



Ending tuberculosis: the cost of missing the World Health Organization target in a low-incidence country

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Abstract

Background Ending tuberculosis (TB) is a global priority and targets for doing so are outlined in the World Health Organization (WHO) End TB Strategy. For low-incidence countries, eliminating TB requires high levels of wealth, low levels of income inequality and effective TB programmes and services that can meet the needs of people who have not benefited from these and are still at risk of TB. In Ireland, numerous reports have noted a need for more funding for TB prevention and control.

Aim The aim of this research was to estimate the cost of not meeting the WHO End TB target of a 90% reduction in TB incidence in Ireland between 2015 and 2035.

Methods The cost of projected TB cases between 2022 and 2035 is estimated based on trends in surveillance data for the period 2015 to 2019 and outcomes reported in the literature.

Results Between 2022 and 2035, it is projected that a failure to meet the WHO End TB Strategy target will result in an additional 989 cases of TB, 577.3 disability-adjusted life years and 35 deaths with TB in Ireland. The cost of this is estimated to be €70.779 million.

Conclusion Given the estimated cost, Ireland's current prospects of eliminating TB and the tendency towards programmatic funding internationally, greater investment in TB prevention and control in Ireland is justifiable. A national elimination strategy with actions at the levels of the social determinants of health, the health system and the TB programme should be funded.

Keywords Cost · Ireland · Latent tuberculosis · Prevention · Programmatic · Tuberculosis

Tuberculosis (TB) is a leading cause of global morbidity and mortality [1], and its elimination is an international priority [1–4]. In 2020, 57 countries had an incidence of TB of less than 10 cases per 100,000 [1]. For these, achieving the World Health Organization (WHO) End TB Strategy target of a 90% reduction in TB incidence between 2015 and 2035 is an important stepping stone towards its elimination [2, 4]. Improving socioeconomic conditions was a major factor behind the decline of TB in the twentieth century [5]. However, more recently, in European countries, differences

in national wealth and levels of income inequality explained only 50% of the between-country variation in TB burden [6]. Furthermore, although TB burdens declined to a point with improving wealth and income equality, the between-country differences in TB burden diminished [6]. Therefore, although wealth, particularly distributed wealth, is important to address TB, more is needed to eliminate it [4, 5]. In many low-incidence countries, a large proportion of people with TB are recent immigrants, often from countries with much higher burdens of TB, less wealth and more income inequality [5, 7]. Even in wealthy countries with relatively low-income inequality, TB persists (Table 1), particularly among those marginalised by society because of culture, ethnicity, lifestyle or poverty [4]. For example, in Ireland, Travellers were disproportionately affected [8], in England, people who were homeless [9], and in Canada, the incidence of TB among Inuit people is over 50 times that of the general population [10]. Therefore, for low-incidence countries, eliminating TB requires high levels of wealth, low levels of

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Table 1 Tuberculosis in high-income low-incidence European countries

Country	Gini index ^a	People with TB foreign-born, 2019 (%) ^b	People with TB unknown country of birth, 2019 (%) ^b	Incidence of drug-susceptible TB, 2019 (per 100,000) ^c	Average annual percentage change TB incidence, 2016–2019 ^d
Norway	27.7	88.5	0.6	3.3	– 15.3
Finland	27.7	42.7	1.8	4.7	0.0
Netherlands	29.2	74.7	1.3	5	– 5.1
Denmark	27.7	72.6	0	5.2	– 4.0
Switzerland	33.1	68.2	N/a	5.4	– 10.5
Sweden	29.3	86.6	0	5.5	– 11.0
Ireland	30.6	44.7	15.4	5.8	– 6.5
Austria	30.2	55.5	0	6	– 8.6
Italy	35.2	56.2	2.1	6	– 5.6
Germany	31.7	70.2	2.5	6.4	– 6.7
UK	35.1	70.4	3.1	8	– 6.1
Belgium	27.2	55.9	0	8.9	– 3.7
France	32.4	60.6	10.9	9	+ 1.1
Spain	34.3	37	8.8	10	– 5.6

