Social protection and tuberculosis control in 21 European countries, 1995–2012: a cross-national statistical modelling analysis

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Summary

Background WHO stresses the need to act on the social determinants of tuberculosis. We tested whether alternative social protection programmes have affected tuberculosis case notifications, prevalence, and mortality, and case detection and treatment success rates in 21 European countries from 1995 to 2012.

Methods We obtained tuberculosis case notification data from the European Centre for Disease Prevention and Control's 2014 European Surveillance System database. We also obtained data for case detection, treatment success, prevalence, and mortality rates from WHO's 2014 tuberculosis database. We extracted data for 21 countries between Jan 1, 1995, and Dec 31, 2012. Social protection data were from EuroStat, 2014 edition. We used multivariate cross-national statistical models to quantify the association of differing types of social protection programmes with tuberculosis outcomes. All analyses were prespecified.

Findings After we controlled for economic output, public health spending, and country fixed effects, each US$100 increase in social protection spending was associated with a decrease per 100 000 population in the number of tuberculosis case notifications of –1·53% (95% CI –0·28 to –2·79; p=0·0191), estimated incidence rates of –1·70% (–0·30 to –3·11; p=0·0201), non-HIV-related tuberculosis mortality rate of –2·74% (–0·66 to –4·82; p=0·0125), and all-cause tuberculosis mortality rate of –3·08% (–0·73 to –5·43; p=0·0127). We noted no relation between increased social spending and tuberculosis prevalence (–1·50% [–3·10 to 0·10] per increase of $100; p=0·0639) or smear-positive treatment success rates (–0·079% [–0·18 to 0·34] per increase of $100; p=0·5235) or case detection (–0·59% [–1·31 to 0·14] per increase of $100; p=0·1066). Old age pension expenditure seemed to have the strongest association with reductions in tuberculosis case notification rates for those aged 65 years or older (–3·87% [–0·95 to –6·78]; p=0·0137).

Interpretation Investment in social protection programmes are likely to provide an effective complement to tuberculosis prevention and treatment programmes, especially for vulnerable groups.

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Introduction

In March, 2014, almost five decades after Thomas McKeown's seminal study showing how most of the decrease in tuberculosis mortality predated the introduction of BCG immunisation and chemotherapy, the WHO's World Health Assembly voted to include social protection as one of the core pillars of the WHO post-2015 global tuberculosis strategy.[1] Previously, policies to tackle this disease had focused on health-care interventions, such as directly-observed treatments, which were designed to enhance passive case detection and adherence to treatment for active strains of the disease in an effort to contain costs.[2,3] Although health systems have made great strides in strengthening their response to tuberculosis, the pace of improvement in the control of the disease has slowed in some countries, causing some to refocus their efforts once again on the social determinants of tuberculosis incidence, case detection, and treatment success.[4–9] Although the post-2015 Millennium Development Goal (MDG) targets have not yet been finalised, the emphasis on social protection in WHO's new strategy shows growing

concern about and recognition of "health in all policies",[10] with focus on the importance of social factors, such as poverty, malnutrition, and poor housing associated with tuberculosis.

In line with this strategy and in the face of fiscal retrenchment in many European countries, there are growing calls to protect financing of tuberculosis programmes—especially those that reach out to vulnerable populations—and to address the wider determinants of tuberculosis. There are two reasons behind these calls. First, poverty is a major determinant of the spread of tuberculosis, as shown during the economic crises besetting post-Soviet nations in the 1990s, which saw a resurgence of the disease. Factors included rising incarceration rates,[11] with overcrowding and inadequate care common in prisons, and cuts to spending on public health programmes.[12] Second, the rise of drug-resistant strains of tuberculosis, which is partly attributable to a failure of treatment regimens and is most common in deprived groups who live in densely populated settings with inadequate nutrition, such as homeless people and drug users.[11,13] Regimen completion

rates are typically lower in these groups so that, at a population level, a reduction in the prevalence of vulnerable groups might help prevent the emergence of drug-resistant tuberculosis. Thus, the 2010 *Lancet* tuberculosis Series called for a renewed emphasis on tackling poverty and promoting social protection, education, and empowerment to curb the epidemics,[6] and another review concluded that acting on "the social determinants of health provides a real opportunity to expand the current paradigm for tuberculosis control".[14]

