Immigrants and tuberculosis in Hong Kong

CC Leung *, CK Chan, KC Chang, WS Law, SN Lee, LB Tai, Eric CC Leung, CM Tam

ABSTRACT

Objective: To examine the impact of immigrant populations on the epidemiology of tuberculosis in Hong Kong.

Design: Longitudinal cohort study.

Setting: Hong Kong.

Participants: Socio-demographic and disease characteristics of all tuberculosis notifications in 2006 were captured from the statutory tuberculosis registry and central tuberculosis reference laboratory. Using 2006 By-census population data, indirect sex- and age-standardised incidence ratios by place of birth were calculated. Treatment outcome at 12 months was ascertained from government tuberculosis programme record forms, and tuberculosis relapse was tracked through the notification registry and death registry up to 30 June 2013.

Results: Moderately higher sex- and age-standardised incidence ratios were observed among various immigrant groups: 1.06 (Mainland China), 2.02 (India, Pakistan, Bangladesh), 1.59 (Philippines, Thailand, Indonesia, Nepal), and 3.11 (Vietnam). Recent Mainland migrants had a lower sex- and age-standardised incidence ratio (0.51 vs 1.09) than those who immigrated 7 years ago or earlier. Age younger than 65 years, birth in the Mainland or the above Asian countries, and previous treatment were independently associated with resistance to isoniazid and/or rifampicin. Older age, birth in the above Asian countries, non-permanent residents, previous history of treatment, and resistance to isoniazid and/or rifampicin were independently associated with poor treatment outcome (other than cure/treatment completion) at 1 year. Birth outside Hong Kong was an independent predictor of relapse following successful completion of treatment (adjusted hazard ratio=1.76; 95% confidence interval, 1.07-2.89; P=0.025).

Conclusion: Immigrants carry with them a higher tuberculosis incidence and/or drug resistance rate from their place of origin. The higher drug resistance rate, poorer treatment outcome, and excess relapse risk raise concern over secondary transmission of drug-resistant tuberculosis within the local community.

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CC Leung *, MB, BS, FHKAM (Medicine)
CK Chan, MB, BS, FHKAM (Medicine)
KC Chang, MB, BS, FHKAM (Medicine)
WS Law, MB, ChB, FHKAM (Medicine)
SN Lee, MB, ChB, FHKAM (Medicine)
LB Tai, MB, ChB, FHKAM (Medicine)
ECC Leung, MB, BS, FHKAM (Medicine)
CM Tam, MB, BS, FHKAM (Medicine)

Tuberculosis and Chest Service, Department of Health, Wanchai Chest Clinic, 1/F, 99 Kennedy Road, Wanchai, Hong Kong

* Corresponding author: cc_leung@dh.gov.hk

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New knowledge added by this study

- Immigrants carry with them a higher tuberculosis incidence and/or drug resistance rate from their place of origin to Hong Kong.

Implications for clinical practice or policy

- Their higher drug resistance rate, poorer treatment outcome, and excess relapse risk may increase the risk of secondary transmission of drug-resistant tuberculosis within the local community.

Introduction

Great disparity in tuberculosis (TB) rates has been reported in different parts of the world.[1] Patients with TB from 22 high-burden areas accounted for over 80% of all notified TB cases in the world.[1] Immigrants from these high-burden areas have often been blamed for their impact on the TB situation in many developed areas.[2-12] A rapid increase in population was observed in Hong Kong in the last century, largely due to a heavy influx of immigrants from Mainland China.[13-15] Despite remarkable socio-economic improvement over the past four decades, TB remains a common disease in Hong Kong. In 2006, the TB notification rate remained as high as 84.1/100 000.[16] With continuing population movement between the Mainland and Hong Kong, there has been major concern about cross-border transmission of infections including TB.

