

Is Singapore on track to eliminate tuberculosis by 2030? A policy case study

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Abstract

Tuberculosis remains the top 10 causes of death worldwide in 2015, with the largest number of new tuberculosis cases occurring in Asia. Singapore, a high-income Asian country, still has an intermediate tuberculosis burden. This study is to determine Singapore's tuberculosis policy with regard to achieving tuberculosis elimination goals. This is a case study of tuberculosis elimination policy in Singapore. Data were collected by policy review and literature review. Policy documents and reports were gathered from the websites of the Ministry of Health and the World Health Organization for policy review. The literature review was carried out through PubMed and Google Scholar to identify articles on epidemiology, treatment, and prevention of tuberculosis in Singapore. Data analysis of policy reports revealed that despite the overall downwards trend in the tuberculosis incidence rates between 2000 and 2015, the tuberculosis incidence rates reversed in 2008. Singapore tuberculosis policies are mostly consistent with the World Health Organization Stop TB Strategy, although over half of the performance indicators were not achieved by 2015. After screening 1014 articles, 18 studies were included in the literature review. The rapidly ageing population, great population mobility, and continuous community transmission were found to be major obstacles to achieving Millennium Development Goals in Singapore. Singapore is lagging in achieving the targets. Scaling up the existing tuberculosis programme to accelerate the tuberculosis decline is required to meet Sustainable Development Goals 2030. Unlike other high-income countries with an intermediate tuberculosis burden in Asia, Singapore has increasing tuberculosis incidence rates. While other countries face the burden of an ageing population, Singapore faces an additional burden of an influx of migrants from high-incidence countries. Singapore will need to control tuberculosis in both these demographic groups to reverse the increasing incidence trend.

Keywords

Elimination, infectious disease, policy, Singapore, Stop TB, tuberculosis, sustainable development goal, Asia, case study

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Introduction

Tuberculosis (TB) remains the top 10 causes of death worldwide, with the greatest proportion of cases occurring in Asia, 61% in 2015.¹ However, among developed Asian countries with intermediate TB burden, there is a great variation in incidence as follows: Japan (17 per 100,000 population in 2015), Hong Kong (71 per 100,000 population in 2015), South Korea (80 per 100,000 population in 2015), and Singapore (44 per 100,000 population in 2015; Supplemental Appendix 1).² Although Singapore had one of the lowest TB incidences among those countries with intermediate burden, its TB reduction rate remained static with only about 10% decrease within 15 years, while Japan almost halved their incidence.^{3,4} Singapore's current situation is similar to that of Japan's in the 1980s–1990s: Japan's incidence rate was

similar to Singapore's current incidence rate, and Japan also experienced stagnation in annual reduction during that time. In response to a rate increase in 1997, a declaration of TB emergency was made in 1999 by the Japanese government. TB control programmes were reformed, including global standardized treatment (2HREZ/4RH), nationwide evaluation of treatment outcomes through cohort analysis, and the introduction of Directly Observed Therapy Short Course

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(DOTS) for all hospital inpatients as well as ambulant treatment for homeless patients in urban areas.⁵ Thus, the Japanese government made TB control a health priority in the country. In contrast, the latest Singapore healthcare masterplan concentrated on healthcare financing and listed healthy behaviours associated with non-communicable diseases as their key priority.⁶

In Singapore, the ageing population, continued community transmission, and population mobility, with the threat of multi-drug-resistant tuberculosis (MDR-TB), represent a sizable reservoir of TB infection.⁷ To control TB, Singapore established the National TB Control Programme, later enhanced by the Singapore Tuberculosis Elimination Programme (STEP).⁷ Despite these endeavours, the TB reduction rate was far from reaching the targets of Millennium Development Goals (MDG) and Stop TB strategy, which was to halve the TB incidence by 2015.^{8,9}

Several country case studies on TB, HIV/AIDS, and malaria have been conducted in developing countries over the last decade,^{10–12} although the emphasis was seldom on high-income countries such as Singapore. By evaluating and comparing the successes and gaps in policies, to explain the TB situation in Singapore, some light may be shed on the underlying reasons for the continued burden of TB in this high-income country and other countries with similar economic status and disease burden in Asia.

