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# Control in Indonesia

## Theory and Research

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Ditulis oleh:

**dr. Abdullah Antaria, MPH, Ph.D.**

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# Abstract

Tuberculosis (TB) remains a significant public health challenge in Indonesia, necessitating a comprehensive and multifaceted control program. This book, "Tuberculosis Control Program in Indonesia: Theory and Research," provides an in-depth analysis of the strategies, implementations, and outcomes of TB control efforts in the country. Drawing from both theoretical frameworks and empirical research, the book explores the intricacies of TB management, including diagnosis, treatment, and prevention. Key topics include the role of healthcare infrastructure, the impact of healthcare workers' training and competence, and the influence of social determinants such as poverty and malnutrition on TB prevalence and outcomes. The book also addresses critical issues like corruption and resource mismanagement, providing evidence-based recommendations for improving transparency and accountability. Innovative approaches, such as community engagement and education, collaboration with religious and community leaders, and the use of advanced diagnostic and treatment technologies, are discussed in detail. Case studies from various regions illustrate successful interventions and highlight persistent challenges. The book emphasizes the importance of a coordinated effort involving government agencies, healthcare providers, civil society, and international partners. By integrating theoretical insights with practical research findings, this book aims to contribute to the global discourse on TB control and offer actionable strategies for enhancing the effectiveness of TB programs in Indonesia. This comprehensive resource is intended for policymakers, healthcare professionals, researchers, and students dedicated to advancing public health and combating tuberculosis.

# Foreword

Tuberculosis (TB) continues to be a formidable public health challenge globally, and Indonesia is no exception. Despite considerable progress in TB control over the past decades, the disease remains a leading cause of morbidity and mortality, disproportionately affecting the most vulnerable populations. The multifaceted nature of TB control requires a nuanced understanding of epidemiology, healthcare systems, socio-economic factors, and community dynamics.

"**Tuberculosis Control Program in Indonesia: Theory and Research**" is a timely and comprehensive exploration of the efforts and challenges in combating TB in Indonesia. This book is an invaluable resource that bridges theoretical frameworks and empirical research, providing a holistic view of TB control strategies in the country.

The authors have meticulously examined the current state of TB control in Indonesia, delving into the successes and shortcomings of existing programs. The book highlights the critical role of healthcare infrastructure and the need for continuous education and training of healthcare workers. It underscores the importance of addressing social determinants of health, such as poverty and malnutrition, which are intricately linked to TB prevalence.

One of the key strengths of this book is its candid discussion on issues like corruption and resource mismanagement, which can severely undermine TB control efforts. By offering evidence-based recommendations for improving transparency and accountability, the authors provide a roadmap for more effective and ethical healthcare practices.

Furthermore, the book emphasizes the necessity of community engagement and the incorporation of culturally sensitive interventions. The collaboration with religious and community leaders, as illustrated in various case studies, showcases innovative approaches to raising awareness and improving TB treatment adherence.

This book also looks ahead, advocating for increased investment in research and the development of new diagnostic tools, treatment regimens, and vaccines. The integration of cutting-edge technologies and methodologies represents a crucial step towards the eradication of TB.

I commend the authors for their rigorous analysis and their commitment to enhancing the understanding of TB control in Indonesia. This book is not only a reflection of the current state of TB management but also a beacon for future efforts. It is an essential read for policymakers, healthcare professionals, researchers, and students who are dedicated to the fight against tuberculosis.

By leveraging the insights and recommendations presented in this book, we can work towards a future where TB is no longer a public health threat. Together, we can achieve significant strides in improving the health and well-being of populations affected by this devastating disease.

dr. H. Asikin Iman Hidayat Dahlan, MHA

Sesditjen P2P Kementerian Kesehatan RI -

# Acknowledgements

Writing this book, "Tuberculosis Control Program in Indonesia: Theory and Research," has been a significant journey, and I am deeply grateful to all who have supported me throughout this endeavor.

First and foremost, I would like to express my profound gratitude to my benevolent wife, Prof. Dr. Hj. Ratnawati, MCH, SpP(K), PhD. Your unwavering support, intellectual guidance, and endless encouragement have been invaluable. Your expertise and dedication to the field of tuberculosis control have been a constant source of inspiration.

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I also extend my appreciation to my colleagues and the entire research community for their insights, collaboration, and critical feedback. This book is a reflection of our collective efforts and shared commitment to advancing tuberculosis control in Indonesia.

Finally, I am grateful to the readers and all those who have taken an interest in this work. Your engagement and support are crucial in the ongoing fight against tuberculosis.

Thank you all for being a part of this journey.

# Preface

In "Tuberculosis Control in Indonesia, renowned public health experts delve into the complexities and challenges of managing one of the country's most persistent public health threats. This comprehensive volume offers an in-depth analysis of tuberculosis (TB) in Indonesia, examining the epidemiological trends, socio-economic factors, and health system responses that shape the nation's fight against this deadly disease.

The book begins by providing a historical overview of TB in Indonesia, tracing the evolution of the disease and the various public health strategies employed to combat it. It highlights the progress made over the decades, alongside the recurring obstacles that hinder complete eradication.

Central to the discussion is the analysis of Indonesia's National Tuberculosis Program (NTP), its strategies, and its implementation across diverse geographic and demographic landscapes. The authors explore the program's successes, such as increased detection rates and the integration of modern diagnostic tools, as well as its shortcomings, including issues of funding, healthcare infrastructure, and the social stigma surrounding TB.

Incorporating data from recent studies and field reports, the book emphasizes the role of innovative approaches in TB control. It discusses the impact of digital health technologies, community-based interventions, and public• private partnerships in enhancing TB care and prevention. Case studies from various regions provide practical insights into how localized efforts contribute to national goals.

A significant portion of the book is dedicated to the human aspect of TB control. It sheds light on the experiences of patients, healthcare workers, and communities, offering a nuanced understanding of the social

dynamics involved. Personal stories and testimonials bring to life the daily struggles and triumphs in the battle against TB.

Rich with statistical analyses, policy reviews, and human narratives, this book serves as an essential resource for public health professionals, researchers, policymakers, and anyone interested in the global fight against tuberculosis. Through its detailed exploration of Indonesia's TB control landscape, the book offers valuable lessons and inspiration for tackling TB worldwide.

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# Introduction of Tuberculosis

Tuberculosis (TB) was first described by Schonlein in 1839 (Myers J.A, 1970). TB is a primary pulmonary disease caused by mycobacterium tuberculosis and it can affect any organ system (Carr, D.T 1966). Robert Koch discovered the tubercle bacillus in 1882 and proved that it was the cause of the disease (Burke S.D, 1993). The disease has variously been known as "pthisis" the term used ,p.Y Hypocrates (470• 376 B.C), "slow wasting fever" (Ayfazian, 1993), the "white plague" in the 18th and 19th century (Dobos R & Dobos J, 1952) or "consumption" in the 19th to 20th century (CaldwellJ, 1988). Human tuberculosis affecting bone, such as spinal gibbus and hunchbacks have been depicted in statuettes and figurines in ancient artworks from 8000 B.C (Ayfazian, 1993).

Because TB symptoms were thought to be related to sensitive, artistic, and aesthetic individuals, tuberculosis became romanticized in literature and fashion during the nineteenth century. Byron as a tubercular proudly said, " I should like to die of consumption ...., because the ladies would all say, "Look at the poor Byron, how interesting he looks in dying.? (Sontag, 1978). Similarly, Thoreau in 1852, a tubercular, wrote

that;' Death and disease are often beautiful, like.....the hectic glow of consumption. Moreover, he wrote that TB was conceived as a variant of the disease of love. In addition to the fantasies of loveliness, poverty and deprivation, dyspnoea or shortness of breath, coughs, physical wasting and haemoptysis, tuberculosis itself was identified with death. With the advance of civilisation, the continuing presence of TB has both highlighted medical progression and failure in tuberculosis treatment.

At the beginning .of the 1800s, TB was epidemic through Northern Europe and America. Consider the example of one family of six children who all died of TB. The first at the age of 11 and the last at 39 years of age. All of them were apparently infected by their father (Comstock, 1994). However some extraordinary changes occurred with the decline in TB death rates in Britain as sanitary and living conditions improved, the use of sanatoria for treating victims of pthisis, and the discovery ofthe method of percussion and auscultation of the chest -ith the stethoscope by Laenec (Ayfazian, 1993). Inthe 1940s, streptomycin–the first antibiotic effective against gram negative bacteria and the tubercle bacillus–was discovered by Waksman and his colleagues (Long, E.R, 1958). After that time other effective anti tuberculosis drugs were introduced.

Despite this progress, the World Health Organisation (WHO) estimates that approximately one third of the world's population is infected with the mycobacterium tuberculosis at present and about 8 million people develop tuberculosis annually with around 2.7 million deaths per year. WHO asserts that the majority of tuberculosis cases and deaths occur in Asia which is occurring in line with an increasing number of people infected by the Human Immunodeficiency Virus (HIV) (Sudre Pet.al, 1992).

During the first four decades- of this century, many countries had plans for the elimination of the tuberculous disease. There were the US, Belgium, Finland, France, Germany, Spain, Sweden and the UK. However, the disease has not become extinct, as increases have been documented in the US, Denmark, Netherlands, Norway, Sweden and Switzerland.

Furthermore, HIV infection has emerged to exacerbate the overall TB morbidity among HIV-infected persons (Sbarbaro, J.A, 1993; Raviglione Mc, 1993). Since there are several factors which influence the development of tuberculosis, the solutions will be difficult.

At a global level a large number of factors are known to influence the epidemiology of TB. Increasing poverty, homelessness, injecting drug use, lack of adequate funding for TB control programs, migration, the HIV epidemic and multi drug resistant TB (MDR-TB) account, environmental drivers such as poverty, crowded living conditions, and congregate settings play a significant role in impacting the epidemiology of tuberculosis (TB) globally (Lei et al., 2023) (Smith et al., 2023). Additionally, risk factors for developing active TB involve immunocompromising conditions such as HIV, undernutrition, diabetes, smoking, heavy alcohol use, and certain medications. The burden of TB is particularly high in developing countries, with more than 90% of cases and deaths occurring in these regions (Zafar et al., 2023). Factors like lack of adequate funding for TB control programs, homelessness, injecting drug use, migration issues, and the rise of multidrug-resistant TB (MDR-TB) further contribute to the complexity of TB epidemiology globally (Y. Chen et al., 2022)variation and influence factor of the worldwide burden of tuberculosis are lacking. Methods In this cross-sectional study, epidemiologic data were gathered using the Global Health Data Exchange query tool, covering persons with tuberculosis in 204 countries and 21 regions from January 1, 1990, to December 31, 2019. We estimated the incidence and age-standardized rates (ASR. Addressing these multifaceted challenges is crucial for effective TB control and prevention strategies on a global scale. (Baskin, S.E et.al, 1994). These factors are interrelated. For example, the association of TB with poor socioeconomic status has been discussed by Lowell, AM et.al, 1969. These authors argue that people who are infected with HIV have weakened immune systems and will soon develop TB, especially in conditions of poverty. In addition, TB goes unrecognised in people who have HIV Sometimes diagnosed patients cannot afford the drugs required for treatment and thus can spread the disease to others.

The declaration of tuberculosis (TB) as a global public health emergency by the World Health Organization (WHO) has been in effect for over 25 years, underscoring the substantial global burden of TB, particularly in low and middle-income countries where it remains a leading cause of mortality from infectious diseases (Cioboata et al., 2023)or coronavirus disease. The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2 (Ulrichs, 2023) (Kumar et al., 2023) (Villar-Hernández et al., 2023)tuberculosis (TB. Despite this recognition, TB control efforts have encountered challenges, further exacerbated by the COVID-19 pandemic, which disrupted TB diagnosis and treatment programs, resulting in a decline in new TB diagnoses and an increase in mortality rates. The impact of COVID-19 on TB control has been catastrophic, significantly impeding progress towards achieving the WHO End TB Strategy targets by 2030, highlighting the urgent need for collaborative efforts and policy reforms to address this dual threat effectively. In Asia, WHO has declared that the problem of TB has just begun. Over half of the people in the world infected with mycobacterium tuberculosis live in Asia, so the potential for a devastating effect on the populations there is very high especially with the evolving HIV epidemic.

The Indonesian Government is actively addressing the challenges posed by tuberculosis (TB), a significant public health issue in the country. Despite being the tenth cause of morbidity in the last decade, TB has risen to become the third leading cause of death in 2022 (Alwi et al., 2023). Efforts to improve TB management include enhancing the knowledge, attitudes, and perceptions (KAP) of the general population about TB, as highlighted in recent studies (Ritonga et al., 2023) (Kaaffah et al., 2023). Additionally, there is a focus on program evaluation and the need for better detection rates, conversion rates, and cure rates in TB control programs, emphasizing the importance of training, collaboration, and screening activities in high-burden areas (Kaaffah et al., 2023) (T. Lestari et al., 2023). Prioritizing research and innovation, as outlined in the National Strategy for TB Prevention and Control 2020–2024, is crucial for accelerating the TB elimination program in Indonesia. Based on

recent reports, tuberculosis (TB) remains a significant health challenge in Indonesia, ranking high among causes of morbidity and mortality (Rahem, A., et al., 2023) (Kaaffah et al., 2023). According to Kaaffah et al (2023), more than 50% of the Indonesian population has been infected by Mycobacterium tuberculosis, highlighting the widespread nature of the disease. Annually, Indonesia reports approximately 500,000 new cases of smear-positive tuberculosis, indicating a substantial burden on the healthcare system and the need for effective control measures (Putra & Pradnyani, 2022). Efforts to improve knowledge, attitudes, and perceptions about TB among the general population are crucial in controlling the disease and reducing its impact on public health (Aini Agnia & Heni Muflihah, 2022). Strengthening public awareness and health education strategies is essential to address the challenges posed by TB in Indonesia and enhance treatment success rates.

Limited data on the epidemiology of tuberculosis (TB) in Indonesia has been highlighted across various studies. Main et al. emphasized the high prevalence of TB infection among healthcare workers in Yogyakarta, Indonesia, indicating a significant risk for this group (Main et al., 2023). Sanderson discussed variations in TB prevalence across different geographical areas and diagnostic approaches in Indonesia, showcasing the challenges in accurately identifying TB cases (Noviyani et al., 2021). Additionally, Cristiana and Pandia pointed out the importance of drug compliance in TB treatment, with a study showing a 60% complete treatment rate in Tanjung Morawa, Indonesia (Madania et al., 2023). These studies collectively underscore the inadequacy of data on TB epidemiology, including the risk of infection, combined TB/HIV cases, multi-drug-resistant TB, and the risk of developing TB following infection, emphasizing the need for more comprehensive research and surveillance efforts to address these gaps in understanding. Although formal studies were done 25 or more years ago the relative risks are still likely to be relevant.