A large-scale population census has been conducted in Hong Kong every 10 years since

香港移民與結核病

梁子超、陳志權、鄭國釗、羅穎思、李淑娜、戴麗文、梁中正、譚卓明

目的：研究移民人口對於香港結核病流行病學的影響。

設計：縱向隊列研究。

安排：香港。

參與者：根據法定的結核病通報資料庫和中央結核病參考實驗室中選取2006年所有結核病呈報病例的人口學和疾病特徵資料。採用2006年中期人口統計數據，按其出生地來計算間接的性別和年齡標準化發病率。從政府的結核病計劃紀錄確定患者12個月後的治療結果，再透過結核病通報資料庫以及死亡登記處的紀錄追踪至2013年6月30日以確定是否有復發病例。

結果：不同移民群體的性別和年齡標準化結核病發病率都偏高：1.06（中國大陸）、2.02（印度、巴基斯坦、孟加拉）、1.59（菲律賓、泰國、印度尼西亞、尼泊爾）和3.11（越南）。中國大陸新移民的性別和年齡標準化結核病發病率較7年前或更早期的移民低，分別為0.51比1.09。65歲以下、於內地或以上提及的亞洲國家出生，以及曾接受結核病治療都是異煙肼和/或利福平耐藥性的獨立相關因素。年紀較大、於以上提及的亞洲國家出生、非永久居民、曾接受結核病治療和異煙肼和/或利福平耐藥性都是1年後有較差治療結果（並未康復或完成治療）的獨立相關因素。此外，在香港以外地方出生是成功治療後出現復發的獨立預測因素（調整後危險比=1.76；95%置信區間：1.07-2.89；P=0.025）。

結論：移民人口會隨着他們的原籍地方帶來較高的結核病發病率和/或耐藥性。較高的耐藥性比率、較差的治療結果和較高復發率引起對社區內耐藥性結核病二次傳播的關注。

1961, with a smaller by-census in-between. Tuberculosis is a statutorily notifiable disease, and basic demographic, clinical, and bacteriological data of notified cases are regularly captured by the TB notification registry. All residents are issued an identity card, and the identity card is used by both the TB notification registry and death registry as a unique personal identifier. Eighteen government chest clinics offer free programmatic case-finding and treatment services for TB patients under a centralised Tuberculosis and Chest Service of the Department of Health, with estimated programme coverage of over 80% of the population. Sputum culture and drug susceptibility testing are regularly performed by a centralised laboratory that is a Supranational Reference Laboratory within the World Health Organization/International Union Against Tuberculosis and Lung Diseases (WHO/IUATLD) network. Standard short-course regimens are used in line with the WHO recommendations. Patients are regularly followed up for 2 years after initiation of TB treatment to facilitate cohort analysis of treatment outcome. Using regularly captured data within the statutory registries and government TB programme, a longitudinal cohort study was performed to examine the impact of immigrant populations on the epidemiology of TB in Hong Kong.

Methods

Data on sex, age, place of birth, residency status, case category (new or retreatment), disease form (pulmonary with or without extrapulmonary involvement, or extrapulmonary only), sputum smear and culture results of consecutive patients notified within 2006 were obtained from the territory-wide TB notification registry of Hong Kong. An active case of TB was defined as positive isolation of *Mycobacterium tuberculosis* complex or, in the case of absent bacteriological confirmation, disease diagnosed on clinical, radiological, and/or histological grounds together with an appropriate response to anti-TB treatment. As part of the public health surveillance, bacteriological results of notified cases were verified with the reports from the central TB reference laboratory, with drug susceptibility test results for streptomycin, isoniazid, rifampicin, and ethambutol retrieved for culture-positive cases.

The sex- and age-stratified population data were obtained from the 2006 By-census for the following places of birth: Hong Kong (Group I); Mainland China (Group II); India, Pakistan, and Bangladesh (Indian subcontinent: Group III); Philippines, Thailand, Indonesia, and Nepal (other key Asian minority groups, Group IV); Vietnam (Group V); and other miscellaneous places of birth (Group VI).[17] The crude incidence of TB among each of the above population groups was calculated with adjustment made by a multiplication factor (total notified cases / [total notified cases – cases with missing place of birth]) for cases with missing data on place of birth. The sex- and age-specific (by 5-year age-group) TB rates were derived from the overall population data and applied to the corresponding sex-age groups of each of the above six population groups to obtain the expected number of cases. The observed number of TB cases for each population group was compared with the respective number of expected cases to obtain the indirectly standardised TB incidence ratio. The 95% confidence intervals (CIs) were calculated by assuming a Poisson distribution in the occurrence of events. For those born in Mainland China, further stratification was made by the duration of residence in Hong Kong.

