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Narrative Review

Systematic screening for active tuberculosis amongst refugees and asylum seekers in Western Europe: Is universal chest radiography justified? A literature review

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ABSTRACT

Introduction: Tuberculosis (TB) prevalence is considered high amongst refugees and asylum seekers (RAAS). Active TB screening using universal (indiscriminate) chest radiography (CXR) has been adopted in several European countries. Universal CXR screening raises concerns for radiation protection; no existing research reviews the literature from a radiography perspective. This review aims to identify and analyse relevant primary research to discuss the justification of universal CXR for RAAS in an active TB screening context.
Methods: The search strategy included the databases CINAHL, MEDLINE, EMBASE and ScienceDirect and used predefined Boolean search terms and inclusion/exclusion criteria. A critical appraisal evaluated the quality of papers included in the review, and a synthesis-analysis method was used to find common themes.
Results: Eight papers were included in the review. The thematic analysis identified three themes for discussion: the 2014/15 crisis, the complexity of defining TB risk amongst RAAS, and the value of CXR-led versus symptom-led screening for RAAS. Findings support continued systematic screening for TB amongst RAAS but with re-evaluation of CXR eligibility or the screening algorithm.
Conclusions: The heterogeneity of TB risk amongst RAAS indicates that CXR-led screening should be targeted at specific high-risk groups rather than universally applied.
Implications for practice: Justification of CXR screening for RAAS is context-specific and should be informed by TB risk amongst the target population. The advantages of CXR-led screening over other screening algorithms (e.g. symptom-led) justify its use for TB screening in most settings. Considerations identified in this literature review could help inform the development of local protocols for justifying CXR for TB screening amongst RAAS.

Introduction

The World Health Organisation's[1] (WHO) most recent global report estimates that 1.3 million people died of tuberculosis (TB) in 2022, making it the second leading global cause of mortality from a communicable disease. In low-TB incidence European countries, most new cases of TB are attributed to foreign-born individuals migrating from high-incidence countries.[2,3] Early detection through systematic screening of high-risk migrant populations is identified as a priority to achieve TB elimination in Europe by 2030.[3–5]

An asylum seeker awaits a decision regarding refugee status in a host country, having been forcibly displaced from their country of origin due to 'a well-founded fear' of persecution.[3,6] Recent systematic reviews and meta-analyses demonstrate high TB prevalence amongst refugees and asylum seekers (RAAS).[2,3,7,8] RAAS may originate from high-prevalence regions and/or be exposed to conditions conducive to TB transmission (overcrowding or poor sanitation).[5,9] The WHO,[5] United Nations High Commissioner for

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Refugees[10] (UNHCR) and European Centre for Disease Prevention and Control[3] (ECDC) recognise RAAS as vulnerable to TB and recommend host countries provide active TB screening.

TB screening algorithms vary across Europe with some settings adopting universal chest radiography (CXR), defined in this review as (voluntary or mandatory) indiscriminate screening of all arriving RAAS using CXR.[11] The WHO[12] recommended 'indiscriminate' CXR screening was discontinued in 1974 due to declining global TB prevalence.[13] However, a recent resurgence in universal CXR screening is observed to be driven by *The End TB Strategy*'s[14] emphasis on early case detection and improved access to digital radiography equipment (including tele reporting).[12,13]

Universal CXR screening raises concerns because CXR uses ionising radiation.[15] Justification is a central principle of the International Commission on Radiological Protection[16] (ICRP). Guided by the linear non-threshold principle that all radiation exposures are potentially harmful, it safeguards against unnecessary doses of radiation by stipulating that the medical benefits of an examination must outweigh the risks of radiation exposure.[17] Considerations include the availability and suitability of alternative tests and whether the examination changes the individual's treatment or management.[17–19] The ICRP's[16] standards for radiation protection are legislated regionally[20] and nationally.[21]