Social protection programmes might be able to mitigate the social determinants of risks associated with tuberculosis infection and treatment success (panel 1). Such programmes act to alleviate homelessness and overcrowding, reduce poverty, and improve social factors associated with inadequate diagnosis and incomplete treatment. The main types of social protection programme include initiatives to provide housing when there is overcrowding or risk of homelessness,[15] income support to those who have lost work,[16,17] and pensions to combat material deprivation in old age or when the death of a spouse can increase risks of poverty and thereby increase risk of tuberculosis reactivation.[18]

These social protection interventions potentially reduce tuberculosis prevalence through three main mechanisms. First, they reduce susceptibility to disease by preventing a deterioration of social and economic conditions and, to the extent they do worsen, mitigate

their effects in populations at high risk of tuberculosis—eg, drug users,[19] homeless people,[20] children,[21] elderly people,[22] and other immunocompromised groups.[23] Social protection might also reduce the period of infectiousness and thus transmission. Second, they prevent diseases reactivation in people who have latent tuberculosis and can alleviate financial hardship,[24–27] under-nutrition,[28,29] diabetes,[30] and hazardous alcohol drinking.[31,32] In settings with a low burden of tuberculosis, latent disease is most common in people older than 50 years and migrants.[22,33–35] Third, social protection programmes can improve the effectiveness of case detection and treatment by providing an additional point-of-entry for people who have adverse life circumstances.[36,37] Often, by the time high-risk groups interact with health-care systems, their illness has progressed, reducing the possibility treatment success.[38] High levels of social protection might enhance the opportunities for outreach, facilitating increased case detection and providing stable social conditions that make it easier to complete a course of treatment.[6,39–41]

Nearly all societies provide some degree of social protection for people at risk of poverty, hunger, or homelessness, although much variation exists in the scale and types of programmes available across countries.[16,42] Welfare systems that aim for universal coverage (ie, those offering protection to almost all of the population through tax-funded risk pooling) are common in European countries and might have a greater effect on tuberculosis than less universalistic regimes. Within European welfare systems with universal coverage, substantial variation exists in levels of income replacement and in the eligibility criteria that make them accessible.[17] Although which, and if any, social protection interventions are most effective in reducing risks associated with tuberculosis, and how these compare with alternative medical interventions, is unclear.

Here, using cross-national data from 21 European Union (EU) member states covering 1991 to 2012, we test whether and the extent to which alternative social protection programmes contribute to tuberculosis prevention and control.

Methods
Data sources and study design
For this cross-national statistical modelling analysis, we obtained data for tuberculosis incidence, prevalence, and mortality from the monitoring system maintained by the European Centre for Disease Prevention and Control (ECDC) in 2014.[43] We estimated models using case notifications for smear-negative, extrapulmonary, and smear-positive incidence per 100 000 population. We also evaluated changes in the tuberculosis prevalence, mortality from non-HIV related tuberculosis, and total tuberculosis mortality per 100 000 population.

Panel 1: Components of social protection spending

Sickness and disability: cash benefits or benefits in kind that replace in whole or in part loss of earnings during a temporary or long-term inability to work due to sickness or injury.

Old age and survivors: cash benefits and benefits in kind against the risks linked to old age and those who are the survivors of a deceased person.

Family and children: cash benefits and benefits in kind to households with dependent children.

Unemployment: cash benefits and benefits in kind to people who are capable of and available for work but are unable to find suitable employment.

Housing: benefits in kind to help households meet the cost of housing (recipients of these benefits are means-tested).

Social protection, not elsewhere classified: administration and monitoring of overall social protection policies, plans, programmes and budgets. Administration and operation of government agencies engaged in applied research related to social protection. Cash benefits and benefits in kind to people who are socially excluded or at risk of social exclusion (such as people who are homeless, low-income earners, or alcohol and substance abusers).

