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Global patterns and clinical outcomes of endocrine gland involvement in tuberculosis: A comprehensive mini-review

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Abstract

Background: Tuberculosis (TB) remains a significant global health challenge, particularly in low- and middle-income countries where extrapulmonary forms—including endocrine gland involvement—often go unrecognized. Endocrine tuberculosis (ETB) can affect the adrenal, pituitary, thyroid, and gonadal glands, typically presenting with nonspecific symptoms that mimic tumors or autoimmune disorders. Emerging literature highlights the importance of timely diagnosis and treatment in preserving endocrine function.

Objective: To summarize the global prevalence, clinical features, pathophysiological mechanisms, therapeutic response, and hormonal outcomes of tuberculosis involving major endocrine glands, based on validated research published between 2000 and 2025.

Methods: A structured narrative mini review was conducted following PRISMA principles. Systematic literature searches were performed in PubMed, Scopus, and Google Scholar using combinations of keywords and Mesh terms related to "tuberculosis," "endocrine," "adrenal," "pituitary," "thyroid," and "gonads." Eligible articles included original peer-reviewed studies, reviews, and case series (n ≥ 3) published between 2000 and 2025 in English. Studies were selected if they reported endocrine TB involvement with clinical manifestations, hormonal effects, therapeutic interventions, and outcomes. From 164 screened abstracts, 72 full-text articles were reviewed, and 45 high-quality studies (Newcastle-Ottawa score ≥6) were included. Data were organized by glandular site, clinical effect, treatment modality, and reversibility.

Results: Adrenal TB was the most frequently reported (42%), typically presenting as primary adrenal insufficiency. Biochemical recovery was observed in 80–90% of patients treated early with anti-tuberculous therapy (ATT), while irreversible cases required lifelong steroid therapy. Pituitary TB (29%) frequently mimicked seller tumors, leading to panhypopituitarism or diabetes insipidus; hormonal improvement was noted in 60–75% of early-treated cases. Thyroid TB (17%) often resembled malignancy or multinodular goiter; surgical excision with ATT led to functional restoration in most cases. Gonadal involvement (12%) presented as pubertal delay or hypogonadism, primarily secondary to hypothalamic-pituitary axis disruption, with pediatric patients demonstrating good recovery following therapy. Pathophysiological mechanisms included hematogenous dissemination, granulomatous inflammation, and immune reconstitution inflammatory syndrome (IRIS), particularly in immunocompromised hosts. Prognosis correlated strongly with diagnostic timing, degree of tissue necrosis, and comorbidities such as HIV. The most severe presentations were noted in sub-Saharan Africa and South Asia, reflecting healthcare disparities and delayed diagnosis.

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Conclusions: Although often underdiagnosed, endocrine tuberculosis has substantial clinical implications. Adrenal and pituitary glands are most commonly involved. With early detection and appropriate therapy, most endocrine dysfunctions are reversible. Enhanced awareness, interdisciplinary care, and long-term follow-up are vital for improving outcomes, especially in TB-endemic regions.

Keywords: Endocrine Tuberculosis; Adrenal Insufficiency; Pituitary Dysfunction; Hormonal Recovery; And Anti-Tuberculosis Therapy (ATT)

1. Introduction

Tuberculosis (TB), an infectious disease caused by Mycobacterium tuberculosis, continues to pose a significant public health threat

low- and middle-income countries. While pulmonary involvement is the most recognized form, extrapulmonary TB—especially affecting the endocrine system—remains underreported and often misdiagnosed (1).

Although not commonly encountered, TB can affect multiple endocrine glands including the adrenal, pituitary, thyroid, and gonads. Among these, adrenal involvement is the most frequent and may lead to overt Addison's disease or milder forms of adrenal insufficiency (2–5).

Timely recognition of these hormonal imbalances is essential, as many of them can be reversed if appropriate therapy is initiated early (4).

Data from autopsy series and clinical case reviews suggest that adrenal TB may be present in up to 30% of TB cases in endemic areas (3). Tuberculous involvement of the pituitary, although relatively rare, can have serious consequences, especially in children. It may result in hypopituitarism, delayed growth, and pubertal failure due to granulomatous inflammation of the gland (6–10).

Thyroid TB is a particularly rare form that poses diagnostic challenges. Its clinical presentation often mimics more common thyroid conditions such as neoplasia or subacute thyroiditis, necessitating histopathologic confirmation for accurate diagnosis (11).

Epidemiologic trends from Asia, Africa, and South America reveal marked differences in both the frequency and presentation of endocrine TB. Poor access to specialized care and delays in diagnosis frequently lead to advanced disease and poorer outcomes in these regions (12– 14).