Previous reviews have investigated prevalence, yield, efficacy and cost-effectiveness[7,22,23]; however, none have evaluated the evidence from a radiography perspective. This review, therefore, aims to identify and analyse relevant primary research and discuss the justification of universal CXR for RAAS in a systematic active TB screening context. The review is confined to Western Europe for feasibility and to facilitate comparison between countries with similar geopolitical and socioeconomic contexts, including healthcare provision and low TB incidence.[24,25]

Methods

The literature review was aligned to constructivist epistemology and relativist ontology. Constructivist epistemology emphasises the importance of understanding the context in which knowledge is constructed. This aligns well with the nature of radiography (CXR), where the understanding and interpretation of evidence can vary based on contextual factors such as radiation protection principles. The use of a relativist ontology acknowledges the subjectivity of truth and reality, which is appropriate when dealing with topics like justification in radiation protection. The research is situated within and informed by the shared values of the radiography discipline, evaluating the evidence from the perspective of radiation protection (justification).[26]

The research question was formulated using SPI(C)E[27]: *does the evidence indicate that universal CXR screening* (intervention) *for active TB* (setting) *is justified* (evaluation) *for RAAS in Western Europe* (population)*?*

The literature review followed a method based on the 'SALSA' framework[28]:

1. A database search observing PRISMA[29] guidelines.
2. Critical appraisal of papers using an approved tool.
3. Narrative synthesis and tabular presentation of results.
4. Thematic analysis and evaluation of justification.

The search strategy utilised the databases of CINAHL, MEDLINE, EMBASE and ScienceDirect using Boolean operators in December 2023 (Table 1) as these databases are well-known for their extensive coverage of medical and healthcare-related literature. Searching for evidence that use clinical decisions within evidence-based medicine (EBM) generally uses the hierarchical system[30] of classifying evidence of a high level. As such journal editorials, newspaper articles, grey literature or testimonials, etc were excluded as these can include bias and lack objectivity (Table 1). The results were screened using predefined inclusion/exclusion criteria based on the hierarchy of evidence and aims of the review.[31] Countries in Western Europe were defined in line with previous healthcare research.[25,24] Publications since 2014 were included to capture the 2014/15 European refugee crisis[32] and identify papers written in the ongoing context of large displacements towards Europe.

Critical appraisal using a validated framework[33] evaluated the quality of papers, although no papers were excluded at this stage. The appraisal element of the AXIS framework[33] to assess the quality of the studies does not provide a numerical scale or output score for assessment, thus the appraisal determined a quality rating of good, moderate or poor for comparative purposes in a thematic matrix,[31] additional commentary on poor quality scoring of individual articles are provided in the results. Narrative data synthesis used Popay et al.'s[34] 'four element' framework. Thematic analysis was undertaken according to Aveyard's[31] 'simplified approach' which is a well-regarded method for identifying patterns and themes in qualitative data. This approach is suitable for evaluating the justification for

Table 1
Search strategy including Boolean operators and inclusion/exclusion criteria.

Boolean Operators:				
[TB OR tuberculosis]	AND	[Refugee OR refugees OR asylum OR "asylum seeker" OR "asylum seekers" OR "displaced person" OR "displaced persons"]	AND	[Radiography OR x-ray OR xray OR imaging OR "diagnostic imaging" OR radiology OR "medical imaging"]
Inclusion criteria:		**Exclusion criteria:**		
• Published 2014–2023 (inclusive) • Research conducted in region of interest (Western Europe): Andorra, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Sweden, Spain, Switzerland and the United Kingdom		• Published before 2014 • Research conducted outside region of interest		
• Primary empirical research, published in peer-reviewed journals		• Reviews, case reports (individual or small cohort <10), opinion, letters, policy or guidance, conference proceedings, reference material		
• Setting for research is a TB screening programme targeting refugees and asylum seekers		• Not about refugees or asylum seekers, or about migrants without specifying refugees or asylum seekers		
• Research describes or evaluates a screening programme using universal CXR-led algorithm, i.e. all refugees and asylum seekers have CXR		• Screening algorithm is not CXR-led, i.e. participants are selected for CXR following a pre-screen test, symptom questionnaire or other criteria		