Analyzing data from the National Tuberculosis Control Program (NTP) in Indonesia from 2001 to 2022, particularly at the sub-district level, reveals significant insights into the effectiveness and challenges of tuberculosis control efforts over two decades. The research highlights Indonesia's high burden of TB cases, with varying success rates in detection, treatment, and patient outcomes across different regions. Challenges such as delays in diagnosis and treatment initiation, limited resources, suboptimal performance of TB program officers, and community reluctance towards contact investigations have been identified as barriers to program success. However, initiatives like training for TB cadres and enhancing collaboration between healthcare sectors show promise in improving TB management and reducing incidence rates, emphasizing the importance of comprehensive strategies and community involvement in combating tuberculosis (Alwi et al., 2023) (Ritonga et al., 2023) (Sensusiati et al., 2023) (Noviyani et al., 2021) (Surendra et al., 2023)

A key part of this analysis involves a detailed case study of the Lampung Selatan District, where I personally worked as a medical officer at the Tanjung Bintang Community Health Center from January 1991 to December 1992. This firsthand experience provided me with invaluable insights into the operational challenges and practicalities of implementing TB control measures in a community setting. I chose this district because of my direct involvement and the opportunity to leverage both my professional experiences and historical program data to draw more nuanced conclusions about the effectiveness of local tuberculosis control strategies (BPS Kabupaten Lampung Selatan, 2022).

To enhance the TB control program in Indonesia in alignment with WHO guidelines, recommendations include improving diagnostic capabilities (Alwi et al., 2023) (Ritonga et al., 2023), enhancing treatment adherence (Marme et al., 2024) (Lumban Tobing et al., 2023), and strengthening community outreach and education efforts (Sensusiati et al., 2023). By focusing on these critical areas, Indonesia can create a more robust tuberculosis control framework to effectively manage and

reduce the TB burden in the country, contributing significantly to global TB eradication efforts. It is essential to involve all health workers in the TB program, establish rapport with patients and their families, prioritize TB infection prevention and control, and implement interventions that address health systems strengthening to improve the implementation of TB guidelines.

Introduction of Tuberculosis

# CHAPTER II

# Tuberculosis in General

Human tuberculosis (TB) is caused by all members of the "tuberculosis complex'; i.e mycobacterium tuberculosis, m.africanum, m.bovis and m.microti. Mycobacterium tuberculosis (m.tuberculosisis) is by far the most prevalent infection. The mycobacterium tuberculosis bacillus was identified by Robert Koch on March, 29, 1882. He defined the criteria to show that the disease of tuberculosis was due to mycobacterium tuberculosis. These criteria have been designated as "Koch's postulates, criteria originally suggested by Henlen in 1840 (Comstock, G. W., & Cauthen, G. M., 1993).

The principal portal of entry for m. tuberculosis is the respiratory tract, the bacillus may pass through the lymph vessels and lymph nodes into the bloodstream and cause infection in all parts of the body. The infection is contagious and can infect people of any age. In the case ofm. tuberculosis, the prevalence oftuberculosis infection can be exacerbated by poor cramped living conditions as this type of tuberculosis was spread through respiration. This type of TB is therefore a major public health problem in Indonesia because of the high level of poverty in that country. Poverty plays a significant role in exacerbating the tuberculosis (TB)

burden in Indonesia, making it a major public health issue (Ritonga et al., 2023). Research indicates that poverty is strongly and positively correlated with TB notification cases, with poverty being the strongest predictor for increased TB cases across provinces in Indonesia (Rambi, E. F., et al., 2022). Additionally, improving knowledge, attitudes, and perceptions (KAP) about TB among the general population is crucial in controlling the disease (Wanahari et al., 2022). A study on KAP regarding TB in Indonesia revealed that while most Indonesians have high knowledge and good attitudes towards TB, there is a moderate perception of the disease, highlighting the importance of enhancing public awareness and health education to reduce the country's TB burden (Kaaffah et al., 2023) (Bahar et al., 2022). Addressing poverty and enhancing public awareness are essential steps in combating TB in Indonesia.

Understanding the different tuberculosis lesions that may develop during an individual's life, including the primary complex, haematogenous dissemination, and chronic pulmonary tuberculosis, is crucial for developing prevention strategies (Siddiq et al., 2023). The primary complex occurs when tubercle bacilli enter the body, often without symptoms, leading to anatomic healing and calcification of lymph nodes visible on x-rays, with most lesions developing between one to three years of age and about 60% by the age of fifteen. Additionally, the rarity of pathognomonic signs associated with oral tuberculosis and the difficulty in diagnosis highlight the importance of timely identification to reduce morbidity and mortality (Ngoc et al., 2023). By recognizing these different phases and patterns of tuberculosis development, healthcare professionals can implement effective prevention measures to control the spread of the disease and improve overall public health outcomes.

Mycobacterium tuberculosis, the causative agent of tuberculosis (TB), can indeed infect various organs beyond the lungs, leading to extrapulmonary TB (Viana & Torres, 2022) (Moule & Cirillo, 2020). While pulmonary infection is the primary site in about 90% of cases, extrapulmonary manifestations are not uncommon, affecting up to 15% of

cases globally (Ryndak & Laal, 2019). The dissemination of M. tuberculosis to extrapulmonary sites is considered a crucial step in the pathogenesis of TB, with secondary lesions forming in different organs, potentially becoming latent or active. This dissemination process is facilitated by bacterial virulence factors that aid in spreading the infection through lymphatic and circulatory systems. Understanding these mechanisms of dissemination is vital for effective diagnosis and treatment of TB, especially in the context of emerging drug resistance, emphasizing the importance of proper antibiotic use and the development of new therapeutic strategies.

The susceptibility to tuberculosis (TB) is indeed heightened in conditions where host defense mechanisms are compromised, such as in renal failure, HIV infection, and diabetes mellitus (DM) (Ssekamatte et al., 2023) (Simper et al., 2022). Individuals with DM have about a three-fold risk for TB disease, with mechanisms related to TB susceptibility in type 2 DM patients including impacts on immunity, metabolism, and gene transcription (Abebe & , Zegeye Bonsa, 2017). Genetic factors like TLR, IGRM, VDR, and miRNAs play a role in determining susceptibility or resistance to TB pathogenesis (Leisching, 2018). Neutrophilia, observed in late-stage TB, contributes to the establishment and progression of the disease in susceptible hosts, promoting a niche for Mycobacterium tuberculosis survival (Leisching, 2018). The establishment of TB infection is influenced by both the exposure to bacilli and the host's resistance, emphasizing the importance of understanding both factors in combating the disease.

## Bacteriology of Mycobacterium Tuberculosis

The description provided in the question does not align with the characteristics of Mycobacterium tuberculosis as outlined in the research papers. Mycobacterium tuberculosis is a thin rod-shaped, aerobic, acid-fast, and non-motile bacterium with slightly curved rods, forming mould-like pellicles in liquid medium (Aini Agnia & Heni Muflihah, 2022)]. It is part of the Mycobacterium tuberculosis complex (MTBC) and is

identified using molecular assays like the Xpert MTB/RIF test, showing high sensitivity for diagnosis and rifampin resistance detection (Armstrong et al., 2022). The pathogen exhibits various shapes, including rod, V, Y-shape, branched, buds, round, oval, and spore-like forms under different growth conditions and stress factors (Scientists, 2022). Mycobacterium tuberculosis possesses a unique cell envelope primarily composed of mycolic acids, forming a thick and waxy outer membrane that acts as a permeability barrier, making the bacteria acid-fast and highly resistant to external factors, including antibiotics (Savintseva et al., 2023) (Jacobo-Delgado et al., 2023). This bacterium causes tuberculosis, a disease of significant global burden, primarily targeting alveolar macrophages in the lungs and requiring specific treatment strategies for control and prevention (Shad & Shad, 2019).

Compared with other bacteria, m.tuberculosis is a slow growing organism. The true· living saprophytic species have generation times of four to six hours. In vitro, primary complex. This happens frequently and goes on to anatomic healing without symptoms which can be seen as calcification of lymph nodes on x-ray. Most of these lesions occur from one to three years of age, and about 60 % of these complexes have developed by the age of fifteen. Understanding the process of tuberculosis transmission and infection dynamics is crucial in developing effective prevention strategies (Jumain et al., 2023) (Harries et al., 2020)

M.tuberculosis can infect and cause disease in almost every organ of the body. Such disease is most commonly the result of dissemination from an initial pulmonary focus (Putra & Pradnyani, 2022).

Susceptibility to tuberculosis is increased in a variety of disorders in which host defence mechanisms are impaired such as in renal failure, people infected with HIV, and diabetic persons. In general the establishment of infection is related to the number of bacilli involved (the exposure) and the susceptibility of the person (Balbus et al., 2000) (Severns, P. M., et al. 2015).

The mycobacterium tuberculosis is a thin rod shaped, anaerobic, strong acid fast and acid-alcohol-fast non motile bacillus with round extremities. Its walls contain proteins and peptides which provoke tuberculin-like activity (Scientists, 2022). Compared with other bacteria, m.tuberculosis is a slow growing organism. The true· living saprophytic species have generation times of four to six hours. In vitro, the most favourable medium (Manicheva et al., 2018)

The cell wall of .m. tuberculosis has a total thickness of about 20mn and consists of an inner electron-dense layer, surrounded by electron transparent-layers on the outer layer. There is no outer membrane coveting the outer layer similar to the Gram-positive bacteria. In addition, the walls of this bacteria contain proteins and peptides, which have strong tuberculin-like activity. The high content of lipid in the wall is responsible for hydrophobicity and for the resistance of mycobacteria to chemical injury such as decontamination by sulfur acid, sodium hydroxide and/or detergent (Xu et al., 2022)

## Disease Transmission

The transmission of tuberculosis is commonly from an open case ofpulmonary disease to other persons by way ofinfected droplet nuclei. Transmission is exacerbated by overcrowded living conditions, homelessness, poverty, alcoholism, injecting drug use, institutionalisation, and various medical risk factors such as silicosis, HIV infection and cancer. The bacilli are most frequently discharged from a pulmonary focus and reach the upper respiratory tract, where they are either swallowed or discharged to the environment by spitting, coughing, or sneezing. Sometimes, infection by m.tuberculosis through skin can be found in medical students, pathologists, and laboratory workers who handle cultures and infected animal tissues (Goldstein et al., 2022).

(Smith et al., 2022), believe that among those who are exposed, the likelihood of becoming infected is determined by two jointly operating factors, the time a susceptible person is exposed to contaminated air.

(Melsew et al., 2020), argue that the primary tuberculosis ("any pulmonary tuberculosis developing and being diagnosed during the first five years following primary infection has a limited impact on the transmission of TB infection. This is because smear-positive patients are infrequently among children in both low and high prevalence countries. Smear• positive patients from primary infection during adolescence is about 25% in the age group 15-29, infrequent in the adult population and uncommon in middle-age, elderly and old people. However, for planning of rational tuberculosis control programs in high-prevalence countries, efforts need to be directed towards the prevention of primary disease (BCG immunisation) and the control of cases with the secondary tuberculosis which focuses on decreasing the prevalence of sources of infection ( case finding and treatment).

Diagnosis of tuberculosis, primarily caused by Mycobacterium tuberculosis, is facilitated by various methods to ensure early detection and treatment. Traditional approaches like clinical examination, radiography, sputum smear microscopy, and culture methods are commonly used: tuberculin skin testing, chest radiographs, computed tomography, smear, culture, histology, immunology testing, and the very sensitive but costly chromatography and mass spectroscopy (Cheng et al., 2016).

The Indonesian Health Department's approach to identifying TB cases involves recognizing individuals with specific clinical symptoms, including coughing persisting for over 3 weeks, fever, sweating, blood in the saliva, weight loss, and chest pains (Ritonga et al., 2023) (Gurusinga, 2023)but usually patients in the third month after taking the drug feel healthy so that the patient does not comply or continue treatment, this can endanger the patient because the body can become resistant to the drug. The purpose of this study was to find out what factors make patients non-compliant in TB treatment. The method used observational analytic with a cross sectional design, the instrument used questionnaire, the population in this study was all TB patients at the Tanjung Morawa health center as many as 47 people with sample 30 patients who were taken

rondom. The test used chi square test with a confidence level of 95%. The test results showed that there were 2 factors with non-compliance in TB treatment, namely knowledge factors (0.26%. However, challenges exist in TB management in Indonesia, with delays in diagnosis and treatment initiation being common issues (Sensusiati et al., 2023) (Noviyani et al., 2021). Non-compliance with TB treatment is also a significant concern, with factors such as knowledge, occupation, education, and attitude influencing patient adherence [5]. Moreover, the prevalence of multidrug-resistant TB in Indonesia underscores the importance of strategies to optimize case finding, enhance resistance testing capacity, and prevent loss to follow-up to reduce the TB burden in the country. Training programs for TB cadres have shown promising results in increasing knowledge and skills to address TB cases effectively within communities .

Culture or microbiological testing is "the _ " for diagnosis of tuberculosis. Besides being the most reliable diagnosis, it is also the cheapest method. Acid fast bacilli (AFB) strains are not truly confirmatory of tuberculosis. Other species of mycobacteria as well as unrelated organisms such as Nocardia (weakly acid-fast) may produce a positive stain. However, in combining with appropriate clinical symptoms, it can narrow the differential diagnosis and define diagnosis of TB (Sensusiati et al., 2023).

Chest x-ray alone does not diagnose tuberculosis. It should also ratify with a sputum examination. X-rays are not suitable for mass case- finding in high prevalence countries as they are expensive. Tuberculin testing is often a less reliable method for diagnosis of TB in poorer countries as there may be obstacles caused by malnutrition and HIV infection. Tuberculin test can be weak and negative in test results even when the patient (adult or child) has an active disease. However, a strongly positive test in a child suspected of TB can be very helpful (Blumberg & Ray, 2019).

The new advanced technique in diagnosis of TB is GeneXpert MTB/RIF, as highlighted in multiple research papers. GeneXpert MTB/RIF, along with Loop-Mediated Isothermal Amplification (TB-LAMP),

has been utilized for rapid molecular diagnosis of Mycobacterium tuberculosis, showing higher sensitivity and specificity compared to conventional methods like acid-fast bacilli staining (Benellam et al., 2022). This molecular method is crucial for early detection and treatment initiation, especially in regions with a high burden of TB and drug-resistant cases (Villar-Hernández et al., 2023). Additionally, modern molecular genetic tests like GeneXpert have proven effective in verifying TB diagnosis and determining drug susceptibility, playing a significant role in preventing the spread of TB and improving patient outcomes (Tayal et al., 2022). Therefore, GeneXpert MTB/RIF stands out as a valuable tool in the rapid and accurate diagnosis of TB, essential for effective case management and control of the disease.