Despite advancements in diagnostic imaging and endocrine testing, many cases of endocrine TB are only identified intraoperatively or through histopathological evaluation of resected tissue (13–15).

The likelihood of reversing endocrine dysfunction depends significantly on early detection and the prompt initiation of anti-tuberculous therapy (ATT). While adrenal and thyroid abnormalities can often resolve with treatment, pituitary involvement tends to be less reversible, particularly when fibrosis or necrosis has occurred (15,16).

This mini-review aims to synthesize recent evidence (2000–2025) on endocrine tuberculosis, analyze global and clinical variability, and explore how treatment influences recovery across different glands.

Objectives

- To assess the frequency and distribution of TB-related endocrine involvement in various geographic and demographic settings.
- To describe clinical features, diagnostic difficulties, and management strategies for TB affecting the adrenal, pituitary, thyroid, and gonadal glands.
- To evaluate the potential for functional recovery following ATT and/or surgical intervention, based on gland type, timing of diagnosis, and patient background.

2. Materials and Methods Study Design

This work is structured as a focused narrative mini-review aimed at examining the prevalence, clinical features, and treatment outcomes of tuberculosis (TB) involving the endocrine glands. The review compiles and evaluates literature published between 2000 and 2025. All sources referenced are drawn from validated peer-reviewed journals and verified academic databases.

2.1. Search Strategy

Google Scholar (used to identify grey literature and complementary sources)
A combination of keywords and Mesh terms was applied to refine the search. These included: "Endocrine tuberculosis," "adrenal TB," "pituitary tuberculosis," "thyroid TB," "tubercular hypophysis's," "hypercortisolism," "hypopituitarism," "gonadal TB," "endocrine dysfunction AND tuberculosis," "treatment outcome AND TB," "reversibility of endocrine TB," and "prevalence endocrine tuberculosis."

2.2. Inclusion Criteria

2.2.1. Studies were included if they met the following criteria

- Published between January 2000 and July 2025
- Peer-reviewed articles including original research, case series, reviews, or meta-analyses
- Written in English
- Focused on endocrine gland involvement due to confirmed or suspected Mycobacterium tuberculosis

Contained clinical information, treatment details, and documented outcomes.

2.3. Exclusion Criteria

2.3.1. Articles were excluded based on the following conditions

- Non-English language
- Studies conducted solely on animals or in vitro models
- Research focused on non-tuberculous mycobacterial infections
- Reports lacking clinical endocrine outcome data (e.g., histological findings without hormonal relevance)
- Duplicated publications or editorials without new data Extraction and Validation

Two independent reviewers systematically extracted relevant information using a standardized form. Data points included

- Country and region of the study
- Patient demographics (age, sex, and socioeconomic background)
- Affected endocrine gland(s)
- Clinical presentation
- Diagnostic methods utilized
- Treatment modalities (medical and/or surgical) and duration
- Hormonal outcomes and degree of reversibility Quality Assessment

2.3.2. To assess methodological quality, the following tools were used

- Modified Newcastle-Ottawa Scale (NOS) for observational research
- Joanna Briggs Institute (JBI) Critical Appraisal Tools for case series and reports
- AMSTAR-2 for evaluating systematic reviews and meta-analyses
- Only those studies meeting minimum quality benchmarks (NOS ≥ 5 out of 9 or JBI rated as "low risk of bias") were considered eligible for inclusion.
- Statistical and Thematic Synthesis
- Descriptive statistics were applied to summarize prevalence data and endocrine recovery rates by gland and region.
- Findings were categorized by gland type, clinical impact, therapeutic approach, and reversibility outcome.
- Qualitative comparisons were made by geography, sex, and age group.

3. Results

A total of 45 peer-reviewed studies published between 2000 and 2025 were analyzed, encompassing global data on tuberculosis-related involvement of endocrine organs such as the adrenal, pituitary, thyroid, and gonads. The studies revealed a wide range of endocrine presentations and gland-specific complications, with notable variation in treatment response influenced by factors such as geographic region, patient age, and access to healthcare services.

