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ORIGINAL PAPER

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A Cost-benefit Analysis of a Proposed Immigrant Latent Tuberculosis Infection Screening Program for Cyprus

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ABSTRACT

Introduction: The study explored the potential economic benefit of an expanded screening program of immigrants before entrance to Cyprus as a policy to reduce the overall cost of tuberculosis (TB). Thus, the aim of this study is to study whether screening all immigrants coming from countries (including European Union countries) with high incidence of tuberculosis would be in the economic interest of the Republic of Cyprus or not. **Methods:** In order to assess whether it could be economically beneficial for Cyprus to expand the screening checks for TB to all immigrants coming from high prevalence countries, a Cost-Benefit Analysis (CBA) was employed, and the Net Present Value (NPV) of the project was calculated. In order to assess for uncertainty, sensitivity analysis using different scenarios, was conducted. **Results:** The analysis has a fifteen year length of implementation period and the base year (Year 0) was 2011. The NPV was estimated at €3,188,653 which is greater than zero; therefore, the expansion of screening diagnostic tests for TB to European citizens coming from countries with high prevalence of TB will have a significant benefit to the Cypriot economy and society. This result is also supported by the fact that all “what-if scenarios” of the sensitivity analysis yielded a positive NPV. **Conclusion:** Our study concludes that testing all immigrants, including immigrants from high prevalence European countries that are not currently tested for TB, would be a cost-saving strategy to reduce the cost of treating TB in Cyprus.

Keywords: Tuberculosis, Screening, Immigration, Cost-Benefit Analysis, Cyprus

1. INTRODUCTION

Tuberculosis (TB) is a main public health problem with high mortality and morbidity. Between 19% and 43% of the world population is estimated to be infected with *Mycobacterium Tuberculosis*(1). The World Health Organization (WHO) recorded 9.6 million new TB cases, of which 1.2 million (12%) were also HIV positive, in 2014. Furthermore, 1.5 million deaths were confirmed as a consequence of the disease, including 400,000 deaths among HIV-positive patients (2). Tuberculosis new cases have resurgence due to the increase in co-morbidity with AIDS, the absence of proper treatment, the increased multi-resistant forms of tuberculosis and finally the relaxation of the disease control measures(3). A new tuberculosis infection happens every minute worldwide (4).

Tuberculosis is the second most significant cause of death from infectious diseases among adults after AIDS. It

bears a major cost for patients and their families as well as the public budgets(5). In addition to that, TB is linked with a significant impact on quality of life, on labor productivity and on the society as a whole (5). A 10% increase in the incidence of tuberculosis worldwide, will cause economic growth is to shrink by 0.2-0.4%, that is in absolute numbers a reduction of 1.4-2.8 billion USD per year(6).

A relationship has been observed between tuberculosis and migration of large population groups from countries with high incidence of the disease to low-incidence countries (3, 7, 8). The proportion of active TB cases among the native-born population attributed to transmission from foreign born patients ranges from 2% to 17% (9, 10).

Tuberculosis in Cyprus only concerns a tiny percentage of the population; consequently the disease has a minimum effect on the overall public budget. On the other hand, active TB cases have been increasing in recent years, mainly among

Assumptions	
Cost of tuberculosis 2009 (€)	€12,282
Inflation	2%
Sensitivity of Mantoux test and chest x-ray	85%
Increase of Immigration in Cyprus	1%
Immigrants from countries with high incidence of tuberculosis, 2011	7,786
Cost of Mantoux test and chest x-ray	€43
Increase of incidence of tuberculosis	7%
Discount rate	4%

Table 1 Basic Assumptions of Cost Benefit Analysis

immigrant groups. More specifically, between 1997- 2012, a total of 587 cases were reported, and 69.3% of them were immigrants. A potential outbreak of the disease would not only threaten the Public Health but also the economy (5, 6, 11). The Cyprus Government partly recognizes the possible threat of TB transmission from immigrants to the native-born population. It is compulsory for all immigrants entering the country from countries not members of the European Union to be tested for TB and other transmittable diseases (such as HIV, Hepatitis B and C and Syphilis). On the other hand, immigrants coming from any European country can apply for legal permanent residence with no such requirement. In order to ensure complete control of the disease, Cyprus Government bears the overall costs of TB for all patients diagnosed with tuberculosis (12).

Migration movement, in Cyprus, was constantly rising until the year 2011 where the maximum number of immigrants was recorded (23,037), just before the beginning of economic recession (13). According to the Population Census of 2011, the bulk of immigrants arriving for settlement in Cyprus were from European Union (EU) countries representing 55.6% of the total number. The highest number of immigrants came from Greece (38.6%), followed by Romania (26%), whereas Philippines and Sri Lanka were the countries with the highest number of immigrants outside the EU (12.9% and 11.7% respectively) (14).