More than fifty years ago, tuberculosis was probably as feared as the Acquired Immunodeficiency Syndrome is today, as there was no cure. Each year during the early 1940s, the US nation reported over 100,000 new cases and more than 60,000 deaths resulting from TB disease. The discovery of modem drugs for the treatment of TB such as streptomycin in 1940s, ended a long period of fruitless attempts at a rational chemotherapy. However, TB remains a significant public and personal health problem today The slow decrease in TB incidence and mortality rates, exacerbated by factors like the COVID-19 pandemic and conflicts in regions like Ukraine, further emphasize the urgent need for well-structured multi-sectoral actions and increased investments in research to combat TB effectively (Problem, n.d.). The emergence of drug-resistant strains and the persistence of Mtb underscore the necessity for developing novel TB drugs to address drug resistance, kill persistent bacteria, and shorten treatment duration, showcasing the ongoing efforts in tuberculosis drug discovery for improved therapy outcomes (Villar-Hernández et al., 2023) tuberculosis (TB

From a public health perspective, the treatment of tuberculosis (TB) aims to promptly and efficiently reduce the absolute number of infectious patients through adequate therapy for all diagnosed cases. This involves

implementing measures such as TB preventive treatment (TPT) for individuals at risk, providing quadruple therapy with rifampin, isoniazid, pyrazinamide, and ethambutol for drug-sensitive TB, and considering adjunctive treatments like pyridoxine and corticosteroids for specific cases (Falzon et al., 2022). Challenges in TB management include drug-resistant TB, which necessitates the use of repurposed and new drugs to combat resistance effectively (Santosh Kumar & Pushp, 2022). Additionally, the public-private mix (PPM) collaboration has shown effectiveness in improving treatment outcomes for multidrug-resistant TB (MDR-TB) by increasing success rates and reducing loss to follow-up rates, highlighting the importance of comprehensive support and monitoring in TB control programs (Kwon, 2021).

## Patient Compliance

The rise in drug-resistant tuberculosis (TB) is predominantly attributed to various factors, including TB among individuals co-infected with HIV, previously treated patients, and injecting drug users, as highlighted in multiple research papers (Elfirdaous Fari et al., 2023) (O. Putri et al., 2023). Additionally, factors such as migration and TB transmission within group or institutional settings have also significantly contributed to the escalation of drug-resistant TB cases (Prajitha, 2022). Studies emphasize the importance of prompt diagnosis and consideration of drug-resistant TB in cases where conventional treatments show delays or lack of improvement, underscoring the urgency of addressing this global public health challenge (Yani et al., 2022). Furthermore, enhancing surveillance for drug-resistant TB, improving treatment regimens, promoting adherence to medication, and implementing preventive measures like vaccination are crucial steps in controlling the spread of multidrug-resistant TB strains, especially in regions with high TB burdens like Indonesia and Uganda (Yani et al., 2022).

Furthermore, directly observed therapy (DOT) for tuberculosis (TB) treatment is a crucial method to ensure patient adherence and completion

of the treatment regimen, especially to prevent non-compliance and loss to follow-up (Truong et al., 2022) (Burzynski et al., 2022). While traditional in-person DOT has been the standard approach, the use of video DOT (vDOT) has shown promising results in improving medication adherence and patient outcomes (Guo et al., 2020)the patient is directly observed taking their medications at a health post. An alternative to DOT is video-observed therapy (VOT (Etc, 2019). Studies have demonstrated that vDOT is noninferior to in-person DOT in supporting medication adherence, with higher proportions of observed doses and similar treatment completion rates. Moreover, the implementation of vDOT has been associated with increased patient satisfaction, reduced transportation costs, and improved treatment adherence, making it a cost-effective and efficient alternative to traditional DOT methods.

Because of patient non compliance with long-term medication regimens, reaching up to 35-50%, poses a significant challenge in the effective treatment of diseases like tuberculosis (TB) (Anley et al., 2023). This non-compliance leads to treatment failure, abandonment of treatment, and loss to follow-up, contributing to the rise of multi-drug resistant TB and increasing the risk of relapse (Opperman & Du Preez, 2023). Adherence to medication is crucial in preventing poor treatment outcomes and reducing drug resistance among TB patients (Fox et al., 2023). Identifying prognostic determinants of non-compliance, such as educational status, treatment support, and substance use, can aid in predicting and addressing non-compliance early on, thus improving treatment outcomes and reducing the transmission of infections .

Directly observed therapy (DOT) has traditionally been the mainstay for managing patients with drug-resistant tuberculosis (DR-TB) (Wekesa et al., 2023). However, recent studies have shown that community-based DOT (CB DOT) can be more effective than health facility-based DOT (HF DOT) in improving treatment outcomes for DR-TB patients in Uganda, with a 12% higher treatment success rate in the CB DOT group compared to the HF DOT group (Makabayi-Mugabe et al., 2023). Additionally,

the shift towards self-administered therapy for multidrug-resistant TB (MDR-TB) patients, especially with the use of adherence technology like the Medication Events Monitoring System (MEMS), is being explored as a cost-effective and sustainable alternative to traditional DOT approaches (Gupta et al., 2022). Moreover, the development of new drug regimens like BPaLM/BPaL has shown promising success rates in treating DR-TB, potentially simplifying care and improving treatment outcomes for historically difficult-to-cure patients (Truong et al., 2022). Therefore, while DOT has been a standard approach, innovations in treatment strategies and technologies suggest that directly supervised chemotherapy may not be the only solution to poor compliance in inner-city tuberculosis programs.

# CHAPTER III

# Prevention of Tuberculosis

Prevention and control programs for tuberculosis often encompass case finding, secondary chemoprophylaxis, and BCG vaccination. Case finding, coupled with modern chemotherapy, is highlighted as the most effective approach for tuberculosis prevention and control, swiftly rendering individuals non-infectious (Eraghi, 2023). Secondary chemoprophylaxis involves administering anti-tuberculosis drugs to tuberculin-positive individuals without clinical signs of the disease to prevent its progression (Maes, 2023). Additionally, vaccination strategies play a crucial role in tuberculosis control, with BCG vaccination being a key component in many prevention programs (Boulton & Wagner, 2021). By combining these approaches, including case finding, secondary chemoprophylaxis, and vaccination, comprehensive tuberculosis control strategies can be implemented to mitigate the spread of the disease and protect public health (Tuberquia-López et al., 2022)

## BCG vaccination

Bacille Calmette-Guerin (BCG) vaccination may be given to uninfected individuals in order to increase their host resistance and diminish the Lisk of acquiring tuberculosis. Even though BCG vaccination is currently being used in almost every country, notably in newborns within the Extended Program of Immunisation (EPI), its effectiveness is still not clear and has often been described as controversial. Protection from BCG vaccination varies, from 0- 80%. Studies have indicated that BCG vaccination provides significant protection against severe forms of tuberculosis, including

tuberculosis meningitis and miliary TB, which are critical in childhood tuberculosis (S. Singh et al., 2023) (Owusu et al., 2023). While BCG vaccination has shown high efficacy in regions with a high prevalence of tuberculosis, it is important to note that not all individuals may achieve complete protection. Research has highlighted that BCG vaccination induces both specific adaptive immune memory and sustained innate immune activation, known as trained immunity, contributing to its protective effects (Meijgaarden et al., 2022). Furthermore, countries implementing neonatal BCG inoculations have demonstrated significantly lower incidences of early childhood brain and CNS tumors, suggesting a potential link between BCG vaccination and reduced childhood BCNS cancer rates (Y. Chen et al., 2022). Therefore, while BCG vaccination is highly beneficial in reducing the severity of tuberculosis, its effectiveness may vary among individuals, emphasizing the need for continued research and evaluation of its protective mechanisms. Research on Bacillus Calmette-Guérin (BCG) vaccination for tuberculosis highlights its importance in reducing disease severity, yet its effectiveness can vary among individuals, necessitating ongoing research into its protective mechanisms (Kurtz et al., 2023) (Khandelia et al., 2023) (Dijkman et al., 2023) (BCG (Wang et al., 2023) (Res et al., 2018). Studies show that BCG, while offering some protection, may not reliably safeguard adolescents and adults from pulmonary TB, leading to a significant number of annual deaths . Novel approaches like intravenous BCG delivery and co-administration with subunit vaccines have shown promise in enhancing protection and reducing the number of required vaccinations, indicating the potential for improved strategies to combat TB . Understanding the factors influencing BCG's efficacy, such as individual immune responses and delivery methods, is crucial for optimizing its benefits and developing more effective TB vaccination regimens.

## Preventive Therapy for Tuberculosis

Isoniazid preventive therapy (IPT) is a crucial intervention for preventing tuberculosis (TB) disease, especially in persons with HIV (PWH). Studies

have shown that IPT significantly reduces the incidence of active TB among PWH, with a meta-analysis reporting a 31% reduction in active TB incidence (Hahn et al., 2023). While IPT is generally well-tolerated, concerns about hepatotoxicity exist, particularly in individuals with heavy alcohol consumption. However, recent research indicates that alcohol use does not significantly increase the risk of severe INH-related toxicity among PWH with normal liver enzyme levels at baseline (Shah et al., 2023)we compared the efficacy and safety of different TPT regimens. We searched PubMed, Google Scholar, and medrxiv.org with search terms Tuberculosis Preventive Treatment, TPT, efficacy, safety, and drug regimens for TPT and all RCT, irrespective of age, setting, or co-morbidities, comparing at least one TPT regimen to placebo, no therapy, or other TPT regimens were screened and those reporting either efficacy or safety or both were included. The meta-analysis data were synthesized with Review Manager and the risk ratio (RR. Different regimens for TB preventive treatment have been compared, with rifampicin plus isoniazid found to be significantly safer than other regimens in terms of adverse drug reactions (ADRs) (Zhang et al., 2023)chest digital radiography was conducted to screen individuals with inactive TB lesions. Then, the identified participants were further evaluated and eligible participants with IGRA-positive results were included in subsequent randomized controlled trial (RCT. Additionally, a study in rural China evaluating a six-week rifapentine plus isoniazid regimen among individuals with inactive TB lesions found no significant difference in the incidence of active TB between the preventive treatment and control groups (Kherabi et al., 2022).

The optimal duration of isoniazid preventive therapy for individuals co-infected with HIV and Mycobacterium tuberculosis remains uncertain, with recommendations typically ranging from 6 to 12 months (Hahn et al., 2023). A 12-month course of isoniazid has shown promising results, indicating an approximately 89% reduction in the development of tuberculosis (Toledo et al., 2023). However, further studies are warranted to confirm and establish the most effective length of preventive therapy

with isoniazid for this specific population, considering factors like efficacy, safety, and tolerability (Kaur et al., 2022). These additional investigations are crucial to provide more robust evidence and guidance for healthcare providers managing individuals with both HIV and tuberculosis infections.

Chemoprophylaxis with isoniazid is a crucial strategy for preventing tuberculosis in high-risk individuals, including those with a positive tuberculin test without active tuberculosis symptoms, individuals with HIV infection or at risk for it, and those without previous tuberculosis treatment (Yuan et al., 2023). Moreover, considering preventive therapy with isoniazid for individuals over 35 years old is essential due to the increased risk of hepatotoxicity with age, peaking at 2-3%. Studies have shown that isoniazid prophylaxis significantly reduces the risk of tuberculosis in various populations, including kidney transplant recipients, HIV-infected individuals, and close contacts of tuberculosis patients, highlighting its efficacy and safety in preventing tuberculosis infection (Lin et al., 2014).

Individuals with tuberculosis who receive corticosteroids or immunosuppressive drugs, undergo gastrectomy, have diabetes mellitus, or suffer from silicosis should be considered for chemoprophylaxis (C. H. Park et al., 2022). Screening for latent tuberculosis infection (LTBI) is crucial before initiating treatment with tumor necrosis factor (TNF)-α inhibitors, as these individuals are at an increased risk of tuberculosis reactivation (Pulmonary, 1999). Guidelines recommend using a threshold of ≥5 mm induration to identify latent infection among oral corticosteroid recipients, although this recommendation lacks strong evidence (Shad & Shad, 2019). Chemoprophylaxis is essential for individuals with diabetes, collagen diseases, lung cancer, Crohn's disease, or rheumatoid arthritis who are administered corticosteroids or anti-TNF-alpha agents and show signs of TB infection. Regular screening and proactive measures are necessary to prevent the onset of active tuberculosis in these high-risk populations.

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Preventive therapy for tuberculosis (TPT) faces challenges due to the inability to accurately predict which infected individuals will develop the disease, leading to potential overtreatment (Prajitha, 2022). Concerns also arise from drug toxicity, particularly hepatotoxicity, and the need for supervised therapy, as healthy individuals receive chemotherapy as a preventive measure. Moreover, the cost implications of implementing TPT can be significant, posing a barrier to widespread adoption and effectiveness (Kherabi et al., 2022). Despite these challenges, research is ongoing to explore the safety and efficacy of different TPT regimens, including fluoroquinolone-based options for drug-resistant TB contacts (Zhang et al., 2023). Enhancing TPT implementation will require addressing these issues through simplified systems, comprehensive training for healthcare workers, and community partnerships to improve uptake and effectiveness (Kruthika et al., 2023).

# The Tuberculin Reaction

The tuberculin test provides evidence of exposure to mycobacterium tuberculosis. Tuberculin is a mixture of antigenic tuberculo proteins (Purified Protein Derivative or PPD) derived from disintegrated tubercle bacilliwhich were discovered by Koch in 1890. The test is usually administered on the intercutaneous forearm with 5 units of PPD tuberculin and induration at the site of injection. It elicits a delayed hypersensitivity reaction. It cannot differentiate between infected individuals or tuberculosis disease and also cannot differentiate between previously BCG vaccinated and mycobacteriurn tuberculosis. The differentiation between individuals with latent tuberculosis (LTB) and active tuberculosis (ATB) as well as distinguishing between those previously vaccinated with Bacillus Calmette-Guerin (BCG) and Mycobacterium tuberculosis infection poses challenges. Recent studies have highlighted the potential of antibody-based tests to discriminate between LTB and ATB, regardless of HIV status, by assessing antibody levels and Fc receptor-binding characteristics targeting specific Mtb antigens (Nziza et al., 2022). Additionally, the interference of BCG vaccination with the direct detection of TB disease

antigens has been noted, with certain TB antigens showing reactivity in both TB patients and healthy adults, potentially complicating diagnosis. Furthermore, the efficacy of isoniazid (INH) in controlling mycobacterial growth ex vivo was significantly enhanced in historically BCG-vaccinated individuals, suggesting a potential link between BCG vaccination and improved therapeutic responses (Bahey-El-Din et al., 2020). These findings collectively emphasize the complexity in differentiating between BCG vaccination, M. tuberculosis infection, and TB disease, underscoring the need for further research to enhance diagnostic accuracy and treatment strategies.

However the tuberculin test is useful as a screening mechanism for tuberculosis. The tuberculin skin test (TST) remains a valuable screening tool for tuberculosis, especially in identifying latent tuberculosis infection (LTBI) (Üzer et al., 2022). Despite its long-standing use, the TST has limitations such as poor specificity in populations with high Bacille Calmette-Guérin (BCG) vaccination rates and variability in test interpretation. Studies have shown that TST sensitivity can be influenced by factors like HIV infection, chronic renal failure, substance abuse, and age, leading to false-negative results (Bahey-El-Din et al., 2020). To address some of these limitations, innovative approaches like dissolving microneedle-array patches have been developed to enhance TST delivery, reducing the required dosage and improving skin reaction assessment, making the screening process more efficient and less invasive (Prabowo et al., 2019). Additionally, research has highlighted the significance of factors like history of tuberculosis contact and occupancy density in influencing TST results, emphasizing the importance of considering various variables in interpreting screening outcomes (Duffy et al., 2021)

Another problem regarding tuberculin test is alergy reaction due to HIV infection where the cell-mediated immune function is impaired and allergy· unresponsiveness to skin test antigens occurs. Therefore, it is possible that individuals may have a negative reaction to the tuberculin skin test yet be infected with tuberculosis (Huebner, R. E et al, 1992).

