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Burden, clinical outcomes, and characteristics of tuberculosis in migrant populations in the middle East and North African region: A systematic review and meta-analyses

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ABSTRACT

Introduction: Migrants in the Middle East and North Africa (MENA) region face an increased tuberculosis (TB) risk due to socioeconomic and structural barriers. This systematic review synthesises evidence on TB burden, clinical outcomes, and epidemiological characteristics among migrants in MENA.

Methods: We searched six electronic databases and grey literature sources for studies published between 2000 and September 2024 in any language. Eligible studies reported primary data on TB prevalence, incidence, treatment outcomes, and clinical or epidemiological features in migrants. Pooled estimates were calculated using DerSimonian & Laird's random-effects model where applicable or narratively synthesised.

Results: Of the 779 records identified, we included 57 studies, comprising 95,190 TB cases and 3,532,359 migrants across 12 MENA countries. TB incidence was consistently higher in migrants than non-migrants (26.7–69.8/100,000 vs. 11.5–16.8/100,000). Migrants had lower TB-related mortality (pooled OR 0.8, 95 % CI 0.7–0.9; $I^2 = 2.9$ %), however, treatment success rates were consistently below the WHO-recommended 90 % threshold. Migrant TB patients were younger (mean age difference: 12.8 years; 95 % CI 8.8–16.0; $I^2 = 86.5$ %) and predominantly male (sex ratio: 1:5). Drug-resistant TB was more common among migrants, though this was not always statistically significant (multi-drug-resistant TB: pooled OR 1.2; 95 % CI 0.9–1.6; $I^2 = 40.2$ %), while extrapulmonary TB was more prevalent among non-migrants (33.4–83.4 % vs. 16.6–72.9 %).

Conclusion: Migrants in MENA region experience disproportionate TB burden and poorer treatment outcomes, underscoring the need for targeted interventions. Enhanced data, especially from North Africa, is essential to support regional TB elimination aligned with World Health Organization and Sustainable Development Goals.

1. Introduction

The Middle East and North African (MENA) region has seen a dramatic increase in its migrant population over the last four decades, with current estimates exceeding 40 million [1,2]. This demographic shift is most pronounced in Gulf Cooperation Council (GCC) states such as the United Arab Emirates (UAE), where migrants constitute 89 % of the total population – one of the highest proportional migrant concentrations

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globally[3–5]. However, migrant demographics vary considerably within the region. In GCC states, most migrants are foreign labourers primarily from Asia, followed by other Arab nations, with a growing presence from East Africa [3]. Conversely, in Jordan, Lebanon, and North African nations like Egypt, Tunisia and Morocco, forced displacement accounts for a substantial proportion of migrants, including refugees and asylum seekers [2,6]. In this regard, North African states have emerged as critical transit hubs for Sub-Saharan African migrants traversing the Sahara Desert in pursuit of reaching Europe [6]. Recent geopolitical crises, including the mass displacement of over 1.7 million individuals in Gaza and the ongoing armed conflict in Sudan, suggest that migration flows are likely to intensify further [7].

Tuberculosis (TB) remains a critical global health concern, with over 10 million new cases annually [8]. More than 90 % of the TB burden is concentrated in low- and middle-income countries [9,10]. Migrants are disproportionately affected due to multifaceted risk factors encountered before, during, and after migration [11]. A 2019 systematic review found that in several European and American countries, foreign-born individuals accounted for over 50 % of new TB cases [12]. Additionally, a study conducted in England reported that migrants had an 8.6-fold higher odds of TB compared to non-migrants (95 % confidence intervals (CI) 7.9–9.3) [13]. Furthermore, healthcare barriers experienced by migrants can cause diagnostic delays, which in turn can lead to poorer health outcomes [14–16]. A global meta-analysis found that the standardised mortality rate from TB was six times higher than that of the general population (95 % CI 3.0–11.7, based only on European studies) [17]. In the United Kingdom (UK), successful treatment rates among migrants (72.3 %) lagged behind both non-migrant patients (adjusted odds ratio (OR) 0.29, 95 % CI 0.08–1.01) and the World Health Organization's (WHO) 90 % target [18]. Importantly, multi-drug-resistant TB (MDR-TB) – a critical global concern due to its severe health and economic impacts – is more prevalent among migrants than non-migrants [12,19]. In response, the 'WHO's End TB Strategy identifies migrants as a priority group focus in achieving global elimination targets [20].

Despite the MENA region's significant migration flows and the recognition of migrants as a priority group for TB control, research in the region has predominantly focused on general populations. TB is endemic across all MENA countries, yet incidence rates vary widely from fewer than 24 cases per 100,000 in GCC states to over 50 per 100,000 in parts of North Africa [21]. Crucially, the contribution of migrants to these epidemiological patterns remains poorly understood. The distinct burden, epidemiological and clinical characteristics, and treatment outcomes of TB among MENA's migrant populations have been largely overlooked, limiting the ability to identify disparities between migrant and non-migrant groups. This knowledge gap undermines efforts to design targeted interventions, allocate resources equitably, and advance the WHO End TB Strategy [20,22]. Without evidence on how migration patterns intersect with TB risk in the MENA region, policies risk perpetuating disparities. To address this, we conducted a systematic review to synthesise available evidence on (1) the burden, (2) clinical outcomes, and (3) epidemiological and clinical characteristics of TB among migrants compared to non-migrants in the region.

2. Methods

This systematic review is reported according to PRISMA 2020 guidelines (see Annex 1) and the protocol is registered on PROSPERO (CRD42023433556) [23]. It is part of a wider suite of systematic reviews synthesising the literature on multiple diseases in migrant populations in the MENA region; the protocol of which has also been published [24].

2.1. Search strategy and selection criteria

We searched six electronic databases (Medline, Embase, Web of Science, CINAHL (Ebsco), Index Medicus for the Eastern Mediterranean Region, and QScience) to identify articles reporting on (1) the burden, (2) clinical outcomes, and (3) epidemiological and clinical characteristics of TB among migrants in the MENA region from 2000 to September 2024, without language restrictions. The search was restricted to studies published from 2000 onward to ensure findings are relevant to current migrant flows and infection rates. We combined three sets of free-text and medical subject headings (MeSH) related to migrants, MENA countries, and TB terms. In addition, we extensively searched grey literature via the following relevant international and national websites and Google Scholar: World Health Organization, International Organization for Migration, United Nations High Commissioner for Refugees, and the United Nations Department of Economic and Social Affairs, Médecins Sans Frontières, the Commission of Refugee, and Ministry of Health websites for each country included in the MENA region. We also reference-checked all included studies and relevant systematic reviews, and reviewed included studies with experts for further references (See Annex 2 for the search strategy).