CXR screening in the context of the study. A data extraction table and theme matrix were produced using Microsoft Excel.[35]

According to the university's research policy, ethical approval was not required because the evidence reviewed is available in the public domain.[36]

Results

The search identified (Fig. 1) eight peer-reviewed primary research papers. All studies (Table 2) used a cross-sectional design and were appraised using Downes et al.'s[33] AXIS tool for cross-sectional research. Research originated from Germany,[37–40] Italy,[41,42] France[43] and the UK,[44] with the majority[37–42] conducted using 2014/2015 data.

Only the UK study[44] described universal CXR screening for both adults and children, although universal CXR for children was discontinued during the study.[44] All other papers[37–43] described universal CXR screening for adults (≥16 years of age), excluding pregnant women. Reported TB prevalence rates amongst adult RAAS range from 93/100,000[38] to 996/100,000.[41] Five papers support continued screening for active TB using universal CXR in their setting.[37,41–44] Three papers suggest re-evaluating eligibility for CXR and/or the screening algorithm.[38–40]

Thematic analysis identified three themes for discussion (Table 3): the 2014/15 crisis, the complexity of defining TB risk among RAAS, and the value of CXR-led vs symptom-led screening for RAAS.

The 2014/15 crisis: an impetus to re-evaluate screening strategy

Six of the studies[37–42] related to the 2014/15 time period when RAAS applications to Europe increased 78.5 % (2014 $n = 530,600$ to 2015 $n = 1216,900$)[32] which impacted directly on post-entry screening. Donisi et al.[41,42] and Vanino et al. 42 report on screening activities following a change in policy[45] in the Emilia Romagna region in Italy, both[41,42] support continued universal CXR screening based on the high prevalence rates observed ($n = 535/100,000$[42] and $n = 996/100,000$[41]). Vanino et al.'s[42] cross-sectional report from Bologna is limited by incomplete reporting of methods and results; however, it was the first to describe CXR-led screening in Italy. Donisi et al.'s[41] observational retrospective analysis of screening in Piacenza presents a clear method and discusses the limitations of their small cohort ($n = 316$) for extrapolating a prevalence rate. Set in the same region and during the same time frame as Vanino et al.,[42] it provides a valuable comparison.

Meier et al.'s,[38] and Tewes et al.'s,[39] and Weinrich et al.'s[40] studies in Germany concluded that universal CXR screening was ineffective due to low yields, low prevalence rates and a high number needed to screen (NNS) per active case detected.[38–40] All the studies from Germany[37–40] present strong findings because data was collected through mandatory screening, according to German law,[46] and were therefore not influenced by self-selection bias. Weinrich et al.'s[40] retrospective single-centre analysis and evaluation of screening in Hamburg presents the largest sample size ($n = 17,487$[40]), a clear method and detailed data analysis demonstrating low prevalence (0.103 %, $n = 103/100,000$ equivalent[40]) and a high NNS (174,9[40]). Using historical data, they show that prevalence dropped significantly in 2014–15.[40]

Meier et al.'s 38 epidemiological study in Friedland reported a prevalence of $n = 93/100,000$.[38] Tewes et al.'s[39] retrospective screening analysis from a rural area ($n = 705$) may underestimate prevalence due to incomplete screening for $n = 6/14$ individuals with CXR suggestive of TB. Despite an incorrect calculation ($n = 1/705$ equates to 0.1 % prevalence, not 0.001 %, $n = 141/100,000$