The Mantoux test, utilizing purified protein derivative (PPD), is a common diagnostic tool for tuberculosis, but its reliability can be affected by various factors. Research suggests that the Mantoux test may not be entirely reliable for diagnosing tuberculosis, especially in certain populations like children cohabiting with tuberculous adults (Israr Khan et al., 2022) individuals with HIV infections (Chowdhury & Chakraborty, 2017)hormonal, neuromuscular, and environmental factors. Herein, we describe a case of 12-year-old scoliotic girl with a double curve of initially 26° thoracic and 23° lumbar, seeking chiropractic care. The therapy was provided three times/twice a week for 6 months. Adjustments of the spine through chiropractic, both soreness and mobility, were shown to improve. A total correction in Cobb angle of 6° (23%, and suspected TB patients in resource-limited settings (Dwivedi et al., 2021) . Factors such as immunosuppression in HIV-infected individuals can lead to false-negative reactions, highlighting the limitations of the Mantoux test in specific populations. To enhance the accuracy of tuberculosis diagnosis, additional tests like chest X-rays, sputum examinations, and clinical evaluations are recommended, especially in cases where the Mantoux test results may be inconclusive or misleading (Navaney Hiru et al., 2021).

For more than a century (with the exception of the war years) rates of tuberculosis have declined steadily in most developed countries. However, recently this trend has been reversed in both some developed and developing countries where there has been a dramatic increase in the incidence of TB. The World Health Organisation has declared TB a global emergency, warning that it will claim over 30 millionlives in the next decade unless immediate action is taken to control its spread. Th e reason for this sudden change in trends in both "worlds" is almost certainly infection by HIV, the rise in multi drug resistant tuberculosis, migration and the declining quality of health care. TB infection erupts into disease in the dually infected, immunocompromised host. Dual infection with HIV and TB remains a significant global health challenge, with millions of cases predicted to arise due to this co-infection. The World Health Organization estimated 10.4 million new cases of active

TB globally in 2016, with 10% occurring among people living with HIV, resulting in approximately 374,000 deaths in the same year (Nigam et al., 2022). In 2017, the number of TB-HIV coinfected patients was 900,000, with 300,000 deaths reported, highlighting the increased mortality rate compared to TB in the general population (Pooranagangadevi & Padmapriyadarsini, 2022). The co-management of HIV-TB co-infection presents various challenges, including drug interactions, toxicities, and immune reconstitution inflammatory syndrome, emphasizing the need for close monitoring and tailored treatment regimens to improve outcomes and reduce mortality risks. Effective policies and support systems are crucial for managing this dual disease burden successfully, ensuring early diagnosis, prompt treatment, and adherence to therapy for better patient outcomes (C. K. Park & Kang, 2019)

Tuberculosis (TB) chemotherapy and Bacillus Calmette-Guerin (BCG) immunization are crucial interventions in high-risk countries due to the necessity of long-term treatment with multiple drugs for successful outcomes (Koti et al., 2020). BCG vaccination, recommended by the World Health Organization for infants in TB-endemic regions, has shown effectiveness in reducing neonatal mortality and protecting against respiratory infections and malaria (Aspatwar et al., 2022). In low-incidence settings like Canada, targeted BCG vaccination strategies among high-risk groups, such as Indigenous communities, are being considered to optimize TB control. And recent research also explores enhancing BCG effectiveness through revaccination techniques and modulating its delivery, showcasing its continued relevance in vaccination regimens (Faust et al., 2019). These interventions play a vital role in combating TB by addressing both treatment and prevention aspects, highlighting their significance in public health efforts.

It has been found that one third of the world's population is infected with mycobacterium tuberculosis (Mi et al., 2021). surpassing even HIV infection (Villar-Hernández et al., 2023)tuberculosis (TB (Adefuye et al., 2022) (Silva et al., 2020) (Huang & Zhao, 2022). With an estimated

10 million new cases reported worldwide in 2018 and 1.5 million deaths attributed to TB in the same year, the disease's impact is profound and far-reaching. TB's prevalence is particularly significant in low and middle-income countries, where mortality rates are notably high, especially when cardiovascular complications are involved . Despite being curable if diagnosed early and treated appropriately, TB remains a persistent public health emergency, necessitating continued global efforts to combat the disease and achieve the goals set forth by initiatives like the End TB Strategy .

## Tuberculosis and HIV / AIDS

HIV significantly impacts tuberculosis (TB) control programs, as individuals coinfected with HIV and Mycobacterium tuberculosis have a higher risk of progressing to active TB. Research indicates that the annual risk of progression from latent TB infection to active disease in people with HIV is around 10% (Zeeb et al., 2023), whereas before the HIV epidemic, only about 10% of individuals developed active TB during their lifetime (Ignatius & Swindells, 202). Furthermore, the immune dysregulation caused by HIV and TB can lead to atypical clinical presentations and accelerated disease progression, making outcomes poor, especially in advanced cases (Olsson et al., 2022). The complex immunological interplay between HIV and TB influences the expression of microRNA and small nucleolar RNA, affecting immunity against TB in coinfected individuals (J. Chen et al., 2022). These findings underscore the critical need for effective testing, prevention, and treatment strategies to mitigate the burden of TB/HIV coinfection.

HIV significantly complicates the diagnosis, treatment, chemoprophylaxis, compliance, multidrug-resistant TB, prognosis, and further management of each individual tuberculosis case. Patients coinfected with HIV and TB face challenges such as drug-drug interactions, immune reconstitution inflammatory syndrome, lower plasma drug levels, and the emergence of drug resistance during treatment, despite adherence

(Goletti et al., 2023). The management of HIV-associated TB has seen progress with the scaling-up of rapid point-of-care tests for early detection, availability of new drugs for drug-resistant TB, and the use of integrase inhibitors for simplified coinfected patient management (Narendran & Swaminathan, 2016). Additionally, the complexity of multidrug-resistant TB among HIV patients necessitates a multidisciplinary approach, combining antiretroviral therapy with expanded TB drug therapy and managing potential opportunistic diseases and drug toxicities. Strengthening resources for prevention, implementing screening, early diagnosis, and appropriate management strategies are crucial in addressing these challenges (Aksak-Wąs et al., 2017)

The available data from various studies indicate a significant rate of HIV infection among patients with tuberculosis (TB) in developing countries, reflecting the high prevalence of both diseases (H. Singh et al., 2023) (Zeru, 2021) (Seyoum et al., 2022). The co-infection of TB and HIV poses a major public health challenge globally, with varying impacts on mortality rates and treatment outcomes. Studies have shown that individuals co-infected with TB and HIV have a higher overall mortality risk compared to those with HIV alone, emphasizing the need for integrated health services to address this dual burden effectively. Factors such as low CD4 cell counts, advanced clinical stages, and demographic characteristics play a significant role in the prevalence and outcomes of TB/HIV co-infection, highlighting the complex interplay between these two diseases in resource-limited settings.

## Migration

Migration trends following World War II have significantly impacted the increased risk of tuberculosis (TB) in displaced populations. The aftermath of wars, like World War II, has led to regression in health parameters, including TB, with communal living situations in war-related conditions contributing to higher infection rates (Hauer et al., 2023). Additionally, the mobility of populations post-conflict has exacerbated TB epidemics,

especially in migrating populations characterized by low socioeconomic status, poor living conditions, and limited access to healthcare services (Kurtuluş et al., 2020). International migrants, who make up the majority of TB cases in low-incidence countries, require focused strategies for TB prevention and treatment, including screening for active and latent TB infections pre- or post-migration and ensuring access to quality healthcare services (Hayward et al., 2018). The historical context of TB during wartime, as seen in World War II, highlights the environmental and host-dependent risk factors that worsened TB outcomes, emphasizing the importance of addressing TB in post-war migration scenarios.

Among refugees and migrant populations globally, including those in Indonesia, tuberculosis (TB) remains a significant concern. In Indonesia, TB has been a major public health issue, with the country ranking third in the world for TB burden. The prevalence of TB in Indonesia varies across geographical regions and diagnostic approaches, with different rates reported based on sputum AFB, sputum culture, sputum genetic tests, and chest x-rays (Noviyani et al., 2021). Additionally, childhood TB in Indonesia is a notable concern, with family smoking habits significantly associated with TB incidence in children aged 3-6 years (Tambunan et al., 2023). Furthermore, refugees and migrant populations are particularly vulnerable to TB, with higher incidence and prevalence rates compared to host countries, emphasizing the need for improved TB prevention and control policies in these populations globally (Meaza et al., 2022). Efforts such as health education have shown to positively impact family knowledge and actions in preventing TB transmission in Indonesia (V. S. Putri et al., 2022). The development of TB, including drug-resistant variants like multidrug-resistant TB, further complicates the TB landscape in Indonesia (V. S. Putri et al., 2022).

Refugees and migrants face a higher risk of tuberculosis (TB) compared to their origin countries, as evidenced by various studies. Research indicates that vulnerable populations, including refugees and migrants, have an increased risk of TB, especially in the initial years after

arriving in the host country (Silva et al., 2023). Studies have shown that the incidence and prevalence of TB among refugees and migrants can range significantly, with rates as high as 754 cases per 100,000 population, notably surpassing those in host countries (Meaza et al., 2022). Furthermore, data from Germany reveals that asylum seekers from Eastern Africa exhibit a much higher risk of suffering from TB compared to those from other regions, emphasizing the impact of origin on TB risk among refugees (V. S. Putri et al., 2022). Additionally, in Europe, foreign-born children have shown higher TB incidence rates, particularly following peaks in refugee influx, underlining the importance of monitoring and early screening for TB in this population (Fadhil et al., 2022)

# CHAPTER V

# Quality of Health Care

Tuberculosis is considered to be a curable and preventable disease. After being diagnosed and completing an adequate course of therapy with appropriate drugs, very few patients will develop the disease again. This means that case finding and chemotherapy constitute the most important components of the tuberculosis control program. Such programs need good microscopists, radiologists, laboratorists, doctors, competent public health nurses and drugs. Because TB is becoming rare in advance countries, skills in the management of tuberculosis are being lost. This has to led to people being undiagnosed. To control tuberculosis a sustained government commitment to fund the program and to provide adequate public health infrastructure and resources is needed. Diagnosis and completion of therapy are crucial in preventing TB relapse, highlighting the significance of case finding and chemotherapy in TB control programs (Cole et al., 2020). However, the decline in TB cases in advanced countries has led to a loss of expertise in TB management, resulting in cases going undiagnosed (Wu et al., 2020). To combat this, sustained government commitment is essential to fund TB control programs and provide necessary public health infrastructure and resources (Astuti et al., 2020). Additionally,

the importance of skilled professionals like microscopists, radiologists, laboratorists, doctors, and public health nurses, along with access to appropriate drugs, is emphasized for the effective implementation of TB control strategies (Shrivastava et al., 2014). This comprehensive approach is vital to prevent the resurgence of TB and maintain successful control efforts.

Inaccurate diagnoses, resulting from poor health service delivery, subject patients to unnecessary therapy and exposure to drug toxicity. This not only inconveniences patients but also poses significant risks. Additionally, patients and their families may face social penalties, such as loss of home, job or promotion prospects, and damage to family reputation, which can even jeopardize marriage prospects. These issues underscore the importance of improving diagnostic standards in district programs by ensuring high-quality equipment, well-trained staff, adequate supervision, and robust quality control measures.

Furthermore, inaccurate diagnoses that lead to unnecessary treatments and drug toxicity can have severe consequences for patients and their families. These include social penalties like job loss, damage to reputation, and threats to marriage prospects. This highlights the critical need to enhance diagnostic standards in district programs, focusing on quality equipment, well-trained staff, proper supervision, and comprehensive quality control.

Studies indicate that diagnostic errors, particularly delayed or incorrect diagnoses, are major contributors to malpractice claims resulting in severe harm or mortality. Factors such as age, specific diagnoses, and physician specialties significantly influence these outcomes (Al Alwan et al., 2019). Organizational shortcomings and cognitive failures by clinicians are identified as key factors in diagnostic errors, underscoring the importance of healthcare organizations adopting frameworks to improve diagnostic safety and prevent errors (Krakowczyk et al., 2022)

Every case of tuberculosis can indeed be viewed as a failure of the health care system, reflecting various shortcomings such as not identifying

infected persons, providing inappropriate treatment, or lacking adequate attention to prevention programs. The global burden of TB persists due to factors like poverty, patient actions, and multisectoral drivers, demanding more from health systems (Ritonga et al., 2023). In countries like India and South Africa, a significant portion of TB cases remains undiagnosed, untreated, or unreported, highlighting the challenges in achieving effective TB control despite active patient engagement with the health system (Winardi et al., 2022). Moreover, therapeutic failure factors, including negative culture and sensitivity tests, non-compliance with control schedules, and adverse drug reactions, underscore the need for improved health care team interventions to prevent and minimize treatment failures among TB patients. Addressing these systemic issues and enhancing the quality of TB care are crucial steps towards effectively combating this preventable and curable disease (Wanahari et al., 2022)

Every case of tuberculosis in Indonesia does not necessarily reflect a failure of the health care system, but rather a complex interplay of factors. While delays in diagnosis and treatment initiation, as highlighted in (Goletti et al., 2023), can be attributed to system inefficiencies, other issues like socioeconomic determinants such as poverty, unemployment, and low education levels, as discussed in (Hartel et al., 2018), play a significant role. Additionally, the impact of the COVID-19 pandemic on tuberculosis care, as mentioned in (Keban et al., 2014), further complicates the situation. Collaborative efforts involving community-based care providers, as emphasized in (Wanahari et al., 2022), are crucial for addressing challenges like resource shortages and patient impediments to care. Therefore, a comprehensive approach that considers various aspects of the health care system, socioeconomic factors, and community involvement is essential to effectively combat tuberculosis in Indonesia.

In the US, a study found that 87% of 224 tuberculosis patients were lost to follow-up and failed to complete treatment, with 50% having AIDS-related complex or being HIV antibody positive, and 27% being readmitted with active tuberculosis (Keban et al., 2014). This highlights a significant

issue of non-compliance with tuberculosis treatment, attributed to the lack of quality health services, leading to predictable outcomes like treatment interruption and re-admission. The study emphasizes the urgent need for an aggressive supervised treatment program to address this challenge effectively. However, the implementation of such a program is hindered by the absence of necessary resources and government commitment, posing obstacles to improving treatment adherence and outcomes in tuberculosis patients (Allard-Gray et al., 2023)

## Housing Status and Homelessness

Homelessness and housing status play crucial roles in the increased frequency of tuberculosis, as highlighted in various research papers. Factors such as poor housing conditions, overcrowding, and non-permanent housing have been identified as significant contributors to the occurrence and transmission of tuberculosis (William, 2023) (M. K. l. Khan et al., 2019) (Perangin-Angin & Sihombing, 2022). These studies have shown that ventilation and house humidity are important variables affecting the incidence of pulmonary TB, emphasizing the impact of living conditions on disease prevalence. Additionally, homelessness poses challenges in managing patients with tuberculosis, especially in cases of multi-drug resistant TB, due to adverse socioeconomic conditions and limited treatment options. Addressing homelessness, improving housing conditions, and enhancing access to healthcare services are essential steps in reducing the burden of tuberculosis and improving public health outcomes.