We included cohort, cross-sectional, and case-control studies reporting on (1) the burden, (2) clinical outcomes, including treatment success and mortality, and (3) epidemiological and clinical characteristics of TB, including drug resistance, form of TB, sex, and age, among migrant populations in the MENA region. We also included data from baseline characteristics or control groups of trial studies, where appropriate. We adopted the International Organization for Migration (IOM) definitions (Box 1) for "migrant" and "MENA region" [5]. We excluded studies where data on migrants could not be separated from non-migrant populations. Records were imported into Rayyan and deduplicated [25]. Two reviewers (TM and EE) independently screened the titles, abstracts, and full texts of the studies. Disagreements were discussed with a third reviewer (FS).

2.2. Data extraction

Two reviewers (TM and EE) independently extracted relevant data using a predefined and piloted Excel sheet. This included study characteristics (e.g., location, year of the study, study design), sociodemographic characteristics of the study population (e.g., origin, age, sex, status, occupation), outcomes and definitions, and results (e.g., burden – prevalence, incidence; clinical characteristics – pulmonary TB (PTB), extra-pulmonary TB (EPTB), drug resistance; clinical outcomes – treatment outcomes, mortality). Where studies reported both adjusted and unadjusted analyses, we prioritised adjusted analyses and calculated any missing statistical parameters, including uncertainty measures (e.g., 95 % CI), if data permitted. A third reviewer (FS) provided arbitration in cases of discrepancies.

2.3. Quality assessment

Two independent authors (TM and EE) assessed the quality of included studies using the appropriate Joanna Briggs Institute (JBI) tool, based on study design for peer-reviewed studies [26], and the ACCODS checklist for grey literature documents [27]. In cases of disagreement, a third reviewer (FS) was consulted. Quality scores were calculated as the ratio of affirmative responses to the maximum number of applicable questions. Studies having a score of 80–100 % were considered high quality, 60–79 % medium quality, and 0–59 % low quality. Studies were not excluded based on their quality; however, the results of quality assessments informed the analysis and discussion.

2.4. Data synthesis

When meta-analyses were possible, a random-effects model was applied for a proportional meta-analysis for each outcome separately using the Microsoft Excel add-in for meta-analysis (MetaXL, version 5.3) [28] and OpenMeta [Analyst] (Center for Evidence Synthesis in Health-School of Public Health, Brown University, Rhode Island, USA) [29], given the anticipated heterogeneity in study methodologies and

Box 1
International Organization for Migration definitions

Migrant: The term migrant refers to a person who moves away from his or her usual residence, whether within a country or across an international border, temporarily or permanently, and for various reasons. The term includes refugees, asylum seekers, migrant workers, and internally displaced people.

MENA region: The region comprises the countries of Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Occupied Palestinian Territories, Oman, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates, and Yemen.

settings. Heterogeneity among studies was assessed by inspecting forest plots, using chi-squared test for heterogeneity with a 10 % statistical significance, and using the I^2 statistic. To further investigate heterogeneity, sensitivity analyses were conducted based on TB type and location to analyse clinical differences, and on per-protocol subgroups (study period, study setting, and geographic region) to examine methodological variations. When meta-analysis was not possible due to high heterogeneity or limited number of studies, a narrative synthesis was conducted. Data were displayed in tables and figures to provide a structured summary of evidence.

3. Results

3.1. General characteristics of studies

We identified a total of 779 unique records, and after abstract and full-text screening, 57 studies were included comprising 95,190 TB cases. Twenty-eight full texts were excluded because there were no disaggregated data for migrants, eight because the data were collected before 2000, and seven because full-texts were unavailable, two of those are poster (Fig. 1). Of the 57 included studies, twenty were conducted in Saudi Arabia [30–49], nine in Oman [50–58], eight in Lebanon [59–66], five in Qatar [67–71], three in Libya [72–74] and the rest in other Middle Eastern (ME) countries. All but six of the included studies were retrospective cross-sectional in design. The remaining studies consisted of two qualitative studies, one prevalence study, one case-control study, one quasi-experimental study, and one archived national report. All three of the studies in North Africa (Libya) were found in grey literature searches as they were published in journals not indexed in major international scientific databases. Data within the studies were sourced from national surveillance (51.9 % of cases, n = 28), regional surveillance (22.2 % of cases, n = 12), and hospital or primary care registers (25.9 % of cases, n = 14). Definitions of migrants varied across studies: Most classified them as “non-nationals” (n = 25), “expatriates”/“migrant workers” (n = 18), or “foreigners” (n = 4); seven studies focused on refugees, asylum seekers, or internally displaced people (IDPs). Thirty-seven studies reported data on all TB forms, eight on EPTB, six on PTB, and three on latent TB infection (Table 1).