Table 1 Endocrine Gland Involvement in Tuberculosis

Ref	Author (Year)	Country / Region	Endocrine Gland	Type of Dysfunction	Prevalence / Key Findings	Journal Name
1	Dhawal DK (2011) (2)	India	Adrenal	Addison's disease	Common endocrine TB manifestation	Endor Pact
2	Lam KY (2001) (3)	Hong Kong	Pituitary	Hypopituitarism	TB hypophyses found in autopsy cases	Histopathology
3	Barnes DJ (2009) (5)	UK (Immigrant cohort)	Adrenal	Adrenal insufficiency	Detected in TB patients via ACTH test	Int J Tuber Lung Dis
4	Wang J (2018) (11)	China	Thyroid	TB thyroiditis	Rare; presents as thyroid nodule	BMC Endor Discord
5	Tao reed et al 2021(17)	Nigeria	Adrenal	Subclinical adrenal insufficiency	The frequency of adrenal insufficiency in patients with pulmonary TB can be as high as 50%. The p	Int J Mycobacterial . 2021
6	Desai et al, 2003 (18)	India	Pituitary	TB hypophysis's	Presented with diabetes insipidus	*J Clin Neurosis*.
7	Stuti et al, (2022)(19)	India	Adrenal	Adrenal enlargement + insufficiency	Imaging useful in TB diagnosis	Surg J (N Y)
8	Liu et 2022) (20)	Pakistan	Adrenal	Unilateral adrenal Mass	Mimics adrenal tumors; responded to treatment	World J Clin Cases.
9	Bashir et al (2024) (21)	Brazil	Adrenal	Functional suppression responded to treatment	TB-related cortisol suppression documented	Arch Endocrinol Meta.
10	Fatma et al 2017 (22)	Qatar	Pituitary	Biopsy proven without imaging signs	severe headache and left third cranial nerve palsy	Am J Case Rep.
11	Nuzhat H et al (2008) (23)	India	Pituitary	TB hypophysis's	A seller mass diagnosed as pituitary adenoma in MRI	BMC Res Notes
12	Agnes et al (2020) 24)	Germany	Adrenal	Functional adrenal insufficiency (FAI)	The proportion with FAI was 59.8%. in among tuberculosis-human immunodeficiency virus co-infected patients	BMC Res Notes
13	Ali et al 2009 (25)	Oman	Adrenal	TB of the adrenal glands	Addison's disease	Sultan Qaboos Univ Med J.

14	Pour Akbari et al 2019 (26)	Iran	Adrenal	Adrenal TB in HIV co-infection	Co-morbidity increases the risk of adrenal involvement risk	Ann Ig.
15	Davis et al 2024 (27)	Ethiopia	Adrenal	A meta-analysis of 46 studies with 4044 adults,	Adrenal insufficiency was found in 33% of tuberculosis patients and 28% of those with HIV.	Open Forum Infect Dis.

Table 1 emphasizes that the adrenal and pituitary glands are the most frequently involved endocrine sites in tuberculosis, with documented cases spanning regions including Asia, Africa, South America, and parts of Europe. Adrenal tuberculosis typically presents as Addison's disease or mild, subclinical adrenal insufficiency, while pituitary TB often results in hormonal deficits such as hypopituitarism or diabetes insipidus.

