

Prevalence of Pulmonary Non-Tuberculous Mycobacteria Among People with HIV: A Systematic Review

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ABSTRACT

Nontuberculous mycobacteria (NTM) can cause pulmonary disease in people with HIV, and its clinical picture closely resembles pulmonary tuberculosis (TB), so NTM is often diagnosed and treated as TB without bacteriological confirmation. This systematic review, reported according to PRISMA 2020, synthesized observational studies of culture-confirmed pulmonary NTM among people with HIV to determine the prevalence of NTM among people with HIV, the prevalence of HIV among confirmed NTM cases, the distribution of NTM species, and the reported clinical characteristics. Twelve studies were included from 678 records identified. Methodological quality was assessed with a modified Newcastle-Ottawa Scale, and findings were synthesized narratively because of substantial heterogeneity. Two studies reported a true HIV-stratified prevalence of pulmonary NTM (11.8% and 2.0%), while eight studies reported the prevalence of HIV among confirmed NTM cases, ranging from 9.8% to 78.0% (sample-size-weighted average 40.6%). *Mycobacterium avium* (35.7%) and *M. kansasii* (21.8%) were the most common species. Respiratory (mean 69.5%) and systemic (mean 56.0%) symptoms were the most frequently reported manifestations and closely resembled pulmonary TB. No study was rated as high risk of bias, although only three of twelve were rated low risk. Pulmonary NTM is a clinically significant differential diagnosis in people with HIV and presumptive TB, which supports routine bacteriological confirmation. The scarcity of studies reporting a true HIV-stratified denominator is a priority for future research.

Keywords: nontuberculous mycobacteria; HIV; pulmonary disease; prevalence; *Mycobacterium avium* complex; systematic review

INTRODUCTION

Nontuberculous mycobacteria (NTM) are environmental mycobacteria distinct from *Mycobacterium tuberculosis* and *M. leprae*. Besides persisting in natural environments, they can invade the human body and cause lung disease, particularly in people with low immunity [1, 2]. In people living with HIV, pulmonary NTM disease deserves vigilance: it presents with chronic cough, fever, and weight loss, and chest imaging shows infiltrates or cavities, a picture almost identical to pulmonary TB [3]. Because people with HIV already carry a high baseline risk of TB, clinicians often diagnose and treat NTM as TB without bacteriological confirmation, and NTM escapes clinical suspicion.

Researchers have tracked the changing epidemiology of NTM with growing attention over the past two decades [4]. Global NTM isolation rates are approximately 2.46% of mycobacteriology samples [5], but the global burden of pulmonary NTM disease

remains unknown because most countries do not require NTM reporting. In Indonesia and other high-TB-burden countries, NTM is often unrecognized, and a TB diagnosis is assumed when specialized laboratories are out of reach. A study from Surakarta, Central Java, found that 15% of 1,636 acid-fast bacilli-positive cultures were NTM rather than TB [6].

Reduced cellular immunity, particularly a low CD4 count, raises the risk of opportunistic mycobacterial infection, including NTM [3]. Primary studies of pulmonary NTM among people with HIV differ widely in method, and few report a prevalence figure that is comparable across studies; differences in denominator structure and study population account for much of this variation. Species-level data additionally require bacteriological culture [5]. No clear synthesis currently exists of how often culture confirms pulmonary NTM among people with HIV.

This review therefore synthesizes the published evidence on culture-confirmed pulmonary NTM among people with HIV, covering the prevalence of NTM among people with HIV, the prevalence of HIV among confirmed NTM cases, the distribution of NTM species, and the reported clinical characteristics.

METHODS

Study Design

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [7]. The population was people with HIV, with or without an HIV-negative comparator group; the condition of interest was pulmonary NTM infection confirmed by bacteriological culture; the outcomes were the prevalence of pulmonary NTM, NTM species distribution, and clinical characteristics; and the eligible designs were observational studies (cross-sectional and cohort).

Eligibility Criteria

Studies were eligible if they involved adults living with HIV; reported original, extractable data on pulmonary NTM confirmed by bacteriological culture, which is required for species-level identification; used a cross-sectional, cohort, or case-series design; allowed the HIV and pulmonary NTM populations to be clearly identified; and were published in any year. Single-patient case reports, narrative reviews, editorials, letters and conference abstracts without extractable data were excluded, as were studies of HIV-negative populations only or in which HIV-specific data could not be disaggregated, studies in which pulmonary NTM was not the condition of interest, studies relying solely on non-culture diagnostics, studies of extrapulmonary NTM without separate pulmonary data, and animal, *in vitro* or environmental studies.