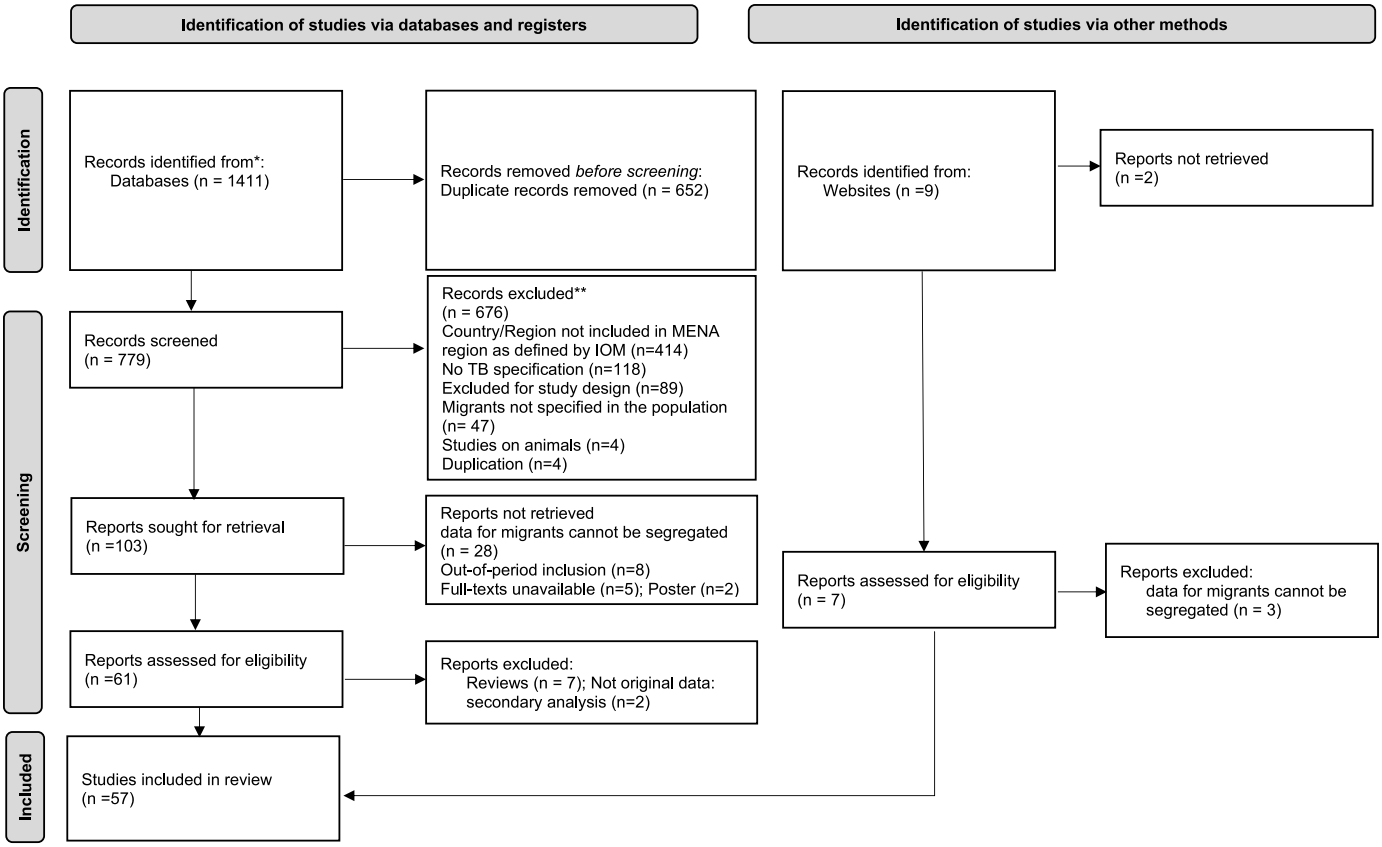

Fig. 1. PRISMA flowchart.

Table 1
Characteristics of the studies included in the systematic review.

Study, year, country	study setting	Study design	Study period	Study population	TB Forms	Outcomes
AKHTAR S. 2008, Kuwait [76]	National TB program	Cross-sectional	Jan 1997–Dec 2006	Screening: Expatriates applying for visa 2328582 migrants	PTB	PTB prevalence 4608 expatriates
AL SHAMY AS. 2008, Kuwait [85]	Health Structure	Cross-sectional	Jan 1996–Dec 2005	Hospitalised patients 31 expatriates; 03 nationals	Miliary TB	TB Clinical characteristics
MOKADDAS A.2008, Kuwait [80]	National TB program	Cross-sectional	Jan 1996–Dec 2005	TB cases 4482 expatriates; 917 nationals	All TB types	TB Drug resistance 589 expatriates; 84 nationals
LOHINIVIA A. 2016 Egypt [96]	Health Structure	Qualitative	Sep–Dec 2011	TB Patients; 22 non-nationals	All TB types	TB treatment adherence
MAISA A. 2020, Qatar [71]	National TB program	Cross-sectional	Jan 2010–Mar 2015	TB cases 3199 expatriates; 102 nationals	All TB types	TB Drug resistance 219 expatriates; 4 nationals
ZAHID M. 2020, Qatar [67]	Health Structure	Cross-sectional	Jan 2016–dec 2019	TB Patients hospitalised 99 expatriates; 01 national	Pleural effusion TB	TB Clinical characteristics
IMAM Y. 2015, Qatar [68]	Health Structure	Cross-sectional	Jan 2006–Dec 2012	TB Patients hospitalised 78 expatriates; 02 nationals	Meningitis TB	TB Clinical characteristics
AL MARRI M. 2012, Qatar [69]	National TB program	Cross-sectional	Jan 1998–Dec 2004	TB cases 247 expatriates; 59 nationals	PTB	Sensitivity of TB test: 8 % false negative TST expatriates 17 % false negative TST nationals
KHAN FY. 2009, Qatar [70]	Health Structure	Cross-sectional	2005	TB Patients hospitalised 59 non-nationals; 6 nationals	Pleural effusion TB	TB Clinical characteristics
AL HOSANI F. 2013, UAE [78]	National TB program	Cross-sectional	Jan–Dec 2010	screening: Expatriates applying for visas 948504 expatriates	PTB	PTB prevalence 1925 expatriates
AL-ZAROUNI M. 2010, UAE [79]	Health Structure	Cross-sectional	Jan 2004–Sep 2008	TB patients 198 expatriates; 51 nationals	All TB types	TB Multi-Drug Resistance 13 expatriates; 02 nationals
HOSTEN E. 2018 Jordan [83]	National TB program	Cross-sectional	Jan 2011–May 2014	contact of TB cases 481 refugees	All TB types	TB incidence (10 refugees)
COOKSON ST. 2015, Jordan [106]	Regional TB program	Quasi experimental	Jul 2013–Jun 2014	screening: Population at risk 69000 refugees	LTBI	TB incidence
BOHLER M. 2005, Sudan [82]	Regional TB program	Case-control	2000	TB patients 295 internal displaced; 154 settled	PTB	TB treatment outcomes 160 IDP cured; 60 settled cured
LEGESSE T. 2021, Sudan [81]	Regional TB program	Cohort	2014–2017	refugee living in a camp	All TB types	TB prevalence; 710 refugees
JAWAD JS. 2014, Bahrain [75]	Regional TB program	Cross-sectional	2000–2006	TB cases 1138 expatriates; 446 nationals	All TB types	TB Clinical characteristics 744 expatriates; 235 nationals
ALKHAWAJA S. 2012, Bahrain [84]	Regional TB program	Cross-sectional	Jan 2004–Dec 2008	TB Patients 1056 non-nationals; 339 nationals	All TB types	TB Clinical characteristics 699 non-nationals; 151 nationals
Ministry of Health. 2021, Lebanon [66]	National TB program	report	2007–2021	TB patients: 8994 notified TB cases: 4329 non-nationals; 4665 nationals	All TB types	TB epidemiological characteristics
KABBANI M. 2021, Lebanon [63]	National TB program	Cross-sectional	2012–2016	TB patients 312 TB cases	All TB types	Risk factors associated with TB trend over time
O'SON L. 2020, Lebanon [61]	National TB program	Cross-sectional	2011–2015	TB patients 1543 non-nationals; 1600 nationals	All TB types	TB Clinical characteristics PTB: 493 non-nationals; 347 nationals
ISMAIL MB, 2020 Lebanon [62]	Health Structure	Cross-sectional	Aug–Dec 2019	Screening: 87 refugees with diabetes	LTBI	TB prevalence 17 cases
AL-Achkar. 2019, Lebanon [59]	National TB program	Cross-sectional	June 2016–May 2017	TB patients: 284 overall	All TB types	TB 2nd line drug susceptibility testing 250 cases: 180 non-Lebanese, 80 Lebanese
ARAJ GF. 2016, Lebanon [64]	National TB program	Cross-sectional	1999–2013	TB patients: 7548 overall	All TB types	TB trend over time
BOYD AT. 2019, Lebanon, Jordan [60]	National TB program	Cross-sectional	2013–2015	TB cases reported to the national TB program: 2079 non-nationals; 2283 nationals	All TB types	TB Clinical characteristics
ISMAIL MB, 2018 Lebanon, Jordan [65]	National TB program	Cross-sectional	2011–2015	TB cases reported to national TB program Jordan: 591 foreign-born; 533 natives Lebanon: 353 foreign-born; 297 natives	All TB types	TB Clinical characteristics
AL-MAHROUQI S. 2022, Oman [52]	National TB program	Cross-sectional	2009–2018	TB Patients 1198 Foreigners; 1341 nationals	All TB types	TB trend over time
AL-MAHROUQI S. 2022, Oman [50]	National TB program	Cross-sectional	2009–2018	TB patients 1198 expatriates; 1341 nationals	All TB types	TB Drug resistance 176 expatriates; 163 nationals
SINGH J. 2022, Oman [57]	National TB program	Cross-sectional	2018–2020	Screening of expatriates applying for visas applying: 501290	PTB	TB cases 53 expatriates
ALYAQUOBI F. 2020, Oman [51]	Regional TB program	Cross-sectional	1981–2018	screening: Expatriates applying for visas 1049	All TB types	TB prevalence 234 migrants
YAQUOBI FA. 2018, Oman [58]	National TB program	Cross-sectional	2016	TB patients 154 foreign-born; 190 natives	All TB types	TB Clinical characteristics