This case study of TB elimination policy in Singapore aims to determine the successes and challenges in TB policy towards eliminating TB by 2030 in Singapore, review the implementation status of TB policy in Singapore, and compare it to the World Health Organization (WHO) Framework.

Methods

Data collection included data analysis, policy review, and literature review.

Data analysis

To review the TB burden, data extracted from reports ‘Communicable Diseases Surveillance in Singapore’ were used to compile graphs to present the TB situation in Singapore.

Policy review

A policy is defined here as legislative or regulatory action, programme, or standard by local government, governmental agencies, non-governmental organizations, and academic institutions which have a direct impact on TB elimination. Policy documents were searched through the official website of the Ministry of Health (MOH) of Singapore. Documents available online, including ‘MOH Clinical Practice Guidelines on Prevention, Diagnosis and Management of TB (2016)’⁷ and annual ‘Communicable Diseases Surveillance

in Singapore’ reports (2003–2015), were obtained; other related information recommended on MOH websites¹³ such as ‘TB on Health Promotion Board website’ and ‘TBCU at Tan Tock Seng Hospital’ were also looked over.

Reports and strategies on TB control and elimination from WHO, such as Global TB report,³ Stop TB strategy,⁹ and End TB strategy,¹⁴ were reviewed.

Literature review

The literature review was conducted to answer questions related to Singapore’s TB policy as follows:

What are experts’ opinions on Singapore’s TB policy?

What is the impact of the national TB programme (NTP)?

What is the burden of TB disease in Singapore?

Two electronic databases, including PubMed and Google Scholar, were used to search for relevant articles. PubMed was mainly for identifying journal literature with the following keyword phrases: ‘tuberculosis’ or ‘TB’ in combination with the terms ‘Singapore’, ‘elimination’, ‘policy’, ‘policy review’, ‘programme’, ‘control’, or ‘burden’. Google Scholar was utilized to seek for grey literature and conference papers.

Articles were limited to those written in English, access to full text, and published between 1990 and 2017 as the MDG target was set to compare the TB incidence and mortality rates in 2015 to their levels in 1990. Only those articles describing TB burden, control measures, and precautions in Singapore were included for review. Studies were excluded if duplicated or unable to meet the abovementioned criteria.

Overall, 1086 papers were identified via the two databases, including 809 from PubMed and 277 from Google Scholar, and 18 were eventually included for review.

Ethics approval

Ethics approval to conduct this study was obtained from the Survey and Behavioural Research Ethics Committee of The Chinese University of Hong Kong on 15 May 2017.

Results

Data analysis

Figure 1 showed that there was an overall downwards trend in the TB incidence rates from 51 to 44 per 100,000 population between 2000 and 2015, while it reversed in 2008 from 37 to 44 in 2015.^{4,15} Compared to Japan, South Korea, and Hong Kong, only Korea showed a similar reversal in 2008 from 88 to 99 in 2011 (Figure 3 in Supplemental Appendix 5). The TB incidence rates increased with the increasing age, with the

