A data-driven approach to tuberculosis screening of migrants entering Australia

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Summary

Background Migrant screening strategies are important for low tuberculosis (TB) incidence countries aiming for TB elimination. We sought to develop an objective data-driven approach to guide TB screening selection.

Methods We used anonymised linkage of Australian visa applicant data (2014–2019) and immigration medical examination outcomes, as well as local TB registers. Multivariable logistic regression analyses identified variables associated with 'screen detectable' pulmonary TB, defined as TB diagnosed during visa application or within 6 months of visa issuance. An internally validated risk prediction tool was developed and assessed for screening sensitivity and specificity - at different TB risk thresholds.

Findings The study cohort comprised 13,691,772 visa applicants of whom 863 (6.30/100,000) were judged to have had 'screen-detectable' pulmonary TB; 851 (98.6%) with bacteriologically -confirmed disease. The estimated TB incidence in the applicant's country of citizenship was the strongest determinant of TB risk. The model developed showed strong predictive validity; area under the ROC curve (AUC) 0.89 in the development cohort (applicants during 2014–2018) and 0.91 in the validation cohort (applicants during 2019). When applied to the 2019 cohort, using a risk threshold of 17/100,000, the risk estimation tool would have screened 10% of visa applicants to detect 59% of 'screen detectable' TB cases. Using a stricter risk threshold of 7/100,000, the risk estimation tool would have screened 19% of visa applicants to detect 87% of 'screen detectable' TB cases. The existing approach screened 33% of visa applicants and detected 54% of 'screen detectable' TB cases.

Interpretation Use of data-driven prediction tools can improve the effectiveness and efficiency of visa applicant TB screening. It provides an objective and transparent selection mechanism, which can be further refined with expanded data collection.

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Introduction

Globally, tuberculosis (TB) is the leading infectious disease killer with the vast majority of cases occurring in under-resourced settings with high TB incidence rates.[1] Most low TB incidence countries employ some form of migrant TB screening to reduce the risk of disease importation and spread.[2,3] Increased frequency of global travel and migration,[4] emphasises the need for processes and policy settings that optimise the effectiveness and efficiency of TB screening approaches. Ethical and effective TB screening programs have benefits for migrants and the communities that receive them,[5,6] but current practices are highly variable and rarely evidence based.[4]

Australia has maintained low TB incidence rates (~6/100,000 population) since the 1980s, but there has

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Research in context

Evidence before this study

Migrant screening for tuberculosis (TB) typically relies on 'expert opinion' and poorly quantified risk perception, which is often subjective and inefficient. The development of an objective data-driven approach to select visa applicants for TB screening has not been described but is important to develop objective evidenced-based policy.

Added value of this study

This is the first study to link visa application and TB diagnosis data, including off- and on-shore TB screening results and in-country TB diagnoses within 6 months of visa issuance. Linked data informed the development of a pulmonary TB risk estimation tool. The risk estimation tool was more effective (more TB cases detected) and efficient (less visa applicants screened) than the existing approach, demonstrating the value of using local data to guide rational TB risk assessment.

Implications of all the available evidence

Implementing data-driven approaches to guide migrant TB screening policy will improve transparency, effectiveness and efficiency. Policymakers would be able to adjust policy settings and screening guidelines according to the TB importation risk they are willing to accept. Similar approaches should be feasible in other settings with high quality linked data, optimising local contextualisation but requiring regular revision to stay current.

been little progress towards TB elimination despite limited local TB transmission.[7,8] This reflects Australia's economic dependence on migrants from high TB incidence countries; ~90% of people diagnosed with TB in Australia every year were born overseas.[7] Australia has strict health protection regulations to mitigate TB importation risks. The Migration Act of 1958 requires the Department of Home Affairs to ensure that people are free from TB disease at the time of migration.[9]

