Expanding the epidemiologic profile: risk factors for active tuberculosis in people immigrating to Ontario

Research

Recherche

Wendy L. Wobeser,[*] Lilian Yuan,[†] Monika Naus,[‡] Paul Corey,[†] Jeff Edelson,[§] Neil Heywood,[¶] D. Linn Holness[†]

From *the Department of Medicine, Queen's University, Kingston, Ont.; †the Department of Public Health Sciences, University of Toronto, Toronto, Ont.; ‡the Public Health Branch, Ministry of Health, Toronto, Ont.; §SmithKline Beecham Pharmaceuticals, Collegeville, Pa.; and ¶Selection Branch, Citizenship and Immigration Canada, Ottawa, Ont.

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Abstract

Background: Many people immigrating to Canada come from countries with a high burden of tuberculosis. The aim of this study was to develop a detailed epidemiologic profile of foreign-born people with tuberculosis living in Ontario.

Methods: In this population-based case–control study, cases of tuberculosis diagnosed in 1994–1995 were identified from the database of the Ontario Reportable Disease Information Service and were considered eligible for analysis if a record of landing (receipt of permission to establish residence in Canada) from the period 1986–1995 was found in the Citizenship and Immigration Canada (CIC) database, if the person was at least 11 years of age at the time their visa was issued, and if the person had not been diagnosed with tuberculosis before becoming legally landed in Canada. Control subjects, who met the same criteria as the case subjects but who did not have tuberculosis in 1994–1995, were identified from a CIC database for landed immigrants.

Results: A total of 1341 cases of tuberculosis in foreign-born people were reported in Ontario in 1994–1995. A record of landing was found in CIC databases for 1099 of these people, 224 of whom were not legally landed at the time of diagnosis. In total, 602 cases met the inclusion criteria. The 2 strongest determinants of risk among those who had become landed within the preceding 10 years were referral for medical surveillance by immigration officials (odds ratio [OR] 3.8, 95% confidence interval [CI] 2.6–6.0) and world region of origin (Somalia [OR 67.7, 95% CI 31.3–154.9], Vietnam [OR 25.0, 95% CI 12.5–50.0], the Philippines [OR 11.9, 95% CI 6.0–23.3], other sub-Saharan African countries [OR 11.6, 95% CI 5.7–23.2], India [OR 9.7, 95% CI 4.9–18.9], China [OR 6.1, 95% CI 3.1–12.1], other Asian countries [OR 4.7, 95% CI 2.4–9.1], the Middle East [OR 4.1, 95% CI 2.0–8.3], Latin America [OR 1.9, 95% CI 0.9–3.8), and the former socialist countries of Europe [OR 1.8, 95% CI 0.8–3.8]; the reference category was countries with established market economies). Low socioeconomic status was an independent risk factor.

Interpretation: The risk of tuberculosis in groups of people migrating to Ontario is highly variable and is influenced by several factors. Successful population-based tuberculosis prevention strategies will need to accommodate this variability.

Developed countries are experiencing a concentration of cases of tuberculosis among foreign-born persons.[1–7] Many people who immigrate to Canada come from countries with a high burden of tuberculosis, a factor that puts them at high future risk for this disease.[5,8] Anyone applying to become legally landed in Canada (i.e., to be given lawful permission to establish residence) is required to undergo a medical evaluation at the time of immigration. If active tuberculosis is detected, a complete course of treatment is required before immigration. This process also detects people at greater risk of future tuberculosis, primarily on the basis of suggestive indications seen on chest radiography; these people are referred to local (i.e., provincial) public health authorities after immigration, a process called "medical surveillance." Specific guidelines have been developed for the eval-

uation and management of such individuals by Canadian health authorities.[9]

The purpose of this study was to develop a detailed epidemiologic profile of legally landed, foreign-born Ontario residents who were diagnosed with tuberculosis after immigration. This study had several interesting and unique characteristics. By linking the Ontario tuberculosis registry with immigration databases, we were able to determine the proportion of cases that had been referred for medical surveillance. We estimated the independent effects of sex, age at immigration, socioeconomic factors (including immigration category and education), world region of origin, referral for medical surveillance and time since immigration. This study is the first to analyse all of these factors simultaneously in an immigrant population.

