Impact of x-ray screening programmes for active tuberculosis in homeless populations: a systematic review of original studies

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ABSTRACT

Background Tuberculosis prevalence is generally low in industrialized countries, but many cities now operate surveillance programmes to actively screen for tuberculosis in known risk groups including homeless people. While several studies have reported on individual screening programmes, this study is the first known systematic review specifically looking at chest x-ray screening programmes for tuberculosis in homeless populations.

Methods Systematic review of relevant studies published in the last 20 years using the PRISMA checklist.

Results Fourteen studies were reviewed: 12 cross-sectional studies, 1 retrospective cohort study and 1 ‘data-linkage’ study. The studies were heterogenous in terms of the objectives, measured outcomes and methodological quality. Active tuberculosis prevalence was found to be higher in homeless populations and screening programmes appear to identify tuberculosis earlier, reduce prevalence and transmission, and increase treatment compliance.

Conclusions Active x-ray surveillance programmes in homeless communities appear to be cost-effective in reducing prevalence within the homeless population particularly in related strains and may have some benefits over passive finding. While there is a need for high-quality research to further assess the impact of these programmes, this study has outlined the benefits and limitations of existing programmes and included recommendations to achieve maximum coverage, uptake and cost–benefit.

Keywords communicable diseases, management and policy

Introduction

Tuberculosis (TB) prevalence is generally low in industrialized countries, but higher rates are known in certain risk groups including substance misusers, prisoners and, particularly, homeless people.1–6

Homeless populations are also known to have high rates of known risk factors for both acquiring latent tuberculosis infection (LTBI) and progressing to infectious active tuberculosis including smoking, drug/alcohol abuse, HIV infection and malnutrition.1,3,7 Shared accommodation increases the risk of transmission once infected,1,7 while fear or lack of access to health services means, they are more likely to present later. For the same reasons, they may also show less adherence to treatment regimes, leading to the development of drug-resistant strains.8

For these reasons, many cities now operate surveillance programmes to actively screen for tuberculosis at locations where homeless people congregate before individuals become infectious. This involves deliberate screening for either latent TB using tuberculin skin tests (TST) or active TB via symptom assessment and/or chest x-rays (CXRs). This differs from passive detection where infected individuals normally present once symptomatic.

In March 2012, the National Institute for Health and Clinical Excellence (NICE) published guidance on identifying tuberculosis among hard to reach groups including homeless
populations. This report contained recommendations on reducing tuberculosis prevalence including ‘in areas of identified need, commissioners should ensure there is a programme of active case finding using mobile digital radiography in places where homeless people congregate’.

Since then, several papers have expanded upon this issue and provided evidence supporting the recommendation. While one systematic review looked more generally at the issue of active case finding in high-risk subpopulations, there has been no systematic review specifically addressing the impact of active case finding using CXRs. The purpose of this review is therefore to appraise original studies reporting on x-ray screening programmes for tuberculosis in homeless populations. The study aims to aid healthcare professionals who are considering implementing surveillance programmes by appraising the literature to date and identifying any knowledge gaps.

Methods
For a detailed description of the methodology, see Supplementary data, Appendix S1.

Protocol and information sources
The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) checklist was used to report this review. A Boolean-based search criteria were used to search the ASSIA, CINAHL, Cochrane Library, Medline, Scopus and Web of Science databases for articles published between 1992 and January 2014. This time period was chosen to reflect current research while retrieving sufficient results. NHS Evidence and NICE Public Health Guidance were also searched manually for relevant literature, and citation lists of the included studies were searched to identify any additional relevant studies.

Study selection, data collection and bias
Retrieved studies were filtered on title and abstract, and full-text studies were further evaluated against specific inclusion/exclusion criteria. Where there was any doubt, the study was accepted to the next level. Only studies equal to or above OCEBM Level 4 evidence that reported on relevant objective measures of CXR TB screening programmes primarily in relevant homeless populations were included.

Objective data were extracted from the studies and summarized into tables. As most studies were cross-sectional studies, no existing quality assessment tool was found to be suitable. Instead, study quality was assessed using an eight-point score system adapted from CASP checklists and other guidance.