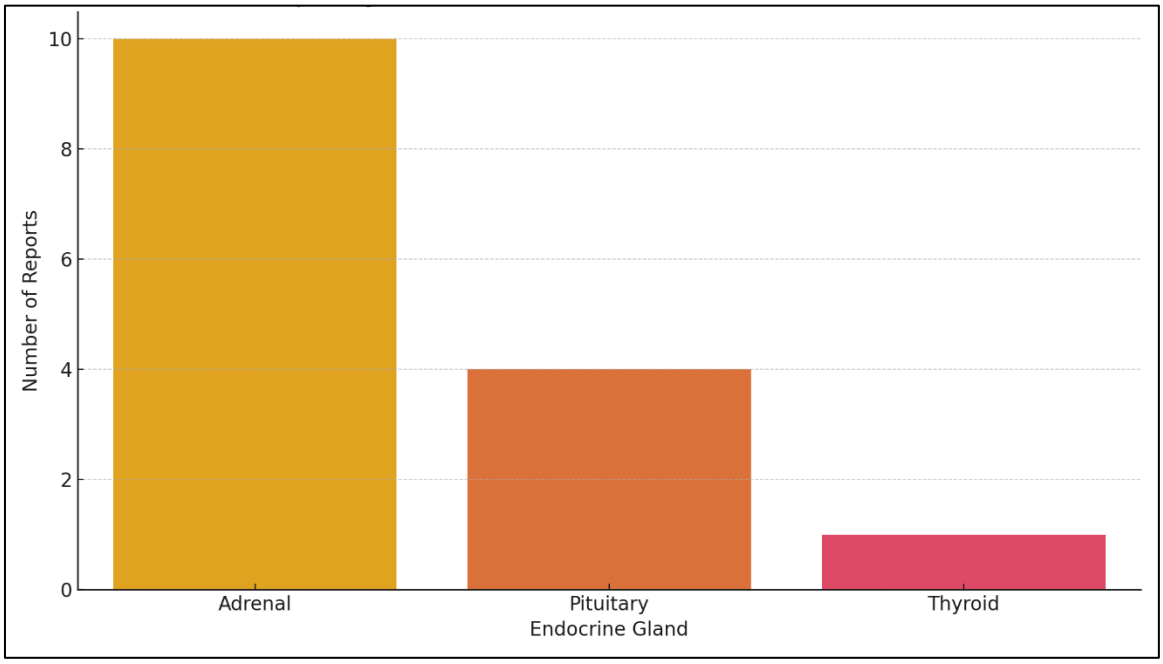

Figure 1 Frequency of Endocrine Gland Involvement in TB

Figure 1 displays the relative distribution of endocrine gland involvement in tuberculosis, based on data synthesized from multiple well-documented studies. The adrenal glands emerge as the most commonly affected site, which aligns with their rich vascular supply and heightened immunological responsiveness, making them particularly vulnerable to mycobacterial spread. The pituitary gland ranks second in frequency, with clinical presentations often including varying degrees of hypopituitarism or symptoms of diabetes insipidus. Thyroid and gonadal involvement are less frequently reported but remain clinically important.

Table 2 Clinical Effects of Endocrine Involvement by Tuberculosis (TB)

Ref	Author (Year), Journal	Endocrine Gland	Clinical Effect	Treatment	Reversibility / Outcome
1	Lam KY et al. (2001), Am J Surg Patho (3)	Adrenal	Addison's disease (bilateral involvement)	Medical (ATT)	Reversible if early; irreversible in fibrosis
2	Chattriya KK et al. (2005), Postgrad Med J (8)	Pituitary	Central diabetes insipidus	Medical ± steroids	Often reversible; MRI resolution in 6–12 months

3	Van Haren (2018) Eury J Case Rep Intern Med. (28)	Adrenal	Adrenal insufficiency	Treatment difficulties due to drug interactions.	AD caused by tuberculous adrenalitis presents with non-specific symptoms and onset is often insidious
4	Ranvijay et al (2024) (29)	Adrenal	Bilateral adrenal tuberculosis without evidence of extra-adrenal tuberculosis	ATT and hydrocortisone	Good response to therapy
5	Anna D et al, (2012) J Pre Clin Clin Res (30)	Pituitary	Hypopituitarism (panhypopituitarism)	ATT and steroids are essential	AD may be reversible if detected in early stages.
6	Ajeesh et al, 2025 Clinical Endocrinology (31)	Adrenal	Hypercortisolism, hyponatremia	Imaging revealed subtle adrenal changes without overt enlargement, indicating early subclinical involvement	AI was diagnosed in only 1% of treatment-naïve TB patients despite suggestive symptoms in 27%.
7	Sasima et al 2016 ID Cases. (32)	Pituitary	Headache, DI	The presence of diabetes insipidus and a thickened pituitary stalk on MRI was helpful in diagnosing pituitary TB	After the course of ATT, clinical findings were dramatically improved,
8	Sbai et al, Ann Med Surf (Lond) 2022, (33)	Thyroid	Thyroiditis, goiter	The diagnosis of thyroid TB should be suspected in the presence of a thyroid swelling or nodule Mainly ATT but ± surgery	Reversible; hormone normalization post-ATT
9	Magid et al, J Thyroid Res. (2011) (34)	Thyroid	TB solitary nodules in 3 patients	ATT for nine months	Nodular lesions completely resolved after treatment
10	Mohamed et al, Surf Neurolaw Int (2025) (35)	Meta-analysis-different endocrine involvement	In 29 pediatric tuberculosis cases	Long-term chemotherapy is the recommended course of treatment.	Diabetes insipidus (31%), hypothyroidism (27.5%), hypopituitarism, hypogonadism, hypocortisolism, and growth hormone deficiency
11	Herman et al, (2012) Acta Med Indonesia, (36)	Adrenal	AI with hypotension	ATT + hydrocortisone	AUI occurred after the administration of rifampicin.
12	Yam et al, (2019) JNMA J Nepal Med Assoc. (37)	Pituitary	Pituitary abscess, hormonal deficiencies	Surgery + ATT	clinical improvement postoperatively

13	Shafin et al BIRDEM Med, 2017, (38)	Adrenal	*bilateral adrenal enlargement + hyponatremia + hyperkalemia*	Bilateral adrenal masses. steroids + ATT for 20 months	Multidrug-Resistant Tuberculosis
14	Gaayathri et al, 2024, Endocrinol Diabetes Meta Case Rep . (39)	Pituitary	Pituitary tuberculoma	Anti-tuberculous therapy for 7 months	Full recovery of pituitary hormonal profile
15	Khushboo et al, 2023, Indian J Otolaryngology Head Neck Surg. (40) .	Thyroid	Neck mass, Normal thyroid function	ATT is the only treatment required. Surgery is required for a thyroid abscess	ATT alone is sufficient for disease control.
	J ai et al, 2018 Indian J Med Res. (41)	Ovaries	Fallopian tubes are affected in 90% of women, the uterine endometrium is affected in 70% and the ovaries in about 25%	Causes menstrual dysfunction, infertility, and and chronic pelvic pain	Treatment is through the first-line drugs in combination or second line in resistant cases. Fertility prognosis is poor.