Methods

This population-based case–control study was a collaborative effort of the Public Health Branch, Ontario Ministry of Health, and Citizenship and Immigration Canada (CIC).

All cases of tuberculosis diagnosed in Ontario in 1994–1995 in people born outside of Canada were selected from the Ontario Provincial Tuberculosis Surveillance System (Reportable Disease Information System [RDIS]). Only people who were at least 11 years of age at the time of visa issue (those younger than 11 years of age do not undergo screening chest radiography during the medical evaluation) and who had received landed immigrant status between 1986 and 1995 were included (Fig. 1).

RDIS data were linked to CIC databases to obtain background information on all cases of tuberculosis in foreign-born people. All linked cases were confirmed by individual review of the person's records. A database of landed immigrants was the source of the controls for the case–control analysis. Controls (4 controls for every case) were randomly selected from all people who were granted landed status between 1986 and 1995, who were destined for Ontario and who were at least 11 years old at the time of visa issue. Preliminary results of the analysis using matched and unmatched controls were similar, so unmatched controls were used. This allowed us to estimate and report the effects of all factors (including age, sex and year of arrival).

The countries of origin for the cases analysed in this study included the 5 countries that account for the greatest number of tuberculosis cases among foreign-born residents of Ontario (Vietnam, the Philippines, Somalia, India and China); the countries of origin for the other cases were grouped into regions according to the World Bank scheme.[1,5,10] Immigration category was divided into 5 groups: family class (close relatives sponsored by a Cana-