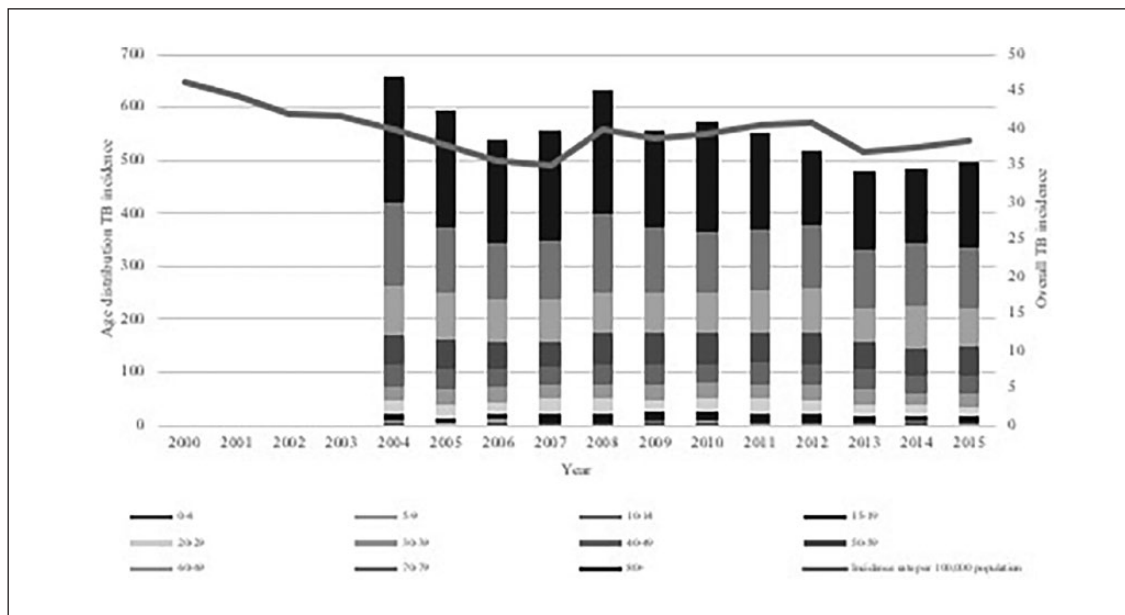


Figure 1. Overall TB incidence rates in Singapore and age distribution among Singapore residents between 2000 and 2015. Source: World Bank – WHO Global TB report; MOH – Communicable Disease Surveillance in Singapore 2000–2015.

largest proportion in the age group of 80 years or above among the Singapore residents between 2004 and 2015.⁴

Between 2000 and 2015, the proportion of new TB cases among Singapore residents decreased from 69% to 55%, while the proportion increased from 31% to 45% among non-residents (Figure 1 in Supplemental Appendix 3).

The TB notification rates differed in ethnic groups. The general Singapore population consists of approximately 75% Chinese, 14% Malays, 9% Indians, and 3% from other ethnic groups.¹⁶ Although the Chinese accounted for the largest proportion of TB cases,⁴ Malays had the highest incidence rates (Figure 2 in Supplemental Appendix 4).

Policy review

Comparison of Singapore TB policy and WHO Stop TB strategy. Singapore TB policies mostly follow the WHO Stop TB Strategy in terms of pursuing high-quality DOTS expansion and enhancement, addressing MDR-TB, engaging all care providers, empowering people with TB and communities, and enabling and promoting research.

The STEP pursued DOTS expansion and enhancement with the backup of the Infectious Diseases Act including laboratory support for acid-fast bacillus smear examination, mycobacterial cultures, and drug susceptibility testing through NTP; provision of standardized treatment with supervision through carrying out DOTS at the 18 polyclinics; provision of outreach of DOTS to selected patients in their homes; and monitoring and evaluating performance through National Treatment Surveillance Registry.⁷

The programme also addresses MDR-TB by scaling up the prevention and management of MDR-TB through STEP; by responding to the needs of TB contacts through contact screening of household and family members, and close contacts in workplace,⁷ and the needs of poor and vulnerable populations through DOT/SHOP programme which provides financial incentives to TB patients from low-income households; and by requiring outsiders who apply for student, work, and long-term social visit pass to undertake TB screening.⁷

Only one area of the WHO Stop TB Strategy was not addressed: the WHO Stop TB Strategy advises assessing how a National TB Control Programme is performing regarding its contribution to health system strengthening.⁹ However, in the Singapore TB policy documents, there was no mention of how the effort was made to contribute to health system strengthening.

Evaluation of the status of implementation. Table 1 illustrated that Singapore fulfilled two out of five performance indicators for monitoring TB control programmes suggested by the WHO Stop TB strategy. The mortality rate per 100,000 population in 1990 had halved by 2015,^{3,17} and the TB detection rate under DOTS reached at least 70% by 2005.¹⁷

However, Singapore has not yet reached the other three targets. Neither the prevalence nor incidence rates in 1990 had halved by 2015: the TB prevalence rates decreased from 82 to 59,^{3,17} while the incidence rates dropped from 63 to 44 per 100,000 population.^{16,17} The treatment success rate also

Table 1. Status of implementation of MDG and Stop TB Strategy in Singapore.