We compiled data from WHO and the ECDC, which estimate incidence and prevalence and adjust for under-reporting. In most countries, under-reporting was constant over time.[21] However, our findings were not sensitive to the inclusion of countries with changing estimates of under-reporting.

We obtained data for social protection spending, government public health service expenditure (a subset of total government spending on health including tuberculosis disease detection and prevention), and gross domestic product (GDP) from EuroStat, using the 2014 edition.[44] Almost all countries are compliant with EuroStat's financial reporting guidelines, providing largely consistent and comparable data for expenditures.[45] However, there were some missing data for public health service spending for Belgium, Greece, Romania, and Slovakia (39 country-years of missing data). These data were omitted rather than imputed, although none of the results was substantively changed by this step. We excluded Cyprus, Luxembourg, and Malta from the analysis because of their small population sizes, yielding a final analytical sample of 24 EU member states. We disaggregated expenditure for each sector of social protection described in panel 1.[45] EuroStat data included only expenditures and thus did not allow more refined analyses of welfare regimes, including conditional and unconditional forms of social protection. To measure the generosity of state pensions within a country over time we also used the Comparative Welfare Entitlements database, which provides a composite indicator of both the quantity of funds provided and the proportion of the population covered. All spending data and GDP were in per-person terms and adjusted for inflation and purchasing-power.

Statistical analysis

In the first step of the analysis, we quantified associations between levels of social protection spending and the various measures of tuberculosis incidence, prevalence, and mortality. We adjusted these models for GDP and government spending on public health services using the following equation:

$$TB_{it} = \beta_0 + \beta_1 SocialProtection_{ikt} + \beta_2 GDP_{it} + \beta_3 Public\ Health_{it} + \mu_i + \varepsilon_{it}$$

In this equation, i is country, t is year, k is type of social protection spending (panel 1). TB is an indicator of tuberculosis, on a logged scale. *Social Protection* is the measure of government expenditure per person on social protection. *GDP* is a measure of per-person GDP. *Public Health* is a measure of government investment in disease detection and prevention. All models adjust for country-specific differences that are constant over time, such as housing or employment policies that could affect exposure and susceptibility and differences in accounting procedures that are constant over time. Observations in which annual changes in total social

protection spending was implausibly large were excluded from the sample (n=13), although none of our results was qualitatively changed by this step.[46] We used STATA (version 13) for all statistical analyses.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

We noted a strong inverse association between per-person social protection spending and tuberculosis incidence (r=–0·65; p=0·0003) and mortality (r=–0·62; p=0·0104; figure). In the cross-national statistical models of tuberculosis outcomes, correcting for GDP and public health expenditure, we saw that each US$100 rise in total social protection spending was associated with a reduction in tuberculosis notification
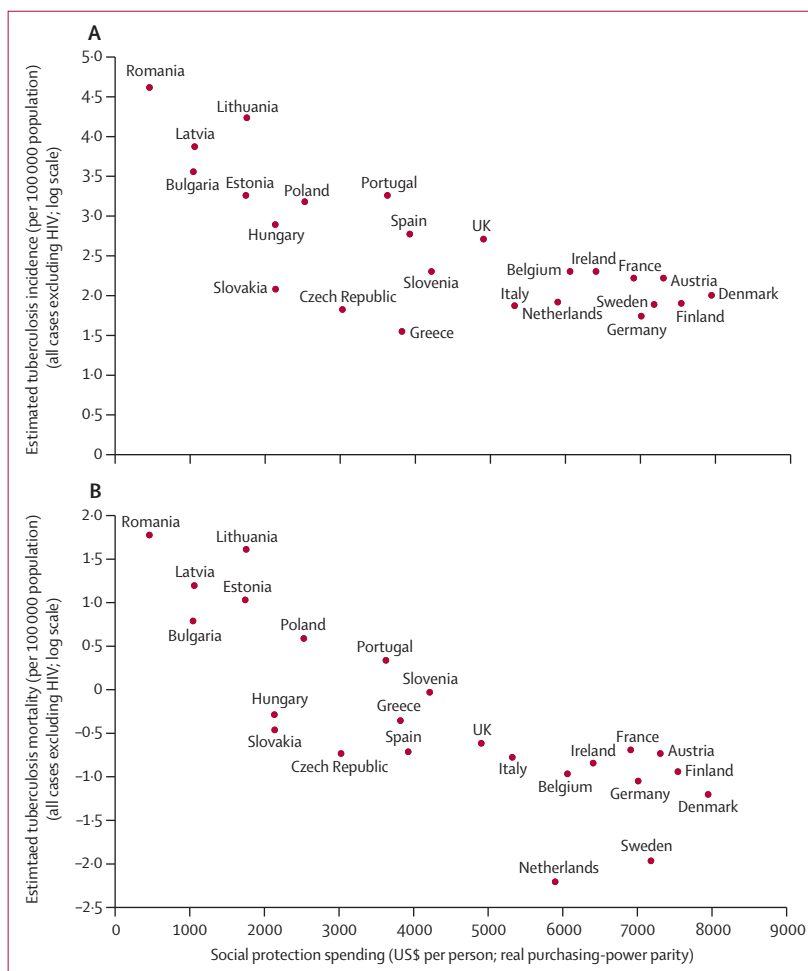