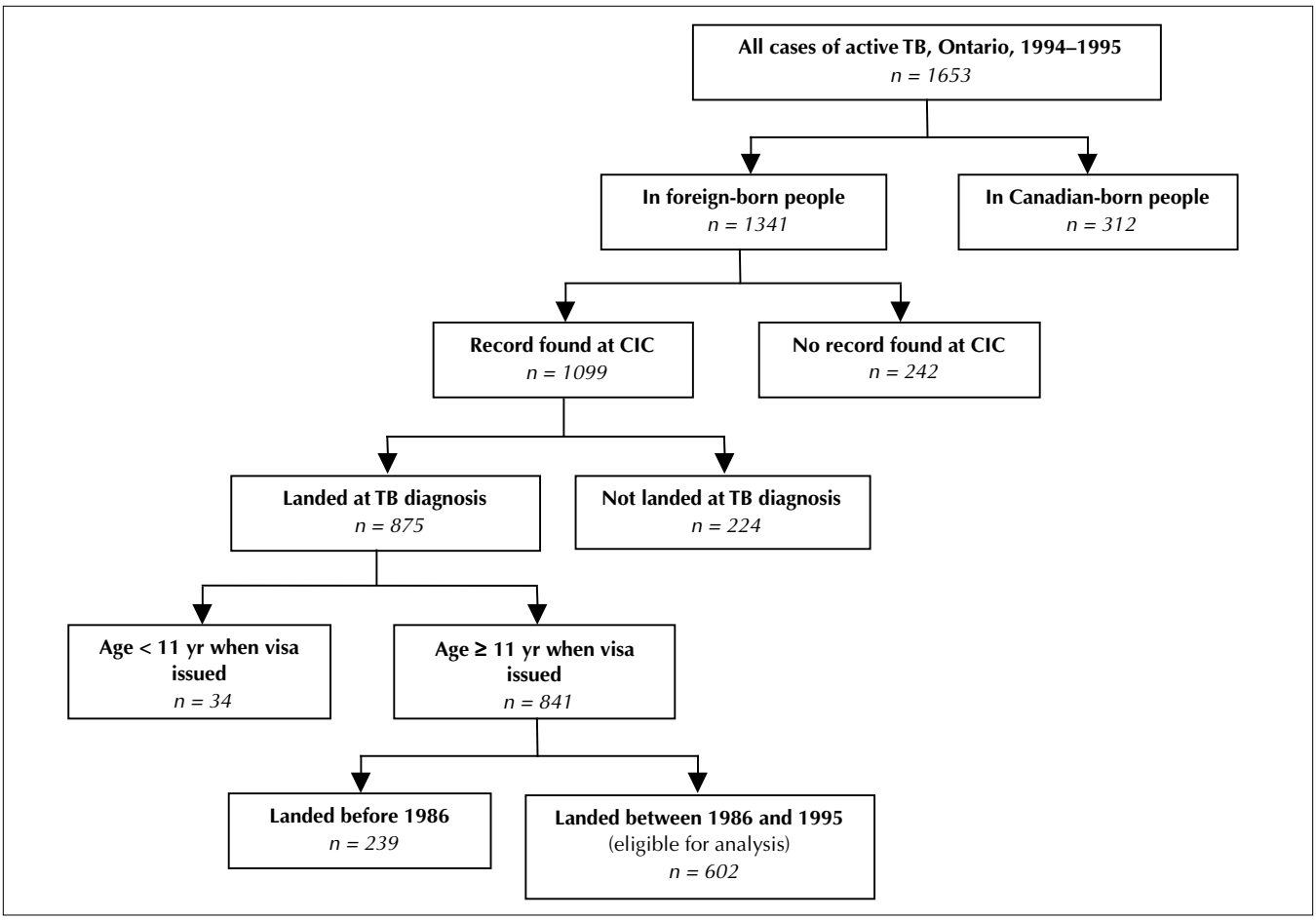

Fig. 1: Cases of active tuberculosis identified in Ontario in 1994–1995 in relation to the criteria for inclusion in the study. TB = tuberculosis, CIC = Citizenship and Immigration Canada.

dian citizen or permanent resident), refugees ("convention refugees" as defined by the United Nations High Commissioner for Refugees and refugees admitted under a special program), designated classes (members of specific classes designated by the Governor-in-Council in accordance with Canada's humanitarian tradition), other independent immigrants (self-employed people, investors, entrepreneurs, live-in caregivers and foreign household domestic workers) and retired people. Education was determined on the basis of the number of years of schooling attained at the time of immigration.

The χ^2 statistic was used to analyse categorical variables and Student's *t*-test was used for continuous variables. A logistic regression model, using active tuberculosis as the outcome, was constructed. Interaction terms were included in the model. The criterion for removal of a variable from the model was a change in the model –2 log likelihood associated with $p < 0.1$. Confidence intervals for proportions were derived by either the Gaussian approximation or exact calculations (binomial probability method).

Results

In 1994–1995, 1653 cases of tuberculosis were reported in Ontario (Fig. 1). Of these, 312 cases occurred in native-born Canadians and were therefore excluded. In addition, 242 of the cases in foreign-born people were excluded, because no record could be found in CIC databases. A further 224 cases were excluded because the people were not legally landed at the time of diagnosis. In most of those who were not legally landed, the disease was diagnosed within 3 years of their arrival in Canada; 112 (50%) had made a refugee claim in Canada, and tuberculosis was detected in 54 (24%) through immigration screening. Among the 875 who were legally landed at the time of diagnosis, 34 were excluded because they were less than 11 years of age at the time of visa issue; a further 239 were excluded because they had received landed status before 1986. A total of 602 cases were therefore eligible for further evaluation.

The characteristics of the included cases ($n = 602$) and the controls ($n = 2408$) are detailed in Table 1. There was no difference in sex distribution between the 2 groups. Those with tuberculosis were more likely to be older than 70 years of age ($p < 0.01$). People who were single or widowed at the time of landing were overrepresented among the cases ($p < 0.001$). Refugees and family class and assisted relatives were overrepresented, whereas other independent immigrants were underrepresented among the cases ($p < 0.001$). People with tuberculosis were less well educated than controls ($p < 0.01$) and were more likely to have arrived recently ($p < 0.001$).