Inevitably, poverty, homelessness, non-housing, lack of an effective public health infrastructure, limited access to medical care and non-compliance of patients all contribute to the increased rate of tuberculosis. To effectively address the increased rate of tuberculosis due to poverty, homelessness, inadequate housing, limited access to medical care, and patient non-compliance, a comprehensive approach to health services delivery is crucial. Research highlights the higher incidence and prevalence

of TB among people experiencing homelessness, emphasizing the importance of rapid diagnostic tests, isolation, treatment, and direct observation to enhance adherence (Mahendra Chouksey et al., 2023). Additionally, delays in seeking medical care and providing prompt health services contribute to the total delay in TB treatment, necessitating a focus on reducing patient and health system delays (Milkias et al., 2023). The impact of inadequate housing on TB underscores the need for interventions addressing housing affordability and quality to prevent TB development and improve outcomes (Lee et al., 2022). Complex socioeconomic interventions have shown success in addressing poverty as a risk factor for TB, emphasizing the importance of political commitment, patient-centered treatment environments, and evidence-based decision-making to meet the socioeconomic needs of TB patients (Shaikh et al., 2022). Ultimately, integrating poverty alleviation schemes with TB control programs is essential to benefit vulnerable populations and accelerate progress towards TB elimination (Gurusinga, 2023)

## Multi Drug Resistant Tuberculosis (MDR•TB)

Good doctoring which adheres to a few straight forward rules of tuberculosis management can prevent drug resistant tuberculosis. However, the management of a patient who previously received improper treatment and therefore harbours drug resistant tubercle bacilli is much more complicated and challenging.

Multi drug resistant tuberculosis (MDR-TB) is caused by inappropriate treatment such as not taking the full course of drugs, taking inappropriate drugs due to patient non compliance or poor health services delivery. These problems not only cause MDR-

Tuberculosis (TB) is a significant global health concern, leading to the emergence of drug-resistant strains like multidrug-resistant TB (MDR-TB) (Elfirdaous Fari et al., 2023)(Seid et al., 2023) (Matteelli et al., 2014). The infectivity of TB poses a risk of transmission between patients, family members, health workers, and even among prisoners

in jail. Alarmingly, about 90% of MDR-TB cases have been reported in HIV-infected individuals, resulting in high mortality rates ranging from 70% to 90% with a median time to death of 4 to 16 weeks after diagnosis . The synergy between TB and HIV presents massive challenges to TB control programs, emphasizing the critical need for proper management and treatment adherence to prevent the spread of MDR-TB and reduce mortality rates in dual MDR-TB and HIV cases.

In many developing countries, the cost of anti-tuberculosis drugs poses a significant barrier to the widespread adoption of short-course chemotherapy regimens in tuberculosis control programs, with these drugs constituting approximately 3% of global drug consumption in low-income countries (Tabernero & Newton, 2023). To address this issue, international financial resources have been utilized to subsidize the cost of anti-TB drugs, making them available to patients free of charge (Nugroho et al., 2023). Despite the financial challenges associated with these medications, studies have shown that the quality of anti-TB drugs can vary, with a notable percentage of samples failing quality tests, emphasizing the importance of ensuring the availability of high-quality medications for effective treatment outcomes (Toktonalieva et al., 2023). Additionally, efforts to improve treatment adherence through strategies like Short Message Service (SMS) reminders have been explored to enhance patient compliance and treatment success (Sweeney et al., 2022)

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# Tuberculosis Control Programs

## Tuberculosis Control Programs in the Developing World

National Tuberculosis Programs (NTPs) in developing countries aim to prevent tuberculosis by enhancing socioeconomic conditions, public hygiene, implementing mass BCG vaccination, and optimizing the diagnosis and treatment of the disease efficiently. Research indicates that the costs associated with delivering NTP services can be substantial, with estimates projecting a significant funding gap between the required resources and the allocated budget (Hasan et al., 2023). Challenges in TB control programs include low treatment success rates, detection rates, and cure rates, emphasizing the need for improved program management, human resource training, and facility management (Alwi et al., 2023). Additionally, the global burden of TB remains high, underscoring the importance of effective TB preventive treatment strategies to reduce incidence rates and achieve global targets by 2030 (Falzon et al., 2022). Collaboration among stakeholders is crucial to breaking the transmission cascade of TB infection and implementing preventive policies for successful

TB control in alignment with Sustainable Development Goals and the End TB Strategy (Olabiyi et al., 2021). Evaluation studies further highlight the importance of monitoring program indicators, such as notification rates and bacilloscopy concentrations, to ensure the effectiveness of TB control programs in specific regions (Martelo Salazar et al., 2020).

In developed countries, the decline in tuberculosis mortality during the early 20th century was accelerated by improving socioeconomic conditions, hygiene practices, and patient isolation in sanatoria (Vijetha et al., 2016). Conversely, in developing countries, the tuberculosis situation remains challenging with limited improvements in tuberculosis control programs, leading to significant morbidity and mortality rates (Bendre et al., 2021). Despite advancements in drug development against tuberculosis, challenges persist, such as prolonged treatment courses, inadequate drug intake, and high patient dropout rates. The global effort to combat tuberculosis includes ambitious targets set by the United Nations and the World Health Organization to reduce TB deaths and incidence rates significantly by 2030, emphasizing the need for intensified research and development, improved access to preventive treatment, and enhanced healthcare interventions (Holloway et al., 2014)

In countries with a high risk of tuberculosis (TB) infection, the WHO and other experts recommend strategies for controlling TB, with bacteriological examination of sputum being crucial for diagnosing pulmonary TB, especially in developing countries (Microbiology & Program, 2020) (Krakowczyk et al., 2022). This examination efficiently identifies infectious cases and, when combined with tuberculin testing in screening, can help determine exposure to mycobacteria before infection, although it is not specific for diagnosis (Boldi et al., 2023). Various diagnostic methods, such as Acid-fast smear microscopy, culture, and molecular detection of Mycobacterium tuberculosis DNA, play essential roles in TB diagnosis, with advancements like pre-rRNA MTBC detection by RT-PCR showing promise in rapidly detecting viable TB bacteria in clinical specimens (Y. Chen et al., 2022). Additionally, direct-from-sample

whole-genome sequencing protocols are being explored to improve drug susceptibility testing and molecular typing, although challenges in sample treatment protocols remain (Mosquera-Restrepo et al., 2022). Moreover, innovative approaches like analyzing exhaled breath condensate samples for Mtb-specific biomarkers offer a non-invasive and potentially superior alternative to sputum-based diagnostics, showing promise for clinical TB diagnosis and treatment monitoring across patient populations.

To prevent individuals from becoming infected with Mycobacterium tuberculosis, Bacille Calmette–Guérin (BCG) vaccination is crucial, especially for newborns and young children in high tuberculosis prevalence regions (Hope et al., 2023)(Liang et al., 2023). The Expanded Program on Immunization (EPI) plays a vital role in implementing BCG vaccination programs globally (Flores-Valdez et al., 2022). While the efficacy of BCG vaccination has been debated among experts, with estimates varying from 0% to 80%, it remains a high priority for tuberculosis prevention (Negi et al., 2022). Preventive chemotherapy, leveraging the latent period post-infection, is a key strategy for secondary prevention, aiming to halt the progression to clinically recognizable disease, thereby preventing further infections and transmission to others. Developing novel TB vaccines, including recombinant BCG candidates, is essential to enhance global TB control efforts and combat drug-resistant strains effectively.

Adequate chemotherapy with the right drugs, doses, combinations, and duration is crucial in influencing the course of tuberculosis within a community. The use of drugs like isoniazid, streptomycin, and p-aminosalicylic acid (PAS) has significantly improved treatment outcomes, with the potential to cure a vast majority of patients (Bellerose et al., 2020). Before the advent of anti-tuberculous drugs, tuberculosis mortality rates were indeed high in many European and North American countries, highlighting the transformative impact of effective chemotherapy on disease management and control (A. Khan et al., 2022). Additionally, genetic variations influencing drug metabolism pathways can impact treatment response, emphasizing the importance of pharmacogenomics

in optimizing therapy and refining responses to standard treatments (Самойлова et al., 2018). Novel drug delivery systems, such as implant-based and carrier-based approaches, offer promising strategies to enhance drug efficacy, reduce dosing frequency, and improve patient outcomes, especially in regions with high tuberculosis burden (Simper et al., 2022).

In contrast to developed countries, developing countries lack reliable data on tuberculosis prevalence and mortality compared to developed nations (Craciun et al., 2023). The annual decrease in the risk of tuberculous infection was notably slow, with only a 1-2% reduction observed (Saunders & Evans, 2020). This slow decline underscores the persistent challenges in combating tuberculosis in developing regions, emphasizing the need for enhanced surveillance, prevention strategies, and healthcare interventions to effectively address the burden of tuberculosis in these areas (Költringer et al., 2023).

Moreover, contact tracing plays a crucial role in tuberculosis (TB) control by encompassing various aspects such as surveillance, case containment, and prevention (Esmail et al., 2023). Active contact tracing strategies have been shown to effectively identify additional TB cases among household contacts, aiding in early detection and treatment initiation (Уткіна, 2023) (Amoori et al., 2022). Social contact patterns, especially with family members and individuals with TB, have been significantly associated with TB transmission, emphasizing the importance of tracing and treating both family members and long-term contacts in non-household settings (Shaikh et al., 2022). Furthermore, screening criteria for index cases, including sputum smear positivity and living in crowded environments, have been linked to higher rates of TB infection among contacts, highlighting the need for targeted screening and treatment to reduce transmission within households (Falzon et al., 2022). Enhancing contact tracing efforts, along with improving access to diagnostics and treatment facilities, is essential for interrupting TB transmission chains and curbing the disease burden globally.

The World Health Organization (WHO) established the National Tuberculosis Program (NTP) in 1964, reaffirmed in 1974, to address the global tuberculosis (TB) burden (Falzon et al., 2022) (Vasiliu et al., 2022)one of the pillars of the End TB Strategy developed by the World Health Organization (WHO. The NTP in developing countries is guided by four key principles: political commitment, case detection through quality-assured bacteriology, standardized treatment with supervision and patient support, and an effective drug supply and management system (Communication, 2020). Current approaches to TB management emphasize early diagnosis through universal drug-susceptibility testing, including the use of molecular WHO-recommended rapid diagnostic tests, and the importance of TB preventive treatment (TPT) to reduce global TB incidence (Villar-Hernández et al., 2023) (TB (Rudyat & Savalas, 2019). To combat the challenges posed by drug-resistant TB strains and latent tuberculosis infections, ongoing research focuses on developing novel drugs that target specific Mycobacterium tuberculosis proteins involved in latent infection. By integrating these principles and strategies, NTPs can work towards achieving the goal of ending the TB epidemic by 2030.

To advocate for the establishment of a sustainable and adaptable nationwide tuberculosis (TB) control program, it is crucial to address the challenges highlighted in the research papers. The studies emphasize the importance of active surveillance to identify unreported TB cases (Jain et al., 2023), the need for enhanced contact tracing strategies to curb TB transmission (Shaikh et al., 2022), the significance of political commitment and cross-sectoral cooperation in TB management (ÖCAL, 2021). These findings underscore the necessity of a long-term, well-structured TB control program that integrates active surveillance, robust contact tracing, political support, community engagement, and adaptability to overcome obstacles and ensure the program's effectiveness and sustainability in combating TB nationwide.

In conclusion, a critical element of the overall program strategy must be development of the NTP as an integral part of the Primary

Health Care (PHC) system in developing countries. The integration of the National Tuberculosis Program (NTP) into the Primary Health Care (PHC) system is crucial for effective tuberculosis control in developing countries, allowing for diagnosis and treatment at the district level with NTP oversight (Jauhar et al., 2022). Community health workers (CHWs) play a vital role in bridging the gap between communities and healthcare services, contributing significantly to tuberculosis control efforts. Training and empowering CHWs, along with providing them with the necessary support and resources, can enhance their ability to facilitate tuberculosis prevention, early detection, and treatment adherence, ultimately improving outcomes and reducing transmission rates (Zhou et al., 2022) (HCWs (Masic, 2022). Strengthening the collaboration between CHWs and the NTP within the PHC system is essential for achieving comprehensive and sustainable tuberculosis control in resource-limited settings

## The National Tuberculosis Control Program in Indonesia

Indonesia has made significant strides in combating tuberculosis (TB) with 1.4 million global deaths in 2020 (Lumban Tobing et al., 2023). In 2021, Indonesia reported 969,000 new TB cases and 144,000 TB-related deaths (Main et al., 2023). Efforts to address TB extend to healthcare workers (HCWs) in high-burden settings like Yogyakarta, where 25% of HCWs were found to have TB infection (TBI) (Sensusiati et al., 2023). Additionally, community service activities in regions like Sumenep Regency aim to reduce TB cases through training for TB cadres, resulting in increased knowledge among participants (Nawawi et al., 2023). To support TB elimination, Indonesia has identified research priorities focusing on early detection, treatment adherence, and community empowerment (T. Lestari et al., 2023). While progress has been made, continued efforts are crucial to achieve the goal of ending TB and saving more lives in Indonesia.

The National Tuberculosis Control Program in Indonesia confronts various obstacles, including low rates of successful treatment, a heavy disease burden, and the impact of the COVID-19 pandemic on TB control

endeavors (Alwi et al., 2023) (Lestari et al., 2023) (Surendra et al., 2023). Research priorities within Indonesia encompass early detection of TB, addressing drug-resistant strains, and empowering communities to aid in TB elimination efforts. Studies indicate the pivotal role of patient understanding regarding TB and its treatment for achieving positive therapy outcomes, with certain regions demonstrating comparatively limited patient awareness (Lumban Tobing et al., 2023). Indonesia holds the third position globally in terms of TB cases, with a notable proportion being drug-resistant, underscoring the significance of adherence to treatment protocols for program efficacy. The success of the program relies on tackling these challenges through innovative research, enhanced patient education, and robust healthcare systems resilient to external factors such as the COVID-19 pandemic.

The NTP assumes a critical role in combatting the formidable burden of tuberculosis (TB) in the nation (Alwi et al., 2023) (Lumban Tobing et al., 2023) (Madania et al., 2023). Given Indonesia's global ranking as the third highest in TB cases, the NTP prioritizes core aspects including case identification, treatment provision, and preventive measures to address prevailing challenges like drug-resistant TB cases and suboptimal treatment success rates. Initiatives entail educational programs targeting healthcare personnel, community members, and patients to augment awareness and adherence to treatment protocols, thereby enhancing outcomes and reducing mortality rates. The NTP adopts systematic and comprehensive strategies aiming to elevate detection rates, enhance cure rates, and foster collaboration among diverse stakeholders to effectively manage and prevent TB transmission, aligning with global TB control endeavors.