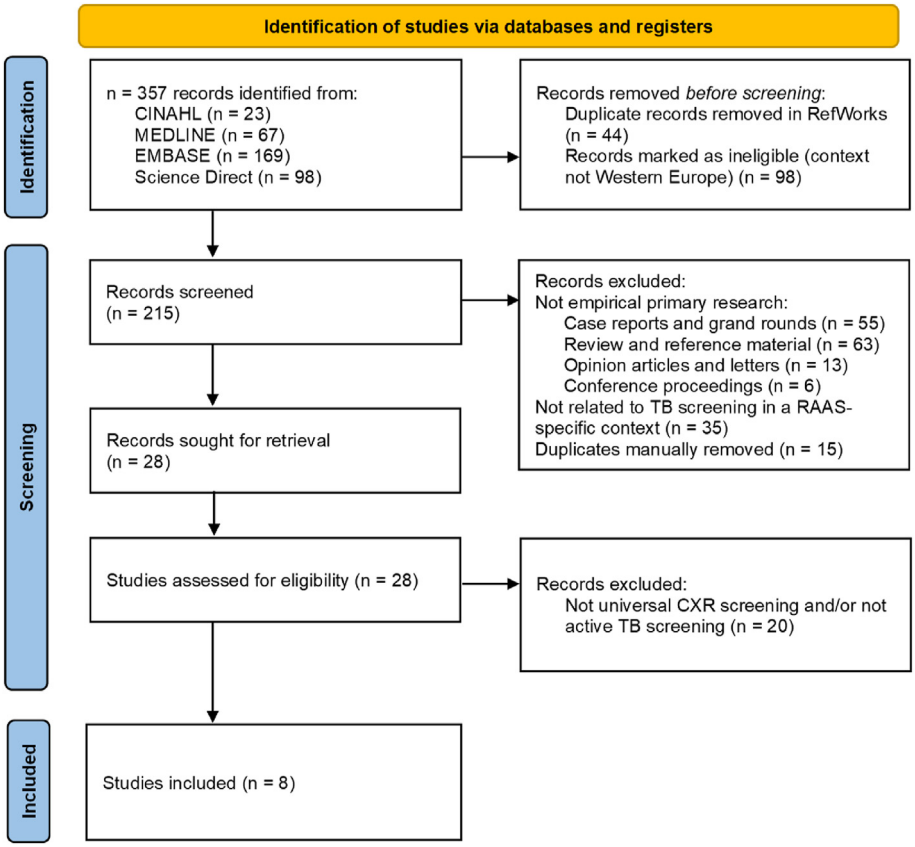

Figure 1. PRISMA[29] flow diagram outlining search results.

Table 2
Data extraction table summarising papers included in the review and presenting key characteristics and findings.

Paper	Country	Aims	Method	Sample size (n =)	Study time frame	Findings	Comparative quality rating
Donisi et al., 2020[40]	Italy	Describe the results of screening at a health centre	Observational retrospective study	316	01/2015–12/2015	• Prevalence 3/301 (996/100,000 equivalent), NNS 301 • Systematic screening method valid and should continue	Good
Guthmann et al., 2023[42]	France	Evaluate TB screening by centres de lutte antituberculeuse (CLATs) for Ukrainian refugees	Retrospective: questionnaire sent to CLATs	432	02/2022–10/2022	• Prevalence 116/100,000, NNS 862 • Screening method by CLATs in France effective for Ukrainian refugees	Moderate
Kortas et al., 2017[36]	Germany	Analyse the rate of infectious diseases among asylum seekers	Retrospective medical record review	1999	01/2015–12/2015	• Prevalence 200/100,000 • Data supports continued systematic entry screening • Prevalence in RAAS's country of origin predicts TB prevalence at entry screen	Good
Macfarlane et al., 2023[43]	UK	Describes an active and latent screening programme	Not stated, uses a cross-sectional design	203	11/2021-Unknown	• Prevalence 0.17 % (170/100,000 equivalent) (adults) • Hotel-based screening improves attendance (+42.6 % compared to hospital-based) • Screening method successful, but prevalence lower than expected: Suggest travel history/socioeconomic factors	Moderate
Meier et al., 2016[37]	Germany	Quantify the risk of active TB amongst asylum seekers at the time of arrival	Prospective descriptive epidemiological study	11,773	11/2014–10/2015	• Prevalence 93/100,000 • Low prevalence; refine criteria for CXR • Prevalence in RAAS's home countries may predict prevalence at entry screen; more data is required to characterise risk	Moderate
Tewes et al., 2020[38]	Germany	Describe and evaluate management, performance and results of systematic screening	Retrospective analysis of screening results	705	09/2015–10/2015	• Prevalence 1/705 (141/100,000 equivalent) (note incorrect calculation 0.001 % in paper) • Low prevalence, research needed to define risk group criteria for CXR	Moderate
Vanino et al., 2017[41]	Italy	Report TB screening of asylum seekers	Not stated, uses a cross-sectional design	3366	08/2014–07/2015	• Prevalence 535/100,000, NNS 187 • Systematic screening method valid and should continue • Travel history may be a greater TB risk factor than country of origin	Poor
Weinrich et al., 2017[39]	Germany	Determine TB prevalence, NNS and diagnostic accuracy of CXR	Retrospective single-centre study	17,487	01/2015–12/2015	• Prevalence 0.103 % (103/100,000 equivalent), NNS 1749 • Low prevalence, screening low yield; need data to define risk group criteria for CXR	Good