The world region of origin was significantly different for cases and controls ($p < 0.001$). Almost all (554/602 [92.0%]) of the cases occurred in people born in countries where the World Bank has estimated that the annual incidence of tuberculosis is at least 100 per 100 000 population;[10] in contrast, only 57.0% (1373/2408) of controls came from these countries (data not shown). In addition, only 6 (1.0%) of the cases occurred in people born in a country with an estimated incidence of tuberculosis of less than 25 per 100 000 population; for controls, this proportion was 217/2408 (9.0%).

Overall, 77 (12.8%) of the cases but only 69 (2.7%) of the controls had been referred for medical surveillance ($p < 0.001$). Of the 325 cases of pulmonary tuberculosis, 54 (16.6%) had been referred for medical surveillance. Among cases diagnosed within 2 years after arrival in Canada, 30 (16.0%) of the 188 cases of tuberculosis at any site and 25 (22.5%) of the 111 cases of pulmonary tuberculosis had been referred for medical surveillance.

World region of origin and referral for medical surveillance were the strongest independent predictors of tuberculosis ($p < 0.001$), followed by age ($p = 0.002$), education ($p = 0.04$) and immigration category ($p = 0.07$) (Table 2). Sex, marital status and year of landing did not contribute independently to risk of disease in the multivariate model. An interaction was found between the oldest age group and education ($p = 0.08$); the relation between age and education is presented in Table 3. There was no interaction between education and country of origin.

Interpretation

This study identified risk factors for tuberculosis in a migrant population. The two factors that were most predictive of a diagnosis of tuberculosis were world region of origin and referral for medical surveillance by immigration officials. Other factors that were independently associated with tuberculosis were advanced age and low socioeconomic status (as indicated by education achieved at the time of immigration and immigration category). Factors associated with risk of tuberculosis on univariate analysis but not multivariate analysis included marital status (those who were widowed or single were at higher risk than married people) and year of landing (those who had landed more recently were at higher risk). We also found an interaction between age and education; elderly people with little education were at particularly high risk of tuberculosis. No association was evident between risk of tuberculosis and sex.

Previous studies have shown that world region of origin,[1,5,6,8] age[5,6] and referral for medical surveillance[11,12] are important determinants of risk of tuberculosis in a migrating population. People who migrate from world regions with a high burden of tuberculosis are more likely both to be infected with *Mycobacterium tuberculosis*[13] and to develop active disease.[5,8] The relation between age and risk of tuberculosis is generally thought to be a result of cumulative risk of infection; however, the risk of disease after infection may increase among elderly people.[14] Other Canadian studies have suggested that the risk of disease among people referred for medical surveillance is 4 times higher than among those not referred.[11,12] In addition, these studies

Table 1: Characteristics of cases of tuberculosis identified in Ontario in 1994–1995 that met study criteria and controls