Information Sources and Search Strategy

PubMed/MEDLINE, Scopus, Embase and Web of Science were searched using Boolean combinations of terms for HIV (e.g. people with HIV, HIV-positive, PLHIV), NTM (e.g. nontuberculous mycobacteria, pulmonary NTM, atypical mycobacteria) and study design. Grey literature was searched through Google Scholar and ProQuest, and the reference lists of included studies and relevant reviews were hand-searched.

Study Selection and Data Extraction

Records were imported into Rayyan and screened for duplicates, then titles and abstracts were screened, followed by full-text review. Reviewers were blinded to each other's decisions, and disagreements were resolved by discussion. Extracted data included the first author and year, location, study design, population characteristics, sample size, diagnostic method used to confirm NTM, species identified, prevalence of pulmonary NTM, clinical characteristics, and the pulmonary versus extrapulmonary distribution.

Quality Assessment

Methodological quality was assessed with a modified Newcastle-Ottawa Scale (NOS) for cross-sectional and observational studies [8], because the included studies span cross-sectional, prospective cohort, and retrospective cohort designs. A maximum of 10 stars was available across selection (5), comparability (2), and outcome (3). Scores of 7–10 were classified as low risk of bias, 4–6 as moderate, and 0–3 as high. No study was excluded based on quality.