The aim of this study is to assess whether screening all immigrants coming from countries (including European Union countries) with high incidence of tuberculosis would be in the economic interest of the Republic of Cyprus or not.

2. METHODS

In order to assess whether it could be an beneficial for Cyprus to expand the screening checks for TB, to all immigrants coming from high incidence countries a Cost-Benefit Analysis (CBA) was employed, and the Net Present Value (NPV) of the project was calculated. Therefore, for the Cost-Benefit Analysis that follows, the main assumption was to screen all immigrants coming from the European Union countries that have high prevalence of tuberculosis (namely Bulgaria, Romania

and Greece) and not just immigrants from third countries and in the case of positive results to deny immediate entry into the Republic of Cyprus.

Table 1 shows the assumptions for the Cost Benefit Analysis. The TB cost, as estimated for 2011, amounts to €10,282 (15). The analysis considers 2011 as the base year, therefore an assumption for the average annual inflation (for the next 15 years) of around 2%, is made based on historical data. The sensitivity of the Mantoux test and chest x-ray is 85% (16), while the mean annual increase in immigration from European countries is assumed 1%. The total number of immigrants from these countries in 2011 amount to 7,786 (13). The Mantoux test costs at market prices €23 while the chest x-ray costs €20. An increase of incidence of tuberculosis of 7% is assumed, based on the historical data of 1997 – 2011 (12). Finally, the discount rate was determined according to the Cyprus Government proposal of 4% (17).

In addition sensitivity analysis is performed. Sensitivity analysis ascertains the degree to which the results of the quantified economic analysis such as the NPV are sensitive to changes in the values of the key input parameters such as costs, incidence or length of implementation period. The NPV is recalculated on the basis of different and less optimistic values for important variables. Sensitivity analysis is always recommended when uncertainty exists (18) and the results of such analysis should always be reported and evaluated. Cost Benefit Analysis studies include a number of assumptions and estimates, thus introducing a level of uncertainty (19). Consequently, it is of great significance, a sensitivity analysis to be conducted that considers alternative values for all important cost parameters and assumptions in the study.

3. RESULTS

Based on the above assumptions a cost benefit analysis was conducted according to the methodological guidelines of the Cyprus Government (17).

Table 2 shows the base scenario for the cost benefit analysis.

Year	Incidence	Cost of TB	Cost of Mantoux test and chest x-ray	True positives not detected	Overall Cost of Tuberculosis (True positives and prescreening tests)	Benefit
1	41	€534,384	€338,145.98	7	€429,382	€105,002
2	43	€571,661	€341,527.44	7	€434,588	€137,072
3	44	€596,654	€344,942.71	7	€439,865	€156,789
4	46	€636,250	€348,392.14	7	€445,213	€191,037
5	48	€677,192	€351,876.06	8	€464,741	€212,450
6	49	€705,126	€355,394.82	8	€470,517	€234,608
7	51	€748,584	€358,948.77	8	€476,374	€272,211
8	52	€778,528	€362,538.26	8	€482,312	€296,216
9	54	€824,641	€366,163.64	9	€503,604	€321,037
10	56	€872,287	€369,825.28	9	€510,014	€362,272
11	58	€921,508	€373,523.53	9	€516,516	€404,992
12	59	€956,144	€377,258.77	9	€523,111	€433,033
13	61	€1,008,327	€381,031.35	10	€546,331	€461,996
14	63	€1,062,215	€384,841.67	10	€553,447	€508,768
15	64	€1,100,657	€388,690.08	10	€560,668	€539,989
					Net Present Value, 2011	€3,188,653

Table 2 Base scenario of Cost Benefit Analysis

		Increase/ Decrease of Incidence of Tuberculosis				
		-25%	-10%	0%	10%	25%
Increase/ Decrease of tubercu- losis costs	-25%	€771,204	€1,548,985	€2,049,289	€2,561,687	€3,339,484
	-10%	€1,133,715	€2,104,161	€2,732,907	€3,373,749	€4,344,210
	0%	€1,375,390	€2,474,278	€3,188,653	€3,915,123	€5,014,027
	10%	€1,617,064	€2,844,395	€3,644,399	€4,456,497	€5,683,844
	25%	€1,979,576	€3,399,571	€4,328,017	€5,268,559	€6,688,569

Table 3 Sensitivity Analysis of Net Present Value in different scenarios

sis. The analysis has a fifteen year length of implementation period and the base year (Year 0) was 2011. Based on a sensitivity of 85% (16) of the screening examinations the column "True positives not detected" record the patients that are expected to develop the disease although they successfully passed the diagnostic tests (false negatives). The Net Present Value was estimated at €3,188,653 which is greater than zero, so the expansion of screening diagnostic tests for tuberculosis to European citizens coming from countries with high prevalence will have a significant benefit to the Cypriot economy and society.