Characteristic	No. (and %) of subjects: Cases *n = 602*	Controls *n = 2408*	OR (and 95% CI)	*p*
Sex				NS
Male	293 (48.7)	1175 (48.8)	1.0 (0.8–1.2)	
Female	309 (51.3)	1233 (51.2)	1.0 (reference)	
Age at landing,* yr				< 0.01
11–35	381 (63.3)	1501 (62.3)	1.1 (0.9–1.4)	
35.1–70	191 (31.7)	858 (35.6)	1.0	
> 70	30 (5.0)	49 (2.0)	2.8 (1.7–4.4)	
Marital status				< 0.001
Single	273 (45.3)	965 (40.1)	1.3 (1.1–1.6)	
Married	281 (46.7)	1325 (55.0)	1.0	
Widowed	39 (6.5)	76 (3.2)	2.4 (1.6–2.6)	
Divorced or separated	9 (1.5)	42 (1.7)	1.0 (0.5–2.1)	
Immigration category				< 0.001
Family class	339 (56.3)	1224 (50.8)	2.2 (1.7–2.9)	
Refugee†	132 (21.9)	378 (15.7)	2.8 (2.0–3.8)	
Designated class‡	48 (8.0)	177 (7.4)	2.2 (1.5–3.3)	
Other independent§	73 (12.1)	586 (24.3)	1.0	
Retired	10 (1.7)	43 (1.8)	1.9 (0.9–3.9)	
Education at time of immigration, yr				< 0.01
≤ 12	435 (72.2)	1421 (59.0)	1.8 (1.5–2.2)	
> 12	167 (27.7)	984 (40.9)	1.0	
World region of origin				< 0.001
Vietnam	107 (17.8)	92 (3.8)	31.6 (16.3–61.1)	
Philippines	72 (12.0)	156 (6.5)	12.5 (6.5–24.3)	
Somalia	68 (11.3)	22 (0.9)	83.9 (38.9–180.9)	
India	68 (11.3)	170 (7.0)	10.9 (5.6–21.1)	
China	58 (9.6)	201 (8.3)	7.8 (4.0–15.3)	
Other Asian countries	79 (13.1)	435 (18.1)	4.9 (2.6–9.4)	
Latin America	29 (4.8)	377 (15.6)	2.1 (1.0–4.2)	
Other sub-Saharan African countries	54 (9.0)	116 (4.8)	12.6 (6.2–25.0)	
Middle East	36 (6.0)	231 (9.6)	4.2 (2.1–8.5)	
Former socialist countries of Europe	20 (3.3)	307 (12.7)	1.8 (0.8–3.7)	
Countries with established market economies	11 (1.8)	301 (12.5)	1.0	
Referred for medical surveillance				< 0.001
Yes	77 (12.8)	69 (2.9)	5.0 (3.5–7.0)	
No	525 (87.2)	2339 (97.1)	1.0	
Year of landing*				< 0.001
1986–1987	63 (10.5)	317 (13.2)	0.9 (0.7–1.3)	
1988–1989	77 (12.8)	420 (17.4)	0.9 (0.6–1.2)	
1990–1991	143 (23.8)	513 (21.3)	1.3 (1.0–1.7)	
1992–1993	207 (34.4)	638 (26.5)	1.5 (1.2–1.9)	
1994–1995	112 (18.6)	520 (21.6)	1.0	

Note: OR = odds ratio, CI = confidence interval, NS = not significant.
*Receipt of lawful permission to establish residence in Canada.
†"Convention refugees" as defined by the United Nations High Commissioner for Refugees and refugees admitted under special programs.
‡Members of specific classes designated by the Governor-in-Council in accordance with Canada's humanitarian tradition.
§Includes skilled workers, business class immigrants and live-in caregivers.

showed that 1.5% to 2.8% of all those referred for medical surveillance were diagnosed with active disease at their first medical evaluation in Canada.[11,12]

The relation between socioeconomic status and tuberculosis has long been recognized.[15–18] This study quantifies this relation in a migrant population. The correlation between low socioeconomic status and crowding sets the stage for local transmission of disease. Effective access to medical care by people facing significant economic, cultural and linguistic barriers is likely to prove difficult.[19] Although risk of active tuberculosis is reportedly related to time since immigration,[1,5,8,20,21] our multivariate analysis did not show such a relation. This may be because our analysis was restricted to people who were legally landed at the time of diagnosis, all of whom would have been screened for tuberculosis. Importation of active disease might be lower in this group than among all immigrants, which would, in turn, diminish the relation between risk of disease and time since immigration. Through the process of identifying cases for our analysis, we found 224 cases of tuberculosis in people who were not landed immigrants at the time of diagnosis, a finding supported by Enarson and colleagues.[8] The biggest group among those not landed at the time of diagnosis were people claiming refugee status. Refugee claimants who have already arrived in Canada may be at particularly high risk of tuberculosis[22,23] and may not have undergone a medical evaluation before their arrival. Delays in both making the refugee claim and performing the medical evaluation required before a claim can be processed may result in local transmission of disease. Attempts are currently being made to minimize such delays in this group; however, further study is needed to ensure that local transmission is prevented.