The treatment outcome 12 months after initiation of treatment was ascertained for those patients being managed by the government chest clinics under the Tuberculosis and Chest Service from the programme record form of the Tuberculosis and Chest Service. Treatment success was defined as cure or treatment completion (successfully completed treatment of ≥6 months for new cases

and ≥8 months for retreatment cases), irrespective of subsequent relapse or death or loss to follow-up. All other treatment outcomes (including death before treatment completion, default, transferring out, still on treatment at 12 months after treatment initiation) were regarded as unsuccessful. Permanent residents who successfully completed treatment under the government TB programme were subsequently tracked up to 30 June 2013 through the territory-wide TB notification registry and death registry for relapse of TB or death.

Chi squared and Fisher's exact tests were used as appropriate for categorical variables and analysis of variance was used for continuous variables. Logistic regression modelling was used for multivariate analysis of 12-month outcome. For censored data of TB relapse during follow-up, Kaplan-Meier analysis was used in univariate analysis and Cox proportional hazards modelling was used in multivariate analysis to adjust for potential confounders. A two-tailed P value of 0.05 was considered statistically significant.

The study was part of a public health surveillance exercise in tracking the profile and outcome of statutory TB notifications. It did not involve intervention on human subjects.

Results

A total of 6246 TB notifications were received in 2006, 480 of which were excluded because of duplicate notification or revised diagnosis, leaving 5766 cases in the 2006 TB notification registry. Of these, 18 cases involving tourists, 17 cases involving illegal immigrants, and 329 cases without information on place of birth were also excluded, leaving 5402 cases for analysis. Table 1 shows their basic characteristics as stratified by place of birth. The vast majority (92.3%) of TB cases involved residents born in either Hong Kong or Mainland China. Significant differences were observed between the six population groups in terms of sex and age distribution as well as proportions of new and pulmonary cases, but not proportions of either smear-positive or culture-confirmed cases.

Table 2 summarises the incidence of TB and indirectly sex- and age-standardised incidence ratio (SIR) of TB for the six population groups. The TB SIR was significantly above 1 for those born in Mainland China (males and combined), Group III (females and combined), Group IV (females and combined), and Group V (males and combined), but significantly below 1 for those born in Hong Kong (males, females, and combined) and other miscellaneous places of birth (males, females, and combined). Mainland-born permanent residents (staying in Hong Kong for ≥7 years) maintained a higher TB risk than the population average for both sexes and combined. Nonetheless, recent Mainland immigrants with duration of stay of less than 7 years actually had a lower TB risk than the general population, despite sex and age standardisation.

Table 3 shows the resistance profile of 3474 (98.1%) culture-confirmed cases (with available drug susceptibility testing results) by place of birth. Table

TABLE 1. Basic characteristics of tuberculosis cases notified in 2006 in Hong Kong as stratified by place of birth

Characteristic	Group No.*, No. (%)							P value
	I (n=2138)	II (n=2846)	III (n=38)	IV (n=284)	V (n=30)	VI (n=66)	Overall (n=5402†)	
Male gender	1368 (64.0)	2028 (71.3)	18 (47.4)	45 (15.8)	22 (73.3)	44 (66.7)	3525 (65.3)	<0.001
Age-group (years)								<0.001
0-14	35 (1.6)	12 (0.4)	1 (2.6)	0	0	0	48 (0.9)	
15-34	666 (31.2)	201 (7.1)	12 (31.6)	152 (53.5)	18 (60.0)	11 (16.7)	1060 (19.6)	
35-64	1036 (48.5)	922 (32.4)	22 (57.9)	114 (40.1)	10 (33.3)	34 (51.5)	2138 (39.6)	
≥65	401 (18.8)	1711 (60.1)	3 (7.9)	18 (6.3)	2 (6.7)	21 (31.8)	2156 (39.9)	
Permanent residency‡	2136 (99.9)	2785 (97.9)	25 (65.8)	79 (27.8)	9 (30.0)	59 (89.4)	5093 (94.3)	<0.001
New cases	1924 (90.0)	2489 (87.5)	36 (94.7)	270 (95.1)	26 (86.7)	59 (89.4)	4804 (88.9)	0.001
Pulmonary§	1920 (89.8)	2640 (92.8)	30 (78.9)	222 (78.2)	26 (86.7)	59 (89.4)	4897 (90.7)	<0.001
Smear-positive	697 (32.6)	887 (31.2)	13 (34.2)	72 (25.4)	12 (40.0)	22 (33.3)	1703 (31.5)	0.183
Culture-confirmed	1391 (65.1)	1897 (66.7)	23 (60.5)	166 (58.5)	22 (73.3)	42 (63.6)	3541 (65.5)	0.093