Performance indicators	Singapore				
	Target	1990	2015	Percentage change	Target achieved
Prevalence of disease per 100,000 population	1990 prevalence rate halve by 2015	82	59 (in 2013)	-28.05%	No
The incidence of disease per 100,000 population	Incidence rate halved by 2015	63	44	-30.16%	No
TB mortality rate per 100,000 population	1990 mortality rate halve by 2015	4	1.4	-65%	Yes
TB detection rate under DOTS	At least 70% by 2005	83%	87% (in 2005)	4.82%	Yes
Treatment success rate	At least 85% by 2005	88% (in 1994)	81% (in 2005)	-7.95%	No

Source: WHO Stop TB Strategy; UN – MDG indicators; WHO Global TB Control Report; World Bank.

DOTS: Directly Observed Therapy Short Course; WHO: World Health Organization; MDG: Millennium Development Goals; TB: tuberculosis.

did not reach the targeted 85% by 2005 but decreased from 88% in 1990 to 81% in 2015.¹⁷

Literature review

Literature was categorized into six themes for analysis: four on the impact of the NTP,^{18–21} three regarding calling for action on reversing TB,^{22–24} five regarding the high-risk population,^{25–29} two on treatment,^{30,31} two about DOTS,^{32,33} and two on drug-resistant TB^{34,35} (Table 2).

Studies described the significant impact of NTP and STEP on reducing TB in Singapore with the implementation of DOTS, the introduction of computerized surveillance modules to track the treatment progress and outcome, and national policy of preventive treatment for lately infected close contacts. Despite the effort, the TB incidence reversed in 2008 for the first time in 10 years, which initiated a call for urgent action from academics to include additional measures and resources in battling this reversal. Some studies suggested possible explanations for this, including the influx of immigrants, rapidly ageing population, and escalation of TB transmission in the community.

Regarding the high-risk population for TB, these included those of older age, male sex, Malay ethnicity, and migrant workers, especially unskilled workers from countries with high TB incidence. Among TB patients in a Singapore hospital, most were elderly, and the number of male cases was more than double that of female cases.²⁸ TB cases among Malays were more serious and contagious than other ethnicities.²⁷ Meanwhile, the number and proportion of foreign-born TB cases decreased from 2000 to 2004 but reversed afterwards following the liberalization of Singapore's immigration policy in 2005. The majority of drug-resistant TB cases in Singapore were among the foreign-born. Unskilled workers from high TB incidence countries comprised the greatest numbers and increases in foreign-born TB patients.²⁶

Nonadherence to treatment posed a threat of TB drug resistance: many TB patients in Singapore were treated under DOTS, but DOTS affected the patients' daily living

activities and increased their socioeconomic burden, making it difficult to adhere to the treatment. The introduction of 'DOT & Shop' scheme, which disbursed low-income TB patients by grocery vouchers for being adherent to DOTS, slightly improved the overall treatment completion rates. Stigma also played a role as patients were afraid of being shunned by others if their diagnosis was known.

Discussion

This study found that Singapore TB policy is generally consistent with the WHO Stop TB strategy for the reduction of the global burden of TB by 2015 in line with the MDG, but the country has not achieved all five performance indicators: Singapore fulfilled two of the targets, including halving the TB mortality rate by 2015 and reaching over 70% of TB detection rate under DOTS by 2005.^{3,17} Three performance indicators remained unreached, including halving TB prevalence and incidence by 2015 and reaching over 85% of the treatment success rate by 2005.^{3,15,17} While the MDG focused on prevalence, incidence, and TB mortality, the Sustainable Development Goals (SDG) narrowed the focus to the latter two only, with more stringent targets: the SDG aims to decrease incidence by 80% and mortality rate by 90% by 2030. Given that Singapore only managed to decrease incidence by 30% from 1990 to 2015, great efforts are needed to fulfil the SDG in the next 15 years. Meanwhile, as the MDG target for mortality was reached, there is a reason to be optimistic that the SDG target for mortality could foreseeably be reached.

The Singapore government has endeavoured to address the TB epidemic through introducing a comprehensive TB policy in terms of diagnosis, treatment, and prevention which have contributed to its successes. Some highlights of its accomplishments include the early case detection under laboratory support, DOTS expansion and enhancement, treatment and outcome monitoring through National Treatment Surveillance Registry, preventive therapy for recently infected close contacts of infectious TB cases, and

Table 2. Summary of literature.