As a result, the immigration medical examination (IME) is a statutory requirement before a long-term visa can be issued.[10] In principle, any foreigner intending to stay in Australia for more than 6 months and coming from a country with a high incidence of TB (defined as ≥40/100,000 population according to the latest estimates), or who plans to work in the health, disability or aged-care sectors, must undergo TB screening, although this is open to the discretion of visa officers.[10,11] TB screening conducted as part of the IME includes a questionnaire, physical examination, chest X-ray and sputum examination performed by an accredited medical provider or laboratory.[11] A visa applicant found to have TB disease must complete a full course of supervised treatment and have a negative *Mycobacterium tuberculosis* sputum culture before a visa can be granted.[10,11]

Current TB screening criteria are often based on published TB risk reports and expert opinion rather than relevant local data. In countries that have data-informed approaches,[12,13] this is mostly based on routine monitoring and evaluation data. The aim of this study was to develop a data-driven approach that utilizes data linkage for TB risk estimation and to assess its sensitivity and specificity relative to the current approach.

Methods

We included all Australian visa applicants who applied for a visa between 1 January 2014 and 31 December 2019 and entered Australia within 180 days of visa issuance. The Australian immigration electronic system was implemented from 1 January 2014; prior to this it was a paper-based system which precluded comprehensive data extraction. Given delays in ethics approval from all States and Territories, data linkage could only be performed by the second half of 2020. Visa applicant data were obtained from the Australian Department of Home Affairs. Information collected included country of citizenship, sex assigned at birth, age group, and visa class applied for. Country of citizenship was classified according to WHO estimates of country-specific TB incidence in 2020 as ≤10, 11–40, 41–100, 101–200 and >200 per 100,000 population. Visa types were classified as Family Reunion, Skilled Migrant, Student, Temporary Resident (skilled and unskilled), Visitor, Working Holiday and Other (including refugees and humanitarian visas). Age was classified as <15 years, 15–34 years, 35–54 years, 55–74 years, and ≥75 years.

Supplementary Table S1 provides an overview of specific data sources used in the study. TB disease was ascertained by linkage to TB register data, including all TB cases notified between 1 January 2014 and 30 June 2020 in Australia. Data on visa applicants diagnosed with TB during their IME assessment were retrieved from the Department of Home Affairs IME database. Only cases classified as pulmonary TB (considered potentially infectious) were included in the analysis. They were classified as bacteriologically-confirmed if the sputum was smear, culture, or Xpert MTB/RIF® positive. The analysis was limited to those in whom pulmonary TB was diagnosed during IME screening or within 6 months of visa issuance, since these cases were considered potentially 'screen detectable'.

Probabilistic linkage of all 3 databases (Australian visa applicant core dataset, collated Australian TB register and the IME database), was performed by the Australian Institute of Health and Welfare (AIHW) as an authorised 'third party', using name, date of birth,

sex assigned at birth, and country of birth. Names and dates of birth were removed after linkage and replaced by anonymised identifiers and five-year age groups. Only de-identified data were available for analysis to ensure confidentiality.

We divided this merged dataset into a development cohort, comprising data for people whose visas were issued between the years 1st January, 2014 and 31st December 2018, and validation cohort, comprising data for people whose visas were issued between 1st January 2019 and 31st December 2019.

Statistical analysis

Using the full cohort, a logistic regression model fitted using SAS version 9.4 assessed the association between demographic and epidemiological characteristics, ascertained during visa application, and the occurrence of pulmonary TB, at the time of screening or within 6 months of visa issuance. The available demographic and epidemiological characteristics included sex assigned at birth, age group, visa type applied for, and incidence rate for TB in country of citizenship (classified as described above). Multivariate analyses were used to calculate odds ratios (OR) with 95% confidence intervals (CIs). To obtain valid estimates of the standard error (and hence 95% CIs), we corrected for overdispersion in the estimates using a scale factor, calculated as the model deviance divided by the number of degrees of freedom.[14,15]