* I: Hong Kong; II: Mainland China; III: Indian subcontinent (India, Pakistan, and Bangladesh); IV: Other key Asian groups (Philippines, Indonesia, Thailand, and Nepal); V: Vietnam; VI: Miscellaneous

† Excluding 18 cases involving tourists, 17 cases involving illegal immigrants, and 329 cases without information on place of birth

‡ 7 Years of stay in Hong Kong required for permanent residency, except by birth

§ Pulmonary disease with or without extrapulmonary involvement

TABLE 2. Annual incidences of active tuberculosis (all forms) in resident population by place of birth in 2006

Place of birth	Sex	Population	Observed TB cases	Incidence* (95% CI) per 100 000-year	SIR*
I. Hong Kong	Female	2 039 064	770	40.0 (37.3-42.7)	0.87 (0.82-0.93)
	Male	2 099 780	1368	69.2 (65.7-72.6)	0.92 (0.88-0.97)
	Both	4 138 844	2138	54.8 (52.6-57.0)	0.90 (0.87-0.94)
II. Mainland					
Permanent resident	Female	997 765	774	82.6 (77.0-88.3)	1.08 (1.00-1.15)
	Male	943 370	2011	216.5 (216.5-235.6)	1.10 (1.05-1.14)
	Both	1 941 135	2785	152.3 (146.8-157.8)	1.09 (1.05-1.13)
<7 Years of stay	Female	192 718	44	24.2 (17.2-31.1)	0.52 (0.37-0.67)
	Male	81 927	17	22.0 (11.8-32.2)	0.50 (0.27-0.73)
	Both	274 645	61	23.5 (17.8-29.3)	0.51 (0.39-0.64)
All residency status	Female	1 190 483	818	73.2 (68.5-77.9)	1.02 (0.95-1.08)
	Male	1 025 297	2028	209.5 (200.8-218.1)	1.08 (1.04-1.13)
	Both	2 215 780	2846	136.2 (131.5-141.0)	1.06 (1.03-1.10)
III. Indian subcontinent (India, Pakistan, Bangladesh)	Female	12 458	20	169.9 (99.5-240.2)	3.11 (1.82-4.40)
	Male	13 259	18	144.0 (81.2-206.7)	1.45 (0.82-2.08)
	Both	25 717	38	156.5 (109.5-203.5)	2.02 (1.41-2.62)
IV. Philippines, Indonesia, Thailand, and Nepal	Female	240 168	239	105.5 (92.9-118.1)	1.82 (1.60-2.03)
	Male	29 661	45	161.0 (116.7-205.3)	0.96 (0.70-1.23)
	Both	269 829	284	111.6 (99.4-123.9)	1.59 (1.42-1.77)
V. Vietnam	Female	6463	8	130.7 (45.0-216.5)	2.01 (0.69-3.33)
	Male	4031	22	590.5 (362.2-818.4)	3.86 (2.37-5.34)
	Both	10 494	30	307.3 (205.0-409.6)	3.11 (2.07-4.14)
VI. Miscellaneous	Female	102 754	22	22.8 (13.9-31.8)	0.43 (0.26-0.60)
	Male	100 928	44	46.4 (33.5-59.3)	0.41 (0.30-0.53)
	Both	203 682	66	34.5 (26.7-42.3)	0.42 (0.32-0.52)
Overall†	Female	3 591 390	1993	55.5 (53.1-57.9)	-
	Male	3 272 956	3738	114.2 (110.5-117.9)	-
	Both	6 864 346	5731	83.5 (81.3-85.7)	-

Abbreviations: CI = confidence interval; SIR = sex- and age-standardised incidence ratio; TB = tuberculosis

* Adjustment made by proportional allocation of 329 cases with unknown places of birth to each birth group through the application of a multiplication factor (total notified cases / [total notified cases – cases with missing place of birth])

† Including 329 cases with unknown places of birth

4 summarises the results of univariate and multiple logistic analyses with respect to isoniazid, rifampicin, and multidrug resistance (resistance to both isoniazid and rifampicin) of 3434 culture-confirmed cases after combining all patients born in Asian countries listed under Groups III, IV and V, and excluding 40 patients with miscellaneous places of birth in Group VI that included very few drug-resistant cases. In the multiple logistic regression models using a backward stepwise elimination approach, only age <65 years, place of birth, and history of previous treatment (ie retreatment cases) remained important independent predictors of isoniazid, rifampicin, and multidrug resistance.