N/a not available, TB Tuberculosis, UK United Kingdom

^aReported for the most recent year available. A measure of income inequality. The Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. Thus, a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality. Source: World Bank, Gini Index. Available at <https://data.worldbank.org/indicator/SI.POV.GINI>

^bSource: European Centre for Disease Control and Prevention, Tuberculosis surveillance and monitoring, 2021. Available at <https://www.ecdc.europa.eu/sites/default/files/documents/tuberculosis-surveillance-monitoring-Europe-2021.pdf>

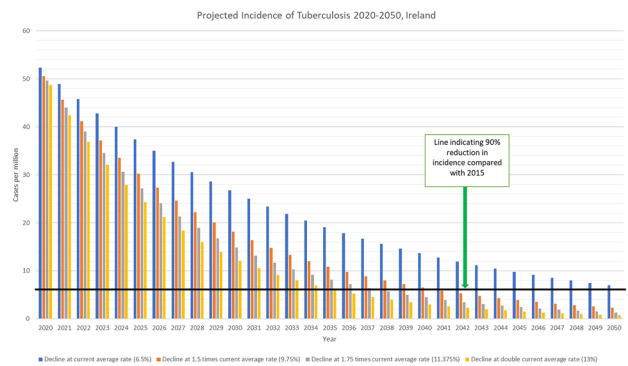
^cSource: World Health Organization, Global tuberculosis report, 2021, TB burden estimates. Available at <https://extranet.who.int/tme/generateCSV.asp?ds=estimates>

^dCalculated as the incidence in 2016, minus the incidence in 2019, expressed as a percentage of the incidence in 2016

income inequality and effective TB programmes and services that can meet the needs of people who have not benefited from these and are still at risk of TB [4].

Eliminating TB in Ireland, a high-income low-incidence country, will be challenging. TB in Ireland is increasingly concentrated within marginalised groups [11]. The COVID-19 pandemic may have harmed TB control in Ireland [11]. In other low-incidence countries, during the pandemic, testing for TB decreased, TB diagnoses were delayed, patients had more severe disease at diagnosis and more household contacts had TB infection (suggesting increased transmission) [12–15]. There will probably be an increase in TB nationally, particularly drug-resistant TB, related to the arrival of people from Ukraine (where the incidence of TB was 73 cases per 100,000 prior to the war [1]) [11]. Drug-resistant TB can require prolonged multidrug treatments, which can be costly and resource-intensive to provide [2, 4, 16]. Like other low-incidence countries [17, 18], most TB in Ireland is likely due to the reactivation of latent TB infection (LTBI), which can be difficult to diagnose and treat [4]. Even without considering these factors, to achieve the WHO End TB target by 2035 in Ireland, the rate of TB incidence decline would have to double from 6.5% to 13% (Fig. 1) [19].

Compared with other low-incidence European countries, Ireland is not dissimilar in how it is currently positioned to eliminate TB (Table 1). However, other European countries are funding coordinated programmes to improve their TB programme and service delivery. Finland, the Netherlands, Switzerland, Italy, the UK and Spain all have TB control



Source: O'Connell J. A Quality of Care Evaluation to Identify Priorities for Improving Tuberculosis Care in Ireland (MD Thesis) Dublin: Royal College of Surgeons in Ireland; 2021

Fig. 1 Projected incidence of tuberculosis, Ireland, 2021–2030

strategies [20]. Latent TB infection screening programmes of recent migrants exist in Norway, the Netherlands, Switzerland, Sweden, Denmark, France, the UK, Italy and Germany [21]. Most countries in Europe have programmes for raising awareness of TB at the community care level [20]. Ireland, like comparable countries, should be intensifying its TB control efforts. Over the previous 20 years, TB prevention and control in Ireland have been examined repeatedly, and numerous reports have made recommendations for its strengthening, often noting that activities were becoming more resource intensive and that more funding was needed [22–25]. The aim of this study was to estimate the cost of not meeting the End TB Strategy target in Ireland. This could be informative for future resource allocation decisions.