Risk of selection and publication bias were evaluated at study level, and no meta-analysis was performed due to the heterogeneity of the collected data.

Results
For more information on results including the summary tables of extracted data, see Table 1 and Supplementary data, Appendix S2.

Study selection and study characteristics
The review retrieved 797 individual studies that were filtered by language, title, OECD country and abstract leaving 24 studies. Ten studies were excluded at full text for not reporting required objective data, leaving 14 studies included in this review. Figure 1 shows the selection process. The studies comprised 12 cross-sectional studies, 1 retrospective cohort study and 1 ‘data-linkage study’. Two of the cross-sectional studies included a case–control study to compare passive finding rates and LTBI prevalence. While all reported on similar programmes, the main objectives were varied and the reported outcomes varied considerably. Quality assessment scores ranged from 3 to 7 out of 8 and are detailed in Supplementary data, Tables S1 and S2.

Approximately 60 000 individuals (min = 221; max = 38 717) were screened across the studies, although duplication between studies was not accounted for and one study did not report the number of individuals. The population was well described as users of homeless shelters and was representative of UK homeless populations in most studies. The studies either selected a group consisting solely of homeless persons or separated data from other known risk groups. They also included data on known preventative/risk factors including gender, age, substance misuse and immigration status. However, three studies, although primarily screened homeless groups did not separate their data from other at-risk groups, e.g. substance misusers and asylum seekers who may not have been homeless. These studies were still included as the findings are likely to be relevant to this review.

There was no evidence of assessor (radiography/respiratory specialist) blinding in any study meaning measurement bias cannot be excluded. Two studies had insufficient sample size to associate TB incidence with any measured population characteristic, although five further studies did not include any statistical analysis and simply measured TB incidence.