(*continued on next page*)

Table 1 (*continued*)

Study, year, country	study setting	Study design	Study period	Study population	TB Forms	Outcomes
GAIFER Z. 2017 Oman [54]	Health Structure	Cross-sectional	Aug 2006–Dec 2015	TB cases: 260	EPTB	risk factors related to EPTB
Al-Maniri A. 2010 Oman [53]	Health Structure	Qualitative	NR	HC workers: 17	All TB types	TB control challenges
AL-MANIRI A. 2010, Oman [55]	National TB program	Cross-sectional	2005–2007	Spoligotyped isolates 81 immigrants; 231 nationals	All TB types	TB microbiologic characteristics
AL-MANIRI A. 2007, Oman [56]	National TB program	Cross-sectional	1981–2005	TB cases reported to the national program 2433 non-nationals; 9093 nationals	All TB types	TB Clinical characteristics
EL-MASRY OS. 2022, Saudi Arabia [35]	National TB program	Cross-sectional	2018	TB patients 1452 non-nationals; 1091 nationals	PTB	TB Clinical characteristics
SEMILAN HM. 2021, Saudi Arabia [38]	Regional TB program	Cross-sectional	Jun–Sept 2018	TB patients 720 non-nationals; 416 nationals	All TB types	TB Clinical characteristics
AL-HAYANI A. 2021, Saudi Arabia [45]	Regional TB program	Cross-sectional	Jan 2016–sep 2020	TB cases reported: 234 non-nationals; 238 nationals	All TB types	TB Drug resistance
Al-Ghafli H. 2019, Saudi Arabia [46]	Regional TB program	Cross-sectional	Aug 2014–jul 2016	EPTB cases reported: 902 16,6 % non-nationals; 83,4 % nationals	EPTB	EPTB clinical characteristics
SARVATH A. 2018, Saudi Arabia [34]	Regional TB program	Cross-sectional	2014	TB patients 169 non-nationals; 193 nationals	All TB types	TB Clinical characteristics
VARGHESE B. 2018, Saudi Arabia [41]	Health Structure	Cross-sectional	Aug 2014–Jul 2016	TB Patients 808 non-nationals; 1284 nationals	All TB types	TB Clinical characteristics
AL-HAJOJ S. 2015, Saudi Arabia [31]	National TB program	Cross-sectional	Jun 2009–Jul 2010	MICROBIOLOGY 157 non-nationals; 224 nationals	EPTB	TB microbiologic characteristics
AL AMMARI M.2018, Saudi Arabia [44]	National TB program	Cross-sectional	2014–2015	TB cases reported: 6753	All TB types	TB Drug resistance
NABIL A. 2015, Saudi Arabia [37]	Health Structure	Cross-sectional	2013	HC workers 184 non-nationals; 24 nationals	LTBI	Tuberculin skin test positive 43 non-nationals; 4 nationals
VARGHESE B. 2014, Saudi Arabia [42]	Regional TB program	Cross-sectional	2009–2011	M *tuberculosis* strains 214 non-nationals; 201 nationals	All TB types	TB microbiologic characteristics
MEMISH ZA. 2014, Saudi Arabia [48]	National TB program	Cross-sectional	2010–2011	TB patients 4035 non-nationals; 4130 nationals	All TB types	TB clinical characteristics
VARGHESE B. 2013, Saudi Arabia [40]	National TB program	Cross-sectional	Jul 2009–Jun 2011	TB culture positive: 381	All TB types	TB microbiology characteristics
AL-HAJOJ S. 2013, Saudi Arabia [43]	Regional TB program	Cross-sectional	Aug 2009–Jul 2010	TB cases reported: 2235	All TB types	TB Multi-Drug Resistance foreign: 5 %; National: 3 %
VARGHESE B. 2013, Saudi Arabia [39]	Regional TB program	Cross-sectional	Jun 2009–Jul 2010	TB cases reported: 223	All TB types	endogenous reactivation characteristics; 27 migrants; 12 Saudis
ABOUZEID MS. 2013, Saudi Arabia [32]	National TB program	Cross-sectional	2001–2010	TB cases reported 13240 non-nationals; 20428 nationals	All TB types	TB fatality rate 711 non-nationals; 1312 nationals
Gleason J. 2012, Saudi Arabia [36]	National TB program	Cross-sectional	2005–2009	TB cases reported 9768 non-nationals; 1078 nationals	All TB types	TB trend
ABOUZEID MS. 2012, Saudi Arabia [33]	National TB program	Cross-sectional	2000–2009	TB cases reported 35037, 16178 nationals; 18859 non-nationals	All TB types	TB characteristics
AL-ZOHAIRY MA. 2011, Saudi Arabia [49]	Health Structure	Cross-sectional	Jan 2005–Dec 2009	TB patients hospitalised: 165	All TB types	TB Clinical characteristics
AL-HAJOJ S. 2010, Saudi Arabia [30]	National TB program	Cross-sectional	2000–2005	TB cases reported 1505	All TB types	TB microbiology characteristics
AL-OTAIBI F. 2010, Saudi Arabia [47]	Health Structure	Cross-sectional	2001–2007	EPTB patients hospitalised 59 non-nationals; 372 nationals	EPTB	EPTB clinical characteristics
Alriyah S. 2023, Libya	Regional TB control center	Cross-sectional	2008–2011 and 2016–2017	TB cases reported 155 non-nationals; 494 nationals	All TB types	EPTB epidemiological characteristics
Ben Ramadan AA. 2022, Libya	National TB center	Cross-sectional	2003	EPTB cases reported 255 migrants; 509 nationals	EPTB	EPTB epidemiological characteristics
Dow MA. 2014, Libya	Health structure	Cross-sectional	2005–2007	TB patients counselling the TB department	All TB types	TB epidemiological characteristics