Of the 5402 subjects included in this study, 4319 (80.0%) were managed, at least at some stage of the disease, within the government TB programme. A total of 3304 (76.5%) patients successfully completed treatment within 12 months after initiation of treatment. Table 5 summarises the factors associated with 12-month treatment outcome in both univariate analysis and multivariate logistic regression analysis. Of those patients who successfully completed treatment, 3176 (96.1%) permanent residents in Hong Kong were followed up by cross-linking with the TB notification registry and death registry until

TABLE 3. Resistance to first-line drugs by place of birth

Drug susceptibility test	Group No.*, No. (%)						Overall
	I	II	III	IV	V	VI	
All	(n=1362)	(n=1864)	(n=23)	(n=163)	(n=22)	(n=40)	(n=3474†)
Fully sensitive	1231 (90.4)	1706 (91.5)	19 (82.6)	147 (90.2)	15 (68.2)	34 (85.0)	3152 (90.7)
S-resistant	102 (7.5)	105 (5.6)	1 (4.3)	2 (1.2)	5 (22.7)	4 (10.0)	219 (6.3)
H-resistant	57 (4.2)	83 (4.5)	4 (17.4)	13 (8.0)	6 (27.3)	2 (5.0)	165 (4.7)
R-resistant	11 (0.8)	20 (1.1)	0	5 (3.1)	1 (4.5)	0	37 (1.1)
M-resistant	8 (0.6)	11 (0.6)	0	1 (0.6)	1 (4.5)	0	21 (0.6)
MDR	5 (0.4)	17 (0.9)	0	2 (1.2)	1 (4.5)	0	25 (0.7)
New	(n=1235)	(n=1668)	(n=21)	(n=155)	(n=18)	(n=37)	(n=3134)
Fully sensitive	1117 (90.4)	1540 (92.3)	17 (81.0)	140 (90.3)	13 (72.2)	31 (83.8)	2858 (91.2)
S-resistant	92 (7.4)	86 (5.2)	1 (4.8)	1 (0.6)	3 (16.7)	4 (10.8)	187 (6.0)
H-resistant	49 (4.0)	62 (3.7)	4 (19.0)	12 (7.7)	4 (22.2)	2 (5.4)	133 (4.2)
R-resistant	9 (0.7)	15 (0.9)	0	4 (2.6)	0	0	28 (0.9)
M-resistant	7 (0.6)	9 (0.5)	0	0	0	0	16 (0.5)
MDR	3 (0.2)	12 (0.7)	0	1 (0.6)	0	0	16 (0.5)
Retreatment	(n=127)	(n=196)	(n=2)	(n=8)	(n=4)	(n=3)	(n=340)
Fully sensitive	114 (89.8)	166 (84.7)	2 (100.0)	7 (87.5)	2 (50.0)	3 (100.0)	294 (86.5)
S-resistant	10 (7.9)	19 (9.7)	0	1 (12.5)	2 (50.0)	0	32 (9.4)
H-resistant	8 (6.3)	21 (10.7)	0	1 (12.5)	2 (50.0)	0	32 (9.4)
R-resistant	2 (1.6)	5 (2.6)	0	1 (12.5)	1 (25.0)	0	9 (2.6)
M-resistant	1 (0.8)	2 (1.0)	0	1 (12.5)	1 (25.0)	0	5 (1.5)
MDR	2 (1.6)	5 (2.6)	0	1 (12.5)	1 (25.0)	0	9 (2.6)

Abbreviations: H = isoniazid; M = ethambutol; MDR = multidrug-resistant; R = rifampicin; S = streptomycin

