 1031 135.8	11 1208 182.1	13 1377 188.8	7 1858 75.3
Mosakahiken (Moose Lake)	0 293 0	5 325 307.7	4 415 192.8	1 610 32.8

Nelson House - includes South Indian Lake (Nelson House)	12 1719 139.6	8 1953 81.9	6 2094 57.3	6 2408 49.8
Northlands** (Lac Brochet)	4 371 1078.2	10 418 478.5	5 494 202.4	7 620 225.8
Norway House (Norway House)	6 2052 58.5	8 2302 69.5	9 2632 68.4	0 3148 0
Oak Lake (Pipestone)	1 236 84.7	3 256 234.4	285 0	0 354 0
O-chi-chak-ko-sipi** (Crane River)	2 106 377.4	0 121 0	1 155 129.0	0 241 0
Opaskwayak** (The Pas)	0 1156 0	1 1279 15.6	3 1556 51.9	1 2020 9.9
Oxford House (Oxford House)	7 941 148.8	1078 111.3	2 1259 31.8	3 1444 41.6
Peguis (Hodgson)	0 1323 0	2 1497 26.7	0 1835 0	1 2276 8.8
Pine Creek (Camperville)	0 390 0	0 443 0	0 460 0	0 625 0
Poplar River (Negginan)	4 465 172.0	0 538 0	2 632 63.3	0 831 0
Pungassi** (Pungassi)	N/A	N/A	N/A	4 369 271.0
Red Sucker Lake (Red Sucker Lake)	0 315 0	0 353 0	0 434 0	0 515 0
Rolling River (Erickson)	0 258 0	1 244 82.0	0 280 0	1 314 63.7
Roseau River (Ginew)	3 494 121.5	0 560 0	1 591 33.8	3 881 68.1
Sakgeeng (Fort Alexander)	5 1747 57.2	5 1906 52.5	3 2124 28.2	2 2705 14.8
Sandy Bay (Marius)	2 1312 30.5	12 1500 160.0	3 1898 31.6	1 2442 8.2
Sapotaweyak** (Pelican Rapids)	7 482 290.5	5 468 213.7	2 457 87.5	0 617 0

Sayisi** (Tadoule Lake)	16 265 1207.5	18 244 1475.4	1 269 74.3	1 263 76.0
Shamatawa (Shamatawa)	0 498 0	0 566 0	0 656 0	3 781 76.8
Sioux Valley (Griswold)	1 729 27.4	1 726 27.5	1 839 23.8	1 1026 19.5
Split Lake** (Split Lake)	7 922 151.8	9 1068 168.5	7 1197 117.0	2 1438 27.8
St. Theresa Point (St. Theresa Point))	10 1102 181.5	2 1332 30.0	1 1693 11.8	2 2072 19.3
Swan Lake (Swan Lake)	5 209 478.5	1 221 90.5	1 305 65.6	0 399 0
Tootinaowaziibeeng** (Shortdale)	0 287 0	0 264 0	0 293 0	0 410 0
War Lake** (Ilford)	N/A	2 24 1666.7	0 53 0	0 133 0
Wassagomachi (Wassagomachi)	2 529 75.6	1 660 30.3	1 758 26.4	1 21.6
Waterhen (Skownan)	0 262 0	0 301 0	0 365 0	0 439 0
Waywayseecappo (Waywayseecappo)	3 473 126.8	26 543 957.6	10 724 276.2	2 934 42.8
Wuskwi Sipihk** (Birch River)	N/A	1 162 308.6	0 144 0	0 171 0
York Factory (York Landing)	0 294 0	0 99 0	1 308 64.9	6 102 397.4

*rate per 100,000 population
**
1976
-God's River was created from part of God's Lake Narrows
1977
-Dauphin River was created from part of Little Saskatchewan
1979
-Northlands was created from part of Barren Lands
1980
-War Lake was created from part of Split Lake and part of Fox Lake
1983
-Indian Birch was created from part of Shoal River

1985
-Churchill changed its name to Fort Churchill
1991
-Pauingassi was created from part of Little Grand Rapids
1992
-The Pas changed its name to Opaskwayak
1993
-Fort Churchill changed its name to Sayisi
-Shoal River changed its name to Sapotaweyak
1994
-Valley River changed its name to Tootinaowaziibeeng
-Crane River changed its name to O-chi-chak-ko-sipi
-Indian Birch changed its name to Wuskwi Sipihk

Appendix E: TB incidence rates and cases by community, Winnipeg, Manitoba, 1990 through 1994.