Theme	Authors	Year of publication	Purpose	Study design	Population	Results/conclusion
Impact of national TB Programme	Snodgrass and Chew ¹⁸	1995	To oversee epidemiological trends of TB in Singapore with a new microcomputer-based surveillance system	Evaluation study	N/A	The system could improve surveillance through tracking notifications as well as TB culture results and analysing data and offer prompt information for NTP by timely dissemination of information
	Chee et al. ¹⁹	1997	To stress the importance of political will and government backing in fighting against TB	Qualitative study (editorial)	N/A	An exhaustive TB programme with government support is required. With collaboration and commitment at all levels, Singapore should succeed in keeping the country free from TB
	Chee and James ²⁰	2003	To introduce and elucidate the STEP	Qualitative study	N/A	STEP would progress towards the TB elimination in Singapore, with the political commitment and backing of medical professionals and the public
	Chee et al. ²¹	2004	To report experience with LTBI treatment for close contacts of communicable TB cases in Singapore	Prospective cohort study	5699 close contacts of 1374 infectious TB cases	Treatment of LTBI for close contacts is practicable as a supplementary TB control approach in a country with an intermediate TB burden and BCG-vaccinated population
Calling for action on TB reverse	Cutter and Wang ²²	2010	To call for action on reversing the TB trend in Singapore	Qualitative study (commentary)	N/A	The latest increase in TB incidence raised the alarm for action through the cooperation and commitment of healthcare and lay community
	Chee et al. ²³	2012	To heighten TB awareness and foster continued vigilance among the public and the medical community	Qualitative study (commentary)	N/A	There is a pressing need to raise the awareness of the public and medical community to decrease the time taken to diagnose contagious TB cases in Singapore
High-risk population	Chee et al. ²⁵	2005	To call for additional measures and resources to address the rising TB trend since 2008	Qualitative study (commentary)	N/A	The focus of key supplementary measures should be on addressing TB among foreigners, while the political will against TB must involve removing obstacles to diagnosis, enabling all TB patients to treat under DOTS and assuring that all TB healthcare providers are accountable to the public health system
	Chee et al. ²⁵	2005	To describe the experience with contact investigation and LTBI treatment in high-risk contacts in correctional facilities (CF)	Prospective cohort study	704 CF contacts were compared with those of 2729 household/family contacts	There was a high LTBI rate among CF contacts which presented a chance for intervention
	Kyi Win et al. ²⁶	2011	To determine the amount of foreign-born TB patients in Singapore	Retrospective cohort study	19,000 cases of TB	The number and proportion of foreign-born TB cases decreased from 675 (33.6% in 2000 to 444 (25.5%) in 2004 but reversed afterwards to 788 (37.6% in 2009. Unskilled workers from high TB incidence countries comprised the greatest numbers and increases in foreign-born TB patients: Of foreign-born TB patients, 3,386 (56.9%) were long-term pass holders (LTPHs). Of LTPH TB patients, 2,562 (75.7%) were unskilled workers. TB cases among LTPH increased from 220 (49.5%) in 2004 to 532 (67.5%) in 2009, while that among permanent residents (PRs) increased from 45 (6.7%) in 2000 to 124 (15.7%), and cases among naturalized citizens decreased from 342 (50.7% in 2000 to 132 (16.8%) in 2009. Of TB cases in migrant workers from countries with high incidences of TB, >75% came from five of the seven countries with highest incidences of TB (India, China, Indonesia, Bangladesh, and Philippines). These trends coincided with the liberalization of Singapore's immigration policy in 2005

(Continued)

Table 2. (Continued)