Findings
Study population
Six studies included homeless population estimates allowing coverage to be calculated which ranged between 1 and 72%.
<table>
<thead>
<tr>
<th>Name</th>
<th>Study location</th>
<th>Study duration</th>
<th>Sample definition</th>
<th>Sample population size</th>
<th>Number of CXRs</th>
<th>Estimated homeless population</th>
<th>Uptake (%)</th>
<th>Coverage (%)</th>
<th>Background homeless LTBI incidence</th>
<th>Known prevalence rate in the homeless (per 100 000)</th>
<th>Background population prevalence rate (per 100 000)</th>
<th>No. of active cases</th>
<th>Active case finding rate (%)</th>
<th>Active case finding rate per annum (%)</th>
<th>Active case finding rate per annum (per 100 000)</th>
<th>Before and after prevalence found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badiaga et al.</td>
<td>Marseilles, France</td>
<td>2 days</td>
<td>Users of two homeless shelters. Regular and occasional users of 28 shelters with large numbers of beds (4–5000) or in which TB had been previously identified.</td>
<td>221 221</td>
<td>1500</td>
<td>41 15</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>0.905</td>
<td>0.905</td>
<td>905</td>
<td>—</td>
<td>—</td>
<td>Total cases dropped during the course of the study (20 per year to 8 per year) and while proportion of related cases dropped from 75 to 30%.</td>
</tr>
<tr>
<td>Bernard et al.</td>
<td>Paris, France</td>
<td>14 years</td>
<td>Regular and occasional users of 28 shelters with large numbers of beds (4–5000) or in which TB had been previously identified.</td>
<td>- 22 000</td>
<td>25 000</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>223</td>
<td>28</td>
<td>313</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>de Vries et al.</td>
<td>Rotterdam, Netherlands</td>
<td>Unclear</td>
<td>Residents of various homeless shelters. A person who frequently used day-care, night-care, residential or other facilities for homeless persons.</td>
<td>507</td>
<td>1100</td>
<td>46 29%</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>6</td>
<td>1.183</td>
<td>1.183</td>
<td>1183</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>de Vries et al.</td>
<td>Rotterdam, Netherlands</td>
<td>3 years 8 months</td>
<td>Those appeared in the public health department and declared that they had stayed overnight for &gt;2 days in a homeless shelter.</td>
<td>3248</td>
<td>8559</td>
<td>4500</td>
<td>72</td>
<td>—</td>
<td>511</td>
<td>9</td>
<td>28</td>
<td>0.862</td>
<td>0.236</td>
<td>236</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Goetsch et al.</td>
<td>Frankfurt, Germany</td>
<td>5 years</td>
<td>Those appeared in the public health department and declared that they had stayed overnight for &gt;2 days in a homeless shelter.</td>
<td>2308</td>
<td>2814</td>
<td>8000</td>
<td>29</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>25</td>
<td>1.083</td>
<td>0.217</td>
<td>217</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Study</td>
<td>Location</td>
<td>Duration</td>
<td>Study Participants</td>
<td>Screening Method</td>
<td>Number of Cases Found</td>
<td>Number of Contacts Screened</td>
<td>Prevalence</td>
<td>Abnormal X-rays</td>
<td>TB Symptomatics</td>
<td>Adherence to Screening</td>
<td>Comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kumar et al.</td>
<td>London, UK</td>
<td>4 weeks</td>
<td>Visitors of temporary homeless shelter either reporting TB symptoms or who completed a questionnaire.</td>
<td>595</td>
<td>595</td>
<td>45,000</td>
<td>14–25</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>9</td>
<td>1.513</td>
<td>1.513</td>
<td>1513</td>
<td>–</td>
</tr>
<tr>
<td>Lau et al.</td>
<td>Sydney, Australia</td>
<td>5 years</td>
<td>Residents and staff at 5 major hospitals for homeless men.</td>
<td>3555</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2</td>
<td>0.056</td>
<td>0.011</td>
<td>11</td>
<td>–</td>
</tr>
<tr>
<td>Laurenti et al.</td>
<td>Rome, Italy</td>
<td>1 year</td>
<td>Volunteers from two homeless shelters in Rome.</td>
<td>259</td>
<td>46</td>
<td>23,000</td>
<td>39</td>
<td>1</td>
<td>0.456</td>
<td>–</td>
<td>16.6</td>
<td>1</td>
<td>0.386</td>
<td>0.386</td>
<td>386</td>
<td>–</td>
</tr>
<tr>
<td>Lee et al.</td>
<td>Seoul, South Korea</td>
<td>6 months</td>
<td>Users of five homeless shelters in Seoul that were over 20 years old and had provided written consent.</td>
<td>313</td>
<td>313</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>33%</td>
<td>–</td>
<td>115</td>
<td>18</td>
<td>5.751</td>
<td>11.502</td>
<td>11,502</td>
<td>–</td>
</tr>
<tr>
<td>Schlager et al.</td>
<td>New York, USA</td>
<td>3 years</td>
<td>Users of community-based social service organizations including housing assistance and drug and alcohol programmes.</td>
<td>3828</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.33</td>
<td>–</td>
<td>50.4</td>
<td>20</td>
<td>0.522</td>
<td>0.174</td>
<td>174</td>
</tr>
<tr>
<td>Solsona et al.</td>
<td>Barcelona, Spain</td>
<td>2 years</td>
<td>Non-voluntary 447 subjects as a pre-requisite before admission to homeless shelters and soup kitchens.</td>
<td>495</td>
<td>495</td>
<td>–</td>
<td>1</td>
<td>–</td>
<td>75%</td>
<td>–</td>
<td>38.4</td>
<td>5</td>
<td>1.010</td>
<td>0.505</td>
<td>505</td>
<td>–</td>
</tr>
<tr>
<td>Southern et al.</td>
<td>London, UK</td>
<td>2 years</td>
<td>Users of hostels, night shelters and day shelters for homeless and refugees.</td>
<td>1905</td>
<td>1905</td>
<td>–</td>
<td>40–90</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>10</td>
<td>0.525</td>
<td>0.262</td>
<td>262</td>
<td>–</td>
</tr>
</tbody>
</table>