Our study supports current recommendations for focusing preventive strategies on people referred to local public health authorities by immigration officials;[9,24] however, it also emphasizes that people who are not referred for medical surveillance account for most cases of tuberculosis diagnosed after landed status is attained. In this study we did not examine the effectiveness of medical surveillance. The current system has a number of shortcomings, including lack of notification of the appropriate Canadian public health authorities, poor adherence to the guidelines for medical surveillance in Canada[11,12] and low rates of preventive therapy among those referred for surveillance. As a result, opportunities to prevent future cases of tuberculosis may be lost.

International migration places the responsibility for understanding the health care needs of migrants on host countries.[3] Immigration is a powerful force affecting the epidemiology of tuberculosis in developed countries. In this study we have shown that the risk of tuberculosis in a migrating population is extremely variable. Although community-wide interventions coordinated through public health departments may be appropriate for some particularly high-risk groups, primary care physicians caring for people born outside of Canada must educate themselves about tuberculosis, its detection and its prevention. Health care providers in this country can reduce the potential impact of this disease on the Canadian-born population by judicious use of preventive therapy, as well as early diagnosis and appropriate treatment of infectious cases. Removing barriers to health care for new Canadians will be key to the success of efforts to prevent and control tuberculosis.

Table 2: Adjusted odds ratios for risk factors for tuberculosis

Risk factor	Adjusted OR (and 95% CI)	*p*
Age at landing, yr		0.002
11–35	1.2 (0.9–1.5)	
35.1–70	1.0	
> 70	2.8 (1.6–4.8)	
World region of origin		< 0.001
Vietnam	25.0 (12.5–50.0)	
Philippines	11.9 (6.0–23.3)	
Somalia	67.7 (31.3–154.9)	
India	9.7 (4.9–18.9)	
China	6.1 (3.1–12.1)	
Other Asian countries	4.7 (2.4–9.1)	
Latin America	1.9 (0.9–3.8)	
Other sub-Saharan African countries	11.6 (5.7–23.2)	
Middle East	4.1 (2.0–8.3)	
Former socialist countries of Europe	1.8 (0.8–3.8)	
Countries with established market economies	1.0	
Medical surveillance	3.8 (2.6–6.0)	< 0.001
Education at time of immigration, yr		0.04
≤ 12	1.3 (1.0–1.6)	
> 12	1.0	
Immigration category		0.07
Family class	1.5 (1.1–2.0)	
Refugee	1.6 (1.1–2.3)	
Designated class	1.4 (0.8–2.3)	
Other independent	1.0	
Retired	1.3 (0.6–2.9)	

Table 3: Adjusted odds ratios for age in relation to education

	Education;* adjusted OR† (and 95% CI)	
Age at landing, yr	≤ 12 yr	> 12 yr
11–35	1.6 (1.1–2.3)	1.2 (0.8–1.8)
35.1–70	1.2 (0.8–1.8)	1.0
> 70	4.3 (2.3–8.1)	0.4 (0.1–3.8)

*At the time of immigration.
†Adjusted for world region of origin, immigration category and referral for medical surveillance.

Competing interests: None declared.

Contributors: Dr. Wobeser undertook this work as part of her thesis. She was the principal investigator and was responsible for data acquisition, data analysis and manuscript preparation. Drs. Holness, Yuan and Edelson were on Dr. Wobeser's thesis committee; they contributed to the study design, data analysis and interpretation. Dr. Naus contributed data from Ontario and critical input into the development of the study questions. Dr. Heywood contributed data from Citizenship and Immigration Canada; he also contributed to the study design and data analysis. Dr. Corey was the biostatistician for the project; he contributed to the study design and data analysis.

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Reprints requests to: *Dr. Wendy L. Wobeser, 3013 Etherington Hall, Queen's University, Kingston ON K7L 3N6; wlw@post.queensu.ca*