Theme	Authors	Year of publication	Purpose	Study design	Population	Results/conclusion
	Lim et al. ²⁷	2013	To illustrate the socio-demographic and clinical attributes of TB cases among Singapore residents by ethnicity	Cross-sectional study	15,622 resident case records from the TB registry's electronic database	TB cases among Malays were more serious and contagious than other ethnicities: More Malays had a highly positive acid-fast bacilli smear (OR: 1.64) and cavitary disease on chest X-ray (OR: 1.41). Further effort is required in contact investigations, case management, and amelioration in socioeconomic conditions to lower TB cases in this ethnic group
	Jappan and Low ²⁸	2015	To investigate trends among newly diagnosed TB patients at the Singapore General Hospital	Retrospective case study	1979 cases of TB	As elderly, aged over 65 years, contributed remarkably to the TB burden, increased efforts are needed to manage this susceptible population. Most of the TB patients at Singapore General Hospital were elderly (31.9%)
	Low et al. ²⁹	2009	To recognize the risk factors of TB patients' mortality on treatment in Singapore	Retrospective cohort study	7433 TB patients	Identifying the risk factors for TB death, such as being in a long-term care facility, over one site of TB, bacteriologically confirmed laboratory results and drug-resistant TB, presented an opportunity for instituting proper and timely interventions to prevent TB deaths
Treatment	Chee et al. ³⁰	2014	To report the outcomes of Singapore residents being treated for TB from 2002 to 2011	Evaluation study	Singapore citizens and permanent residents treated for TB	With the introduction of computerized treatment surveillance module and other initiatives over the last decade, TB treatment completion among Singapore residents has improved since 2002
	Wang et al. ³¹	2012	To raise the awareness towards nonadherence to TB treatment in Singapore	Qualitative study	N/A	Despite the supportive measures, TB patients were still non-adherent to treatment. The society and the government must decide on how far they are willing to protect people from TB
DOTS	Lee et al. ³²	2016	To assess the impact of DOTS on TB patients and to quantify their socioeconomic burden	Questionnaire survey	356 patients with TB who were on DOTS at nine local polyclinics	DOTS influenced patients' daily living activities and quality of life and increased their socioeconomic burden. Additional alleviative measures are required to address the problem
	Chua et al. ³³	2015	To determine the impact of the 'DOT & Shop' scheme on treatment completion rates	Descriptive study	883 TB patients	There was a slight improvement in the overall treatment completion rates before and after the execution of this NGO-funded incentive scheme for low-income TB patients on DOTS
Drug-resistant TB	Chee et al. ³⁴	2012	To emphasize the imminent threat of MDR-TB in Singapore	Qualitative study	N/A	Although the amount of MDR-TB cases among Singapore-born had remained relatively low, some attention should be given on the proper treatment of drug-resistant TB cases under stringent programme conditions to prevent the development of MDR-TB in the first place
	Ong and Tambyah ³⁵	2011	To raise the awareness towards the dollars and sense of managing drug-resistant TB in Singapore	Qualitative study (editorial)	N/A	The government should regulate the business forces on promoting medical tourism in Singapore to limit the transmission of potentially mortal communicable diseases within the border. It is unworthy of paying the price

TB: tuberculosis; NGO: non-governmental organization; LTBI: latent tuberculosis infection; MDR-TB: multi-drug-resistant tuberculosis; DOTS: Directly Observed Therapy Short Course; NTP: national TB programme; STEP: Singapore Tuberculosis Elimination Programme; BCG: Bacillus Calmette-Guérin.

chest radiography for foreigners applying for work pass, student pass, and long-term social visit pass.⁷ The STEP and chest radiography for long-term pass holders are part of the remarkable achievements of Singapore TB policy. However, obstacles remain to fulfil the SDGs, such as the rapidly ageing population, population mobility from high incidence TB countries, continuous community transmission, DOTS implementation, and stigma.