Continued
### Table 1

<table>
<thead>
<tr>
<th>Name</th>
<th>Study location</th>
<th>Study duration</th>
<th>Sample size</th>
<th>Number of CXRs</th>
<th>Estimated homeless population</th>
<th>Uptake (%)</th>
<th>Coverage (%)</th>
<th>Background homeless LTBI incidence</th>
<th>Known prevalence rate in the homeless (per 100,000)</th>
<th>Background population prevalence rate (per 100,000)</th>
<th>No. of active cases</th>
<th>Active case finding rate (%)</th>
<th>Active case finding rate per annum (per 100,000)</th>
<th>Before and after prevalence</th>
<th>Passive cases found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Story et al.</td>
<td>London, UK, 5 years</td>
<td>Individuals who were screened at sites for homeless persons, including hostels and day centres.</td>
<td>38,717</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>27</td>
<td>0.070</td>
<td>0.014</td>
<td>14</td>
<td>–</td>
<td>Odds of smear-positive disease were lower than passively identified cases from the same population (OR 0.37, CI 0.15–0.9).</td>
<td></td>
</tr>
<tr>
<td>Watson et al.</td>
<td>London, UK, 1 year 9 months</td>
<td>Homeless.</td>
<td>5024</td>
<td>6067</td>
<td>30–90</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>17</td>
<td>0.338</td>
<td>0.193</td>
<td>193</td>
<td>–</td>
<td>Passive controls, had almost three times the delay observed. Active cases less likely to be smear positive 44 compared with 66% (OR 0.35 (0.15–0.81)).</td>
<td></td>
</tr>
</tbody>
</table>
The range is not surprising as coverage is affected by programme duration, incentive use, promotion and perception. Studies with the lowest coverage were either small or short programmes based within large homeless populations or did not use incentives or did not promote screening in advance. The role of homeless staff was also found to be critical in building trust and encouraging uptake (Table 1 and Supplementary data, Tables S2–S3).

Six studies reported uptake rate that ranged from 14 to 100%. Mandatory programmes or those using incentives witnessed the highest uptake rates. Similarly, the study that reported the lowest uptake was a short-term study that used no incentives.

Programme design

Eleven studies reported using sputum smears and/or cultures to confirm diagnosis of active TB. One study used physical examination and symptom history while another used interpretation of chest radiographs. The data-linkage study used a record on the tuberculosis surveillance database as a positive result (Table 1 and Supplementary data, Tables S2–S4).

The majority of programmes immediately provided CXR screening results, although one programme involved a 48-h delay which is known to reduce treatment compliance. Conversely, another study only offered CXR following a positive TST result that takes 72 h and may deter individuals and reduce uptake and coverage.

Measured outcomes

Active case finding rate. Active case prevalence (detection rate) ranged between 0.011 and 11.502% (11–11,502 cases per 100,000), although the two studies with the lowest rates either reported or had the potential for high dropout rates between CXR screening and final diagnosis. The remaining 11 studies all reported case prevalences of between 174 and 1,513 cases per 100,000 per annum (Table 1 and Supplementary data, Tables S2–S5).

Comparison with background prevalence. Active case detection rate is likely to be linked to active and latent TB prevalence in homeless communities and active TB prevalence within non-homeless communities. These were reported in 2, 4 and 6 studies, respectively, although no correlation was found with higher TB prevalence in the homeless. It was noted however that the study that had the highest active case detection rate occurred in a country with a high active prevalence rate in the general population.

Pre- and post-surveillance active case prevalence. Three studies reported a drop of at least 50% in active prevalence over the course of the screening programmes. In one study, this reflected the trend in non-homeless communities. However, in two it occurred in the absence of or prior to decreasing prevalence in non-homeless communities, suggesting that active TB prevalence in homeless communities decreased faster than background prevalence.

Comparison with passive case finding rate. Two studies reported passive case finding rates that occurred simultaneously to surveillance programmes. In both, substantially more cases were found passively than actively. This suggests that active case finding programmes are significantly less cost-effective although Story et al. found that cases identified through active x-ray screening were less likely to be smear-positive and therefore more likely to be identified earlier prior to infectious stages.