Methods

The cost of not reaching the WHO End TB Strategy target of a 90% reduction in TB incidence between 2015 and 2035 can be measured in morbidity (cases and disability-adjusted life years (DALYs)), mortality, direct costs and indirect costs. This analysis estimates these measures using assumptions (Table 2) based on trends in surveillance data for the period 2015 to 2019 and outcomes reported in the literature. Direct care cost estimates were derived from a TB service in Ireland [26] and those reported in the literature (inflated to 2019 values using Organisation for Economic Co-operation and Development (OECD) consumer price index data for the origin country [27] and then converted to Euros (Ireland) using the purchasing power parity index as reported by the OECD [28]).

Results

Between 2022 and 2035, it is projected that a failure to meet the WHO End TB Strategy target will result in an additional 989 people having TB disease, 577.3 DALYs and 35 deaths with TB in Ireland (Table 3). The cost of not meeting the End TB target is projected to be €70.779 million between 2022 and 2035.

Discussion

This analysis estimates the future cost to Ireland of failing to achieve the WHO End Tuberculosis Strategy target of a 90% reduction in TB incidence by 2035 as being €70.779 million. Given Ireland's current prospects of eliminating TB and the tendency towards programmatic funding in other low-incidence countries, investment in effective interventions to reduce the burden of TB in Ireland is financially

justifiable. In addition, a 2015 health technology assessment estimated universal bacille Calmette-Guerin (BCG) vaccination to cost €2.4 million annually in Ireland and concluded that a move to a selective approach for BCG vaccination could be considered but that there was first a need to invest in other aspects of TB control [43]. BCG vaccination has since ceased in Ireland, but substantial investment in other aspects of TB control has not materialised. Of course, many would argue that funding for TB should not be viewed through such a “zero-sum” approach and that it should be much greater than this. The burden of other sequelae of TB disease for patients has been poorly evaluated in Ireland. Prolonged symptoms prior to diagnosis, stigmatization, socioeconomic consequences such as loss of housing and post-TB complications (e.g. chronic lung disease, cardiovascular disease, psychological ill health) [44], may mean the true cost of TB disease is much more than the monetary costs reported in this analysis.

There are several limitations to this analysis. First, it assumes that meeting the End TB Strategy target in low-incidence countries is achievable, primarily because TB is preventable and treatable. How feasible it is in Ireland to achieve the entirety of the required reduction in TB incidence by 2035 can be debated. TB economic analyses would typically describe the potential cost–benefit of an intervention based on modelling of future epidemiological scenarios with and without the intervention. Such analyses may use a Markov model which can account for uncertainty in the cost estimates and the probability of outcomes occurring [45]. TIME Impact, an epidemiological transmission modelling tool, can provide projections of future TB incidence that account for the natural history of TB, drug resistance and treatment history [46]. This analysis considered only single-point estimates from the literature for all variables, not accounting for any uncertainty in the estimates, meaning only a single-point estimate is presented as the final cost. For example, there is a large variation in the cost of drug-resistant TB care in the literature [33–37]. The analysis does not account for any potential detriment in TB control in Ireland related to the COVID-19 pandemic, changes in immigration patterns or changes in drug-resistant TB prevalence. Therefore, the methodology used in this analysis was simplistic. However, the primary preventive intervention in low-incidence countries is LTBI screening. In Ireland, LTBI prevalence data are lacking to reliably inform any such economic evaluations [47]. Regardless, what is clear even from this analysis is that continuing at the current rate without intervention is a costly choice. Other limitations were that the cost of any operational (e.g. surveillance) or communication and engagement activities conducted by the TB programme were not included. The direct cost of TB care and contact management may change in the future, particularly if shorter treatment regimens become the preferred standard