Figure: **The relation between social protection spending and tuberculosis incidence (A) and mortality (B), 2011**
Social protection spending is adjusted for inflation and purchasing-power parity.

	Case notification rate (per 100 000 population)	Incidence (per 100 000 population)	Tuberculosis prevalence (per 100 000 population)	Tuberculosis mortality, non-HIV (per 100 000 population)	Tuberculosis mortality, all causes (per 100 000 population)
US$100 increase in social protection spending	−1·53% (−0·28 to −2·79); p=0·0191	−1·70% (−0·30 to −3·11); p=0·0201	−1·50% (−3·10 to 0·10); p=0·0639	−2·74% (−0·66 to −4·82); p=0·0125	−3·08% (−0·73 to −5·43); p=0·0127
US$100 increase in gross domestic product	−0·14% (−0·47 to 0·19); p=0·3994	−0·15% (−0·47 to 0·17); p=0·3428	−0·19% (−0·55 to 0·18); p=0·2993	−0·31 (−0·74 to 0·13); p=0·1583	−0·36% (−0·77 to 0·06); p=0·0885
US$100 increase in public health spending	−22·0% (−11·5 to −32·4); p=0·0003	−29·9% (−21·2 to −38·6); p<0·0001	−29·8% (−20·4 to −39·3); p<0·0001	−15·8% (−4·13 to −27·4); p=0·0104	−22·3% (−7·69 to −37·0); p=0·0047
Number of country-years	232	305	305	305	272
Number of countries	21	21	21	21	21

Data are % (95% CI) or n, unless otherwise stated.

Table 1: Effect of increases in public spending and wealth on tuberculosis outcomes, 1995–2012

	Case notification rate (per 100 000 population)	Incidence (per 100 000 population)	Tuberculosis prevalence (per 100 000 population)	Tuberculosis mortality, non-HIV (per 100 000 population)	Tuberculosis mortality, all causes (per 100 000 population)
US$100 increase in spending on low-income families	−0·67% (−6·67 to 5·34); p=0·8198	−0·36% (−3·70 to 2·98); p=0·8225	0·074% (−3·30 to 3·44); p=0·9639	0·64% (−2·53 to 3·81); p=0·6781	−3·17% (−7·85 to 1·52); p=0·1739
US$100 increase in spending on housing	−1·16% (−33·1 to 30·8); p=0·9405	2·09% (−21·0 to 25·1); p=0·8517	3·73% (−24·4 to 31·8); p=0·7844	4·25% (−14·3 to 22·8); p=0·6380	15·1% (−4·03 to 34·3); p=0·1152
US$100 increase in spending on elderly population	−3·47% (−1·85 to −5·10); p=0·0002	−3·95% (−2·00 to −5·91); p=0·0004	−3·92% (−1·65 to −6·19); p=0·0018	−5·33% (−2·31 to −8·36); p=0·0015	−6·75% (−3·61 to −9·89); p=0·0002
US$100 increase in spending on sickness or incapacity	1·70% (−1·50 to 4·90); p=0·2809	0·24% (−4·33 to 4·82); p=0·9123	1·02% (−3·78 to 5·80); p=0·6592	−4·39% (−10·9 to 2·11); p=0·1741	−3·34% (−10·3 to 3·63); p=0·3295
US$100 increase in spending on unemployment	−1·39% (−5·17 to 2·39); p=0·4518	−0·026% (−2·60 to 2·54); p=0·9831	0·17% (−2·52 to 2·85) ; p=0·8973	0·81% (−5·11 to 6·73); p=0·7792	3·47% (−2·78 to 9·73); p=0·2604
Number of country-years	212	275	275	275	255
Number of countries	21	21	21	21	21