Abbreviations: TB: tuberculosis, EPTB: extra-pulmonary tuberculosis, LTBI: Latent tuberculosis infection.

3.2. Methodological quality

The overall quality of the included studies ranged from low to moderate overall, with a median quality score of 75 %. Ten cross-sectional studies (21.3 %) were rated as high quality across all domains. Domains with the highest risk of bias pertained to confounding: 24 studies did not identify confounding variables where applicable, and only 11 studies described how confounding variables were addressed (see Annex 3).

For qualitative studies (n = 2), the quality score was 70 % for each; domains with the highest risk of bias pertained to the acknowledgment and management of the reciprocal influence between the researcher and the research process. The quasi-experimental, case-control, and prevalence studies were scored 55 %, 65 %, and 60 % respectively. The primary limitations were associated with sampling methodologies and the control process. Finally, the grey literature report achieved a quality score of 40 % based on AACODS parameters. The main constraints were related to the lack of information about the individual author, accuracy, and significance.

3.3. Burden of TB

Six studies conducted across five countries reported the prevalence and incidence of TB among migrant populations [33,36,52,60,64,75]. Prevalence estimates varied widely from 5.8/100,000 in Oman [52] to 22.4/100,000 in Lebanon [64]. Three of these studies conducted in

Bahrain [75], and Saudi Arabia [33,36] compared TB incidence rates between migrants and non-migrants, finding that the absolute incidence rate among migrants ranged from 26.7 to 69.8/100,000, whereas among non-migrants, rates ranged from 11.5 to 16.8/100,000 (see Annex 4). Unadjusted relative risk (RRs) for TB were reported in two of the studies. In Lebanon [60] the RR was 1.7 (95 %CI 1.3–2.2) among 629,128 Syrian refugees compared with 6,965,872 non-refugees, and in Bahrain it was 4.2 (95 %CI 3.7–4.6) among 1,630,372 migrants compared with 2,654, 762 non-migrants [75].

This difference between migrants and non-migrants is further supported by some, but not all studies reporting temporal trends. For instance, in Oman [52], TB incidence among non-migrants declined sharply from 8.5 to 2.7 per 100,000 between 2009 and 2018. In contrast, the decrease was less pronounced among migrants, dropping only from 6.8 to 5.8 per 100,000 during the same period, with two notable peaks exceeding 9 per 100,000 in 2010 and 2014. On the other hand, in Bahrain [75], TB incidence among non-migrants remained between 12.5/100,000 and 18.6/100,000, while in. migrants it peaked at 75/100,000 in 2003 before decreasing to 69.8/100,000 in 2006. Likewise, in Saudi Arabia [33], TB incidence was consistent across time among migrants (26.1/100,000 in 2001 to 26.7 in 2009) and non-migrants (11.4/100,000 to 11.5/100,000).

Four studies reported on routine active TB screening data of expatriates undergoing employment visa processing (new or renewal) in the GCC countries [51,57,76,77] (see Annex 5). Two studies conducted in Kuwait and the United Arab Emirates (UAE) [76,78] found TB prevalence rates of 198 and 203 per 100,000 applicants, respectively. The Kuwaiti study also analysed temporal trends [76] and showed a decrease of TB prevalence over time, from 456/100,000 (95 %CI 424–490) in 1997 to 183/100,000 (95 %CI 169–197) in 2006.

Eighteen studies reported the proportion of migrants among total active TB cases [36,37,44,48,52,56,59–61,65,66,71–75,79,80], with a higher representation of migrants in eight studies (see Annex 6). Estimates varied widely across MENA countries. For example, over a five-year reporting period, migrants accounted for 47.6 % (95 %CI 46.1 %–49.1 %) of 4,359 TB cases in Lebanon [65], whereas in Qatar [71], it reached to 96.9 % (95 %CI 96.3 %–97.5 %) among 3,301 cases. Additionally, two studies identified a significant positive correlation between TB incidence trends and the Syrian refugee influx in Lebanon between 2012 and 2016 ($r = +0.939$, $p = 0.02$) [63,66].