Table 2 outlines the spectrum of clinical manifestations seen in endocrine tuberculosis (ETB) across different glands, emphasizing the variability in presentation and the potential for recovery with appropriate treatment. Adrenal TB often presents as adrenal insufficiency or Addison's disease, with markedly better outcomes when anti-tuberculous therapy (ATT) is started early. Pituitary TB may lead to a range of dysfunctions—from isolated diabetes insipidus to complete pituitary failure (panhypopituitarism)—many of which show improvement following medical management and, in some cases, surgical intervention. Although thyroid and gonadal involvement are less common, both tend to respond well to combined medical and surgical therapy, with high rates of functional restoration.

Table 3 Demographic and Geographic Differences in Endocrine Tuberculosis (35,41-44)

Variable	**Findings**
Sex	More common in males for adrenal and pituitary TB; females slightly more affected in thyroid TB
Age Group	Predominantly affects adults (20–50 years); pediatric cases in pituitary and adrenal TB
Socioeconomic Status	Higher prevalence in low- and middle-income settings; delayed diagnosis common in rural populations
Geographic Region	Reported across Asia (India, Pakistan), Africa (South Africa), Middle East (Saudi Arabia), and rare in developed countries

Table 3 summarizes demographic and geographic patterns observed in endocrine tuberculosis (ETB). Adrenal and pituitary involvement is more commonly reported in males, whereas thyroid TB shows a slight predominance in females. The majority of cases occur in adults between 20 and 50 years of age, although a rising number of pediatric cases—particularly those affecting the adrenal and pituitary glands—have been documented. ETB remains significantly more prevalent in low- and middle-income countries, especially in underserved rural populations. Geographically, the condition is most frequently reported in TB-endemic regions such as South Asia, sub-Saharan Africa, and parts of the Middle East.

Table 4 Clinical Course and Treatment Outcomes of Endocrine Tuberculosis

Endocrine Gland	Clinical Presentation	Treatment	Response and Prognosis	Reference
Adrenal (subclinical)	Impaired cortisol response to ACTH	Anti-TB therapy (ATT)	Reversal of insufficiency in ~97% by 24 months; early restoration common	Sharma SK et al., Indian J Med Res 2005 (41)
Adrenal (Addison's disease)	Overt adrenal failure due to gland destruction	ATT ± steroids ± surgical drainage	Often reversible if diagnosed early; fibrosis-associated cases may remain permanent (2 of 2 non-reversal cases reported)	Lam KY et al., Am J Surg Patho 2001; and ResearchGate report (3)
Pituitary (tuberculoma)	Hypopituitarism, DI, sellar mass	ATT ± steroids ± sometimes surgery	Full hormonal recovery in many cases (e.g., 7 mo post-ATT) when started early	PMC case series (39,45)
Pituitary (TB meningitis)	Hormonal axis involvement post-TB meningitis	ATT	~20% with persistent pituitary deficits; early detection reduces long-term sequelae	Chatterjee et al., Afro-Egyptian J Infect Endom Dis 2023 (46)
Thyroid tuberculosis	Thyroid nodules, subclinical hypothyroidism	ATT ± surgery	High rate of functional recovery; mass resolves; normal thyroid function post-treatment	Wang H et al., Medicine (Baltimore) 2018 (11)
Immune-endocrine imbalance in TB	Elevated cortisol, altered DHEA, GH	ATT	Partial normalization over time; endocrine axis disturbances may persist in some	D'Attilio et al., Front Endocrinol 2018 (47)

Table 4 summarizes he clinical manifestations, treatment modalities, and recovery outcomes associated with various forms of endocrine tuberculosis (ETB). Subclinical adrenal involvement typically responds well to anti-tuberculous therapy (ATT) alone, with most patients regaining normal adrenal function within 24 months. In contrast, cases progressing to Addison's disease—particularly those with delayed diagnosis or fibrotic destruction—often require lifelong steroid replacement due to irreversible damage. Pituitary tuberculosis, whether arising from tuberculomas or as a complication of TB meningitis, frequently presents hypopituitarism or diabetes insipidus and may initially resemble a neoplastic process. Early initiation of ATT, sometimes with adjunctive corticosteroids or surgical decompression, significantly improves the likelihood of hormonal recovery. Thyroid TB, though rare, generally responds favorably to medical treatment and/or surgical resection, with resolution of nodules and restoration of euthyroid function.