Data are % (95% CI) or n, unless otherwise stated.

Table 2: Effect of different forms of social protection on tuberculosis outcomes, 1995–2012

	Case notifications (in individuals aged 0–64 years)	Case notifications (in individuals aged ≥65 years)
US$100 increase in generosity of state pension	−7·26% (−16·8 to 2·32); p=0·1249	−3·87% (−0·95 to −6·78); p=0·0137
Number of country-years	131	131
Number of countries	13	13

Data are % (95% CI) or n, unless otherwise stated.

Table 3: Effect of increase in pension generosity on tuberculosis case notifications, by age, 1995–2012

rates and the estimated incidence rate, and mortality rate (both non-HIV and all causes) per 100 000 population (table 1). Greater spending was not associated with statistically significant improvements in prevalence per 100 000 population.

We saw no statistically significant interactions between increases in GDP and any of the measures of tuberculosis incidence, prevalence, or mortality, after correcting for the associations of government spending with these outcomes (table 1). Increases in expenditure on public health services was associated with reductions in all tuberculosis outcomes (table 1).[47]

When we disaggregated alternative types of social protection spending, we saw the strongest protective associations for spending on older populations, including income replacement to the elderly and cash grants to widows of deceased persons (table 2). By contrast with spending in elderly populations, none of the other forms of social protection spending had a direct effect on any tuberculosis outcomes.

To test the specificity of these findings in a post-hoc analysis, we further disaggregated tuberculosis outcomes by age, into individuals younger than 65 years and those aged 65 years or older, because old-age protection spending would be expected to be associated mainly with benefits for older persons. The estimated effect size was strongest in people aged 65 years or older (table 3). Specifically, our findings showed that greater generosity of state pensions had no effect on case notifications in people younger than 65 years, but statistically significantly reduced case notifications in people aged 65 years or older (table 3).

Finally, we tested whether social protection spending was associated with enhanced tuberculosis treatment success and case detection rates. In these models we further adjusted for case notification and the estimated prevalence, in view of the aforementioned evidence that these might mediate the association between social protection and case detection. We saw no association

between social protection spending and treatment success rates, irrespective of whether it was measured in smear-negative or extrapulmonary cases, smear-positive cases, or retreatment cases (table 4). When we repeated this analysis for case detection, we saw no significant effect of social protection on case detection rates (table 5). We further disaggregated the periods before and during the 2007–10 economic crisis, finding no clear association either before the economic crisis (p=0·1698) or during it (p=0·1066).

We did a series of checks for robustness. First, we excluded countries in which under-reporting rates changed (Bulgaria, Hungary, Latvia, Lithuania, and Romania). After doing so, none of the results changed qualitatively (appendix). Case notification data from ECDC and WHO differ slightly but correlate very highly (r=0·99). Re-estimating our models using ECDC and WHO case notification data, we saw no substantive changes (appendix). HIV incidence might confound the observed associations between tuberculosis and social protection. However, after adjusting our models for each country's HIV incidence rate in the previous year, our results did not qualitatively change (appendix). Because of potential endogeneity between social protection and tuberculosis outcomes, we use so-called Granger causality to assess which came first, tuberculosis incidence or social protection spending, using a series of time lagged statistical models. This techniques fulfils Bradford-Hill's criteria of temporality. We found that social protection spending "Granger causes" both tuberculosis case notifications and the tuberculosis mortality rate (appendix). However, neither case notifications nor tuberculosis mortality "Granger cause" social protection spending (appendix). Finally, we tested whether migration flows confound the association between social protection and tuberculosis incidence and prevalence by including EUROSTAT's measure of annual immigration rates. Our results were not substantively changed (appendix).