3.4. Clinical outcomes of TB

Six studies examined treatment outcomes [39,60,61,73,81,82], and three studies reported mortality [32,61,82]. Regarding treatment outcomes, across the studies the treatment rate (defined as the proportion of patients cured or who completed treatment without evidence of bacteriological failure) was between 48.6 % and 89.8 % among refugees and displaced people (Table 2). Three studies compared treatment success between migrants and non-migrants [39,61,73], reporting that treatment success was 19.5 % lower among migrants in Libya (48.6 % migrants vs. 68.1 % non-migrants), 18.1 % lower among migrants in Lebanon (446/699 migrants, 501/648 non-migrants), and 5.6 % lower among migrants in Saudi Arabia (21/07 migrants, 10/12 non-migrants). Conversely, a study from Sudan [82], which compared 295 IDPs living in camps with non-displaced Sudanese individuals, found that IDPs had a higher likelihood of treatment success (72 % vs 65 % respectively, OR:1.4; 95 %CI 1.0–2.2). However, IDPs experienced significantly longer delays in starting treatment after diagnosis compared to the settled population (5.3 days, SD:11.4 vs. 1.2, SD:6; $p = 0.0001$).

Table 2
Tuberculosis treatment outcomes among migrants in the Middle East and North African region.

Study, country, year	Migrants (N)	Successful treatment rate N (%)
Legesse T. Sudan, 2021 [81]	710	538 (75.8)
O'son L. Lebanon, 2020 [61]	699	446 (63.8)
Boyd AT. Lebanon-Jordan, 2019 [60]	197	177 (89.8)
Varghese B. S Arabia, 2013 [40]	27	21 (77.8)
Bohler M. Sudan, 2005 [82]	295	215 (72.9)
Ben Ramadan A	255	125 (48.6)

Three studies reported TB-related fatality rates among both migrant and host populations [32,61,82]. Meta-analysis showed lower odds of death among 14,234 migrants compared to 21,230 nationals (5.2 % vs 6.3 %, OR: 0.82, 95 %CI 0.7–0.9, $I^2 = 2.9$ %) (Fig. 2).

3.5. Epidemiological characteristics of TB

Seven studies reported the age of TB patients [32,35,39,40,52,55, 75], with four stratifying data by age group [32,35,40,55] and three reporting mean age [39,52,75]. The 15–45 years age group was the most common for TB cases in both migrant and non-migrant groups. However, most studies reported a higher proportion of migrant cases in this age group compared with non-migrants (43.2–83.4 % versus 41.6–72.5 % respectively) [32,40,55]. In contrast, the proportion of cases aged 45 years and over was lower among migrants (16.6 %–20.3 %) than among non-migrants (25.7–36.3 %). Notably, a study conducted in Saudi Arabia [35] showed a different pattern: 55.1 % of PTB cases among migrants were aged over 45 years, compared with only 0.3 % among non-migrants. Nevertheless, the mean age of 2,363 migrant TB cases in three countries [39,52,75] ranged from 22.5 to 33.7 years, whereas the mean age of 1,799 non-migrant TB cases was over 43 years (43.7–63.4 years). A pooled analysis of these data showed 12.3 years (95 %CI 8.8–16.0, $I^2 = 86.5$ %) lower mean age amongst migrant cases compared with non-migrant cases (Fig. 3).

Sex distributions were reported in twenty studies [30,32,33,35,39, 40,50,52,60,75,78,83], nine of which provided comparative data between migrant and non-migrant TB patients [30,32,33,35,39,40,50,52, 75]. These studies consistently found a higher number of male TB cases in both groups, however, a pooled analysis of 37,002 migrant and 43, 897 non-migrant TB cases, showed a higher male-to-female ratio in migrants (1F:5M versus 1F:3M respectively). In addition, the pooled proportion of male TB cases was also higher among migrants than non-migrants (OR: 1.2; 95 %CI 1.1–1.3, $I^2 = 80.7$ %).

3.6. Clinical characteristics of TB

Twenty studies from four countries reported data on EPTB in an overall total of 56,953 participants [33,40,41,47,48,54,61,67,68,70,80, 84]. Among these, nine studies [33,40,41,47,48,54,61,67,80,84] indicated that EPTB accounted for 30.4 % of cases among 28,502 migrant TB patients, compared to 35.7 % among 27,946 non-migrant TB patients (see Annex 7). Four hospital-based studies conducted across two countries reported a higher likelihood of specific EPTB localisations among 505 hospitalised patients. Migrants comprised 91–99 % of pleural TB admissions in two studies [67,70], while two other studies found that TB meningitis was more common among migrants than non-migrants (OR:11.5, 95 %CI 3.1–43.1) [54,68]. Additionally, a study from Kuwait reported that 91 % of 34 hospitalised cases of miliary TB occurred in migrants [85].

Seven studies reported drug resistance patterns [42–44,50,71,79, 80]. All but one of these studies in five GCC countries showed inconsistent trends in MDR-TB (defined as resistance to at least isoniazid and rifampicin) among migrants versus non-migrants [42,43,71,79,80,86], with reported ORs ranging from 0.6 (95 %CI 0.4–1.1) to 2.5 (95 %CI 0.2–40.9). Meta-analysis showed a non-significantly higher OR of MDR-TB among migrants compared non-migrants (pooled OR: 1.2, 95 % CI 0.9–1.6, $I^2 = 40.2$ %) (Fig. 4). Any-drug resistance (defined as resistance against at least one of the first-line TB drugs isoniazid, rifamycin, pyrazinamide, or ethambutol) was generally more common among

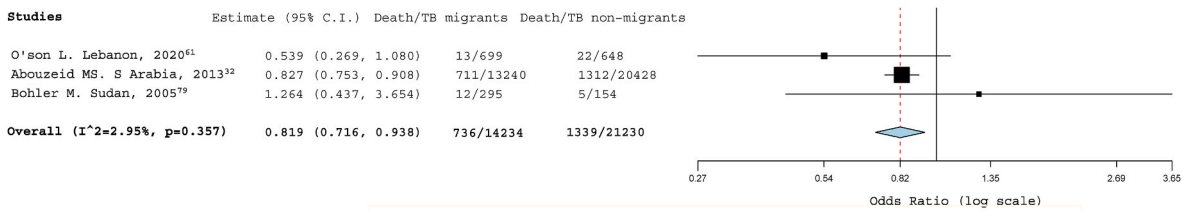

Fig. 2. Forest plot of the estimates for the association between TB fatality rate and migration.
TB: Tuberculosis.