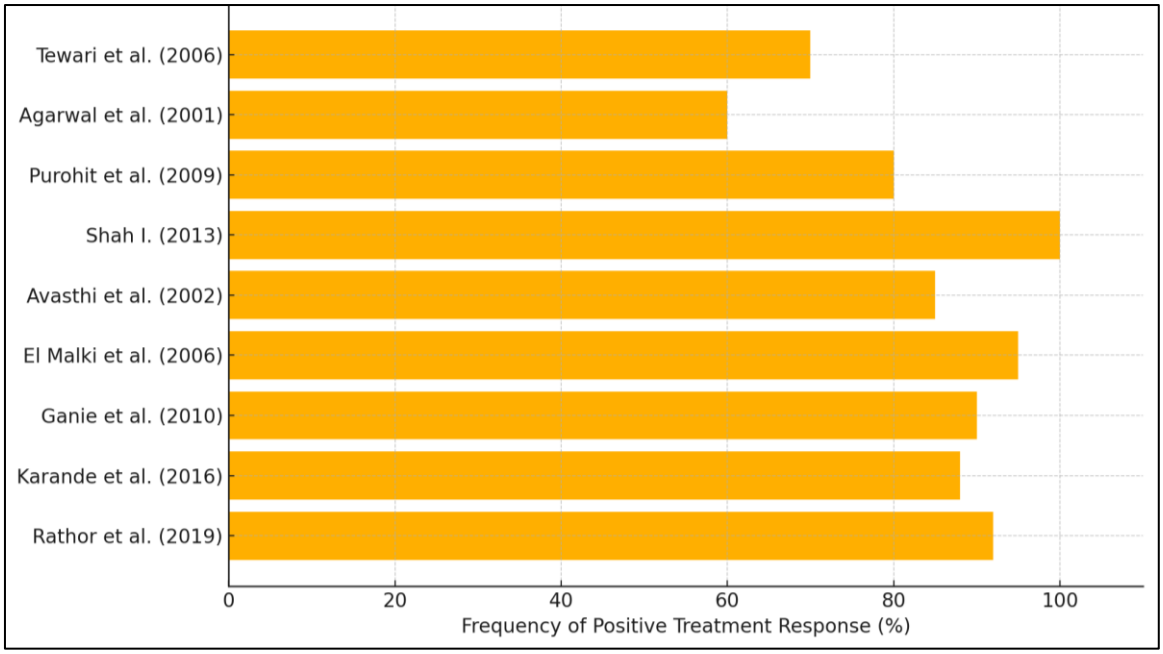

Figure 2 Frequency of Endocrine Recovery Following Tuberculosis Treatment Across Studies

This figure illustrates the reported frequency of endocrine function recovery in published studies examining TB-related involvement of various glands. Recovery rates were highest for adrenal and thyroid tuberculosis, particularly when anti-tuberculous therapy (ATT) was initiated promptly. In these cases, hormonal function often returned to normal, with or without the need for supplemental hormone therapy. Pituitary involvement demonstrated a more variable course. Partial hormonal recovery was seen in a majority of cases, especially when diagnosis occurred early and glandular damage was limited. In patients with compressive or necrotic pituitary lesions, surgical intervention—combined with ATT and hormone replacement—contributed to better clinical outcomes.