* I: Hong Kong; II: Mainland China; III: Indian subcontinent (India, Pakistan, and Bangladesh); IV: Other key Asian groups (Philippines, Indonesia, Thailand, and Nepal); V: Vietnam; VI: Miscellaneous

† Excluding 67 culture-confirmed cases without drug sensitivity results

relapse of TB, death or 30 June 2013, whichever was the earliest. After a mean (± standard deviation) duration of 5.28 ± 1.64 years of follow-up, 80 (2.5%) relapses were detected at a median (range) time interval of 1004 (225-2640) days after initiation of treatment, 37 (46.3%) of which were bacteriologically confirmed. In Kaplan-Meier analysis, the relapse risk was higher among permanent residents born outside Hong Kong than among those born in Hong Kong (3.0% vs 1.9%; log rank test, P=0.019). A consistently higher relapse risk was present among those born outside Hong Kong (adjusted hazard ratio=1.76; 95% CI, 1.07-2.89; P=0.025) after adjustment for gender, age, case category (new or retreatment), type of TB (pulmonary or extrapulmonary only), sputum smear, culture, and drug resistance to isoniazid and/or rifampicin at the baseline. The Figure shows the cumulative hazard curves by place of birth in and outside Hong Kong in Cox proportional hazards modelling.

Discussion

In this study, persons born in Hong Kong had a SIR of 0.90 (95% CI, 0.87-0.94), while those born in Mainland China (Group II), Indian subcontinent (Group III), Philippines, Indonesia, Thailand, Nepal (Group IV), and Vietnam (Group V) had significantly higher SIRs of 1.06, 2.02, 1.59, and 3.11 respectively (Table 2). Recent Mainland migrants (with length of stay <7 years), however, had a significantly lower SIR (0.51 vs 1.09) than other Mainland-born residents. Age <65 years, birth in Mainland or Groups III-V Asian countries, and history of previous treatment were independently associated with resistance to isoniazid and/or rifampicin (Table 4). Older age, birth in Groups III-V Asian countries, non-permanent residents, retreatment case, and resistance to isoniazid and/or rifampicin were independently associated with lower treatment success (cure/treatment completion) rate at 1 year

TABLE 4. Factors affecting isoniazid, rifampicin, and multidrug resistance at baseline*

Factor	Category	Univariate analysis		Multivariate analysis†	
		Resistance, No. (%)	P value	Adjusted OR (95% CI)	P value
Isoniazid					
Sex	Female	50 (4.6)	0.827	-	-
	Male	113 (4.8)			
Age (years)	<65	110 (5.7)	0.004	Reference	0.003
	≥65	53 (3.6)		0.57 (0.39-0.83)	
Place of birth			<0.001		<0.001
	Hong Kong	57 (4.2)		Reference	
	Mainland	83 (4.5)		1.32 (0.91-1.91)	
	Asian countries‡	23 (11.1)		2.78 (1.67-4.64)	
Permanent residency	No	17 (9.8)	0.001	-	-
	Yes	146 (4.5)			
Case category	New	131 (4.2)	<0.001	Reference	<0.001
	Retreatment	32 (9.5)		2.67 (1.77-4.02)	
Rifampicin					
Sex	Female	11 (1.0)	0.821	-	-
	Male	26 (1.1)			
Age (years)	<65	27 (1.4)	0.043	Reference	0.019
	≥65	10 (0.7)		0.39 (0.17-0.86)	
Place of birth			0.026		0.045
	Hong Kong	11 (0.8)		Reference	
	Mainland	20 (1.1)		1.86 (0.85-4.07)	
	Asian countries‡	6 (2.9)		3.48 (1.27-9.58)	
Permanent residency	No	5 (2.9)	0.037§	-	-
	Yes	32 (1.0)			
Case category	New	28 (0.9)	0.008§	Reference	0.001
	Retreatment	9 (2.7)		3.52 (1.63-7.60)	
Multidrug					
Sex	Female	7 (0.6)	0.709	-	-
	Male	18 (0.8)			
Age (years)	<65	17 (0.9)	0.249	Reference	0.031
	≥65	8 (0.5)		0.37 (0.15-0.91)	
Place of birth			0.047		0.047
	Hong Kong	5 (0.4)		Reference	
	Mainland	17 (0.9)		3.48 (1.23-9.85)	
	Asian countries‡	3 (1.4)		3.91 (0.92-16.62)	
Permanent residency	No	3 (1.7)	0.130§	-	-
	Yes	22 (0.7)			
Case category	New	16 (0.5)	<0.001§	Reference	<0.001
	Retreatment	9 (2.7)		6.00 (2.60-13.85)	