Table 2 Projection assumptions for tuberculosis morbidity, mortality, and cost in Ireland, 2022 to 2035

Projection variable	Source and estimate
Population in Ireland to 2035	Central Statistics Office [29]
Incidence of tuberculosis	Tuberculosis surveillance reports [30] (average decline in the incidence of 6.5% between 2016 and 2019 extrapolated to 2035)
Cases of tuberculosis	Product of estimated population and incidence
Deaths with tuberculosis	Tuberculosis surveillance reports [30] (number of deaths with tuberculosis per year as a proportion of cases notified averaged over the years 2015 to 2019 (3.5%))
Pulmonary tuberculosis cases	Tuberculosis surveillance reports [30] (average proportion of cases with pulmonary tuberculosis between 2015 and 2019 (67.7%))
Multidrug-resistant/rifampicin-resistant tuberculosis	Tuberculosis surveillance reports [30] (average proportion of cases with multidrug/rifampicin-resistant TB between 2015 and 2019 (2%))
HIV/TB co-infection	Tuberculosis surveillance reports [30] (average proportion of cases with HIV/TB co-infection between 2015 and 2019 (3.2%))
Number of pulmonary tuberculosis case contacts	Literature review [31], average of 5 contacts per case in high-income countries
Number of pulmonary tuberculosis case contacts accepting screening, being diagnosed with LTBI, starting treatment and completing treatment	Literature review [31, 32], 79.3% accepting screening, 28.1% of those screened diagnosed with latent TB infection (LTBI), 74.8% of those with LTBI starting treatment and 29.3% of those starting treatment completing it
Direct TB care costs	
Cost of active TB case management (drug susceptible)	Cost analysis of TB care in Ireland [19] (mean pulmonary TB cost of €34,903 and extrapulmonary TB cost of €40,005)
Cost of active TB management (multidrug resistant/rifampicin resistant)	Literature review [33–37], median value of adjusted estimates reported in the literature (€79,440)
Cost of TB case contact management	Cost analysis of TB care in Ireland [19] (€70.67 per patient screened using a chest x-ray and an interferon gamma release assay) Cost analysis of TB care in Ireland [19] (€857 per case of LTBI treated to completion using isoniazid 6-month treatment)
Productivity losses	
Mean number of sick days due to TB	Literature review (29.67 days) [19, 38]
Cost per sick day	Mean income earning per day in 2018 and 2019 according to Central Statistics Office (€153.29) [39]
Labour force participation rate	Central Statistics Office (69.7%) [40]
Unemployment rate	Central Statistics Office (5.35%) [40]
Value of disability-adjusted life years	
Disability weights	Literature review [41] (0.333 for drug-susceptible TB, 0.408 for HIV/TB co-infection)
Average duration of case until remission	Literature review [38] (0.5 years for all patients with drug-susceptible TB) Literature review [38] (2 years for all patients with multidrug-resistant and rifampicin-resistant TB)
Average duration of case until death	Literature review [38] (2 years)
Monetary value of each disability-adjusted life year	Literature review [42] (€52,000)

TB Tuberculosis, *HIV* Human immunodeficiency virus

of care. For contact management, the cost of care estimates may be an underestimate because they were calculated using a sample of medical patients with largely uncomplex needs and a high treatment completion rate [19]. A further limitation of this analysis was that future inflation was not factored into cost estimations. However, inflation of health care costs tends to be greater than that of general inflation [48]. This means that, over time, cost savings due to disease prevention become increasingly valuable relative to other costs if inflation is maintained.