Prediction model development

The regression coefficients and covariance matrix for the fitted model were used to calculate an estimated logit value, with 95% confidence intervals, for each combination of identified risk factors. The estimated risk for each visa applicant was calculated as:

$$\widehat{p} = \frac{1}{\left(1 + \exp\left(-\sum_{i=0}^{p} B_i X_i\right)\right)}$$

where the values of X_i are the covariate values (assigned codes for the demographic and epidemiological characteristics) and B_i are the relevant regression coefficients. B_0 is the intercept from the logistic regression model; 95% CIs for each estimate were calculated using the covariance matrix. These values were calculated in SAS proc logistic using the "*lsmeans*" statement with "*GLM*" parameterisation and the "*ilink*" and "*cl*" options. We used these risk estimates to create an Excel-based tool with built-in lookup tables. With sex assigned at birth, age (or date of birth), visa type applied for and country of citizenship as inputs, the tool outputs the estimated risk (as a rate per 100,000 persons) of TB being detected in the next 6 months, with a 95% CI for that estimate.

Risk estimation tool performance

To validate the risk estimation tool, we divided the available data from the full cohort into a development set (comprising visa applicants for the period 1 Jan 2014 to 31 Dec 2018) and a validation set (comparing visa applicants for the period 1 Jan 2019 to 31 Dec 2019). The risk estimation tool was re-fitted using the development set (that is, the 2014–2018 cohort) and then applied to the validation set (that is, the 2019 cohort) to estimate TB incidence (i.e., risk). We compared this risk estimate with two putative 'decision risk thresholds': 7 per 100,000 (very low risk, comparable to the background TB risk in Australia) and 17 per 100,000 (low risk, but more than double the background TB risk in Australia). For each of these risk thresholds the estimated number and proportion of pulmonary TB cases detected by screening (indicative of sensitivity), and the number and proportion of all visa applicants needed to screen (indicative of specificity), were calculated.

Using the same 2019 cohort of visa applicants described in the preceding paragraph, we calculated the number of bacteriologically-confirmed pulmonary TB cases that were identified in the Department of Home Affairs IME database.

Ethics and data independence

Ethics approval was obtained from the Ethics Committee of AIHW and the Health Research Ethics Committees of all eight Australian States and Territories (Supplementary Table S1). The Ethics Committee granted a waiver of the need to obtain individual consent from participants based on the proposal meeting the conditions outlined in Chapter 2.3 of the Australian National Health and Medical Research Council's National Statement on Human Ethics (https://www.nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2025). The data division of The Department of Home Affairs extracted ~18 million unique visa application records from their databases and shared an encrypted version with AIHW.

Role of the funding source

The funders of the study had no input into the data analysis, data interpretation, or writing of the report.

Results

A total of 18,175,532 visa application records were retrieved. After excluding individuals who did not enter Australia, or whose date of entry was more than 6 months after visa issuance, 13,691,772 visa applicants comprised the final study cohort. Table 1 summarises key characteristics of the study cohort. Approximately 50% of applicants were citizens of a country with an estimated TB incidence of ≥40/100,000 population.

Variable	Category	Number (n)	%
Sex[a]	Female	7,059,465	51.6
	Male	6,631,429	48.4
Age group (years)[b]	<15	983,734	7.2
	15–34	6,324,107	46.2
	35–54	3,431,861	25.1
	55–74	2,729,527	20.0
	≥75	219,003	1.6
Country of citizenship[c] (TB incidence per 100,000 population)	<10	5,522,260	40.3
	10–39	1,072,158	7.8
	40–99	3,716,059	27.1
	100–199	1,478,875	10.8
	≥200	1,207,430	8.8
Visa type[d]	Family	154,187	1.1
	Skilled migrant	614,823	4.5
	International student	1,494,553	10.9
	Temporary resident	1,068,068	7.8
	Visitor	9,160,333	66.9
	Working holiday	1,100,392	8.0
	Other	99,416	0.7
Total (N)		**13,691,772**	100

[a]Designated male or female at birth; not specified in 878 (0.01%). [b]There were 3540 (0.03%) records that had missing age group. [c]There were 694,990 (5.1%) records that cannot be assigned to a TB incidence category. [d]A working holiday visa allows the holder to work whilst travelling around Australia. Humanitarian (refugee and protection) visas were rarely issued (7584; 0.06%) and were included with 'Other'.

