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THE PREVALENCE OF TUBERCULOSIS POSES A SERIOUS CHALLENGE TO PUBLIC HEALTH

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Annotation: Tuberculosis (TB) persists as a significant global health burden, despite substantial advances in diagnostic methodologies and therapeutic regimens.[1] The disease's epidemiological resilience is driven by a combination of biological, clinical, and socio-environmental determinants. Latent Mycobacterium tuberculosis infection remains widespread, serving as a continuous reservoir for active disease, particularly among individuals with compromised immune function. Moreover, the increasing prevalence of multidrug-resistant (MDR-TB) and extensively drug-resistant tuberculosis (XDR-TB) presents a critical challenge to existing treatment frameworks and poses a threat to global TB control strategies[2] Transmission occurs primarily via aerosolized droplets, with clinical manifestations typically including chronic cough, fever, weight loss, and night sweats. Effective TB control mandates integrated approaches encompassing early and accurate detection, strict adherence to prolonged pharmacological therapy, sustained vaccination programs, and targeted interventions addressing structural determinants such as poverty, overcrowding, and limited healthcare access. Strengthening health systems and enhancing population-level awareness are essential to mitigating transmission dynamics and reducing TB-associated morbidity and mortality.[4]

Key words: Tuberculosis, mycobacterium tuberculosis, public health, latent infection,multidrug-resistant tuberculosis (MDR-TB), extensively drug-resistant tuberculosis (XDR-TB).

Introduction. Tuberculosis (TB) continues to represent a critical global health challenge, with millions of new infections reported annually. Despite substantial improvements in diagnostic technologies and treatment protocols, TB remains one of the top causes of death from a single infectious agent. Its persistence reflects a complex interplay of biological, socioeconomic, and health-system factors.[3] The long-standing presence of latent Mycobacterium tuberculosis, together with rising antimicrobial resistance, poses substantial barriers to eradication efforts.This article aims to provide a comprehensive overview of contemporary TB research, highlighting current epidemiological patterns, risk determinants, diagnostic challenges, treatment complexities, and strategic public health priorities. The findings provide insight into strengthening TB control efforts, particularly in high-burden countries.

Methods. A narrative literature review approach was conducted using peer-reviewed articles from recognized scientific databases, including PubMed, Web of Science, and Scopus. Search terms included "tuberculosis," "MDR-TB," "XDR-TB," "epidemiology," "diagnosis," and "public health." Articles published between [Year Range] were included. Studies focusing on clinical trials, epidemiology, diagnostics, public health interventions, and socio-structural determinants were prioritized.

Results. TB disproportionately affects populations in low- and middle-income countries. High HIV co-infection rates, limited access to medical care, and poor living conditions contribute to its persistence. Approximately one-quarter of the global population is estimated to carry latent

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TB infection, representing a substantial reservoir for future disease. Tuberculosis (TB) exhibits a markedly uneven global distribution, disproportionately affecting individuals in low- and middle-income countries (LMICs). These regions account for the vast majority of global TB morbidity and mortality due to a combination of biological, socioeconomic, and structural factors.[5] The highest burdens are observed in parts of sub-Saharan Africa, South and Southeast Asia, and certain regions of Eastern Europe. A primary driver of TB incidence in these settings is the high rate of HIV co-infection, which significantly increases vulnerability to both primary infection and reactivation of latent tuberculosis infection (LTBI). HIV compromises cell-mediated immunity, particularly CD4+ T lymphocyte function, which plays a critical role in controlling Mycobacterium tuberculosis. In countries with high HIV prevalence, TB is often the leading cause of death among people living with HIV. Limited access to timely and high-quality medical care also contributes to the persistence of tuberculosis in LMICs. Delayed diagnosis, insufficient laboratory capacity, shortages of trained healthcare workers, and interrupted treatment programs create conditions in which transmission continues unabated. Many individuals experience substantial delays between the onset of symptoms and the initiation of treatment—delays that increase both disease severity and community spread[6,7]. Compounding these clinical and structural factors are poor living conditions, including overcrowded housing, inadequate ventilation, and low socioeconomic status. Such environments facilitate airborne transmission of M. tuberculosis, especially in households, workplaces, and communal settings. Malnutrition and co-existing health conditions, such as diabetes, further weaken immune responses and increase susceptibility to active disease.[8,9] Globally, it is estimated that approximately one-quarter of the population carries latent TB infection, representing a vast reservoir of potential future cases. While most individuals with LTBI do not develop active disease, 5–10% will experience reactivation during their lifetime. The risk of progression is significantly higher in populations affected by HIV, malnutrition, smoking, alcohol use, or other immunosuppressive conditions. This latent reservoir poses a major challenge for global TB control, as it requires long-term strategies that extend beyond the treatment of active cases alone.Furthermore, socioeconomic disparities, migration patterns, urbanization, and gaps in public health infrastructure continue to sustain transmission in many parts of the world. Emerging drug-resistant strains—particularly multidrug-resistant (MDR-TB) and extensively drug-resistant TB (XDR-TB)—complicate control efforts by prolonging treatment, increasing treatment failure, and straining limited health resources.