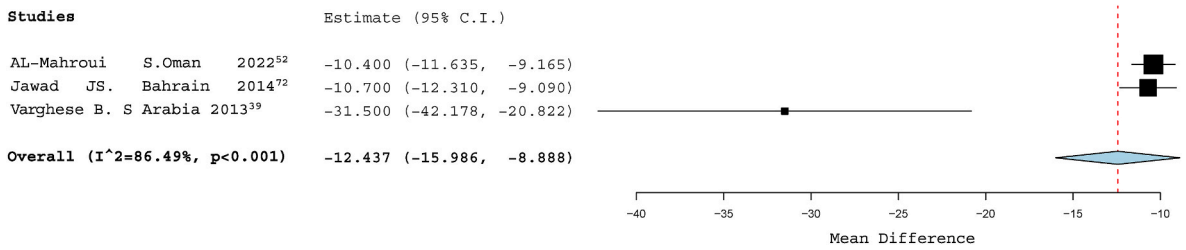

Fig. 3. Forest plot of the estimates of the pooled mean difference of age between migrant TB cases and non-migrant TB cases.
TB: Tuberculosis.

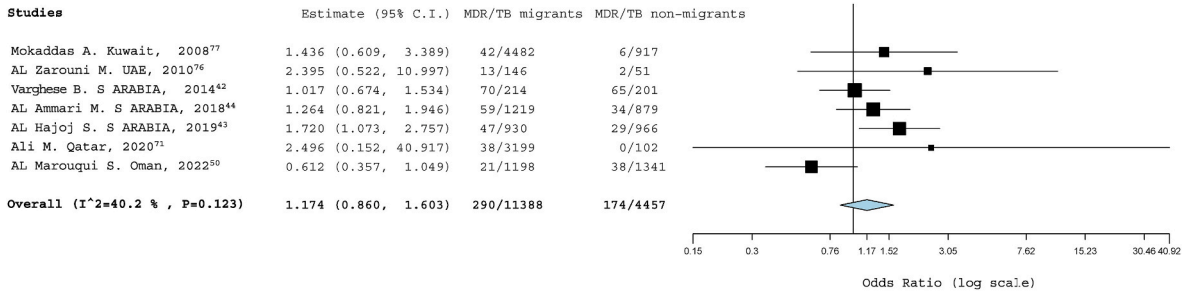

Fig. 4. Forest plot of the estimates for the association between multi-drug resistant TB and migration.
MDR: Multidrug-resistant; TB: Tuberculosis.

migrants, with ORs ranging from 1.1 (95 %CI 0.7–1.5) to 5.5 (95 %CI 3.9–8.0) in four studies [44,50,71,80].

4. Discussion

This systemic review provides the first comprehensive assessment of the burden, clinical outcomes, and epidemiological and clinical characteristics of TB among migrant versus non-migrant populations in the MENA region. Although we found 53 studies, three critical limitations emerged Data from North African countries was scarce and mainly sourced from grey literature, with minimal focus on migrant populations; overreliance on absolute case counts rather than incidence/prevalence measures; and predominant reliance on citizenship rather than migration status. Despite these gaps, ME data consistently found higher TB incidence and prevalence among migrants, with risk estimates up to four times higher than in non-migrants. However, the proportional contribution of migrants to total TB cases varied considerably across settings. Although TB-related mortality was about 20 % lower among migrants, their treatment success rates were consistently below the WHO 90 % target. Drug-resistant TB was generally more common among migrants (OR range: 1.1–5.5), though MDR-TB risk showed inconsistent results across studies (pooled OR 1.2, NS) (Annex 8).

Our finding that the prevalence and incidence of TB are higher in migrants than non-migrants in the MENA region is aligned with global trends. For example, Asadi et al. (2017) [87] reported that TB incidence among migrants in Aberta (Canada) was four times higher than the general population between 2002 and 2013. In Europe, a study in England found that migrants were 8.6 times more likely to have TB than non-migrants (95 % CI 7.9–9.3) [13]. Similarly, TB incidence among asylum-seekers and refugees was reported to be higher than that of the general population in several global contexts, including the Netherlands (754.0 vs 4.6 per 100,000 people), Germany (92 vs 5.3), and India (431 vs 181)[88–90].

The lower TB-related mortality observed among migrants in the ME region is consistent with the results of several European studies[91–93]. In Italy, for example, non-migrants had seven times TB-related mortality than non-migrants [92]. This disparity is likely attributed to several factors, including the 'healthy migrant effect', and the key epidemiological and clinical differences identified between migrant and non-migrant TB cases in this review. EPTB was more common in non-migrant, and on average, migrant TB patients were 13 years younger than non-migrants [91,94]. Advanced age is a well-documented risk factor for TB-related mortality, increasing vulnerability through several mechanisms such as comorbidities (e.g., diabetes, cardiovascular diseases)that raise the risk of adverse reactions to treatment and complicate clinical presentation [47,48,61]. Older patients often present with atypical symptoms, contributing to diagnostic delays, particularly for EPTB [46,95].Age-related immunosuppression and malnutrition further worsen prognosis [32,91,94]. The higher prevalence of EPTB in non-migrants may partly reflect in GCC screening programmes that target PTB while EPTB cases are diagnosed passively. This can contribute to diagnostic delays or misdiagnosis, due both to the clinical

complexity of EPTEB and structural barriers within health systems [10,47,96,97].

While global evidence consistently shows that migrants are disproportionally represented among TB cases [12], our findings suggest considerable variability across MENA countries. This heterogeneity can be attributed to various methodological and contextual differences across studies. Firstly, study setting varied, with some studies conducted in hospital settings while others were based on national programmatic data. Secondly, there were discrepancies in the definitions of 'migrants', particularly between studies conducted in GCC and those carried out in other MENA countries. Thirdly, TB case definitions were not standardised. While some studies relied on bacteriological confirmation of TB, while others used radiological results and specific immune test. Finally, the differences may mirror the different demographic composition across MENA countries. For example, in 2021, migrants represented 88.5 % of the population in the UAE, 52.2 % in Bahrain, 41.6 % in Saudi Arabia, and only 1.3 % in Sudan [98]. These demographic differences may also explain the observed preponderance of TB cases among men and younger age groups. In the MENA region, particularly in GCC countries, the majority of migrants are young male labourers travelling alone [47,75]. This marked gender imbalance may reflect regional labour migration patterns, where employment opportunities are predominantly available to male workers in sectors such as construction and manual labour. These occupations often involve poor living and working conditions, which can increase TB exposure and transmission risk. Moreover, restrictive migration policies and sponsorship (Kafala) systems often limit the migration of women and families, further contributing to the gender imbalance among migrant TB cases in these settings [5,99]. This demographic pattern is aligned with data from Europe, where TB rates among migrants peak between the ages of 22 and 44 years [100], suggesting the presence of common epidemiological factors in migrant-receiving regions.