Table 1: **Demographic characteristics of Australian visa applicants (2014–2019).**

Fig. 1 provides an overview of the data linkage performed and the number of visa applicants identified with 'screen detectable' pulmonary TB. Over the study period, 1842 TB diagnoses were recorded in either Australian TB registers or the IME database. Among these, 863 (46.9%) were judged to have had 'screen-detectable' pulmonary TB, 851 (98.6%) of whom had bacteriologically-confirmed disease. Supplementary Table S2 reflects the contribution of different data sources to the bacteriologically-confirmed pulmonary TB cases identified during the study period (1 January 2014 and 31 December 2019, 6 months after visa application cut-off date).

Table 2 shows the odds ratios for the association between being diagnosed with 'screen detectable' pulmonary TB and epidemiological characteristics recorded at visa application. The risk of 'screen detectable' pulmonary TB was marginally higher in women than in men. The strongest risk predictor was the WHO-estimated TB incidence in the applicant's country of citizenship, with an odds ratio of >40 in those who were citizens of countries with an estimated TB incidence of ≥200/100,000 population, compared to countries with an estimated TB incidence of <10/100,000 population. Apart from the elderly (≥75 years) the risk of 'screen detectable' pulmonary was highest in young adults (15–34 years). Among visa application types, the risk of 'screen detectable' pulmonary TB was highest in those applying for temporary residents (unskilled) visas.

The area under the ROC curve (AUC) for the final risk prediction model, based on the attributes summarised in Table 1, was 0.89 in the development cohort and 0.91 in the validation cohort, indicating strong predictive validity. The risk estimation tool constructed from the regression coefficients estimated in the full cohort was implemented in Excel (DOI:10.17632/ry88677566.1). If the user inserts the current date, together with the applicant's date of birth, sex, visa type applying for, and country of citizenship, the tool generates a TB risk (risk of having 'screen detectable' TB) expressed per 100,000 persons screened, with a 95% CI estimate.

There were 10,551,971 visa applicants in the 2014 to 2018 development cohort. The variables selected and relevant coefficients for the model re-fitted in this development cohort are described in the Supplementary Appendix. The performance of the risk estimation tool was assessed in 3,139,801 visa applicants from the 2019 validation cohort, of whom 134 (4.3/100,000 persons) met the definition of 'screen-detectable' TB. Fig. 2A shows the percentage of 'screen detectable' pulmonary TB cases detected (sensitivity, red line, right axis), and the percentage of all visa applicants needed to screen (a measure of efficiency, blue line, left axis) across expected TB incidence rates ranging from 3 to 20 per 100,000. Fig. 2B shows the same data plotted against number of incident TB cases that would be missed (red line, right axis) and the number of visa applicants that would need to be screened at any given TB risk threshold (blue line, left axis). With a 'risk threshold' of 7 per 100,000, screening 575,006 people (19% of all visa applicants) would have diagnosed 87% of all 'screen detectable' pulmonary TB; missing 18 cases. With a 'risk threshold' of 17 per 100,000, screening 298,026 people (10% of all visa applicants) would have diagnosed 59% of all 'screen detectable' pulmonary TB; missing 55 cases. The existing approach screened 1,035,589 people (33% of all visa applicants) and diagnosed 54% (133/248) of 'screen detectable' pulmonary TB; missing 115 cases.

Discussion

We developed a predictive model based on the actual (observed) incidence of 'screen detectable' pulmonary TB in a cohort of applicants for a visa to enter Australia. To our knowledge, this is the largest cohort ever assessed with comprehensive data on TB diagnosed at the time of visa application screening or within six months of visa issuance. We demonstrated that when using an objective data-driven risk estimation tool for