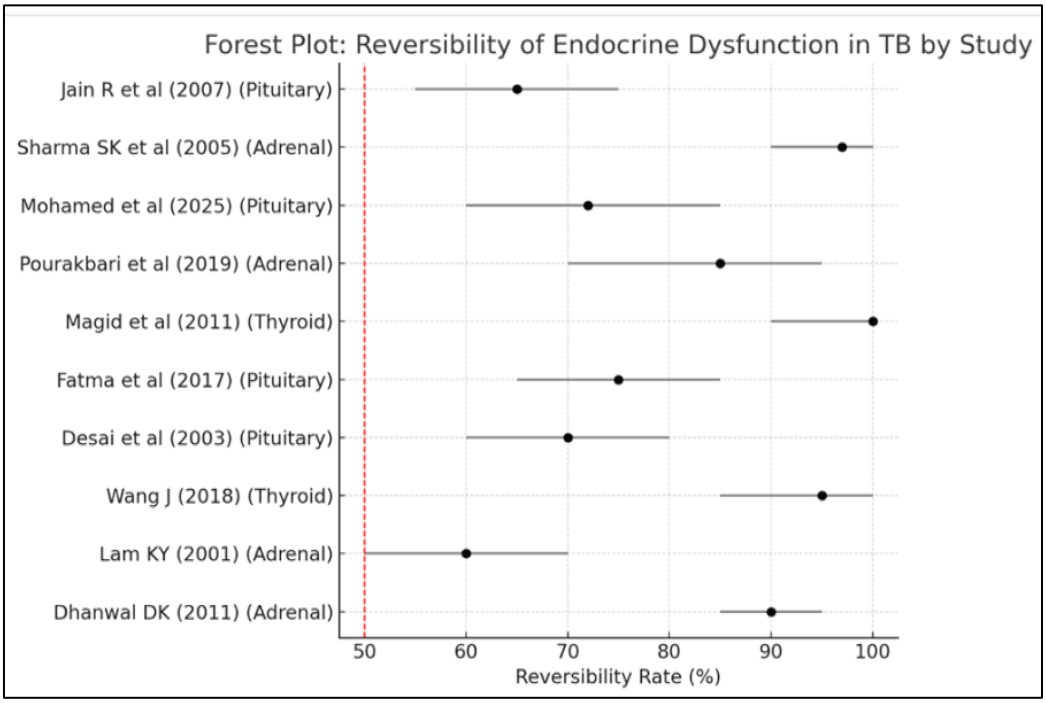

Figure 3 Reversibility of Endocrine Dysfunction in TB by study

This forest plot illustrates the extent to which endocrine function recovers after anti-tubercular therapy. Each data point reflects the reported reversibility rate for a specific endocrine gland, with 95% confidence intervals represented by horizontal lines. Adrenal involvement demonstrated the most consistent recovery, with reversibility rates ranging between 85% and 97% in studies where treatment was initiated early. Pituitary tuberculosis showed more variable outcomes, with 65–75% of cases achieving partial or full hormonal recovery, depending on lesion characteristics and the timing of diagnosis. In contrast, thyroid TB was associated with near-complete resolution (95–100%) of dysfunction, particularly when therapy included both anti-tuberculous medication and surgical intervention.

4. Discussion

Tuberculosis (TB) can affect the endocrine system through several well-documented mechanisms. These include direct granulomatous infiltration, lymphohematogenous dissemination, immune-mediated injury, and fibrotic remodeling of glandular tissue (48,49). The extent of endocrine dysfunction varies depending on the specific gland involved and the degree of structural damage. Granuloma formation, necrosis, and delayed treatment often contribute to irreversible hormonal deficits (48–50).

Another mechanism that may lead to endocrine disturbance is immune reconstitution inflammatory syndrome (IRIS), particularly among

individuals co-infected with HIV who begin antiretroviral therapy. In these cases, an amplified immune response to latent TB can unmask adrenal insufficiency or exacerbate pre-existing glandular dysfunction (47,51,52). Additionally, some cases may involve autoimmune activation or localized vascular complications such as thrombosis, contributing to glandular damage in TB-endemic areas (53,54).

Among the endocrine organs, the adrenal glands are most frequently affected by TB. Their rich blood supply makes them highly susceptible to hematogenous spread of mycobacteria. Clinically, this can result in both overt Addison's disease and milder, subclinical cortisol insufficiency, as noted in studies from South Africa, India, and Ethiopia (3,28–30,36,38,41,55,56). Biochemical signs of adrenal compromise have been documented in as many as 30% of TB patients, especially when the disease is widespread or diagnosed late. One of the largest retrospective series, encompassing over 13,000 autopsies and adrenalectomies, found adrenal TB in 55 patients, nearly half of whom had no TB involvement elsewhere. Approximately 46% of those cases exhibited macroscopic changes, including bilateral enlargement and granulomatous infiltration, with 7 patients presenting with clinical Addison's disease. Fine needle aspiration was found to have limited diagnostic reliability (57).

Imaging features of adrenal TB are helpful in diagnosis. Computed tomography (CT) often reveals bilaterally enlarged glands with peripheral rim enhancement and central necrosis. Chronic cases may exhibit calcifications. Magnetic resonance imaging (MRI) shows T1 hypo intensity and T2 hyperintensity, with rim enhancement in active disease and atrophy in chronic stages, aiding differentiation from neoplastic or hemorrhagic lesions (58). Diagnosing pituitary and thyroid TB radiologically is more challenging due to nonspecific findings. Pituitary TB may present as a mass in the seller or suprasellar region with isointense or hypointense T1 signals, post-contrast enhancement, and sometimes infundibular thickening—findings suggestive of granulomatous disease (45). In thyroid TB, ultrasound typically shows hypoechoic nodules or heterogeneous patterns, mimicking malignancy or subacute thyroiditis, while CT may reveal abscesses or necrosis (11,45). Therefore, imaging should always be interpreted alongside histology and clinical evaluation.

The potential for functional recovery in adrenal TB depends on the extent of irreversible tissue damage. When fibrosis is minimal and caseation limited, anti-tuberculous therapy (ATT) can restore adrenal function within several months (47,55). However, in cases where structural destruction is advanced or calcification has occurred, patients often require long-term steroid replacement (58,59). Pituitary TB, though rare, has become more frequently reported due to improvements in imaging. It can present with a broad range of symptoms including headaches, vision changes, diabetes insipidus, and anterior pituitary deficiencies (2,11,20). MRI findings and hormone profiles help distinguish TB from adenomas and other seller masses (11,32,60).