In line with global findings, our review found that migrant TB treatment success rates among migrants in the MENA region were below the WHO target of 90 % [91,101,102]. Several structural and systemic barriers contribute to this underperformance. Migrants often encounter limited healthcare access, exclusion from health entitlements, and linguistic or health literacy barriers [91,96]. In GCC countries, fear of deportation, repatriation policies, and the restrictive Kafala (sponsorship) system often discourage migrant workers from seeking timely medical care. These structural barriers create significant health risks, and also complicate follow-up and continuity of care [53,79,80,99]. Additionally, the lengthy TB treatment regimens can impose a disproportionate burden on migrants [96]. All these factors reflect broader systemic exclusions that compromise TB control efforts across the region.

These factors may also contribute to the higher observed rates of drug resistance among migrants [19,90,101,102]. While treatment non-adherence and HIV co-infection are established drivers of MDR-TB [19,93,102], the impact of HIV appears limited in the MENA region given to relatively low regional HIV prevalence and mandatory screening policies implemented by GCC countries [19,44]. Instead, incomplete treatment – exacerbated by the structural and policy barriers described – likely serves as the primary driver of drug resistance in migrant populations [43,45,59,71,95].

4.1. Strengthens and limitations

To our knowledge, this is the first review synthesising evidence on tuberculosis disparities between migrant and non-migrant populations across the MENA region, providing valuable insights into differential patterns disease burden, clinical outcomes, and epidemiological characteristics. However, several limitations must be acknowledged when interpreting these results. A fundamental constraint stems from how migration status was operationalised across studies. The available data were not systematically disaggregated by legal status or country of origin, which prevented detailed analysis of how specific migration pathways or origin countries might influence tuberculosis risk profiles. Moreover, despite targeting the full MENA region, limited data were identified from North African countries, limiting the generalisability of findings across the region. This may reflect lower TB prevalence in North African countries compared to Central and Sub-Saharan Africa [103–105]. The geographic gap noted in our review should be addressed in future research to ensure more comprehensive regional representation and better understanding of TB among migrants across the full MENA region. In addition, a harmonised operational definition of "migrant" that specifically synthesises the United Nations High Commissioner for Refugees (UNHCR), WHO, and IOM taxonomies may facilitate the comparability of TB-burden estimates across settings in future studies and reduce the classification heterogeneity observed in our review, for which a structured Delphi consensus process may be a useful tool. Currently, many studies on migrant TB screening focus only on regular migrants, excluding undocumented populations. Future data collection efforts should disaggregate findings by migrant type to ensure more comprehensive insights. Additionally, since this review includes studies published up to September 2024, future updates should incorporate newer research to account for potential epidemiological and clinical changes. These limitations, which primarily reflect gaps in existing surveillance systems and research priorities, necessitate cautious interpretation of the current findings.

Addressing these evidence gaps is critical for developing targeted and effective interventions that reflect the unique TB risks faced by migrant populations in the MENA region. Future research should consider disaggregated analyses by migrant type and country of origin to better tailor public health interventions. Multicentric studies are needed to examine how TB incidence, treatment outcomes, and access to care vary across migrant types and countries of origin in different MENA subregions, with particular attention to underrepresented areas such as North Africa. Additionally, research should explore gender-specific barriers to TB diagnosis and treatment among diverse migrant groups, as well as the social and structural determinants driving these disparities in various host settings, including the GCC countries and North Africa. It is also essential to assess the TB burden and risk profiles among second-generation and long-term resident migrants and compare these with those of first-generation and newly arrived migrants, to gain a deeper understanding of the evolving dynamics of TB risk.

In the meantime, clinicians and policymakers in the MENA region need to consider the wider implications of these findings for both TB management and programmatic strategies to align with the WHO's End TB Strategy. This strategy emphasises equity and prioritises vulnerable populations, including migrants. Lower treatment success rates and higher prevalence of multidrug-resistant TB (MDR-TB) among migrant populations highlight critical gaps in care that require urgent, tailored interventions. Such interventions require multi-sectoral, rights-based approaches grounded in regional collaboration. Ministries of Health in the MENA region must lead in providing inclusive services for all migrants, ensuring equitable access to high-quality prevention, screening, and treatment regardless of their legal status or ability to pay. In order to ensure continuity of care for these highly mobile populations, it is imperative that cross-border referral systems in this region be strengthened. Mobile and outreach services, particularly in high-risk setting, could be used for early detection of this disease. The WHO should promote operational research and inclusive health policies, as well as cross-country coordination and technical support. Humanitarian and civil society actors could play a key role in outreach activities, advocacy, and providing support to improve treatment adherence and trust in the health system.

5. Conclusion

This systematic review highlights critical disparities in TB epidemiology between migrant and non-migrant populations in the MENA

region. Migrants face an elevated risk of TB infection, treatment failure, and potentially the development of drug-resistant strains. These findings underscore the urgent need for tailored TB prevention and treatment services in the region to ensure health equity. However, substantial evidence gaps persist – particularly the absence of North African data – which must be addressed to develop effective, targeted interventions. Filling these knowledge gaps is essential for achieving TB elimination targets and advancing both the WHO TB strategy and the Sustainable Development Goals.

CRediT authorship contribution statement

Taha Maatoug: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Farah Seedat:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Eman Elafef:** Methodology, Formal analysis, Conceptualization. **Anissa Ouahchi:** Methodology, Conceptualization. **Ali Mtiraoui:** Methodology, Conceptualization. **Stella Evangelidou:** Methodology, Conceptualization. **Wejdene Mansour:** Methodology, Conceptualization. **Ana Requena-Méndez:** Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Conceptualization. **Dominik Zenner:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization.

Data sharing

All data used in this review were previously published.

Ethical considerations and consent

Not applicable.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tmaid.2025.102872.

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