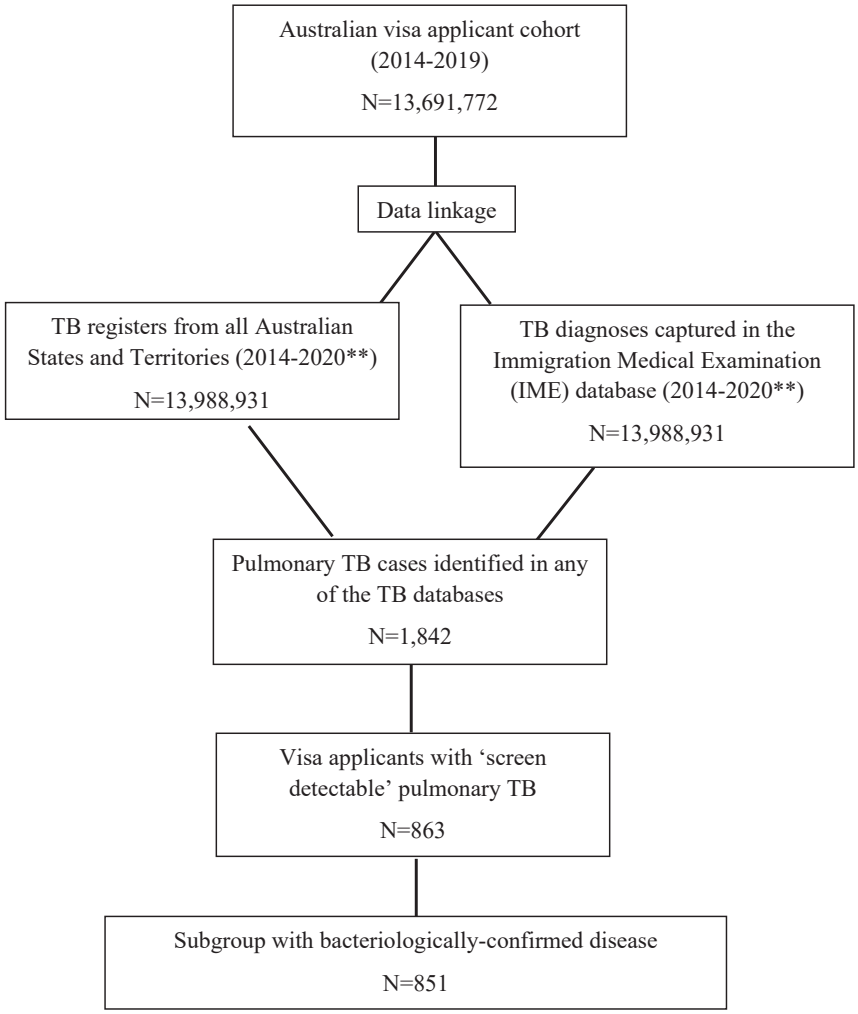


Fig. 1: **Overview of data linkage and 'screen detectable'* pulmonary TB cases identified among Australian visa applicants (2014–2019).** TB, tuberculosis. *TB diagnosed during visa screening or within 6 months of visa issuance. **Until 30 June 2020 - to accommodate all TB cases diagnosed within 6 months of visa issuance.

TB screening, applied to all applicants for entry to Australia, regardless of intended duration of stay, selection is more sensitive and specific in identifying visa applicants with 'screen detectable' TB (as defined) than the existing approach. In the context of screening program, sensitivity translates to the efficacy of the program in finding people with the target condition and specificity translates to the efficiency of the program in avoiding unnecessary futher testing for those without the target condition. Routine use of the proposed risk estimation tool is highly feasible in Australia, since it uses information that is routinely collected during the visa application process. Preferred policy settings will be context specific, but the approach should be generalisable to any country with high quality linked data seeking to detect and treat people with TB at the time of visa application.