Evidently, TB control in Ireland should be intensified and this is financially justifiable. Determining the actions needed should begin with the appointment of a national lead for TB elimination in Ireland, the convening of stakeholders (including patients and people at risk of TB) and the development of a national elimination strategy. This strategy should consider actions at three levels: those at the level of the social determinants of health (e.g. reducing poverty and inequality), those at the level of the health care system (e.g. providing high-quality universal healthcare, improving

Table 3 Estimates of tuberculosis morbidity, mortality and cost, 2022 to 2035

Measure	TB incidence declines at 6.5% per year ^a	TB incidence declines at 13% per year ^b	Difference
Cases	2257	1268	989
Deaths	79	44	35
Disability-adjusted life years	1303	725.7	577.3
Direct costs			
Case management (€, millions)	85.428	48.023	37.405
Contact case management (€, millions)	0.896	0.504	0.392
Total direct costs (€, millions)	86.324	48.527	37.797
Indirect costs			
Productivity losses (€, millions)	6.767	3.804	2.963
Value of disability-adjusted life years (€, millions)	67.756	37.737	30.019
Total indirect costs (€, millions)	74.523	41.541	32.982
Total costs (direct and indirect, €, millions)	160.847	90.068	70.779

^aAverage rate of TB incidence decline between 2016 and 2019.

^bAverage rate of TB incidence decline needed to meet WHO End TB target.

migrant health) and those at the level of the TB programme (e.g. reducing diagnostic delays, programmatic LTBI management and improved contact management and outbreak response). Influencing health and social policy could be challenging for stakeholders when they largely exert no control over them. However, stakeholders can still influence national policy for the better by demonstrating the harms to health of poverty, inequality and a lack of access to health care. At the level of the TB programme, delayed diagnosis has been reported in Ireland [26, 49] and, apart from potentially leading to more transmission [12, 50], probably increases care costs [26]. Strengthening non-acute care pathways between primary care and TB services will be important to address this [26], and this is consistent with the aims of Sláintecare [51]. Research explaining the causes of patient-related delays prior to diagnosis is needed [26].

Expanding LTBI screening and treatment programmatically in low-incidence countries is needed to end TB [4, 52, 53]. Preventive treatment may be targeted programmatically not only at those currently recommended for screening and treatment but also at other vulnerable population groups. In Ireland, detailed data on the prevalence of risk factors among TB cases notified are not routinely reported, and studies evaluating the effectiveness of LTBI screening in at-risk groups in Ireland are needed [47]. If Ireland is to meet the End TB target, 51 of the 56 cases per million (90%) of TB notified in the year of 2019 would have to be prevented. The feasibility of meeting the ambitious End TB target in Ireland will depend on their being high completion rates of LTBI screening and treatment. In 2019, 22% of TB cases in Ireland occurred in people aged 65 and older, and due to shifting age demographics, this proportion may increase over time [54]. Therefore, to end TB, preventive treatment will need to include older at-risk people [4]. However, for older

people, the individual risk of harm from preventive treatment may outweigh the benefits [55]. Programmatic LTBI management should include close surveillance of the incidence of treatment-related adverse events in older people. Internationally, LTBI screening completion tends to be low among migrants and treatment completion low among marginalised groups [32]. Programmatic LTBI management must involve engagement with target groups to understand and overcome the reasons for declining or not completing screening and treatment.

Outbreak prevention could be strengthened by reducing overall TB incidence, reducing delayed diagnoses and improving the management of LTBI. An increase in drug-resistant TB could be a challenge for contact LTBI management because of the need for more complex-tailored preventive treatment regimens with limited evidence to support the duration of treatment choices [16]. To strengthen outbreak prevention, TB advocacy, communication and engagement, as well as testing among vulnerable populations and in institutional settings such as prisons (where large outbreaks have occurred [56]), should be improved. Outbreak response should be strengthened through the provision of additional staff, including social workers and outreach staff, to public health departments, given the increasing complexity of managing outbreaks in vulnerable populations and institutional settings.

Conclusion

The cost of not meeting the End TB target in Ireland is projected to be €70.779 million between 2022 and 2035. A national elimination strategy with actions at the levels of the social determinants of health, the health system and the TB programme should be invested in.

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