TB pathogenesis is driven by M. tuberculosis and its ability to persist within host macrophages. The formation of granulomas and periods of bacterial dormancy are key factors in disease progression. Reactivation is common in individuals with weakened immune systems, especially those with HIV/AIDS or other comorbidities. Tuberculosis pathogenesis is a multifaceted process involving complex interactions between Mycobacterium tuberculosis (M. tuberculosis) and the host immune system. After inhalation of aerosolized bacilli, the bacteria reach the alveolar spaces, where they are phagocytosed by alveolar macrophages[10]. Unlike many pathogens, M. tuberculosis has evolved mechanisms to survive and replicate within macrophages, which serve both as host cells and as vehicles for dissemination.[4]A key virulence mechanism is the ability of the bacillus to inhibit phagosome–lysosome fusion, thereby preventing exposure to degradative enzymes and acidic conditions. Additionally, the bacterium modifies host cell signaling pathways, enabling it to avoid immune detection. Lipid-rich components of its cell wall, such as lipoarabinomannan and mycolic acids, contribute to resistance against oxidative stress and antimicrobial peptides.[3] As the infection progresses, infected macrophages recruit

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additional immune cells, including dendritic cells, neutrophils, and T lymphocytes. This cellular aggregation leads to the formation of granulomas, the hallmark of tuberculosis. While molecular diagnostic tools have improved early detection, many high-burden regions still rely on smear microscopy, which has limited sensitivity. Access to advanced diagnostics such as GeneXpert systems remains uneven. Detection of latent TB also remains problematic due to variability between available tests. Standard treatment regimens last at least six months and require strict adherence to prevent relapse and drug resistance. MDR-TB and XDR-TB are major concerns due to the need for longer, toxic, and less effective treatments. Poor adherence, incomplete treatment, and inadequate health-system capacity contribute to resistance.TB is strongly associated with poverty, malnutrition, overcrowding, stigma, and limited access to healthcare.

Discussion. These factors reduce early diagnosis and treatment success. Health systems in high-burden countries often face funding shortages, workforce limitations, and insufficient infrastructure. Reducing TB incidence requires a multi-sectoral approach that integrates biomedical, social, and policy interventions. Innovations in diagnostics and treatments must be paired with strengthened health systems and social protection programs. MDR-TB and XDR-TB amplify the urgency for shorter, more effective regimens and improved medication adherence strategies .Public awareness, community engagement, digital adherence technologies, and improved surveillance systems all play critical roles in TB control. Addressing underlying socioeconomic factors is essential to reducing both transmission and vulnerability.

Conclusion. Tuberculosis remains a major global health threat. Its persistence is driven by latent infection, drug resistance, and socioeconomic inequalities. Effective TB control requires a comprehensive approach that incorporates advanced diagnostics, consistent treatment adherence, vaccination, and improved social conditions. Continued investment in public health infrastructure, surveillance, and research is essential for achieving global TB reduction targets.

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