Watson et al. compared actively detected and passively detected cases and found that actively detected cases took almost a third of the time to be diagnosed, were less likely to be smear positive (44 compared with 66%; OR 0.35) or show other measures of disease severity. They were also more likely to commence Direct Observed Therapy (DOT) (82 versus 25%).

Treatment compliance. Seven studies reported on treatment compliance following diagnosis, and this ranged from 56 to 100%. Four of these compared results with compliance outside of screening and all found that this was lower, although observed treatment programmes are less commonly
used in non-homeless populations. Details of treatment programmes, e.g. DOT, were generally not given, although it was noticed that the study with the lowest compliance did not have a community TB or homeless nurse which is known to increase compliance. The other studies all reported compliance rates above 75% without enforced isolation.

Genotyping. Three studies reported on the success of genotyping in identifying related TB clusters indicating transmission. Two of these studies found a significant drop in the proportion of related strains (75 to 30% and 82 to 45%) during the screening programme reportedly because of the success of screening in reducing transmission. The third study reported clustering rates of 66%, further suggesting that the majority of cases are linked either by a single point source or from multiple sources sustaining an outbreak.

Contact tracing. No studies reported contact tracing following screening, although it is not clear whether none took place. Traditional contact tracing methods may not be suitable in homeless populations as contacts may not be known by name, willing to be identified or wish to meet with authorities.

Cost. Only one study reported cost data and determined that mobile screening:

- Costs £2180 to prevent one case of active TB.
- Assuming TB treatment costs of £5000, the estimated cost per QALY is £3206 (NICE threshold = £20 000–30 000).
- Becomes more cost-effective with increased targeting of at-risk groups, coverage and uptake and decreased loss to follow-up.

No benefit of preventing future TB infections was included in the cost-effectiveness analysis.

Discussion

Main findings

Homeless populations are difficult to assess, and there is a shortage of high-quality relevant studies. Although the literature search retrieved studies on active surveillance programmes for tuberculosis, methods, objectives and reported outcomes were highly varied and only 13 were considered relevant. The heterogeneity of the studies makes it difficult to produce clear comparisons and make an overarching assessment of their impact.

Importance of programme design

One clear challenge in surveillance programmes is defining homelessness which can include those accommodated on the streets, in hostels, with friends or by local authorities. This influences both the target population size and strategies to maximize coverage, although it is suggested that surveillance programmes can be used to estimate homeless populations.

The majority of studies reviewed targeted shelters/hostels, although it is likely that the proportion and demographics of those screened would vary with the timing of the screening. Coverage can be maximized by screening at specific dates and times, although only three studies reported using this strategy.

Very few studies reported on known confounding protective/risk factors for tuberculosis including age, gender, immigration, substance misuse, incarceration, BCG and HIV status. Because of the small active case prevalence, it was not possible to stratify prevalence by these confounding factors. Practically, it may also prove difficult collecting this sensitive data from individuals and may detrimentally affect trust in surveillance programmes.

The importance of trust was mentioned in several studies as homeless individuals may have poor access or mistrust of healthcare services. This led to uptake rates increasing over the course of surveillance programmes or with advanced promotion by motivated staff. Staff who regularly work with the homeless are critical in building trust, raising awareness, contact tracing, monitoring compliance and symptom screening. Other factors that were shown to increase uptake and compliance included using incentives (food vouchers, priority accommodation) and minimizing the time between screening and result before proceeding to the next stage. This was also found to be the case where it is legally mandatory for users of homeless shelters to be screened for TB.

Story et al. found that mobile digital CXR, used in screening homeless populations, has a very high specificity and NPV (99.2 and 100%), but a comparably low sensitivity and PPV (81.8 and 6.5%). Therefore, although it is excellent in ruling out tuberculosis, a clear diagnostic test is required to confirm active pulmonary tuberculosis. This is typically an immediate sputum smear acid-fast bacillus (AFB) test or fluorescent microscopy, later confirmed with sputum cultures. As many programmes reported loss to follow-up before diagnosis, time between tests should be minimized. Radiographs should be interpreted immediately, and positive screens should be asked to provide sputum samples for diagnosis. This was found to improve uptake as well as retention.