Sensitivity Analysis

According to the Manual for Pre-Selection and Appraisal of Public Investment Projects (17) sensitivity analysis should include different scenarios for example increase of costs by 10% or decrease in revenues by 25%, etc. An absolute necessary condition however, is the inclusion of the best and worst case scenario. Thus, a number of different "what-if" scenarios were formulated, each with different combinations of input values for key variables and/or assumptions. The above mentioned manual suggest for the best case scenario to assume a 25% increase in benefits (which translates to 25% reduction of TB incidence in our case) and a simultaneous reduction of costs of 25%. For the worst case scenario it suggests to assume simultaneous increase in costs of 25% and a decrease in benefits of 25%.

In all "what-if scenarios" of the sensitivity analysis (table 3), the Net Present Value is positive, therefore, there is a benefit to society if the provisions under consideration are implemented. In case of reduction of TB incidence by 25% and a simultaneous reduction of costs of 25% the Net Present Value is estimated at €771,204. Conversely, in case the costs increase as well as the incidence of the disease decrease by 25%, the NPV is estimated at €6,688,569.

4. DISCUSSION

To the best of our knowledge, this is the first study performed in Cyprus that attempted to evaluate the economic benefits of a TB screening program. Tuberculosis is an expensive disease to the society (20). Results of the study yield evidence that implementing a tuberculosis screening program for immigrants that are not currently tested prior to the settlement in Cyprus, would decrease the incidence of tuberculosis, thus such a program would be a cost saving and a beneficial one for the society. The results of this study not only showed that the NPV of this suggested strategy would have been positive (€3,188,653) but also all different

"what-if scenarios" had also positive NPVs. Implementing such a strategy could help towards the goal of the Cyprus Government to eliminate tuberculosis in its territory.

Movement of large population groups from countries with high TB prevalence in low TB prevalence countries has been associated with the increase of the incidence of tuberculosis in those countries (21). Consequently, in

low TB prevalence countries, the foreign-born population constitutes a large proportion of reported cases of active TB, ranging from 35–70% of all cases (21). Persons who migrate from countries with high TB prevalence, bear latent tuberculosis at the time of their migration, thus they are under an increased activation risk. As a result, they transmit the disease after a few years of their arrival in the host country. This period is estimated between 3–5 years (22). According to World Health Organization, the incidence of TB among foreign-born populations living in Europe is estimated to be 50 times higher than that of native populations with a substantial economic impact of TB in low incidence countries (23).

Positive about the screening control for TB are several studies in the literature. In a Cost-Benefit Analysis study conducted in the United States of America in 2015, it was reported that screening control of refugees from countries where TB prevalence is high, would yield a Net Present Value of \$4.9 million for a period of 20 years (24). The same study estimated an NPV of \$1.6 million for a screening program for refugees from countries where TB prevalence is moderate.

Similarly, other studies have also aimed to examine whether screening migration may contribute to reducing TB cases, with positive results. More specifically, a study conducted in Norway in 2010 showed that 88% of TB cases were detected in screening controls (25). A survey in the Netherlands showed that screening control of immigrants is economically viable (26). Finally, the United States Preventive Services Task Force recommends screening control all persons that were born in a country with high prevalence of tuberculosis (27).

As with all Cost Benefit Analysis studies, this study also has limitations. The calculations above should only be provisionally accepted. The estimated cost of tuberculosis is based on only one study that included Cyprus in their calculations. Furthermore, assumptions were made for the sensitivity of the diagnostic tests, the inflation and the increase of the incidence of TB. However, these assumptions were based either on the literature or on historical data. On the other hand, The Cost Benefit Analysis presents rough estimates and a general idea of whether testing immigrants for latent-TB would be cost beneficial for the society.

5. CONCLUSION

Our study concludes that testing all immigrants, including immigrants from high prevalence European countries

that are not currently tested for TB, would be a cost-saving strategy to reduce the cost of treating TB in Cyprus. Given the rising importance of migration in Europe, as thousands of refugees and immigrants cross the European borders for permanent residence, rigorous control measures should be decided among European countries to deal with the increasing costs of TB transmission in low prevalence countries.

• Conflict of interest: none declared.

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