Original

RESP

Is mass screening enough to control tuberculosis in Ecuador's prisons?

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ABSTRACT

Objective: To evaluate mass screening campaigns for tuberculosis in prisoners in Ecuador.
Material and method: Cross-sectional study of Chronic Cough (CC) detected amongst inmates who entered two prisons in Ecuador between January and December 2016 (n = 12,365). The time distribution of the CCs was analyzed with the uniformity test and its relationship with the diagnosed cases of PTB, the prevalence of PTB was calculated. A logistic regression model was performed to determine the factors modifiers of PTB positivity.
Results: 1.332 chronic cougher were recorded, the positivity rate was 17.3% (95% CI, 15.1-19.4), and the prevalence was 1.9% (95% CI, 1.6 - 2.1). There was an absence of uniformity in the detection and diagnosis by epidemiological weeks; there was a positive correlation between CC and PTB cases. The positivity rate was associated with the prison with the highest density (adjusted OR 3.8; 95% CI, 2.5-5.5).
Discussion: Massive screening campaigns are not enough to control tuberculosis in Ecuador's prisons. The incidence found is high. It is necessary to strengthen the diagnostic process to treat all the cases found and thus break the chain of transmission.

Keywords: mass screening; tuberculosis pulmonary; prisons; Ecuador.

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INTRODUCTION

The Roadmap for Tuberculosis Elimination in Latin America and the Caribbean places emphasis on actively searching for PTB cases by identifying chronic coughers and focusing efforts on vulnerable populations. Prison inmates are one such group[1,2].

Controlling tuberculosis in prisons is a major challenge for public health. Screening when entering prison and at regular intervals during incarceration has been shown to be the most effective way to prevent cases of TB, as this approach enables early diagnosis and timely treatment to be applied, thus interrupting the chain of infection[3,4].

In 2016, Ecuador declared that it had a prison population of 160 per 100,000 inhabitants, which places it in the middle ranking amongst South American countries[5]. It has been implementing a reform of the prison system since 2013, which includes major structural changes to some of the country's prisons. However, deficiencies in the physical infrastructure and provision of basic services still exist[6,7].

This study sets out to assess tuberculosis surveillance strategies in the form of mass screening campaigns, using official records in Ecuador, at two men's prisons with a large population density in 2016, to enable the Ministries of Health and Justice to take the necessary measures to improve diagnosis of tuberculosis when entering prison.

MATERIALS AND METHODS

A cross-sectional study was carried out. The population was made up of 1,332 male prisoners with cough and sputum for more than fifteen days, chronic coughing, detected inside the prison through screening campaigns or spontaneous demands, and officially recorded at two prisons at Guayaquil, Ecuador, in 2016.

The information was gathered from the CC and tuberculosis records (secondary sources), which are standardised instruments used by the National Tuberculosis Programme (NTP) to assess the measures taken throughout the country[8]. The data was directly recorded in a data base of the Statistical Package for Social Science (SPSS), which was purged before analysis to prevent duplication, since in the original source the subjects are included every time they are detected with CC. After the data was obtained, the number of visits and other variables for each individual were summarised.

Diagnosing tuberculosis in Ecuadorian prisons has some unique characteristics. According to national standards, the culture should be tested with the Löwenstein-Jensen medium, as well as the two sputum microscopies with the Ziehl-Neelsen stain, in combination with drug sensitivity tests involving the proportion method and polymerase chain reaction to detect anti-microbial resistance in time. Two samples of sputum were collected within the 24 hours after the medical consultation. The samples are examined outside the prison at a specialist hospital in the same city. If the result is positive, treatment and monitoring are then administered in the form of short-term therapy directly supervised by the NTP[8].

To evaluate the effectiveness of the screening strategy implemented in the prisons, the prevalence of the PTB period was calculated, along with the proportion of detected CC, the positivity ratio, the time distribution of the CCs and diagnosed cases of PTB, as well as the period of delay in diagnosis by measuring if the screening is ongoing and uniform in nature.