Discussion

Our findings show that social protection spending is strongly associated with lower tuberculosis case notification, incidence, and mortality rates. These protective associations are concentrated in older populations who are at high risk of tuberculosis re-activation in settings with a low burden of tuberculosis relative to the rest of the population.[33,48] As with any statistical modelling study, our analysis has important limitations. First, the cross-national design used aggregate-level data, creating potential for ecological fallacies. However, in the absence of standardised individual-level data across many countries, this methodological approach is, to our knowledge, the only one that could reassess the population-level relation of social protection with tuberculosis prevention and control. Additionally, our results indicate a clear benefit

	Smear-negative or extrapulmonary treatment success rate (percentage points)	Smear-positive treatment success rate (percentage points)	Retreatment cases treatment success rate (percentage points)
US$100 increase in social protection spending	–0·16 (–0·61 to 0·29); p=0·4582	0·079 (–0·18 to 0·34);p=0·5235	–0·17 (–0·80 to 0·46); p=0·5801
US$100 increase in gross domestic product	0·098 (–0·02 to 0·21); p=0·0861	–0·024 (–0·11 to 0·06); p=0·5735	0·091 (–0·02 to 0·21); p=0·1135
US$100 increase in public health spending	5·01 (–3·37 to 13·4); p=0·2244	0·18 (–3·49 to 3·85); p=0·9186	–1·00 (–9·12 to 7·12); p=0·7983
Number of country-years	111	162	158
Number of countries	18	19	19

Data are percentage points (95% CI) or n, unless otherwise stated.

Table 4: Effects increase in social protection spending on tuberculosis treatment success rates, 1995–2012

	Case detection rates (1995–2006)	Case detection (2007–12)
US$100 increase in social protection spending	–0·34 (–0·83 to 0·16); p=0·1698	–0·59 (–1·31 to 0·14); p=0·1066
US$100 increase in gross domestic product	0·058 (–0·02 to 0·14); p=0·1501	0·018 (–0·14 to 0·18); p=0·8146
US$100 increase in public health spending	0·37 (–0·93 to 1·67); p=0·5520	5·33 (–15·1 to 25·8); p=0·5921
Number of country-years	110	90
Number of countries	18	21

Data are percentage points (95% CI) or n, unless otherwise stated.

Table 5: Effect of increase in different forms of social protection spending on tuberculosis case detection, by periods before and during economic crisis, 1995–2012

for elderly recipients of social welfare in terms of improved tuberculosis outcomes. Second, comprehensive and consistent tuberculosis data are available from ECDC for countries in the European Economic Area only, which limits generalisability of our findings to other regions of the world. However, because poverty levels are higher and social protection levels are lower in low-income and middle-income countries, social protection spending might lead to even greater benefits for tuberculosis prevention and control in such countries. Third, although accounting procedures for EuroStat expenditure data vary slightly between countries, these differences are largely constant over time in our statistical models, so that the fixed-effect modelling approach can adjust for these differences by using country-specific slopes.[45] Fourth, available data for social protection systems were financial, which might not correspond to actual receipt of benefits or the effective implementation of protection programmes.

Panel 2: Research in context

Systematic review

We searched PubMed for articles published in English up to April 1, 2014, using search terms "Social protection" OR "welfare regime" OR "welfare state" OR "income replacement" AND "tuberculosis". Of the 14 papers we identified, three papers examined practices that would limit infection in high-risk occupations, such as the military and physicians. Five studies documented the risk of catastrophic health-care costs associated with tuberculosis. Four papers suggested ways that social protection might alleviate tuberculosis outcomes. Findings from two articles showed that cash transfer programmes can reduce tuberculosis risk factors but did not examine outcomes. We identified no studies that comparatively or systematically assessed the effect of alternative social protection programmes on tuberculosis outcomes.