The cost-effectiveness of this approach will be highly dependent on the selected risk threshold, which determines screening efficiency, in addition to the cost of TB screening and the management of missed TB cases.[16,17] In general, the use of an objective data-driven approach informed by up-to-date local data, is likely to be more cost-effective than subjective non-evidence based approaches currently in use. Adopting a data-driven risk estimation tool allows policymakers to define an 'acceptable risk threshold' and to adjust their policy settings based on real-life data in a fully transparent fashion. The definition of an 'acceptable risk threshold' will be influenced by the local TB incidence rate, the perceived vulnerability of people with whom the migrant might interact, as well as the local risk and cost tolerance. For example, the 'acceptable risk threshold' may be lower for those planning to work in

Variable included in the prediction model	Category	All pulmonary TB			Bacteriologically-confirmed PTB		
		N	Incidence	Odds Ratio (95% CI)	N	Incidence	Odds Ratio (95% CI)
Sex	Female	431	6.11	1.08 (0.96–1.21)	426	6.03	1.08 (0.97–1.21)
	Male	432	6.51	1.00	425	6.41	1.00
Age group (years)	≤14	6	0.61	0.06 (0.03–0.11)	6	0.61	0.06 (0.03–0.11)
	15–34	709	11.21	1.00	702	11.10	1.00
	35–54	112	3.26	0.50 (0.42–0.60)	108	3.15	0.48 (0.41–0.58)
	55–74	30	1.10	0.30 (0.21–0.40)	29	1.06	0.28 (0.20–0.39)
	≥75	6	2.74	0.80 (0.40–1.59)	6	2.74	0.80 (0.41–1.57)
Country of citizenship[b] (TB incidence per 100,000)	≤10	26	0.47	1.00	25	0.45	1.00
	10–39	17	1.59	2.24 (1.35–3.74)	17	1.59	2.33 (1.40–3.87)
	40–99	177	4.76	7.87 (5.57–11.12)	174	4.68	8.03 (5.68–11.36)
	100–199	258	17.45	22.29 (15.88–31.28)	254	17.18	22.82 (16.24–32.06)
	≥200	380	31.47	44.12 (31.61–61.59)	376	31.14	45.39 (32.48–63.44)
Visa type	Family	38	24.65	5.83 (4.31–7.88)	36	23.35	5.52 (4.08–7.48)
	Skilled migrant	106	17.24	4.17 (3.36–5.18)	104	16.92	4.10 (3.31–5.08)
	Student	332	22.21	4.76 (4.00–5.67)	330	22.08	4.73 (3.98–5.62)
	TR (unskilled)	138	21.00	6.21 (5.08–7.58)	134	20.39	6.05 (4.95–7.38)
	TR (skilled)	66	16.06	4.43 (3.45–5.67)	66	16.06	4.44 (3.47–5.67)
	Visitor	172	1.88	1.00	170	1.86	1.00
	Working Holiday	10	0.91	0.40 (0.23–0.71)	10	0.91	0.40 (0.23–0.70)
	Other	1	1.01	Not estimable	1	1.01	Not estimable
Total		**863**	**6.30**		**851**	**6.22**	

TB, tuberculosis; TR, temporary resident; PTB, pulmonary TB; CI, confidence interval. [a]TB diagnosed during visa screening or within 6 months of visa issuance. [b]In 5 instances 'country of citizenship' was not recorded.

Table 2: **Odds ratio of being diagnosed with 'screen detectable'[a] pulmonary TB among Australian visa applicants (2014–2019).**