Table 3
Theme matrix displaying results of thematic analysis.

Theme / Paper	*1) 2014/15 an impetus to re-evaluate screening strategy*	*2) Complexity of defining risk amongst RAAS*	*3) Value of CXR-led vs symptom-led screening for RAAS*
Donisi et al., 2020[40]	✓		
Guthmann et al., 2023[42]		✓	✓
Kortas et al., 2017[36]	✓	✓	✓
Macfarlane et al., 2023[43]		✓	✓
Meier et al., 2016[37]	✓	✓	✓
Tewes et al., 2020[38]	✓		
Vanino et al., 2017[41]	✓	✓	✓
Weinrich et al., 2017[39]	✓		

equivalent[39]), Tewes et al.'s[39] observations and conclusions remain valid. Prevalence rates in all three studies are low compared to those previously reported amongst RAAS.[40,47] Although Kortas et al.'s[37] retrospective review detected a higher prevalence ($n = 200/100{,}000$[37]) and opposes these findings, their sample was unrepresentative with fewer Syrians (29.1 %) compared to the RAAS population in Germany at the time (39.2 %).

The 2014/15 refugee crisis saw the largest influx of RAAS to Europe in recent history, with 1.3 million asylum applications registered in 2015.[48] The studies[37–42] analysing screening activities from 2014/15 take advantage of large sample sizes to estimate prevalence (especially in Germany, where $n = 442{,}000$ RAAS were received in 2015[48]). The papers' findings may reflect the perception of TB risk amongst RAAS at this time; while the high prevalence in Italy validated a recent change in regional strategy, the low prevalence in Germany precipitated recommendations to change the selection criteria for screening. Moreover, the historical comparison provided by Weinrich et al.[40] indicates that TB risk amongst RAAS is sensitive to temporal changes in migration flows.

Due to low prevalence and the high NNS amongst RAAS in Germany, Meier et al.,[38] Tewes et al.[39] and Weinrich et al.[40] recommend refining the selection criteria for CXR screening. A study of systematic TB screening in India[49] similarly concluded that low yield, high NNS CXR screening is not justified because it incurs an unbeneficial radiation dose for most participants.[49] The ECDC and WHO[50] state that universal CXR screening is appropriate for high-risk populations where TB prevalence is >0.5 % (n > 500/100,000[50]); however, prevalence amongst RAAS appears to be heterogenous and context-specific, as confirmed by Menezes et al.'s[51] meta-analysis. Justification should be informed by research evidence;[52,53] variations in prevalence indicate that justification cannot be generalised to the RAAS population, and that context specific estimates of TB risk amongst the target population are required to justify CXR screening.