Interpretation

The World Health Organization's post-2015 tuberculosis strategy places priority on investing in social protection programmes to prevent and control tuberculosis. Our study advances on previous work by systematically assessing the role of alternative components of social protection in the prevention and control of the disease. Using cross-national fixed effects models, we estimated that each US$100 greater spending on social protection programmes were associated with decreases in tuberculosis case notifications, estimated incidence rates, non-HIV-related tuberculosis mortality rates, and all-cause tuberculosis mortality rates. Old-age welfare expenditure had the greatest protective associations on people aged 65 years or older, which was plausible in low-tuberculosis settings where ageing populations are among the highest risk groups. These findings indicate that social protection programmes are likely to provide a vital component of a robust tuberculosis prevention strategy, especially for vulnerable groups.

Although one strength of our study is its ability to draw on variations in the resourcing and design of social protection systems across Europe, the available data for social protection expenditures do not include consistent data from all countries for housing policy, employment policy, food security mechanisms, migrant laws, and other policies related to access to care for those at high risk of tuberculosis. There is a need for future research to understand further how these specific social programmes, including who they target, how they are financed (such as conditional or unconditional forms), and their scope, affect tuberculosis risks in homeless people, migrants, prisoners, ageing populations, and other high-risk groups. This need includes research into alternative elderly welfare policies, especially because at present austerity measures, often involving pension reform, are being widely implemented throughout European countries (panel 2).[49,50] In settings with low

tuberculosis burdens such as western Europe social protection spending on elderly people seems to play important roles in reducing groups at high risk of tuberculosis. This finding is consistent with our observation that old age pension policies significantly reduced tuberculosis risks in people aged 65 years and older. In high-burden settings, where young and middle-aged people are at high risk, alternative social policies might play a more prominent part in tuberculosis prevention and control. Finally, future research is also needed to understand the interaction of social protection with case detection and treatment success outcomes, which depend on regimen design, drug availability, and the mode of detection being used. Social protection programmes might provide crucial entry points for outreach to vulnerable groups who might not otherwise be able to access directly-observed treatment programmes and other biomedical tuberculosis prevention systems.

Taken together, our results have important implications for tuberculosis prevention and control policy. The WHO's post-2015 tuberculosis strategy places emphasis on social protection programmes in efforts to prevent tuberculosis.[3] How to develop such a framework is still being debated. Overall, our findings add to the empirical evidence that investing in social protection is justified, not just because it is fair and protects the most vulnerable populations, but also because it contributes to measures to reduce the global burden of tuberculosis. These findings underscore that social protection programmes can effectively complement existing tuberculosis detection and treatment programmes by helping to reduce the prevalence of tuberculosis in vulnerable groups.[51] Structural socio-environmental approaches to tuberculosis control should not compete with biomedical responses: they should be complementary, addressing different aspects of transmission and treatment.[14] Acting on the social determinants of tuberculosis through limiting poverty, reducing homelessness, and minimising malnutrition should not negate the importance of effective disease detection and treatment programmes.[41] Our findings lend support to WHO's post-2015 efforts to develop a robust framework for addressing social determinants as a base from which to build holistic, whole-of-government tuberculosis prevention programmes.[3] Additionally, WHO's new post-2015 tuberculosis strategy also includes new targets directly related to financial protection, such as averting catastrophic costs due to tuberculosis. The provision of social protection to people through sickness and disability insurance might also help achieve financial risk protection, which is an important outcome in its own right.

Since 2003, the global incidence rate of tuberculosis has been decreasing by 1·65% a year.[52] Our results suggest that increasing social protection expenditure by $100 per capita could reduce tuberculosis incidence by

1·70%, yielding an epidemiological effect similar in magnitude. But the direction of travel in many European nations is to retrench rather than reinforce social safety nets. One extreme case is Greece where budgetary reductions in social protection programmes have corresponded to a doubling in HIV incidence.[53,54] Similar patterns in HIV were also seen in eastern Europe during periods of large reductions in social protection.[12] At a time of ongoing economic hardship and uncertainty in Europe, our findings suggest that such austerity measures might increase the prevalence of vulnerable groups and undermine tuberculosis prevention and control.[49,55]

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