Definition of variables

Type of penal institution: the two prisons in this study were regional and coastal. The regional prison is a maximum security centre where the reforms mentioned above have been put into effect[6,7]. It has a module exclusively for inmates with PTB. The total population in 2016 was 4.170[9]. The coastal prison, where changes are still in the process of implementation, had a total inmate population of 8,195 in the same year[9].

The inmates of the regional prison serve prison sentences, while the prisoners at the coastal prison are in custody or serving final sentence.

The values that were considered were as follows:

- Age: defined as years.
- CC: persons who present cough and sputum for more than 15 days[8].
- PTB case: person with a positive result in at least one ZN diagnostic microscopy.
- Result of the diagnostic microscopies: could be negative or positive. This variable was used to prepare the CC positivity ratio, defined as the coefficient of the number of cases of PTB divided by the CCs that were identified.
- Number of visits in which sputum samples were taken for microscopy: this was quantified from the first time that the prisoner was detected as a CC. This variable was re-codified into two categories: first visit and two or more visits.
- Epidemiological week: moment from when the CC was identified and the sputum sample was taken, in weekly periods.
- CC detection time: calculated from the date of identification of the CC to the date the samples are taken.
- Diagnosis time: calculated from the data when the samples are taken to when the microscopy results are received. When more than one medical consultation is recorded, the analysed result was the last diagnostic test.

Both the detection time and diagnosis time are presented in days, and each one was re-codified from the mean for the analysis.

The prison population reported by the Ministry of Justice[9] was used as the denominator to calculate the prevalence (number of PTB cases) and the proportion of detected CCs. The positivity ratio of PTB was calculated in percentages (cases of PTB/CC). The continuous variables were expressed as mean and standard deviation, with the exception of diagnosis and treatment times, which were described with the mean and interquartile range.

The epidemiological weeks were used to analyse the distribution of the CCs and cases of PTB, and the Kolmogorov-Smirnov (Zk-s) test was also used. The ratio between the frequency of CC and PTB cases was established with the Pearson correlation coefficient (r). The chi-square test (χ^2) was used to contrast the positivity ratio hypothesis with the study variable. A value of $p < 0.05$ was considered statistically significant in both contrasts. The strength of association was presented with the prevalence ratio, with a respective CI of 95%.

The variables used for the logistic regression were: age, the prison, the diagnosis time and number of medical consultations, and the response variable was a PTB case. a logistic regression model was carried out, the results of which are presented with adjusted ORs with their respective CIs of 95%. All the analyses were completed with the SPSS statistical package, version 24.0 (IBM SPSS).

RESULTS

1,332 CCs were found in 2016. The mean age was 31 years (standard deviation: 10), range 18-78. 58.3% were under 30 years of age (771/1,323). The CCs at the regional prison were 592 (44.2%) and 294 were under 30 years of age (50.1%); while 740 CCs were detected at the coastal prison (55.8%) of whom 477 were under 30 years of age (64.8%). The age difference showed a value of $\chi^2 = 29.1$; $p < 0.001$.

88.9% of the prisoners (1,180/1,332) showed only one visit; 9.2% (122/1,332) showed two, while 2.3% (30/1,332) had three or more visits, up to a a maximum of six. The regional prison showed 51 (8.6%) with more than one visit, up to a maximum of four; while the results of the coastal prison showed that 101 (13.6%) had more than one visit up to a maximum of six. At least one sputum sample was obtained in each visit.

The CC detection time showed a range of 0-4 (mean of 0 days), and the quartiles 1 and 3 were both 0 days. The diagnosis time had a range of 0-342 (mean of 6 days), while quartiles 1 and 2 were 4 and 8 days respectively.

Both prisons registered 231 cases of PTB diagnosed with microscopy in 2016, of which 194 had positive microscopy and the culture was carried out on only eight that presented BK+++. The global positivity ratio was 17.3%, with the regional prison showing a ratio of 7.6% and the coastal prison 25.2%.

As regards the global score of the officially declared prison population, the CC detection rate was 10.8%, the prevalence of PTB cases at both centres was 1.9% and the cases of multidrug-resistant tuberculosis were 6.1% (Table 1).