Complexity of defining TB risk amongst RAAS

Five of the studies make observations about the risk factors for high TB prevalence amongst RAAS.[37,38,42–44] Kortas et al.[37] and Meier et al.,[38] correlate TB risk with country of origin, while Vanino et al.[42] and Macfarlane et al.[44] theorised that other factors may inform risk. The four active cases reported by Kortas et al.[37] originated from high-TB burden countries Afghanistan and Eritrea. While Meier et al.[38] speculate that low prevalence in their sample is due to the high proportion of Syrians (Syria has a developed healthcare system and declining TB incidence). Meier et al.'s[38] analysis is limited because insufficient data is provided to support their analysis of TB risk. The ECDC's[3] meta-analysis of six systematic reviews confirms that country of origin is a risk factor; however, their guidelines apply to all migrants and are not tailored to RAAS populations.

Conversely, Guthmann et al.'s[43] retrospective evaluation found prevalence amongst refugees from Ukraine, a relatively low incidence country,[50] higher than expected, indicating screening may be appropriate for this population. Although limited by self-selection bias, Guthmann et al.'s[43] findings are supported by other observations that systematic screening may be beneficial for Ukrainian refugees.[54] Ukrainians currently account for the largest RAAS group in Europe (n = 5,982,900, March 2024);[55] further research on TB risk amongst this population is therefore recommended.

Vanino et al.[42] assert that travel history may determine TB risk to a greater extent than the country of origin. Italy is the primary receiving country for the central Mediterranean route, which may explain the high prevalence in their sample (n = 535/100,000[42]). Although Vanino et al.[42] provide insufficient data to support their claim, it is notable that Donisi et al.[41] also found a high prevalence (n = 996/100,000[41]) in their sample of RAAS in Italy. Moreover, Menezes et al.'s[51] meta-analysis hypothesised that high TB-incidence and poor living and travel conditions encountered along the central Mediterranean route may inflate TB prevalence amongst migrants arriving in Italy. Macfarlane et al.[44] found that the TB prevalence amongst Afghan RAAS relocated under the Afghan Relocations and Assistance Policy[56] (ARAP) lower than WHO estimates. Travel history (direct airplane transfer) and socioeconomic status (ARAP[56] evacuated former employees of the UK government or military) were thought to reduce TB risk among Macfarlane et al.'s[44] cohort.

Stadtmüller, Schröder and Ehlers[57] explored the relationship between TB risk and migration experience by analysing survey data on n = 4000 RAAS' experiences. Migratory route (including duration) and socioeconomic status were found to affect TB risk, especially amongst East African migrants. This supports Vanino et al.'s[42] and Macfarlane et al.'s[44] observations. Moreover, the low prevalence amongst Syrians in Germany observed by Meier et al.[38] could also be influenced by migratory routes. Research[58] shows that Syrians favoured the Eastern Mediterranean route by sea (via the Western Balkans) over the Central Mediterranean route (via Libya) in 2015, owing to increasing instability in Libya and the closure of the Egypt/Libya border. Estimating prevalence and defining risk amongst RAAS is therefore complex, and possible risk factors (e.g. country of origin, travel history and socioeconomic status) are likely sensitive to geopolitical and temporal changes in migration. Aggregated European screening data could improve understanding of risk factors amongst RAAS and provide stronger evidence for the justification of CXR based on TB risk.[11,59]

Value of CXR-led vs symptom-led screening for RAAS

Six of the studies discussed the effectiveness of CXR-led screening, with five studies considering it a valid and valuable method because it facilitated early detection of asymptomatic active cases.[38,42–44] Although Meier et al.,[38] Tewes et al.[39] and Weinrich et al.,[40] found universal screening ineffective, eligibility for CXR based on TB risk was considered preferable to symptom-led screening.[38–40] Both Meier et al.[38] and Vanino et al.[42] observed that one third of active cases identified were asymptomatic. The highest proportion of asymptomatic active cases was identified by Guthmann et al.[43] (n = 7/10) and Macfarlane et al.[44] (n = 1/1), although this is based on a single active case. Meier et al.[38] note that symptoms may be underreported by RAAS due to fear that disclosure may have negative implications for the outcome of their asylum claim. Conversely, Weinrich et al.[40] reported that all active cases (n = 10/17,487[40]) identified by CXR were symptomatic and that symptom screening may, therefore, be more appropriate in their setting; however, comparison of these methods was beyond the scope of Weinrich et al.'s[40] study.