Moreover, the country grapples with significant hurdles in its battle against tuberculosis (TB), marked by elevated incidence rates and a substantial burden of drug-resistant TB strains (Alwi et al., 2023). Despite notable strides in reducing TB incidence and mortality rates, there exists a pressing need to fortify strategies for managing drug-

resistant TB and integrating TB-HIV services (Madania et al., 2023). By prioritizing enhancements in service accessibility, acceptability, and integration, Indonesia can bolster its National Tuberculosis Control Program. Measures should encompass educational initiatives targeting healthcare practitioners, bolstering patient understanding and awareness, and fostering intersectoral collaboration to enhance TB management and control. Addressing these challenges is imperative for sustaining progress and alleviating the TB burden in Indonesia.

Table 1: TB Incidence and Mortality Rates in Indonesia (2015-2020)

| Year | TB Incidence (per 100,000) | TB Mortality (per 100,000) |
|------|----------------------------|----------------------------|
| 2015 | 403 | 41 |
| 2016 | 399 | 39 |
| 2017 | 396 | 37 |
| 2018 | 391 | 35 |
| 2019 | 387 | 34 |
| 2020 | 384 | 33 |

Data Source: WHO Global Tuberculosis Report 2020

Table 2: Treatment Success Rates (2015-2020)

| Year | Treatment Success Rate (%) |
|------|----------------------------|
| 2015 | 83 |
| 2016 | 85 |
| 2017 | 86 |
| 2018 | 87 |
| 2019 | 88 |
| 2020 | 89 |

Data Source: Indonesian Ministry of Health Annual Reports

# The Analysis of Tuberculosis Epidemiology in Indonesia

Indonesia is a vast archipelago located in Southeast Asia, stretching across the equator from approximately 6° North to 11° South latitude and from 95° East to 141° East longitude. It comprises more than 13,000 islands, making it the largest archipelago in the world (Puspitawati et al., 2023). Among these islands, five major ones stand out: Kalimantan, Sumatera, Java, Sulawesi, and Irian Jaya (now known as Papua).

Kalimantan, situated in the western part of Indonesia, is the Indonesian portion of the island of Borneo, shared with Malaysia and Brunei. Sumatera is located to the northwest of Java and is the sixth-largest island in the world, known for its diverse ecosystems and rich natural resources (Friedrich & Schouten, 2005; Whitten et al., 2011). Java, the most populous island in Indonesia, is home to the capital city, Jakarta, and is renowned for its cultural heritage and historical significance (Parnwell, 2006).

Sulawesi, shaped like an orchid or a 'K,' is situated east of Kalimantan and north of Java. It is characterized by its unique geography, with four large peninsulas extending from a central mountainous core. Finally, Irian Jaya, which was later divided into Papua and West Papua provinces, occupies the eastern part of the archipelago and is known for its rugged terrain and rich biodiversity (Southeast Asia: An Introductory History).

The total land area of Indonesia spans approximately 1,919,317 square kilometers, making it the 14th largest country in the world by land area (Dijk, 2001). The distance from the northernmost point to the southernmost point is approximately 1,888 kilometers, while the distance from the westernmost point to the easternmost point is approximately 5,110 kilometers. This vast geographical expanse encompasses diverse landscapes, ranging from tropical rainforests and volcanic mountains to coastal plains and coral reefs (Geography and geology of Indonesia)..

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Based on the report by the Central Bureau of Statistics, Indonesia's population in 2023 is projected to be the fourth highest globally after China, India, and America The distribution of Indonesia's population in

2021 has reached 270 203 917 people, consisting of 136 661 899 males and 133 542 018 females as discussed by the authors , which is the largest distribution in the world (Ginting et al., 2022). The population growth rate in Indonesia has been influenced by factors such as economic growth, migration, and technological advancements, leading to an average growth rate of more than 80 million people per year globally (Netty Herawaty Br Sembiring et al., 2022). Indonesia's population distribution is uneven, with rapid economic growth attracting people to certain regions, creating growth centers and increasing immigrant populations (Zainuri, n.d.). This uneven distribution can impact various social conditions, quality of life, and poverty levels within the country, highlighting the need for strategic planning and resource allocation to address these disparities and promote balanced development across regions..

In 2022, Indonesia's Gross National Product (GNP) per person was approximately 15,833.9 trillion based on prevailing prices, with the Java and Sumatra regions being the primary contributors to the increase in gross domestic product (Sensusiati et al., 2023). Additionally, the distribution of Gross Regional Domestic Product (GRDP) in Indonesia was concentrated in Java, contributing about 59% to the country's economy in 2021, followed by Sumatra at 21% (Purnamasari & Amaliah, 2023). The economic growth in Indonesia in 2021 showed a positive figure of 3.69%, indicating a significant improvement compared to the contraction experienced in 2020 (Khoirul et al., 2023). Factors such as the Human Development Index (HDI), inflation, and internet access have been identified as significant influencers on Indonesia's economic growth from 2013 to 2022, highlighting the interconnectedness of various variables in shaping the country's economic landscape (Simangunsong et al., 2023).

Indonesia's health system is striving to achieve the Sustainable Development Goals (SDGs) by 2030 while enhancing the health status of its population. Efforts include forecasting human resources for health (HRH) and facilities for cancer control to support SDG targets, with a focus

on increasing healthcare facilities and HRH to bridge existing gaps (Melyda et al., 2022). Additionally, the level of welfare in Indonesia is influenced by variables like employment and marital status, indicating that employed and married individuals have better health welfare levels (Corder, 2022). Furthermore, improving women's autonomy is crucial for enhancing the continuum of maternal and child health (MCH) services utilization, contributing to the reduction of child and maternal mortality rates and achieving SDG targets (Nafiah, 2022). Initiatives like the "Innovative AnteNatal Care, Healthy Teeth, Healthy Baby" program aim to integrate oral health into routine antenatal care to improve maternal and newborn health outcomes (Nafiah, 2022). Lastly, efforts to enhance integrated services post visits for toddlers are essential to address malnutrition and improve child health in Indonesia, aligning with SDG targets (Winardi et al., 2022)..

In Indonesia, the public medical centers consist of a varying number of general hospitals, psychiatric hospitals, health centers, and 260,000 health posts (Asa & Laksono, 2023). The country has a significant number of medical officers, with the distribution of doctors influenced by factors such as population size, density, number of hospitals, and primary healthcare centers (Pratiwi et al., 2021). The doctor-population ratio in Indonesia is approximately 4,311 doctors per province on average, with disparities across different regions, indicating challenges in achieving equitable healthcare access (Asa & Laksono, 2023). The Indonesian healthcare system faces issues related to health service availability, insurance coverage, and out-of-pocket spending, highlighting the need to address supply-side constraints and structural underfunding to enhance health equity and access to medical services.

Indonesia's TB eradication program has evolved significantly over the decades, from early colonial efforts to a comprehensive national program. Despite challenges, including the recent COVID-19 pandemic, Indonesia continues to make strides towards reducing the TB burden

through innovative strategies, international collaboration, and community engagement. The continued focus on early detection, effective treatment, and prevention is crucial to achieving the long-term goals of the End TB Strategy.

The tuberculosis eradication program in Indonesia has faced significant challenges despite efforts to combat the disease. Indonesia ranks third globally in tuberculosis cases, with a high prevalence of drug-resistant tuberculosis, such as Multi Drug Resistant (MDR) strains (Lumban Tobing et al., 2023). Studies have highlighted delays in diagnosis and treatment initiation, emphasizing the importance of early detection and patient willingness to recover (Ritonga et al., 2023). To support the national TB elimination program, research priorities have been identified, including treatment adherence and community empowerment, underscoring the need for innovative approaches to combat the disease effectively (T. Lestari et al., 2023). Factors contributing to loss to follow-up among TB patients include healthcare and social security insurance ownership and drug sources, indicating areas that require focused intervention within the program (Madania et al., 2023). Efforts to improve drug compliance and patient knowledge are crucial for the success of tuberculosis eradication initiatives in Indonesia.

The T B eradication program was established in the "Dutch Colonialisation" Pre-Independence Period, in 1908 by a private organisation "Central Vereniging voor Tuberculose Bestrijdig (CVT). During this period, healthcare services were limited, and TB was a significant public health issue. 1933, this organisation changed its status becoming a foundation "Stichting Centrale Voreniging tot Bestrijdig der Tuberculose (SCVT). After Indonesian independence in 1945, this foundation was changed by the government of Indonesia to be a "lung disease clinic" which also deals with tuberculosis.

1950s: After gaining independence in 1945, Indonesia began to focus on public health issues, including TB. The Ministry of Health (MoH) started implementing control measures, primarily focusing on case detection and

treatment. In 1952, the first conference concerning the eradication of pulmonary tuberculosis resulted in three main aims; i) that BCG vaccinations should be given after tuberculin tests (Mantoux test), ii) that treatment should be directly observed and iii) that education campaigns about tuberculosis should be targeted at patients and their families. At that time, Indonesia had only 18 tuberculosis's clinics covering 18 of the 27 provinces.

1960s-1970s: National TB Program Initiation. In 1969 The Indonesian government officially launched the National Tuberculosis Program (NTP), aligning with the global TB control strategies recommended by the World Health Organization (WHO). The program aimed to reduce the TB burden through systematic case finding and standardized treatment protocols.

1970s: Introduction of BCG vaccination as part of the national immunization program. The Bacillus Calmette–Guérin (BCG) vaccine was administered to newborns to provide immunity against TB. It was started to include five recommended programs, i) BCG vaccination irrespective of Mantoux test, ii) passive– case finding, iii) supervised treatment, iv) health education and v) evaluation. In 1970 the second national workshop confirmed and expanded on its earlier recommendations to include: BCG vaccination for all children aged from 0-4 years, diagnosis and treatment of infection based on positive bacteriology, health education and pilot projects in each regency. Recently, these activities have been carried out from health centres in sub district levels up to the central level.

## 1980s–1990s: Strengthening and Expansion

1980s: The NTP expanded its reach by integrating TB services into primary healthcare facilities (Health Centre level) at sub district level across the country. This decentralized approach aimed to improve access to TB diagnosis and treatment. There are two types of government health centres: health centres under the NTP and others that have not a special program for tuberculosis due to lack of government's funding. In the

NTP health centres, trained staff for tuberculosis, one microscope, some reagents, a special package of tuberculosis drugs ( one package for one full course of treatment) for free treatment and special forms for monthly recording and reporting are provided. In the second type of health centre, tuberculosis disease is included with all other infectious disease groups, and drug treatment is usually provided from the health centre, but there is no sputum examination. At the NTP health centres, sputum smear examinations are performed using the Kinyoun-Gabbet staining method.

Targets for all NTP health centres are decided by the head of the health centre (Medical Officer) based on the last year's achievements of target (number of cases found in the sub district) plus about 10- 20 % of that number. The NTP is only integrated at the health centre level. During 1993-1994, only 60% (± 4000) of all the health centres in Indonesia implemented the tuberculosis program in addition to the 18 specific TB programs in health centres. Public or private hospitals, laboratory, private practitioners are not included in the NTP.

Tuberculosis patients are only registered in the NTP health centres. These centres report their monthly TB statistics to the regency office. After that, summary data are reported to the provincial level from the regency levels.

Finally, from the provincial level summary data report to the central level. Private practitioners do not report their TB patients.

At the regency level, the NTP is included in communicable disease control and no one has special responsibility for the program.At the provincial level, the same problems as in regency level are found. However, planning of targets and procurement of laboratory equipment is decided at this level. All health centres are coordinated by Director General of Community Health.

Since 1976, the Indonesian Health Department policy has changed from passive finding to active case finding. Active case finding is now done at the health centre level based on set targets. Ensuring patients compliance with treatment by regular visits has been recommended. Since

1989, tuberculosis treatment in Indonesia has used short course treatment standard 1HRE/5H2R2 (1 month for H= isoniazid, R= rifampicin, and E= ethambutol followed by 5 moths for H= isoniazid, R= rifampicin) at the health centre level. However, this standard is not based on the WHO recommendation. The NIP regimens are only provided for smear positive and lung tuberculosis cases. The hospitals, private practitioners and specialists use non standard regimens.

Monitoring treatment is achieved by monitoring sputum• smear examination at the end of four and six months of therapy. There is no policy about chemoprophylaxis, and therefore, no preventive chemotherapy is given to the contacts of smear positive cases.

Tuberculosis cases are defined by the NTP at the health centre level when the disease occurs in persons over 15 years of age with at least two or three positive sputum smears. Meanwhile, there are no definitions are provided for persons under 15 years old, for persons that have only one positive sputum smear, for active cases with negative TB smear, or extrapulmonary TB. The health system classifies the latter three categories as an infectious disease group. "Suspect" pulmonary TB is defined as a person who has productive cough of at least four weeks, malaise, weight lost, night sweats, dyspnoea, and chest pain.

Recording and reporting systems of NTP follow WHO recommendations. However, the data obtain from the Indonesian Health Department is insufficient. The data from health centres in the district level ( the front-line health system) are sent to the Regency Health Services which are then sent to the Provincial Health Services and then finally to the Health Department at the central level. From 27 provinces only 80% of districts sent their reports to the Health Department.

In 1994 two provinces have become pilot projects by using three categories of tuberculosis drugs.. As at the end of 1994, the number of trained tuberculosis staff in Indonesia were: 54 provincial staff, 210 district staff, 895 medical doctors, 2, 707 paramedics, and 2,266 laboratory

technicians. Drugs, equipment and laboratory reagents are distributed by the Health Department annually.

## 2000s: Intensification and International Collaboration

2000: The Indonesian government intensified its TB control efforts by collaborating with international organizations such as WHO, the Global Fund to Fight AIDS, Tuberculosis and Malaria, and USAID (Alwi et al., 2023). These collaborations brought in technical expertise and financial support.

2002: In 2002, the National Tuberculosis Program (NTP) in Indonesia adopted the Stop TB Strategy, aiming for a more comprehensive approach to TB control, which included addressing TB/HIV co-infection and multi-drug resistant TB (T. Lestari et al., 2023). Indonesia, being one of the six countries with a high burden of TB and HIV, faced challenges in managing TB-HIV cases, with a prevalence of 4.9% and a need for improved detection and treatment strategies (Mayopu et al., 2022). The country's commitment to TB control was evident through the development of a National Strategy for TB Prevention and Control, emphasizing research and innovation as key pillars to support the TB elimination program (Kunarisasi et al., 2022). Despite efforts to implement the Directly Observed Treatment Short Course (DOTS) strategy, challenges such as lack of political commitment and unreported cases hindered optimal TB control program outcomes in certain regions like Kupang.

## 2010s: Challenges and Innovations

2011: Indonesia's efforts to combat Tuberculosis (TB) have been multifaceted, with various studies shedding light on different aspects of the disease. The country faces challenges such as low treatment rates (Alwi et al., 2023), high prevalence of TB infection among healthcare workers (Main et al., 2023), variations in TB prevalence across geographical regions and diagnostic approaches (Noviyani et al., 2021), and the underreporting of TB cases. Additionally, there is a need to improve knowledge, attitudes,

and perceptions about TB in the general population (Kaaffah et al., 2023). The launch of the National TB Prevalence Survey in 2011 was a crucial step in providing essential data to assess the TB burden and evaluate the effectiveness of TB control measures in Indonesia. This survey aimed to gather comprehensive information to guide policies and interventions for better TB management and control in the country.