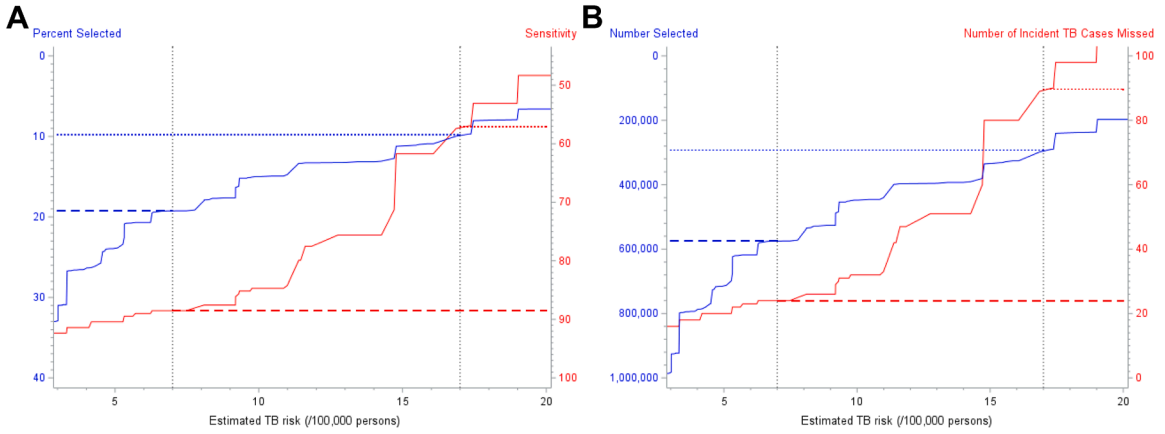


Fig. 2: **Effectiveness and efficiency of the risk estimation tool to select visa applicants with 'screen detectable'* pulmonary TB by TB prevalence (risk) - 2019 cohort.** TB, tuberculosis. *TB diagnosed during visa screening or within 6 months of visa issuance. The X-axis shows the expected number of 'screen detectable' pulmonary TB cases per 100,000 visa applicants screened. The range of data has been truncated to expected TB risk in the range of 3–20 per 100,000 persons, which is the policy-relevant range. A. The right Y-axis shows sensitivity, that is, the proportion of screen detectable TB cases detected, plotted on the red line. The left Y-axis shows the proportion of the visa applicant population needing to be screened, plotted on the blue line. B. The right Y-axis shows number of incident TB cases missed plotted on the red line. The left Y-axis shows the number of visa applicants needing to be screened, plotted on the blue line. The vertical black dotted reference lines identify two plausible reference risk thresholds that could be decided by policy: 7 per 100,000 (very low risk) and 17 per 100,000 (low risk). They can be seen to intersect the red lines (sensitivity and number of TB cases missed) and the blue lines (proportion and number of visa applicants needing to be screened). The horizontal red lines show the sensitivity and number of TB cases missed associated with each of the two selected risk thresholds (on the right y axis) and the horizontal blue lines show the proportion and number of visa applicants needing to be screened associated with these same two risk thresholds, on the left y axis. The dashed blue and red lines relate to the 7 per 100,000 risk threshold and the dotted blue and red lines relate to the 17 per 100,000 risk threshold.

child or aged care than for those visiting as tourists or working in construction.

In a world 'on the move',[4] migration from high TB incidence settings is a major contributor to the TB case load in low TB incidence countries.[18–21] Ambitious End TB targets recognise the importance of limiting cross-border TB spread and subsequent local transmission.[22] In Australia, migrant TB screening plays an important and legally prescribed role in protecting the public against imported TB disease. Australia's geographical location makes it a popular destination for visitors and migrants from high TB incidence countries in the Asia–Pacific region where TB rates, including drug-resistant TB, are amongst the highest in the world.[1,6,23] Investing in effective TB screening programs can make a valuable contribution to TB control in low TB incidence countries with important economic, and public health benefits. If done transparently and well, these measures should also benefit the visa applicant.[5,6,13]

Existing co-morbidities, immunocompromising conditions and extremes of age are known risk factors for TB.[12,24–26] Interestingly, most TB cases in our study occurred in the 15–34 age group, in whom co-morbidity is relatively uncommon. As observed in other countries,[2,3,20] Australian migrants in this age group are mostly from high TB incidence settings, applying for working visa's or coming as international students. They often experience high levels of stress and deprivation due to cultural adjustment, academic pressures and the high cost of living in Australia's capital cities.[7,23] In addition, people in this age group often enter Australia on short-term tourist visas, bypassing initial TB screening, before applying for longer-term visas whilst in Australia. Although not a major factor in our study, the number of refugees and displaced people globally is rapidly rising, with certain parts of the world disproportionately affected.[1,20,27] Careful consideration of the specific needs of refugees and displaced people are required to provide them with the best possible care and to limit the risk posed to local communities.[6,28]

The existing approach to assessment of TB risk excludes people applying for short-term visas from assessment, presumably largely for reasons of administrative convenience. However, there is no biological or epidemiological reason to suspect that the risk of having TB at the time of assessment or during the six-month interval after arrival (when the risk is greatest) is different between those who arrive with the intention of staying for a short period of time and those who arrive with the intention of staying for a longer period of time. Indeed, in the context of health protection in relation to another airborne infectious disease, COVID-19, no such exclusion of the need for quarantine or other health protection measures was implemented for those visiting Australia for short stays. Hence, there is no inherent reason why one would not wish to screen short-term visitors, if they have characteristics that place them at risk of having TB at the time of assessment or during the six-month interval after arrival, which is the purpose of the health assessment. The inclusion of short-term visa applicants is a strength of the new data-driven approach.