International guidelines[3,13,50] consider CXR optimal and preferable to symptom questionnaires because it facilitates rapid screening, reduces delay in diagnosis, and has high sensitivity (87%–98 %[13]), enabling earlier detection of active TB cases.[3,13,50] Due to CXR's low specificity, TB diagnosis should be confirmed clinically and using a bacteriological test with high sensitivity and specificity[13]; all papers reviewed followed these guidelines. CXR screening also benefits individuals by concurrently screening for other pulmonary conditions,[13] as observed by Meier et al.,[38] Macfarlane et al.[44] and Kortas et al.[37] who referred individuals diagnosed with other conditions to receive the appropriate care. Schneeberger Geisler et al.'s[60] cross-sectional study of two years' screening in Switzerland confirms that CXR facilitates earlier case detection than symptom screening. In most European countries, RAAS are assigned temporary collective accommodation when claiming asylum.[61] Early case detection, therefore, benefits individuals from an infection control perspective, as reflected in Germany's *Das Infektionsschutzgesetz*.[46]

Symptom-led screening is recommended in low-resource settings because CXR is resource intensive;[62] however, the WHO[13] emphasise that hospital or mobile radiography equipment should be used if available. Western Europe is not considered a low-resource setting,[63] and two papers[42,44] reviewed took advantage of mobile digital radiography equipment to improve screening. Macfarlane et al.[44] observed that providing hotel-based screening increased attendance by 42.6 %[44] compared to hospital-based screening. Notably, current Italian guidelines contradict the WHO, stating that CXR screening is not recommended for asymptomatic individuals[64]; based on a larger dataset than Donisi et al.[41] and Vanino et al.,[42] the guidelines may better reflect current migration trends and resource availability in Italy.

Justification should consider whether the requested imaging is the most appropriate test for the individual and clinical scenario,

taking into account the resources available and any alternative diagnostic tests.[16,17] Due to the advantages of CXR-led screening, accommodation, arrangements for RAAS and availability of resources in most Western European settings therefore, CXR is therefore justified as the first-line diagnostic test in active TB screening for high-risk groups of RAAS.

Limitations

There are several limitations to this literature review. The literature search returned 357 items, of which 215 were manually screened by the principal researcher; it is possible that some relevant papers were missed. More sophisticated use of Boolean search operators to refine the search may yield different literature.

The scope of the review is limited, covering only three countries in Western Europe, and findings therefore need to be adapted to the local context.

The research was also affected by the limitations of the literature reviewed; for example, retrospective design limited the data available to investigate TB risk factors in several papers.[37–39,41,42] Concerningly, six studies cited no formal ethical approval, and none considered the ethical implications of research involving RAAS or mandatory screening programmes.[65,66] If justification is to be based upon robust evidence, it is recommended that future research considers Bhatia and Mohammed's[66] recommendations to improve the quality of ethics in retrospective cross-sectional and observational research.

Conclusions

Due to the varying methods, populations, sampling and quality of papers reviewed, the literature review question could not be answered definitively. However, the heterogeneity of TB risk amongst RAAS indicates that universal CXR screening of this population is not justified. CXR-led screening is appropriate for a predefined group at high risk of active TB. TB risk is complex and may be influenced by geopolitical and temporal trends in migration flows. Further research is required to better define high risk groups amongst RAAS.

Justification of CXR screening for RAAS is context-specific and should be informed by TB risk amongst the target population. The advantages of CXR-led screening over other screening algorithms (e.g. symptom-led) justify its use for TB screening in most settings. Considerations identified in this literature review could help inform the development of local protocols for justifying CXR for TB screening amongst RAAS.

Conflict of interest statement

There are no conflicts of interest.

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