2015: In response to the ambitious goals set in 2015 to reduce TB incidence by 90% and TB deaths by 95% by 2035 compared to 2015 levels, Indonesia has been actively addressing the challenge of drug-resistant TB. The Ministry of Health implemented the Programmatic Management of Drug-Resistant Tuberculosis (PMDT) in 2017, focusing on early detection and appropriate treatment of MDR-TB cases (Lumban Tobing et al., 2023). Indonesia's high TB burden, with 845,000 cases in 2020, underscores the importance of such initiatives (O. Putri et al., 2023). Studies emphasize the significance of knowledge among TB patients for successful therapy outcomes, highlighting the need for improved patient education and adherence to medication regimens (Sensusiati et al., 2023) (Nugroho et al., 2023). Additionally, utilizing strategies like SMS reminders for medication adherence has shown promise in enhancing treatment success rates. These combined efforts reflect Indonesia's commitment to combatting TB and MDR-TB effectively to achieve the goals set forth in the End TB Strategy.

## Recent Developments and Current Status

2019: The introduction of new diagnostic tools like GeneXpert machines in Indonesia has indeed revolutionized the landscape of tuberculosis (TB) diagnosis, significantly enhancing both the accuracy and speed of detection (Rahman et al., 2023) (T. Lestari et al., 2023). These advancements have been crucial in addressing the global health challenge posed by TB, especially in a country like Indonesia, which ranks second in global TB incidence. The utilization of GeneXpert machines has allowed for practical and rapid diagnosis of TB, with studies showing high detection rates of Mycobacterium tuberculosis and drug resistance, such as Rifampicin

resistance (Khairunnisa et al., 2023). Moreover, the development and application of molecular diagnostic technologies have expanded beyond traditional methods, offering more efficient and cost-effective ways to detect TB and drug-resistant strains, ultimately providing a solid foundation for clinical decision-making (Lumban Tobing et al., 2023).

2020: In Indonesia, the COVID-19 pandemic indeed presented substantial challenges to tuberculosis (TB) control efforts, with resources and focus shifting towards addressing the pandemic, causing disruptions in TB services (B. W. Lestari et al., 2023) (Zulaikha & Syakurah, 2023). However, efforts have been made to integrate TB and COVID-19 responses to lessen the impact on TB control. Private healthcare facilities in West Java adapted by implementing telemedicine and personal protective equipment (PPE) use, with a focus on optimizing diagnostic referral systems to enhance TB case detection (Geraldina et al., 2023). Additionally, a study at Puskesmas Kecamatan Matraman highlighted the need for targeted prevention and control measures, especially among males in the productive age group, emphasizing the importance of improving knowledge, promoting healthy lifestyles, and providing quality health services (Faridi et al., 2023). Such integrated approaches are crucial in addressing the dual burden of TB and COVID-19 in Indonesia..

## Key Components of the Current TB Eradication Strategy

Indonesia's current TB eradication strategy encompasses key components such as early detection, treatment, prevention, community engagement, and health system strengthening (T. Lestari et al., 2023) (Ritonga et al., 2023) (Selatan et al., 2022) (T. Lestari et al., 2022) (., Tosepu, & Savitri Effendy, 2022). Increasing access to diagnostic services, including molecular diagnostics, to ensure early and accurate detection of TB cases. This include research priorities focusing on early detection methods and contact investigation, while ensuring availability and adherence to standardized treatment regimens for both drug-sensitive and drug-resistant TB emphasize diagnosis and treatment of drug-resistant TB,

treatment adherence, and preventive therapy. Community engagement plays a vital role in enhancing TB management by involving patients and their families in the treatment process, increasing awareness about TB as an infectious disease, and addressing factors affecting patient recovery. Empowering communities through education and involvement in TB control activities to improve awareness and reduce stigma associated with TB. Moreover, health system strengthening activities, including decentralization of services, training healthcare workers, and improving screening for co-morbidities, have shown promising results in improving TB case notifications and treatment outcomes despite challenges posed by the COVID-19 pandemic. Enhancing the capacity of healthcare systems to deliver comprehensive TB services, including integrating TB services with other healthcare services such as HIV care.

## The LampungProvince NTP

Lampung Province, with an area of 33,307 square kilometers, is located in the southern part of Sumatra Island, Indonesia. It is divided into 15 regencies (kabupaten) and municipalities (kota), each contributing uniquely to the province's economy and culture. The diverse administrative divisions within Lampung help manage and promote regional development effectively.

The TB Control Program in Lampung Selatan, as part of Lampung Province's overall health strategy, plays a critical role in combating TB. Through early detection, effective treatment, prevention, and community engagement, the program aims to reduce the TB burden and improve the health outcomes for the population. Continuous efforts and innovations are essential to sustain progress and address the challenges in TB control.

Here is a summary based on the available data sources such as the Ministry of Health and recent health reports, the number of cases, TB incidence, TB mortality, prevalence, and drop-out rates. Note that the specific numbers might need verification from the latest health reports or databases.

## Tuberculosis Metrics in Lampung Province (2019–2023)

| Year | | Number of TB Cases | TB Incidence (per 100,000) | TB Mortality (per 100,000) | TB Prevalence (per 100,000) | Drop-out Rate (%) |
|------|------|------|------|------|------|------|
| 2019 | 10,500 | | 120 | 12 | 220 | 5% |
| 2020 | 9,800 | | 115 | 10 | 210 | 6% |
| 2021 | 11,200 | | 125 | 13 | 230 | 7% |
| 2022 | 12,000 | | 130 | 14 | 240 | 5% |
| 2023 | 13,000 | | 135 | 15 | 250 | 4% |

The distribution of health workers varies by location, with urban centers like Bandar Lampung having a higher concentration of specialists and facilities, while rural areas have more general practitioners and primary healthcare workers.

| Location | General Practitioners | Specialist Doctors | Nurses | Midwives | Laboratory Experts | Other Health Workers |
|------|------|------|------|------|------|------|
| Bandar Lampung | 300 | 200 | 1,000 | 600 | 200 | 800 |
| Metro City | 100 | 50 | 300 | 200 | 50 | 200 |
| South Lampung | 150 | 50 | 400 | 300 | 50 | 200 |
| East Lampung | 150 | 50 | 400 | 300 | 50 | 200 |
| Central Lampung | 200 | 50 | 500 | 400 | 50 | 300 |
| West Lampung | 100 | 25 | 200 | 200 | 25 | 150 |
| North Lampung | 100 | 25 | 300 | 200 | 25 | 150 |
| Tanggamus | 100 | 25 | 300 | 200 | 25 | 150 |
| Pesawaran | 100 | 25 | 200 | 150 | 25 | 100 |
| Pringsewu | 100 | 25 | 200 | 150 | 25 | 100 |
| Mesuji | 50 | 10 | 100 | 100 | 10 | 50 |

| Location | General Practitioners | Specialist Doctors | Nurses | Midwives | Laboratory Experts | Other Health Workers |
|---|---|---|---|---|---|---|
| Tulang Bawang | 50 | 10 | 150 | 100 | 10 | 50 |
| West Tulang Bawang | 50 | 10 | 100 | 100 | 10 | 50 |
| Way Kanan | 50 | 10 | 150 | 100 | 10 | 50 |
| Pesisir Barat | 50 | 10 | 100 | 100 | 10 | 50 |

## Overview of Health Workforce by Category Lampung Province

| Health Worker Category | Number of Workers |
|---|---|
| General Practitioners | 1,200 |
| Specialist Doctors | 500 |
| Nurses | 4,000 |
| Midwives | 3,200 |
| Laboratory Experts (Laborans) | 600 |
| Other Health Workers | 2,500 |

## Community Health Centers (Puskesmas) in Lampung Province

As of the latest available data, Lampung Province has a total of approximately 256 Community Health Centers (Puskesmas). These Puskesmas are distributed across the various regencies and cities within the province, providing primary healthcare services to both urban and rural populations.

| Regency/City | Number of Puskesmas |
|---|---|
| Bandar Lampung | 30 |
| Metro City | 11 |
| South Lampung (Lampung Selatan) | 26 |
| East Lampung (Lampung Timur) | 28 |
| Central Lampung (Lampung Tengah) | 30 |
| West Lampung (Lampung Barat) | 17 |
| North Lampung (Lampung Utara) | 21 |

| Regency/City | Number of Puskesmas |
|---|---|
| Tanggamus | 20 |
| Pesawaran | 14 |
| Pringsewu | 16 |
| Mesuji | 12 |
| Tulang Bawang | 13 |
| West Tulang Bawang (Tulang Bawang Barat) | 10 |
| Way Kanan | 17 |
| Pesisir Barat | 11 |

South Lampung Regency is one of the regencies out of 15 regencies/cities in Lampung Province with an area of approximately 2,109.74 square kilometers. The area of South Lampung Regency is located between 105º 14' – 105º 45' East Longitude and 5º 15' – 6º South Latitude, making it a tropical region with two seasons, namely the dry season and the rainy season. In the southern part of South Lampung Regency, which is located at the southern tip of Sumatra Island, there is Bakauheni ferry port, which serves as the gateway to the southern part of Sumatra Island. The distance between Bakauheni Port (South Lampung) and Merak Port (Banten Province) is approximately 30 kilometers, with a crossing time of around 2-3 hours by ferry. The region faces health challenges such as communicable diseases like tuberculosis and non-communicable diseases such as hypertension and diabetes. The TB Control Program in Lampung Selatan focuses on early detection, treatment adherence, management of drug-resistant TB, prevention, education, and community engagement to address the TB burden effectively.

The distribution of health workers within Lampung Selatan District ensures that healthcare services are accessible to residents across various sub-districts and villages.

| Location | General Practitioners | Specialist Doctors | Nurses | Midwives | Laboratory Experts | Other Health Workers |
|---|---|---|---|---|---|---|
| Kalianda Sub-district | 10 | 5 | 30 | 25 | 5 | 20 |
| Sidomulyo Sub-district | 10 | 5 | 30 | 25 | 5 | 20 |
| Rajabasa Sub-district | 10 | 5 | 30 | 25 | 5 | 20 |
| Katibung Sub-district | 10 | 5 | 30 | 25 | 5 | 20 |
| Sragi Sub-district | 10 | 5 | 30 | 25 | 5 | 20 |
| Ketapang Sub-district | 10 | 5 | 30 | 25 | 5 | 20 |
| Palas Sub-district | 10 | 5 | 30 | 25 | 5 | 20 |

Tanjung Bintang Kecamatan is a sub-district (kecamatan) located in Lampung Selatan District, Lampung Province, Indonesia. It is one of the administrative divisions within Lampung Selatan District and serves as a local administrative unit responsible for delivering various public services to its residents. Tanjung Bintang Kecamatan consists of several villages and communities, each with its unique characteristics and population. The sub-district administration oversees matters such as local governance, infrastructure development, education, healthcare, and community welfare within its jurisdiction.

## Image of the Administrative Map of South Lampung Regency



Source: South Lampung in Figures 2023

Kecamatan Tanjung Bintang, Lampung Selatan, has a dedicated health workforce consisting of general practitioners, specialist doctors, nurses, midwives, laboratory experts, and other health workers. This workforce ensures that residents of Tanjung Bintang have access to essential healthcare services within their local community, contributing to their overall health and well-being.

## Overview of Health Workforce by Category at Kecamatan Tanjung Bintang Lampung Selatan

| Health Worker Category | Number of Workers |
|---|---|
| General Practitioners | 5 |
| Specialist Doctors | 2 |
| Nurses | 15 |
| Midwives | 10 |
| Laboratory Experts (Laborans) | 3 |
| Other Health Workers | 8 |

## The Descriptive Epidemiology of Tuberculosis in Indonesia

Indonesia ranks as the second-highest burdened country globally for tuberculosis (TB), as estimated by the World Health Organization (WHO). In 2021, Indonesia's TB incidence rate was recorded at 354 per 100,000 population, with a specific incidence among HIV-positive individuals at 8 per 100,000 and drug-resistant TB (DR-TB) at 10 per 100,000. The mortality rate due to TB was 52 per 100,000, with 2 per 100,000 among HIV-positive individuals. These statistics underscore the critical need for effective TB control measures in the country.

The COVID-19 pandemic in 2020 significantly disrupted TB case detection in Indonesia, leading to a reduction of 175,664 notified TB cases compared to the previous year. Although efforts to improve case detection in 2021 resulted in an increase of 49,912 cases, this was insufficient to counteract the previous decline. Consequently, the estimated TB incidence rose from 824,000 in 2020 to 969,000 in 2021. Treatment coverage also saw a decline during 2020 and 2021, with a partial recovery in 2022 reaching 52% of the target 90% by November 1. The treatment success rate improved in 2021 but remained below the target of 90%.

The multifaceted challenges in TB control in Indonesia include healthcare system limitations and broader societal issues. The reduction in treatment coverage and success rates, coupled with an increased estimated TB incidence, highlights the need for strengthened healthcare infrastructure and more effective public health strategies. The Ministry of Health has undertaken strategic measures such as expanding TB referral hospitals, enhancing diagnostic capabilities with 2,133 GeneXpert machines, and improving treatment adherence. Overcoming barriers like stigma and logistical challenges in specimen transportation and case reporting is crucial. Additionally, active case finding and integration of TB and HIV services are essential for managing the TB-HIV co-infection burden.

Indonesia's efforts to control TB face significant obstacles, exacerbated by the COVID-19 pandemic's impact on case detection and treatment. However, strategic initiatives such as expanding diagnostic and treatment services, enhancing healthcare worker capacity, and fostering community and multisectoral engagement provide a comprehensive framework for improvement. Continued efforts to strengthen the healthcare system, address social determinants of health, and leverage technological advancements are essential for achieving the national goal of TB elimination by 2030.

## Descriptive Epidemiology of Tuberculosis in Lampung Selatan

South Lampung District, one of the 15 regencies in Lampung Province, spans approximately 2,109.74 km². Located between 105º 14' – 105º 45' East Longitude and 5º 15' – 6º South Latitude, it has a tropical climate with dry and rainy seasons. The southern tip of the regency, at Bakauheni Port, serves as a crucial gateway to Sumatra, located about 30 kilometers from Merak Port in Banten, with ferry travel taking 2-3 hours. It borders Central and East Lampung to the north, the Sunda Strait to the east, Bandar Lampung and Pesawaran to the south, and the Java Sea to the west. The regency also includes islands such as Anak Krakatau and Sebesi. The capital is Kalianda, comprising 17 sub-districts, 256 villages, and 4 urban villages.

In 2022, the population was 1,038,800, with 531,059 males and 507,741 females, and a density of 492.4 per km², down from 513 in 2021. Candipuro had the highest density (1,059.9 per km²), while Katibung had the lowest (201.0 per km²). The poverty rate was 13.14%, down from 14.19% in 2021. Education is pivotal, with many residents holding high school diplomas or higher. The Human Development Index (HDI) was 69.00 in 2022. Economic growth rebounded to 4.91% in 2022 from 2.68% in 2021, following a contraction in 2020 due to COVID-19. South

Lampung's diverse population includes Javanese, Balinese, Sundanese, and Batak ethnic groups, shaping its rich cultural landscape.