Impact on TB prevalence

Prevalence varied from 11 to 11 502 cases per 100 000, although 11 of the studies reported prevalence between 174 and 1513 cases per 100 000 which is substantially higher than any background prevalence confirming homeless populations are a high-risk group. The wide range in prevalence also
shows the importance of targeting active case finding programmes at appropriate subpopulations. This was also found by Zenner et al., who recommended that active case finding programmes should be informed by a prior needs assessment and robust surveillance.

Interestingly, it was noted that other than the country with the highest background prevalence, there was no correlation with either LTBI prevalence or background active TB prevalence in the wider community, although this is most likely due to few studies including this data. It may prove beneficial to screen for LTBI, although this requires review as there is often low compliance with prophylactic treatment, and active TB cases can return negative TST results. It was not possible from this review to determine the background prevalence when screening of homeless communities becomes cost-effective.

All three studies that monitored prevalence over the course of the programme reported a decline of at least 50% and this occurred either simultaneously, before or in the absence of a matching decline in the wider community. Findings from these studies suggest that efforts to reduce prevalence/transmission in the homeless population may extend into the background population, although causality cannot be proven. Genotyping in three studies also indicated that active screening reduced the proportion of related strains prevalent in a population indicating that, in homeless populations, many cases are related and transmission rates are high. The studies also proved the value of genotyping in monitoring outbreaks and surveillance effectiveness.

Two studies found that passively detected cases greatly outnumbered actively detected cases in the same period. While active programmes may be less cost-effective, they target a group that may not present to health services, have high transmission risk and identifies tuberculosis at an earlier stage. Screening programmes also report higher treatment compliance, and this is largely attributed to an ongoing role of TB and homeless staff beyond screening.

One study that reported on costs found that active screening was cost-effective, and all but one study reported beneficial outcomes from the programmes. Lau et al. found that the programme was of limited value given the poor sensitivity/specificity of diagnosis and poor compliance to follow-up, although it is likely that these would have been improved with better programme design.

What is already known on this topic

TB prevalence is generally low in industrialized countries, but higher rates are known in certain risk groups including homeless people. Consequently, many cities now operate surveillance programmes to actively screen for tuberculosis at locations where homeless people congregate before individuals become infectious. Several studies have reported on individual CXR screening programmes, and one systematic review has previously looked more generally at the issue of active case finding in high-risk subpopulations.

What this study adds

This study is the first known systematic review specifically looking at CXR screening programmes for tuberculosis in homeless populations. It has outlined the benefits and limitations of existing programmes and included recommendations for future screening programmes to achieve maximum coverage, uptake and cost–benefit.

Limitations

Exclusion criteria rejected studies that did not primarily screen homeless groups. Therefore, studies that targeted other hard-to-reach groups, e.g. substance abusers and asylum seekers, were not included in this review. However, these groups may often use facilities for homeless persons, and it is likely that findings from these studies may still be relevant.

This review would also benefit from higher quality evidence. Large-scale cohort or case–control studies comparing active versus passive or pre- and post screening groups would provide important information. A randomized controlled trial would not be suitable as individual randomization would reduce coverage and deny access while cluster randomization could ignore differences between homeless communities.

Conclusion

This review of 14 studies documenting active surveillance programmes for active tuberculosis in homeless communities has found that prevalence is increased in homeless populations. Although there is a lack of high-quality comparable studies, well-designed active x-ray surveillance programmes appear to benefit both the patient and the wider community by:

- Identifying tuberculosis earlier;
- Reducing prevalence and transmission and
- Increasing treatment compliance.

Given the limited studies, it is crucial, for evidence to grow on this topic, that further studies include key information (identified in Supplementary data, Appendix S3) that would allow the effectiveness of surveillance programmes to be better assessed and compared.
Supplementary data

Supplementary data are available at the PUBMED online.

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