Analysis of the CC and PTB detection frequency distribution in the year showed no uniformity in relation to the epidemiological weeks: Zk-s = 2.8, $p < 0.001$ and Zk-s = 3.1, $p < 0.001$, respectively. The weeks in which most CCs were detected were: week 27 (81), 25 (79) and 34 (58); while the ones when most PTB cases were diagnosed were: week 7 (17), 1 and 25 (14 in each week). Analysis of the correlation between the number of identified CCs and cases of PTB showed a positive relation ($r = 0.716$), $p < 0.001$.

Table 2 shows the positivity ratio according to the prison, the diagnosis time and number of visits. As regards the prison, there was a 3.3 times greater probability of finding a case of PTB in the coastal prison than in the regional centre. When the diagnosis time was six days or more, there was a positivity ratio of 19.7%, significantly different from the ones where the diagnosis time was less (14.6%).

A similar state of affairs was observed amongst inmates that had two or more visits. The proportion of positive CCs was 25.7%, significantly different from those with fewer visits. The OR was 1.6.

While the variables for age, prison, diagnosis time and number of visits showed a significant association with cases of tuberculosis, the age, diagnosis time and number of visits showed no significance when they were adjusted with the multivariate analysis (Table 3).

DISCUSSION

Screening campaigns to diagnose tuberculosis are not enough to control tuberculosis in Ecuadorian prisons.

The prevalence rate of PTB in the two prisons, based on the official figures for the prison population, was 1,870/100,000 inmates, 57.5 times greater than the official figures for the population of Ecuador (32.5/100,000 inhabitants) in the same year. However, the official figure includes men and women[10], in accordance with the findings in systematic review articles, which reported a prevalence of tuberculosis between 3 and 1,000 times greater amongst prisoners than in the community[11].

The prevalence varies according to the country: a prevalence was found amongst prisoners in Río Grande (Brazil) that was 69 times higher than in the community[12], while prevalence in Ugandan prisons was found to be five times higher than amongst the general public[13]. Both studies included an analysis of tuberculosis/HIV co-infection, which was not considered in this study as information of this type is not included in the "CC book".

The positivity ratio of PTB was 17.3% in the prisons that were studied. The calculated data for male prisoners was reported as follows: 32.4% in Brazil[14], 17.0% in Iran[15,16] and 3.5% in South Africa[17]. Similar values were found in countries that included prisoners of both genders: Malaysia 17.4%[18], Thailand 12.0%[18], Ivory Coast 4.2%[19] and Ethiopia 8.6%[20,21].

This article found that PTB is more common amongst young inmates, and similar results have

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Table 1. Prevalence rates of respiratory symptoms and cases of pulmonary tuberculosis.

Prison	Prison population*	Variable	Cases (n)	Prevalence % (CI 95%)
Regional	4,170			
		CC	592	14.2 (13.1-15.3)
		PTB	45	1.1 (0.8-1.4)
		MDR-TB	12	26.7 (13.7-39.6)
Coastal	8,195			
		CC	740	9.0 (8.4-9.7)
		PTB	186	2.3 (2.0-2.6)
		MDR-TB	2	1.1% (0.4-2.6)
Total	12,365			
		CC	1.332	10.8 (10.2-11.3)
		PTB	231	1.9 (1.6-2.1)
		MDR-TB	14	6.1 (3.0-9.1)

Note. *The prison population officially declared by the Ecuadorian Ministry of Justice in its monthly report of inmates in January 2018 was used to determine the rates.

CI: confidence interval; CC: chronic cough; MDR-TB: multidrug-resistant tuberculosis; PTB: pulmonary tuberculosis.

Table 2. Positivity ration of pulmonary tuberculosis according to the analysed variables.

	CC (N)	Positivity ratio (%)	CI 95%	RP*	CI 95%
Prison					
Regional	592	7.6	5.6-9.7		
Coastal	737	25.2	22.0-28.4	3.3	2.4-5.0
Time of diagnosis					
Less than six days§	595	14.6	11.8-17.5		
Six or more days	635	19.7	16.6-22.8	1.4	1.1-1.7
Number of visits					
One§	1.181	16.3	14.2-18.4		
Two or more	148	25.7	18.6-32.7	1.6	1.2-2.1

Note. *Ratio of prevalence and §benchmark categories.
CI: confidence interval; RP: ratio of prevalence; CC: chronic cough.