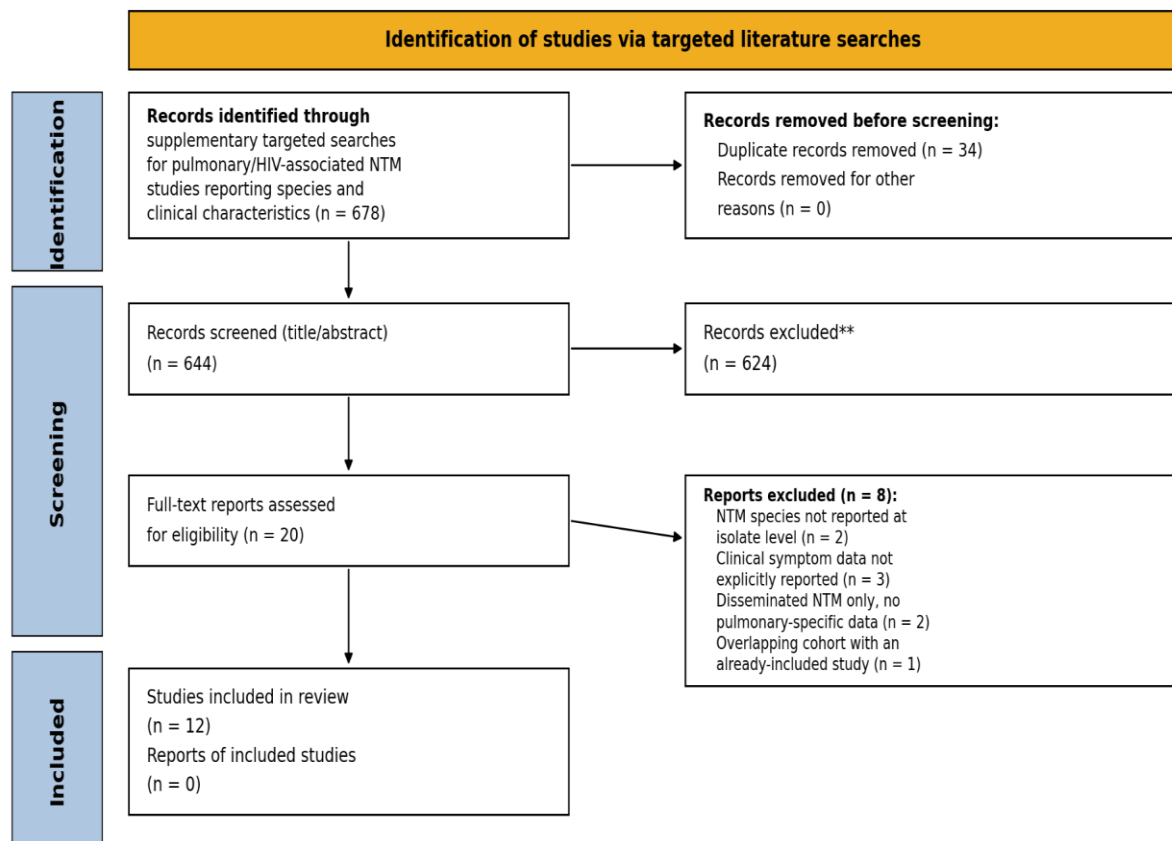
Data Synthesis

The primary outcomes were the prevalence of pulmonary NTM among people with HIV and the prevalence of HIV among confirmed pulmonary NTM cases, extracted as percentages with numerators and denominators. Because of substantial heterogeneity in populations, settings, specimens, diagnostic methods, and outcome definitions, findings were synthesized narratively [7,9]. Where studies reported comparable outcomes, individual estimates are shown together with descriptive unweighted and sample-size-weighted averages; these describe the distribution of reported estimates and are not pooled prevalence estimates.

RESULTS

Study Selection

A total of 678 records were identified; 34 duplicates were removed, and 624 records were excluded after title and abstract screening, leaving 20 reports for full-text review (Figure 1). Eight were excluded: two did not report NTM species at isolate level, three did not explicitly report clinical symptom data, two reported disseminated NTM only without pulmonary-specific data, and one was a cohort overlapping with an included study. Twelve studies were included.

**FIGURE 1:** PRISMA 2020 Flow Diagram of Study Selection.**TABLE 1:** Characteristics and Risk of Bias of Included Studies.

Study	Country	Population	N	Diagnostic Method	NOS (/10)
Saritsiri, 2006 [10]	Thailand	NTM culture-positive	103	Culture	6 (Moderate)
Zamarioli, 2008 [11]	Brazil	Individuals with NTM strains	125	Culture + hsp65	6 (Moderate)
Chou, 2011 [12]	Taiwan	Disseminated NTM	40	Culture + 16S rRNA	4 (Moderate)
McCarthy, 2012 [13]	Southeast Asia	HIV-positive only	1,060	Culture + genotype	7 (Low)
Couto de Mello, 2013 [14]	Brazil	Pulmonary NTM patients	174	Culture + hsp65	5 (Moderate)
Blanc, 2016 [15]	France	NTM infections	170	Culture + genotype	5 (Moderate)
Kone, 2018 [16]	Mali	Suspected TB	439	Culture + molecular	8 (Low)
Carneiro, 2018 [17]	Brazil	NTM lung disease	100	Culture + PCR	5 (Moderate)
Busatto, 2020 [18]	Brazil	Suspected TB (NTM subset)	1,248	Culture + PCR (hsp65/rpoB) + sequencing	6 (Moderate)
Ochayo, 2023 [19]	Kenya	Presumptive TB, HIV+/HIV-	617	Culture + LPA	8 (Low)
Nqwata, 2024 [20]	South Africa	NTM patients	123	Culture + genotype	6 (Moderate)
Młóżniak, 2026 [21]	Poland	HIV-positive with NTM	59	Culture + genotype	4 (Moderate)

NOS = modified Newcastle-Ottawa Scale; LPA = line probe assay; PCR = polymerase chain reaction.

TABLE 2: NTM Species and Clinical Findings Reported by Included Studies.

Study	Main NTM Species	Clinical Characteristics
Saritsiri, 2006	MAC 48.5%, <i>M. kansasii</i> 19.4%, RGM 16.4%	Fever 67%, cough 54.4%, lymphadenopathy 52.4%, weight loss 50.5%, diarrhea 31%
Zamarioli, 2008	<i>M. kansasii</i> 20.0%, MAC 18.4% (HIV+: MAC 25.0%, <i>M. fortuitum</i> 11.5%)	Not reported
Chou, 2011	MAC 70%	Fever 52.5%, lung involvement 42.5%
McCarthy, 2012	<i>M. kansasii</i> 67% (of pulmonary disease)	Respiratory 77%; non-respiratory 94%
Couto de Mello, 2013	<i>M. kansasii</i> 33.9%, MAC 30.4%, <i>M. abscessus</i> 13.2%, <i>M. fortuitum</i> 8.0%	Respiratory only 60.9%; fever + weight loss 8.6%; respiratory + systemic 30.5%
Blanc, 2016	<i>M. avium</i> 31.8%, <i>M. intracellulare</i> 20%, <i>M. kansasii</i> 10.6%	Respiratory 70.6%; non-respiratory 43.5%
Kone, 2018	<i>M. avium</i> 50%, <i>M. simiae</i> 10%, other 40%	Bacillus impregnation syndrome 46.3%
Carneiro, 2018	MAC 35%, <i>M. kansasii</i> 17%, <i>M. abscessus</i> 12%	Prior TB 85%; AIDS comorbidity 24%
Busatto, 2020	<i>M. avium</i> 72%, <i>M. abscessus</i> 20%, <i>M. kansasii</i> 4%	Not reported
Ochayo, 2023	<i>M. avium</i> 33.3%, <i>M. fortuitum</i> 26.7%, <i>M. kansasii</i> 11.8%	Chronic productive cough >2 weeks, appetite loss, fever, fatigue, headache, night sweats
Nqwata, 2024	MAC-PD 74%, <i>M. fortuitum</i> 5%, <i>M. gordonae</i> 4%	Previous TB 44.9%; concurrent <i>M. tuberculosis</i> 39.0%; cavitory lesions 41.4%
Młóżniak, 2026	<i>M. kansasii</i> (colonization) <i>M. avium</i> (disease)	Cough, fatigue, malaise, dyspnea, fever, hemoptysis, chest pain, weight loss; late HIV diagnosis 90%