Abbreviations: CI = confidence interval; OR = odds ratio

* Including 3434 patients in Groups I to V with drug susceptibility results; 40 patients with miscellaneous place of birth excluded

† Predictor variables initially entered included gender, age, retreatment case, place of birth and permanent residency, but only age, place of birth, and retreatment case remained in final model; gender and permanent residency excluded from final model because P>0.10

‡ Groups III, IV, and V combined (India, Pakistan, Bangladesh, Philippines, Thailand, Indonesia, Nepal, and Vietnam)

§ Fisher's exact test, two-sided P value

TABLE 5. Treatment outcome of 4319 patients in government tuberculosis programme at 12 months after initiation of treatment

Variable	Category	Treatment success rate (%)	P value	Adjusted odds ratio*	P value
Gender	Female	76.3	0.831	Reference	0.406
	Male	76.6		0.93 (0.79-1.10)	
Age-group (years)			<0.001		<0.001
	0-14	90.3		1.84 (0.55-6.17)	
	15-34	79.9		Reference	
	35-64	78.0		0.75 (0.61-0.93)	
	≥65	72.2		0.51 (0.40-0.64)	
Place of birth			<0.001		0.021
	Hong Kong	80.0		Reference	
	Mainland	75.8		1.00 (0.85-1.19)	
	Asian countries†	58.1		0.56 (0.38-0.82)	
	Miscellaneous	76.3		1.04 (0.55-1.94)	
Permanent residency	No	55.5	<0.001	Reference	<0.001
	Yes	77.7		2.50 (1.67-3.74)	
Case category	New	77.2	0.002	Reference	0.015
	Retreatment	71.0		0.77 (0.62-0.95)	
Type	Pulmonary	76.7	0.325	Reference	0.443
	Extrapulmonary	74.6		0.90 (0.70-1.17)	
Sputum smear	Negative	76.6	0.882	Reference	0.924
	Positive	76.4		0.99 (0.84-1.22)	
Culture-confirmed	Negative	76.9	0.656	Reference	0.733
	Positive	76.3		1.03 (0.87-1.22)	
Drug resistance‡	No	77.4	<0.001	Reference	<0.001
	Yes	62.4		0.47 (0.36-0.61)	

* Multiple logistic regression, adjusted for all other variables as shown

† Groups III-V combined: India, Pakistan, Bangladesh, Philippines, Thailand, Indonesia, Nepal, and Vietnam

‡ Isoniazid and/or rifampicin resistance

(Table 5). Birth outside Hong Kong (Groups II-V combined) was an independent predictor of TB relapse among permanent residents after successful treatment completion under the government TB programme (Fig).

With the successful control of recent transmission of TB in Hong Kong, the majority of TB cases arose from endogenous reactivation of past infection.[18] The higher SIR and drug resistance prevalence among Mainland immigrants and immigrants from Groups III-V Asia countries corroborate reports of higher TB incidence[2-6,8] and drug resistance[7,12] among immigrants in low-TB-burden countries. These higher risks among immigrants may have resulted at least in part from reactivation of latent TB infection[9-11] acquired during their previous residence in, and/or travel to, their places of birth with higher burdens of TB and/or drug resistance.[1,19-22] Apart from possible selection factors in migration, the progressive fall in TB prevalence in the Mainland over the recent decades[22] could also have contributed to a lower burden of latent TB infection, and hence SIR, among recent Mainland immigrants compared with those who immigrated longer ago. Taking into consideration the independent effects of birth outside Hong Kong on both treatment outcome and relapse (Table 5 and Fig), population mobility may have adversely affected treatment adherence, and thus impacted on treatment outcome and/or relapse with possible acquisition of drug resistance. In line with these observations, a previous case-control study also identified younger age, non-permanent residents, and frequent travel as independent predictors of multidrug-resistant TB among previously treated patients in Hong Kong.[23]