The reversal of TB incidence since 2008, contributing to the failure to halve incidence by 2015, is worrying. Compared to Japan, South Korea, and Hong Kong, only South Korea experienced a similar reversal in 2008. Unlike Singapore, this trend only continued until 2011, when incidence started to drop again. The increasing TB incidence in Korea was attributed to demographic transition, namely an ageing population that contributed to an increased incidence in the older age group.³⁶ While Singapore, Japan, and Hong Kong^{37,38} all face the problems of an ageing population, the incidence rate has nevertheless steadily declined in these countries apart from Singapore. Compared to these countries, Singapore is unique in facing the additional impact of significant TB incidence in foreigners. Foreigners' TB incidence increased even as TB incidence in citizens and permanent residents stagnated. This is likely due to the influx of immigrants from high-incidence countries since 2005 following a liberalized immigration policy.²⁴ It is expected that a greater mobility of migrants and visitors from high TB burden countries surrounding Singapore, including Malaysia, Bangladesh, Myanmar, Vietnam, the Philippines, and Indonesia, will become inevitable in the era of global travel and immigration, which will further increase Singapore's vulnerability to imported TB.^{34,35} Developed countries in Europe face a similar problem to Singapore. A large retrospective cohort study in the United Kingdom found that most TB cases in migrants occurred 4 years after arrival, many due to TB reactivation, especially in those from high-incidence countries.³⁹ There is a general consensus that active screening of TB may be insufficient and latent TB screening and treatment could support elimination efforts.⁴⁰ Screening migrants from high-incidence countries before departure and within 5 years of arrival was found to be cost effective in the United Kingdom.^{41,42} Moving towards the era of SDG, Singapore could consider a similar strategy, although more research is needed to determine whether such an approach would be cost effective in the Singapore setting.

The rapidly ageing population, influx of immigrants, and continuous transmission in the community have been major obstacles to achieving the MDGs in Singapore.⁷ It is anticipated that these issues will pose a continuous challenge to Singapore in reaching the SDGs over the next 15 years: the number of Singaporeans aged 65 and above is projected to double by 2030,³⁴ which implies that the TB incidence in this age group will very likely double. Given that the ageing population consists of a high proportion of latent tuberculosis infection (LTBI), active case finding to offer preventive

therapy for those who have LTBI might be an effective approach for lowering their chance of progression to active TB. Singapore could consider expanding the testing of LTBI to primary healthcare settings in the era of SDG by building on systems that are already in place:² for example, integration of LTBI testing into other age-associated diseases testing such as diabetes mellitus, which is an important risk factor for TB. This is referenced in the third component of the Stop TB strategy⁹ which Singapore has not paid much attention to over the last decade. More could be done to prioritize LTBI control in Singapore. Since 1998, STEP has encompassed targeted LTBI examination and treatment of contacts in its main control strategy through investigations in households, workplaces, schools, and congregate settings.⁴ However, in our literature review, only two studies focused on LTBI control: one on close contacts²¹ and the other on correctional facilities contacts.²⁵ Both were published more than a decade ago. With the lack of research on this topic, it would be difficult for Singapore to make evidence-based policies applicable to the local setting.

The delay in diagnosis and lack of DOTS compliance in Singapore fuel drug-resistant TB and ongoing TB transmission in the community.³⁰⁻³³ To reach the SDG of reducing 80% TB incidence and 90% mortality rates by 2030 in Singapore, additional efforts are needed. DOTS is only available in polyclinics, which provide about 20% of primary healthcare to Singapore.⁴³ DOTS could be expanded into the private clinics, which would increase accessibility, especially for younger patients who need to work. This would also strengthen the primary health system, which is recommended in the Stop TB strategy. In addition, expanding DOTS to hospital clinics could increase accessibility to elderly patients with multiple comorbidities, as they could then receive all their treatments in one place. More research is needed to explore the feasibility of this approach in Singapore.

Limitations

This study has several limitations, including only focusing on the recommendations from the WHO Stop TB Strategy, while other WHO guidelines on TB were not analysed. In addition, the literature review was not systematic and some sources may have been overlooked, as only one academic database was searched. Nevertheless, the findings combined do present a picture of some of the successes and challenges faced by Singapore in its fight to end TB and may be of relevance to other countries in the region with a similar economic status and TB burden.

Conclusion

The TB elimination policy in Singapore is mostly consistent with the WHO Stop TB Strategy in line with the MDG; however, the country is lagging in achieving the WHO targets.

This could be attributed to the issues of rapidly ageing population, great population mobility, and continuous community transmission, which are anticipated to continue to impact on Singapore TB over the next decade. If no additional tools are available to accelerate the efforts to reduce the TB incidence, Singapore will likely be left behind in the ambitious era of SDG 2030.

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Informed consent

Written informed consent was obtained from all subjects before the study.

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Supplemental material

Supplemental material for this article is available online.

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