MAC = *M. avium* complex; RGM = rapidly growing mycobacteria; PD = pulmonary disease.

Study Characteristics

All twelve studies were observational: three cross-sectional, one prospective cohort and eight retrospective cohort studies. Four studies were conducted in Brazil and one each in Thailand, Taiwan, Mali, Poland, South Africa, France and Kenya; one further study covered three countries (Cambodia, Thailand and Vietnam). Publication years ranged from 2006 to 2026. Two studies also enrolled or reported HIV-negative comparator data (Ochayo and Zamarioli). Sample sizes ranged from 40 to 1,248 (Table 1). All studies confirmed NTM by bacteriological or molecular methods; none relied on symptoms or radiology alone.

The populations were defined in two ways. Three studies defined their population by TB or HIV status before NTM was established (presumptive-TB, HIV-positive or suspected-TB cohorts) [13, 16, 19]; their denominators suit prevalence estimation. The other nine began with populations already identified as NTM-related, so HIV status was a characteristic of the population rather than the basis of sampling. A larger total sample did not mean more information on prevalence: Busatto included 1,248 patients but identified only 25 NTM-positive cases [18].

Risk of Bias

Three studies (Ochayo, 8/10; Kone, 8/10; McCarthy, 7/10) were rated low risk of bias, and nine were rated moderate risk (4–6/10); none was rated high risk (Table 1). All twelve scored full marks for exposure ascertainment because of universal culture confirmation. Comparability was the most frequently unscored item (nine of twelve studies), reflecting the largely descriptive, unadjusted nature of this literature. Most moderate ratings arose because the sample frame was already restricted to confirmed NTM cases, which limits representativeness for prevalence but not the validity of the species and clinical characterization.

Prevalence of Pulmonary NTM Among People with HIV

Only two studies provided a true HIV-stratified prevalence (Table 3). Ochayo et al. found NTM in 62 of 523 HIV-positive patients with presumptive TB in Kenya (11.8%), compared with 2 of 94 HIV-negative patients (2.1%) [19]. McCarthy et al. reported 2.0% (19 of 1,060) in an HIV-care cohort in Southeast Asia, without an HIV-negative comparator [13]. Kone et al. and Busatto et al. reported overall NTM prevalence in suspected-TB populations (9.3% and 2.0%), with HIV-positive patients forming 17.1% and 65.0% of the NTM-positive subgroup, respectively;

an HIV-specific prevalence cannot be reconstructed from either [16, 18]. The estimates were too heterogeneous to pool.

TABLE 3: HIV-Stratified Prevalence of Pulmonary NTM.

Study	Setting	HIV+ (N)	NTM+	PREV. (HIV+)
Ochayo, 2023 [19]	Presumptive TB, Kenya	523	62	11.8%
McCarthy, 2012 [13]	HIV cohort, SE Asia	1,060	19	2.0%

Ochayo et al. also reported 2.1% (2/94) in HIV-negative patients; McCarthy et al. had no comparator.