Although this study showed an increased risk of TB among immigrants in Hong Kong, which is a

metropolitan city with intermediate TB burden, the vast majority of TB cases still occurred among the majority population groups of local-born persons or permanent residents born in Mainland China (both of which were largely of Chinese ethnicity). This is contrary to the situation in most low-burden areas, where the majority of TB cases often came from foreign-born minority groups.[2,3,12] The relatively high crude TB incidence rate of 55/100 000, even among the local-born (both genders combined) in this intermediate burden area (Table 2), could have reduced the risk differential between the immigrant groups and the local-born, thus reducing the influence of immigrants on the overall TB incidence. Nonetheless, the higher drug resistance rate, poorer treatment outcome, and higher relapse rate among immigrants in this study remain critical areas of concern. In a recent study on the transmission of drug-resistant TB in Hong Kong,[24] 46% of all multidrug-resistant TB cases were new cases with no previous history of treatment. This suggests ongoing transmission of these difficult-to-treat TB cases within our community. The degree of molecular clustering was as high as 65% among extensively drug-resistant TB cases, the majority of which did not have obvious epidemiological linkage, suggesting active transmission outside households or other conventional close contact settings.[24]

This study was based on territory-wide data from by-census, statutory registries, a centralised government TB programme, and centralised TB laboratory. The well-developed health care infrastructure in Hong Kong with easy access to free TB care services allowed capture of relevant information from TB patients notified in a by-census year and successful tracking of the majority of them for treatment outcome and relapse. Some degree of incomplete case ascertainment was still likely as in all other public health surveillance systems. Even though around 20% of the notified patients were managed outside the government TB programme, this might not have substantially confounded the internal comparisons among different population groups if access to care could be assumed to be roughly parallel. If the usual inverse care law[25] did apply, the direction of bias would likely be underestimation of the risks among the immigrants as an underprivileged group. With the limited amount of socio-demographic and clinical information contained in the various statutory registries and programme forms, this study may not be in a strong position to analyse the complex mechanisms that underlie the observed associations between immigrants and treatment outcome or relapse. Further studies are therefore warranted to identify potential areas of intervention for specific minority groups.

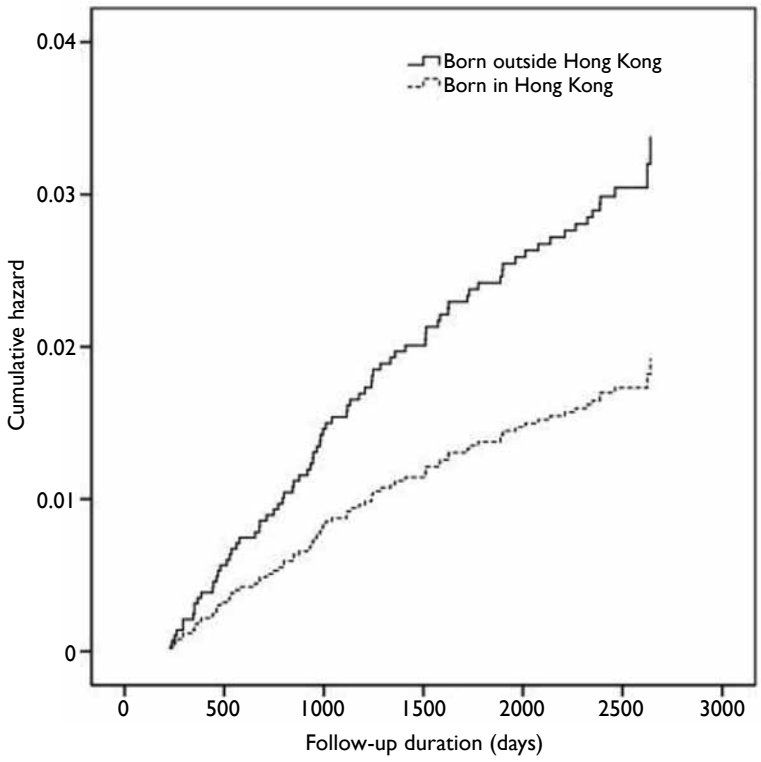

FIG. Cumulative hazard curves for relapse of tuberculosis after successful completion of treatment among 3176 permanent residents by place of birth
Cox proportional hazards modelling, adjusted for all variables shown in Table 5 (P=0.025)

Declaration

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