Important study limitations include the small number of variables available for inclusion in the prediction model. Having reliable data on a visa applicants' history of previous TB, recent contact with an infectious TB case, occupation, the number of people living in the household (as a proxy for crowding) etc. could strengthen the accuracy of the risk estimation tool.[12,13,25] Despite the limited number of variables available, the simulated sensitivity and specificity of the risk estimation tool outperformed existing approaches. Given the absence of unique identifiers, people with the same name and date of birth could not be separated in the database. This is sub-optimal but should be a rare occurrence with negligible effect on the study findings and could be overcome in future with the use of a unique applicant identifier.

Classifying all TB diagnosed within 6 months of visa issuance as 'screen detectable' may have over-represented the number of cases truly detectable during routine visa application screening. However, given the long diagnostic delays reported with passive case finding and increased recognition of sub-clinical TB disease,[28,29] we preferred to include all TB cases identified during this 6 month window. We believe this provided the best practical compromise given the datasets at our disposal and provides a more conservative estimate to guide decision making.

We are unable to comment on visa applicants who developed TB disease outside Australia - not detected during visa screening. This limits our ability to comment on overall TB disease risk in the study cohort. However, the study aim was to identify better methods for selecting people potentially having TB disease in Australia, who may be detected through appropriate screening protocols at the time of visa application. We believe this was achieved, given the inclusion of all TB cases detected during visa screening or diagnosed in Australia within 6 months of visa issuance. The risk that TB cases may have gone undetected within Australia is small, given excellent health care access and routine autopsies performed on all people dying from an unspecified cause. All migrants and visitors have access to free TB services, and a TB disease diagnosis has no influence on a person's visa status.[6] Visa applicants in whom a TB concern is identified, but without a firm clinical or bacteriological diagnosis at the time of screening, are flagged for routine post-arrival

monitoring in Australia.[19] There are also good verification systems in place to ensure the accuracy of reported TB case numbers.

The quality of international TB screening services is an important issue that is independent of the selection process. Australia has a stringent system of IME quality control, where only accredited providers and quality assured laboratories provide TB screening services. However, strict quality assurance can be challenging and requires ongoing vigilance to ensure best practice and the highest possible quality of TB screening. Given the dynamic global and variable context specific challenges, it should be emphasised that the risk estimation tool cannot be static. It will require repeat data-linkage and analysis at regular (2–5 year) intervals to ensure that it draws on the most relevant information and remains current.

There are many important considerations when drafting optimal policies and procedures for migrant TB screening,[30] but these are rarely informed by local data. Our findings demonstrate the value of objective data-driven approaches that utilise data linkage to guide screening policies in low TB incidence countries, like Australia. The risk estimation tool presented here, offers a blueprint for transparent TB screening policies with optimal effectiveness and efficiency, with scope for regular data-driven revision, if high quality data is available and adequate data linkage systems are established.

Contributors

GMS, GBM and BJM conceptualised and designed the study. GMS led the data collection, national coordination and ethics approvals, assisted by BJM. GBM, MRA and GMS verified the data and developed the data analysis plan. GBM and MRA analysed the data, assisted by GMS and BJM. GMS drafted the manuscript. All authors contributed to revisions and approved the final manuscript. GBM, MRA and GMS had full access to all the data and had final responsibility for the decision to submit for publication.

Data sharing statement

The Excel spreadsheet implementing the prediction tool is available at https://doi.org/10.17632/ry88677566.1.

Declaration of interests

The authors declared no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2026.102017.

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