Table 3. Factors associated with PTB amongst Ecuadorian prisoners in 2016.

Variable	N	Positive PTB	Negative PTB	Crude OR* (CI 95%)	Adjusted OR* (CI 95%)
Age (years)	769	-		-	1.0 (0.9-1.0)
Coastal prison	737	186 (25.2)	551 (74.8)	4.10 (2.9-5.8)	3.8 (2.5-5.5)
Diagnosis time of more than six days	635	125 (19.7)	510 (80.3)	1.43 (1.1-1.9)	1.1 (0.8-1.6)
Two or more visits	148	38 (25.7)	110 (74.3)	1.8 (1.2-2.8)	1.5 (0.9-2.3)

Note. *Benchmark categories: regional prison; diagnosis time of less than six days, number of medical consultations.
CI: confidence interval; OR: odds ratio; PTB: pulmonary tuberculosis.

come to light in prison studies in Brazil, Ethiopia and Spain[12,22,23]. The largest number of inmates held in custody or serving a short sentence for a minor crime are also generally young men[24].

Incarceration in the coastal prison is associated with a higher risk of PTB. The prison is characterised by greater overcrowding, with young prisoners awaiting sentencing, most of whom are in custody for minor offences, and where the penal reforms had not yet been implemented in the year of the study[7]. Although we have no data about the length of imprisonment, there are grounds to believe that prisoners serving shorter sentences are sent to this prison. A study of prisons in Ethiopia[25] and another in South Africa[17] found no association between the length of imprisonment and the likelihood of presenting PTB, although more cases were found amongst inmates incarcerated for less than two years in Ethiopia and for less than three in South Africa.

The lack of uniformity in detecting cases of CC and PTB over the period measured in epidemiological weeks was not found in other studies available in indexed journals or grey literature. This information means we can assume that most of the CCs are detected in the screening campaigns carried out approximately every three months, coinciding with the quarterly evaluation reports and never at the moment the inmates enter prison, when there would be an increase of CCs between week 1 and 22, which is the rainy season on the Ecuadorian coast. We can also infer from this that the diagnosis does not include the culture and therefore the drug sensitivity test. This is because only the samples of BK+++ were cultivated, which does not meet the recommendations of national and international regulatory bodies[8,26].

The PTB diagnosis time was 4-8 days for 75% of the CCs that were detected and more than six days in 20% of the PTB cases. This possible delay in diagnosis is attributed to: not having a nearby laboratory available, not carrying out an X-ray test, and not having enough staff and time to carry out exhaustive interviews with suspected cases and so comply with international recommendations[26-29].

Some researchers[27] have found that inmates generally have limited access to medical care because of the stigmas and changes in medical care patterns for populations of this type. At the same time, it has also been acknowledged that there are more opportunities to take effective control measures amongst prison inmates, given that they are captive populations.

Such measures would be:

1. Regular and standardised medical evaluations for early CC detection when entering prison.
2. Including the culture and drug sensitivity tests in the PTB diagnosis.
3. Isolating positive cases.
4. Provision of directly supervised standardised treatment.
5. Coordination with external control programmes.
6. Methadone maintenance programmes for heroin addicts[28].

It has been shown that such measures are the most effective way to prevent TB cases, since they enable early diagnosis and timely treatment of the disease, and so reduce incidence[3,4].

This study has the following limitations. The information collected was cleaned, given that the data is collected per visit and not per case. It is impossible to determine with any precision if the first consultation coincides with the inmate's entry into prison, and the cultures to diagnose tuberculosis have not been made in line with national regulations.

These situations raise the following questions: did the prisoners enter with latent tuberculosis and later develop PTB inside prison? Were they entering the prisons with active PTB? Or did they fall ill inside prison? Whatever the answers may be, the determining factors that play a part in the circulation of *Mycobacterium tuberculosis* should be major considerations for future studies.

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