number	Neighbourhood	cases	mean cases	1991 pop	rate*
3123	South Point Douglas	9	1.8	380	473.7
3101	Logan-CPR	8	1.6	480	333.3
3328	Dufferin Industrial	1	0.2	150	133.3
1104	Spence	27	5.4	4,870	110.9
1103	West Broadway	21	4.2	5,455	77.0
3102	Centenial	10	2.0	2,740	73.0
4417	Peguis	1	0.2	355	56.3
1108	Daniel McIntyre	29	5.8	10,395	55.8
3339	Lord Selkirk Park	3	0.6	1,290	46.5
3302	William Whyte	14	2.8	6,620	42.3
3105	West Alexander	10	2.0	4,755	42.1
1120	Downtown	27	5.4	13,320	40.5
3311	North Point Douglas	6	1.2	3,205	37.4
3301	Dufferin	4	0.8	2,370	33.8
5523	Victoria Cresent	1	0.2	595	33.6
3313	St. John's Park	1	0.2	610	32.8
3323	Riverbend	4	0.8	2,445	32.7
1112	St. Matthews	10	2.0	6,390	31.3
3321	Mandalay West	5	1.0	4,490	22.3
1111	River-Osborne	5	1.0	4,540	22.0
3325	Tyndall Park	13	2.6	12,975	20.0
3315	Shaughnessy	2	0.4	2,300	17.4
3303	Burrows Central	4	0.8	4,850	16.5

2605	Maybank	2	0.4	2.510	15.9
3306	St. John's	6	1.2	8.270	14.5
3316	Garden City	4	0.8	5.920	13.5
2613	Edgeland	1	0.2	1.530	13.1
3317	The Maples	9	1.8	14.570	12.4
3309	Jefferson	5	1.0	8.430	11.9
2623	Riverwest Park	1	0.2	1.715	11.7
5517	Worthington	3	0.6	5.425	11.1
1115	Minto	3	0.6	5.475	11.0
4405	East Elmwood	2	0.4	3.635	11.0
4422	Valley Gardens	5	1.0	9.095	11.0
3114	Weston	3	0.6	5.715	10.5
4406	Kern Park	1	0.2	1.900	10.5
5501	North St. Boniface	1	0.2	1.940	10.3
2207	Birchwood	1	0.2	1.970	10.2
5502	Central St. Boniface	3	0.6	6.585	9.1
2612	Crescent Park	1	0.2	2.315	8.6
4409	West Elmwood	1	0.2	2.330	8.6
2602	Beaumont	1	0.2	2.420	8.3
5521	Pulberry	2	0.4	4.855	8.2
3124	Brooklands	1	0.2	2.465	8.1
1665	Lord Roberts	2	0.4	5.290	7.6
3305	Luxton	1	0.2	2.710	7.4
3320	Leila-McPhillips Triangle	1	0.2	2.700	7.4
1604	Grant Park	1	0.2	2.905	6.9
3307	Burrows-Keewatin	1	0.2	2.885	6.9

5515	St. George	1	0.2	2,900	6.9
1118	Sargent Park	2	0.4	5,910	6.8
2643	Pembina Strip	1	0.2	3,025	6.6
5514	Norwood West	1	0.2	3,090	6.5
3319	Inkster Gardens	1	0.2	3,120	6.4
5546	Island Lakes	1	0.2	3,115	6.4
2645	South Tuxedo	1	0.2	3,175	6.3
1611	Central River Heights	1	0.2	3,330	6.0
2210	Crestwood	3	0.6	10,005	6.0
4416	Mission Gardens	1	0.2	3,315	6.0
4413	Rossmere-A	4	0.8	13,960	5.7
1110	McMillan	1	0.2	3,630	5.5
5504	Alpine Place	1	0.2	3,630	5.5
2224	Westwood	2	0.4	7,865	5.1
5508	Glenwood	1	0.2	4,035	5.0
1113	Wolseley	2	0.4	8,140	4.9
3308	Inkster-Faraday	1	0.2	4,070	4.9
3312	Robertson	1	0.2	4,120	4.9
1117	Roslyn	1	0.2	4,170	4.8
1106	Earl Grey	1	0.2	4,635	4.3
2633	Betsworth	1	0.2	4,705	4.3
4418	River East	2	0.4	9,360	4.3
2632	Westdale	1	0.2	5,260	3.8
3324	Templeton-Sinclair	1	0.2	5,195	3.8
2221	Heratage Park	1	0.2	5,320	3.8
5529	River Park West	2	0.4	10,750	3.7

2203	King Edward	1	0.2	5,760	3.5
5646	Waverley	1	0.2	5,695	3.5
5554	Meadowood	1	0.2	6,415	3.1
4412	Munroe East	1	0.2	8,525	2.3
4401	Chalmers	1	0.2	9,810	2.0
5525	Windsor Park	1	0.2	10,800	1.9
5615	Fort Richmond	1	0.2	12,425	1.6
3121	Pacific Industrial	1	0.2	small pop	N/A
3329	Inkster Industrial Park	2	0.4	small pop	N/A

*rate per 100,000 population.

Appendix F: Manitoba Correctional Institutions, population and proportion of inmates.

Institution	population	%
Dauphin Correctional Institute	50	3.4
The Pas Correctional Institute (includes Egg Lake)	100	6.8
Portage Correctional Institute	50	3.4
Agassiz Youth Centre	120	8.2
Brandon Correctional Institute	150	10.2
Headingly Correctional Institute	300	20.4
Milner Ridge	120	8.2
Stony Mountain Penitentiary	404	27.6
Rockwood Institute	172	11.7
total	1466	100.0