Prevalence of HIV Among NTM Cases

Eight studies reported the proportion of HIV-positive patients among confirmed NTM cases (Table 4). The proportion ranged from 9.8% to 78.0%, an almost eight-fold difference. The sample-size-weighted average was 40.6% (363 of 894 NTM cases), and the unweighted average of the eight percentages was 46.9%. Higher proportions came from South Africa (78.0%), Poland (76.3%), and Thailand (68.9%), and lower proportions from Brazil (9.8–41.6%) and France (21.2%). The Polish cohort was assembled through HIV-focused services, yet only 45 of 59 NTM patients were HIV-positive, so it was retained in this analysis.

TABLE 4: Prevalence of HIV Among NTM Cases.

Study	Setting	HIV+ / NTM	HIV+ (%)
Saritsiri, 2006 [10]	Thailand	71 / 103	68.9
Zamarioli, 2008 [11]	São Paulo, Brazil	52 / 125	41.6
Chou, 2011 [12]	Taiwan	22 / 40	55.0
Couto de Mello, 2013 [14]	Rio de Janeiro, Brazil	17 / 174	9.8
Blanc, 2016 [15]	France	36 / 170	21.2
Carneiro, 2018 [17]	Porto Alegre, Brazil	24 / 100	24.0
Nqwata, 2024 [20]	South Africa	96 / 123	78.0
Młóznik, 2026 [21]	Poland	45 / 59	76.3
Total (weighted)		363 / 894	40.6

NTM Species Distribution

Eleven of twelve studies reported at least one dominant species. Across all isolates, *M. avium* accounted for 35.7% and *M. kansasii* for 21.8%, together 57.5% (Figure 2). Other species were *M. fortuitum* (5.6%), *M. abscessus* (4.6%), *M. intracellulare* (4.0%), and isolates reported only as *M. avium* complex (MAC, 3.4%).

A further 11.9% were grouped as other species (including *M. simiae*, *M. gordonae*, *M. peregrinum* and *M. xenopi*) and 11.7% were not identified to species level. Some studies reported *M. avium* and others only MAC, which reflects the level of identification rather than distinct organisms. MAC dominated Nqwata (74%) and Chou (70%), whereas *M. kansasii* led in McCarthy (67% of pulmonary disease cases); Blanc was the exception, with five species distributed fairly evenly (1.8% to 10.6%).

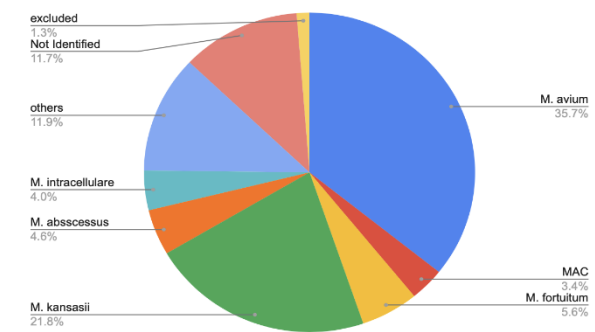


FIGURE 2: Distribution of NTM Species Across Included Studies.

Clinical Characteristics

Clinical data were less consistently reported than species data, and several key variables (age, antiretroviral therapy status, and mortality) were not reported by any study. Respiratory symptoms were reported in three studies (77%, 70.6% and 60.9%; mean 69.5%) [13, 14, 15], and systemic symptoms in the same three (94%, 43.5% and 30.5%; mean 56.0%), the widest spread of any category. Fever was quantified in four studies (8.6% to 67%; mean 43.6%) and weight loss in three (8.6% to 50.5%; mean 35.1%). Lymphadenopathy (52.4%) and diarrhea (31%) were reported only by Saritsiri et al. [10], and Kone et al. grouped fever, night sweats, weight loss, anorexia and fatigue as a composite “bacillus impregnation syndrome” (46.3%) [16]. Nqwata et al. reported previous TB in 44.9%, concurrent *M. tuberculosis* in 39.0% and cavitory lesions in 41.4% [20], and Carneiro et al. reported previous TB in 85% [17]. Where site of disease was measured, pulmonary disease predominated (53.9% to 92%), but extrapulmonary or disseminated disease was substantial in some cohorts (45.9% in Blanc; 46.1% in Młóznik) [15, 21].

DISCUSSION

Principal Findings

This review integrated twelve studies in which all participants were people with HIV and pulmonary NTM was confirmed by culture. Pulmonary NTM must be part of the differential diagnosis in this population, especially in patients presenting with TB-like symptoms. Reported prevalence varied widely and could not be combined into one unified figure, because study populations, clinical settings, diagnostic procedures, case definitions and eligibility rules were not standardized.