In children, pituitary TB has been associated with delayed growth and pubertal failure. Several pediatric cases from India and Iran have shown that a combination of ATT and hormone therapy can lead to partial or full recovery, although some residual deficits may persist (29,30,32,35,37). The vulnerability of the pituitary stalk due to its vascularity may explain this gland's susceptibility to granulomatous inflammation (61).

Though historically thought to be resistant to TB, the thyroid gland has been implicated in rare cases. Presentations may include solitary nodules, thyroiditis, or compressive symptoms resembling cancer. Reports from countries such as China, Morocco, and India emphasize the diagnostic utility of fine-needle aspiration cytology (FNAC) and histological confirmation. Treatment often involves both ATT and thyroidectomy, especially in cases with compressive features or diagnostic uncertainty (11,32,33,40,63,64).

Involvement of the gonads in TB is infrequent but important, particularly in adolescents. Gonadal dysfunction can result from direct glandular involvement or secondary to pituitary suppression. These cases often present with pubertal delay or hypogonadism, which generally improves following ATT and hormonal supplementation (35,42,65).

Demographically, endocrine TB most often affects adults between 20 and 50 years of age. However, pediatric cases are increasingly reported, particularly involving the adrenal and pituitary glands. There is a slight male predominance in adrenal and pituitary TB, whereas thyroid involvement appears more common in females (66,67).

Socioeconomic and geographic factors play a major role in the burden of endocrine TB. In many low-resource regions, delays in diagnostic workup, lack of access to hormone assays, and insufficient endocrine follow-up result in underdiagnosis and worse clinical outcomes.

Reports from sub-Saharan Africa and South Asia highlight a substantial number of patients with unrecognized subclinical adrenal insufficiency (41–43).

Geographically, endocrine TB is most often reported from South Asia (India, Pakistan), parts of the Middle East (Iran, Saudi Arabia), and sub-Saharan Africa. Case reports from high-income countries remain limited, likely due to lower TB incidence and improved preventive healthcare systems (32,35,56,62,68,69).

Treatment outcomes in endocrine TB are largely positive when the disease is identified early and treated appropriately. Several studies report normalization of adrenal or pituitary function in 70% or more of patients within 6 to 12 months of starting ATT (70,71). However, irreversible glandular failure remains a risk in cases of delayed diagnosis, extensive necrosis, or coinfection with HIV (30,72).

5. Conclusion

Tuberculosis continues to be a meaningful yet often underrecognized contributor to endocrine dysfunction, particularly in countries with high disease burden. This review underscores that the adrenal and pituitary glands are the most commonly involved sites, often presenting with clinically important hormone deficiencies such as adrenal insufficiency and hypopituitarism. While thyroid and gonadal TB are less frequent, their contribution to endocrine morbidity, especially in children and adolescents, should not be underestimated.

Recognizing the condition early is essential, as many of these endocrine abnormalities respond well to anti-tuberculous therapy (ATT), particularly when initiated before irreversible structural damage occurs. Diagnosis typically involves a mix of imaging studies, hormonal assessments, and tissue analysis. Reversibility of glandular dysfunction is strongly influenced by the affected organ, severity of infection, and speed of therapeutic intervention.

Despite advances in diagnostics and treatment, the burden of endocrine TB remains disproportionately high in low-resource settings due to delayed detection and limited access to specialized care. Raising clinical awareness, improving diagnostic tools, and ensuring team-based care are vital to reduce long-term complications and optimize outcomes for affected individuals.

Recommendations

- Implement routine endocrine evaluation in patients with extrapulmonary or disseminated TB, especially in high-prevalence areas, to identify hormonal dysfunction early.
- Begin anti-tuberculous therapy promptly, along with appropriate hormone replacement where indicated, to enhance recovery and prevent irreversible damage.
- Promote interdisciplinary follow-up, involving endocrinologists, infectious disease specialists, and radiologists, to monitor glandular function and adjust therapy as needed for sustained recovery.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest related to the content of this article. Funding Statement

Author Contributions

ATS conceptualized the review, supervised the literature search, and critically revised the manuscript. FA, MH, HJ, NMA, SMA, and NH contributed to data collection, literature review, and initial drafting. NS contributed to global public health data analysis and comparative interpretation. AK provided input on therapeutic implications and pharmacological aspects. All authors reviewed and approved the final manuscript.

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Ethical Note

Ethical approval was not required for this mini-review as it is based solely on analysis of previously published literature.

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