Prevalence

The two HIV-stratified estimates (11.8% and 2.0%) should not be read as evidence of different underlying risk between Kenya and Southeast Asia. Ochayo et al. enrolled only patients already registered for TB screening, which inflates the detected prevalence, whereas McCarthy et al. enrolled all HIV-positive patients in routine care regardless of symptoms. Reported NTM prevalence also depends on case ascertainment and laboratory methodology rather than on biological risk alone [22]. The range of 2.0–11.8% is therefore reported as separate, context-specific estimates. The wide range of HIV proportions among NTM cases (9.8–78.0%) is plausibly explained by differences in background HIV prevalence, referral and recruitment channels (for example, HIV-focused centers versus general respiratory clinics), and the two decades over which antiretroviral access and diagnostics changed. These figures are descriptive summaries of this evidence base, not precise generalizable parameters.

Clinical Overlap and Diagnostic Considerations

The symptoms of pulmonary NTM (fever, cough, weight loss and lymphadenopathy) overlap almost completely with those of pulmonary TB, and progressive HIV disease can itself cause similar constitutional symptoms. None of the included studies identified a symptom or combination with enough discriminatory value to separate NTM from TB or HIV progression, and one study documented concurrent NTM and *M. tuberculosis* infection [20]. Acid-fast smear microscopy cannot distinguish NTM from *M. tuberculosis* [23], so bacteriological culture is the minimum standard, ideally with molecular species identification [24]. This matters because MAC and *M. kansasii* require different regimens from each other and from standard TB therapy [25]. Poor response to anti-tuberculous treatment should prompt consideration of NTM, rather than an assumption of drug-resistant TB or non-adherence alone.

Species, Geography and the HIV–NTM Relationship

M. avium complex and *M. kansasii* predominated despite studies spanning nine countries and two decades, consistent with their established role in HIV-associated immunosuppression [26], but their relative shares varied by setting. Geographic coverage was uneven: Brazil contributed four of twelve studies, Southeast Asia was represented by one multi-country cohort, and no Indonesia-specific study was identified. Lower-resource settings should not be assumed to carry a higher true burden; they may simply detect and report less NTM because culture and molecular capacity are limited. CD4 count was reported in only four studies, none of which allowed testing of a dose–response relationship, so this review cannot confirm a quantitative link between immunosuppression and NTM risk. In the Polish cohort, the lowest median CD4 count (25 cells/mm³) coincided with the highest proportion of disseminated disease (41.0%) [21], which is directionally consistent with the expected gradient but is a single study-level observation.

Implications for Practice and Research

Clinicians should consider pulmonary NTM in people with HIV and TB-compatible symptoms, particularly when response to TB therapy is poor, and should confirm by culture with species identification rather than rely on smear positivity. Mistaking NTM for TB delays effective therapy and risks unnecessary toxicity, whereas a missed TB diagnosis carries transmission risks. Routine NTM case ascertainment could be added to existing TB program surveillance where culture capacity exists. Future work should include prospective multicenter studies with a defined HIV-positive population and, ideally, an HIV-negative comparator; standardized diagnostic criteria combining culture and molecular species identification; standardized reporting of CD4 count, age, antiretroviral therapy status and mortality; and studies in under-represented regions, particularly Southeast Asia and Indonesia.

Strengths and Limitations

Strengths include the strict requirement for culture confirmation, the exclusive focus on people with HIV, wide geographic coverage, and the integration of prevalence, species, clinical, and geographic evidence. Limitations include substantial heterogeneity that precluded pooled estimation, differing diagnostic criteria, populations and sample sizes (40 to 1,248), incomplete clinical reporting (quantified symptom data from only four studies), pronounced geographic imbalance, and unresolved species identification in 11.7% of isolates. Publication or reporting bias, and the omission of relevant studies, cannot be excluded.

CONCLUSIONS

Pulmonary NTM is a genuine and clinically significant diagnostic consideration among people with HIV. Only two of twelve studies reported HIV-stratified prevalence (2.0–11.8%), while HIV prevalence among confirmed NTM cases ranged from 9.8% to 78.0% (weighted average 40.6%). *M. avium* (35.7%) and *M. kansasii* (21.8%) dominated, and the symptom profile closely overlaps with pulmonary TB. Routine bacteriological confirmation with species identification is recommended in HIV-positive patients with presumptive TB, together with strengthened culture and molecular capacity and integration of NTM surveillance into TB programs, especially in high-TB-burden settings.

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