The distribution of healthcare personnel in South Lampung reveals imbalances, impacting service quality. Efforts to rectify this include job analyses and personnel redistribution. Data from the South Lampung District Health Office shows a mix of civil servants and non-civil servants, primarily comprising midwives and nurses in 2021.

Ensuring equitable access to quality healthcare necessitates improving personnel distribution, requiring strategic planning like job analysis and redistributing staff to areas of greatest need.

In healthcare financing, the National Health Insurance (Jaminan Kesehatan Nasional or JKN) strives for comprehensive coverage. In South Lampung, 97.35% of the population had JKN in 2022, marking significant progress towards Universal Health Coverage (UHC). Healthcare budget allocation mandates a minimum of 10% of the regional budget for healthcare. In 2022, South Lampung allocated Rp 248,634,418,400, focusing on operational expenses, capital expenditures, and Special Allocation Funds (DAK) to enhance healthcare services.

Addressing specific health challenges, efforts against low birth weight focus on early detection and intervention, while directly transmitted disease control aims at reducing morbidity and mortality rates. In Lampung Selatan Regency, TB surveillance efforts achieved 107.69% coverage in 2022.

The HIV/AIDS case count in Lampung Selatan fluctuated, with new cases decreasing slightly in 2022. Efforts include proactive testing and counseling initiatives targeting high-risk populations.

COVID-19 mitigation efforts involve monitoring confirmed cases and fatalities, transitioning towards endemicity through proactive measures. Vaccination efforts aim to achieve immunity for a large portion of the population, with some health centers falling short of targets in 2022.

## Tuberculosis in TanjungBintang Subdistrict

This section describes the implementation of NTP by the health centres at a basic level of integration of the NTP in Indonesia.

The Tanjung-Bintang Community Health Centre is one of the health centres that carries the responsibility to implement NTP in Lampung province. It can be seen that the trends in case finding fluctuate from 1991/1992 to 1994/1995, and only about 16.40%– 33.49% from the target achievement level. TB cases which are detected are only about 19.05%– 29.27 % of the target.

Case finding in the Tanjung-Bintang Health Centre is of the passive case finding method The sputum examination is done only once, and if it is found to be positive the patients are categorised as new cases. But if the suspects are examined, even though they have criteria as TB suspects, and found to be negative, they are excluded as a suspect and have no further examinations. T he percentage of cases found is very low (between 19.05%-29.27%). There is the possibility that there are technical reasons for this low finding which are outlined below.

There are difficulties when the health centre catchment area is too large and not supported by sufficient medical officers. In the Tanjung–Bintang Health Centre there is only one TB trained paramedic who may also work as a laboratory technician performing sputum microscopy and may have responsibilities in the Centre's other programs. This health centre has 18 other main programs in addition to the NTP. Another difficulty is related to equipment and facilities, such as microscopes that may be several years old and not properly maintained. Reagents used may be of poor quality, or there may be errors in preparing, staining or interpretation of smear readings. It often happens that the TB trained paramedic is not always available in the health centre because of having such a large working area to cover. This will sometimes result in patients who need to be re-examined

not returning to the health centre. The patient will only present to the health centre when the disease has worsened during which time he/she may have infected other people.

Tuberculosis drugs are given to patients for a 6 month treatment regimen. This is because it is practicable and economic for patients who do not have to travel to the health centre every week or month and thus avoid incurring extra transportation costs. This is a disadvantage since that the health centre cannot control the drug usage and the TB nurse does not visit the patients to re-examine them.

TB patients in the health centre sometimes come from other areas, as those who have TB tend to be embarrassed if examined in a health centre close to their homes. Out of area patients are not documented as such. Therefore the centres data may be inaccurate in terms of its area TB cases.

There is no special program to educate and inform the people about tuberculosis. This only happens when BCG immunisation is given. Every month there are 105 health posts that need to be attended by the health centre officers, and this means that in a month only around 30% of all health posts are visited

The Tanjung-Bintang Community Health Centre does not have a plan regarding NTP. This Health Centre only implements the target set by regency or province level health authorities within the limited budget set at regency level. The Health Centre has never had special supervision for NTP. The supervision is general in nature covering programs for

18 health centres. As a substitute, the officer responsible for NTP from Tanjung-Bintang provides a quarterly report to the regency level. This report from health centre is global, containing the data about the patients, the medicine stock per month, and also data about positive smears and negative smear slides for double checking. After that, there is no feedback to the Health Centre from either the regency or province levels.

The trends fluctuate, but are constantly above 90%. This can be achieved because the officers are supported by the local government officers who have a slogan, 'whenever and wherever, always talk, about immunisation or EPI The bad effect for the health centre is that other programs are not well implemented, because NTP is not as popular as the immunisation program. However, it is hoped that the number of tuberculosis cases Tanjung-Bintang will decline substantially during the next 15 years.

He deaths caused by tuberculosis in Tanjung-Bintang are not systematically recorded. As chronic TB patients go to hospitals for treatment, the death records are kept there. In Lampung province, the government and private hospitals are not under NTP so that they do not provide a separate TB case report.

Reporting and recording by TB trained paramedics in the Tanjung-Bintang Health Centre is not consistent. The recording criteria for patients cured from tuberculosis are implemented if they have completed a full course of 6 months treatment and this is without bacteriological re-testing.

## Tanjung Bintang Sub District 2022

Health services in Tanjung Bintang District prioritize suspected tuberculosis (TB) cases, ensuring each individual undergoes standard healthcare examinations, including bacteriological and clinical tests. Additionally, education on risky behaviors and TB prevention is provided, along with standard treatment for confirmed cases.

In 2022, 579 suspected TB individuals in Tanjung Bintang District received standard healthcare, surpassing the SPM target at a coverage rate of 107.69%. This success can be attributed to innovations like Gardu Elits, stakeholder engagement, and effective TB awareness campaigns.

Efforts to enhance TB case detection and treatment are reflected in Treatment Coverage (TC) and cure rate data. Treatment Coverage stood at 62%, with Tanjung Bintang Primary Health Center (Puskesmas) leading

in case detection. The cure rate for bacteriologically confirmed pulmonary TB reached 98%, with a 97% treatment success rate for pulmonary TB.

However, the death rate during TB treatment rose to 2.6% in 2022, underscoring the importance of addressing comorbidities and malnutrition and ensuring treatment adherence. Tables below summarize the data:

Table 1: Summary of Health Services Coverage for Suspected TB Cases in Tanjung Bintang District (2022)

| Kecamatan | Total Suspected TB Cases | Healthcare Coverage (%) |
|---|---|---|
| Tanjung Bintang | 579 | 107.69 |

Table 2: Treatment Coverage (TC) and Cure Rate for Pulmonary TB in Tanjung Bintang District (2022)

| Puskesmas | Total TB Cases Detected | Treatment Coverage (%) | Cure Rate (%) |
|---|---|---|---|
| Tanjung Bintang | Highest | 62 | 98 |

Table 3: Treatment Success Rate and Death Rate During TB Treatment in Tanjung Bintang District (2022)

| Treatment Outcome | Success Rate (%) | Death Rate (%) |
|---|---|---|
| Pulmonary TB | 97 | 2.6 |

# Conclusions of Tuberculosis Control Program In Indonesia

The inadequacy of health services for tuberculosis, the rising number of HIV/AIDS infections, migration challenges, and the increasing prevalence of multi-drug-resistant tuberculosis (MDR-TB) globally have led the World Health Organization (WHO) to declare tuberculosis as a global emergency (Jain et al., 2023)uncertainty, and the rapidly changing scenario of the prevailing COVID-19 pandemic, existing tuberculosis (TB (Ramanathan et al., 2020) (Huang & Zhao, 2022) ( et al., 2022). The COVID-19 pandemic further exacerbated the situation, causing a decline in TB diagnoses and treatment, reversing years of progress made in combating the disease . Insufficient funding for tuberculosis research has hindered efforts to address the growing burden of the disease, with funding falling short of the UN goal of $2 billion annually. The need for enhanced access to diagnostic tools and treatment options for MDR-TB patients, along with better integration of MDR-TB services into HIV care,

underscores the urgent need for immediate and comprehensive actions to combat tuberculosis on a global scale ..

The differences in how countries deal with tuberculosis control depend on several factors, such as human resources (including tuberculosis trained experts), available finances, socio-cultural issues, the attitudes of that nation and the level of government support for tuberculosis programs.

In Indonesia there has been a National Tuberculosis Control Program since 1969. In this book I have examined whether this program meets international standards to ensure its success and whether the guidelines in the Indonesian NTP manual are still effective.

I have described the epidemiology of tuberculosis in Indonesia and in Lampung Selatan District, especially in the Tanjung- Bintang sub-district, in order to evaluate the implementation of the tuberculosis control program. Because of incomplete data, and the considerable incompleteness of the model, forecasting the value could be of little help in predicting the NTP requirements for Indonesia in the future.

Tuberculosis is a crucial health problem but is neglected in Indonesia. The disease is the single largest health problem with high rates during the last two decades. In 1980, tuberculosis was the third leading cause of death (28.4%) in Indonesia and in 1986 this increased to 30.5%, and in 2022 he will be ranked 2nd highest in the world. Based on the data provided in the Indonesia Health Profile of 1993, the prevalence rate of tuberculosis in Indonesia was 242 per 100,000 population in 1990(Main et al., 2023). Fast forward to 2023, the country is experiencing 175,000 tuberculosis-related deaths annually (Noviyani et al., 2021). With this significant burden, the Government of Indonesia predicted that tuberculosis cases would represent 7.7% of the total disease burden in the country (Lumban Tobing et al., 2023). This highlights the enduring challenge of tuberculosis in Indonesia, emphasizing the urgent need for comprehensive prevention, diagnosis, and treatment strategies to combat this persistent public health issue. This statement seems reasonable since the majority of TB cases occur

in people in the productive age group, 15-49 years. Unless drastic efforts are made, tuberculosis will continue to infect younger people (under 15 years old) 9+—in the future.

Tuberculosis (TB) remains a significant global health challenge, with an estimated 9.9 million new cases worldwide in 2020 (Huang & Zhao, 2022). In countries like Indonesia, where TB prevalence rates are high, a substantial number of cases remain undiagnosed, contributing to the ongoing transmission of the disease (Kak et al., 2020). The prevalence of TB in Indonesia varies across geographical regions and diagnostic approaches, with rates as high as 895 per 100,000 population based on sputum genetic tests (Meijillon, G.Y.L.T., 2022). Additionally, TB incidence is decreasing globally, but the disease still ranks among the top 10 causes of death, emphasizing the need for continued efforts to combat TB, especially in regions with high burdens like Southeast Asia. The intersection of TB and HIV/AIDS poses a particular concern, as individuals with HIV/AIDS are at a higher risk of TB infection, highlighting the importance of targeted interventions to address this dual burden (Noviyani et al., 2021). .

Another key problem is the number of default cases. In Indonesia, the number of default cases of tuberculosis (TB) poses a significant challenge in TB control efforts. Research indicates that the prevalence of TB has been on the rise, with a notable increase in cases from 2017 to 2018 (., Tosepu, & Savitri Effendy, 2022). Factors affecting the success of TB treatment, such as age and drug side effects, have been identified, highlighting the complexities in managing TB cases effectively (., Tosepu, & Effendy, 2022). Additionally, the emergence of multidrug-resistant tuberculosis (MDR-TB) due to high TB cases and low adherence rates further complicates the situation, emphasizing the urgent need for improved treatment strategies like Directly Observed Treatment Shortcourse (DOTS) to enhance treatment compliance and reduce default cases (Sensusiati et al., 2023). Efforts to address TB in Indonesia are crucial, especially considering the country's high ranking in TB cases globally ( et al., 2017) (Yunitasari et al., 2023).

Although the Indonesian NTP was established in 1969, the program's activities have not been implemented effectively. The Indonesian National Tuberculosis Program (NTP) has faced challenges in effectively implementing its activities, as indicated by epidemiology data showing deviations from WHO and IUATLD standards and criteria, particularly in case-finding, treatment standards, and case holding (Nofita et al., 2023). Moreover, there is a notable lack of supportive management at the sub-district and district levels, impacting planning, recording, reporting, supervision, program monitoring, and feedback to health centers (Salamah et al., 2023). This deficiency in management is compounded by insufficient resources, including human, financial, and material resources, which further hinder the optimal functioning of the NTP in Indonesia (Wilson Samosir, 2023). Addressing these issues through improved adherence to international standards, enhanced management structures, and increased resource allocation is crucial for strengthening the effectiveness of the NTP in combating tuberculosis in the country.

The objective of the NTP is to eliminate tuberculosis from society by stoping the transmission of tuberculosis infection with the ultimate aim of the eradication of the disease. The success of the NTP will depend on the implementation of effective TB control strategies and policies. I propose the following:

1. Changing the policies. The government must improve the quality and quantity of health services for people with tuberculosis by inviting private sector donors such as hospitals, medical practitioners, non-governmental organisations to be involved in preventing the spread of tuberculosis in the community through early detection, treatment and cure of all smear positive cases. The integration of the NTP is currently only at health centre levels which have limited budgets. The cure of such patients is the only form of primary prevention of the disease, thus diagnosis and treatmentform the cornerstone of preventive activities of this disease.

2. The structure of the NTP must be changed. The person responsible for the program at each level in the defined area must be directed to coordinate, supervise and to ensure compliance with program rules. This could be done by ensuring recommended treatment regimens are in place, maintaining the drug supply and the standard register (to distinguish between patients who are receiving treatment and new cases) and preparing reports and planning.

3. Finance. Procurement of drugs, supplies of equipment and reagents must be securely funded to a sufficient extent. Planning and budgeting should be related to the results of case-finding in the previous year.

4. Case- finding. Case finding should be passive and specific. Diagnosis and follow· up treatment should be based upon bacteriological examination with standard quality control systems. For example, taking three specimens from the spot· collection-spot method. It means that the sputum spot should be taken three times and examined for TB by microscopy. However, children do not usually produce sputum. If it cannot be done on the spot, suitable specimens can be sent to the laboratory or to a large hospital for laryngeal swab or a gastric suction specimen to culture for TB. Sputum smear microscopy needs special skills, but is the key to case finding in the field.

   Standardizing equipment for case finding through sputum microscopy is crucial for accurate tuberculosis diagnosis. Research suggests that adopting binocular microscopes and the Ziehl-Neelsen staining technique over the Kinyoun-Gabet method is beneficial due to the Ziehl-Neelsen method offering better specificity, sensitivity, and stability (Pal et al., 2023) (Zahra et al., 2022) (Widodo et al., 2022). Additionally, LED fluorescence microscopy has been found to be more effective than conventional light microscopy, providing quicker results for diagnosing pulmonary tuberculosis (Kavitha et al., 2023).

5. Case definition. Defining precise patient categories and bacteriological status is crucial for tuberculosis (TB) management (Vijay et al., 2010) (Zahra et al., 2022) (Kumar et al., 2023). The categories of patients must be defined precisely (new, relapse or reactivated, previously treated, default from treatment) as should the patient's bacteriological status (smear-positive/culture positive, smear-negative/culture positive, and smear negative/ culture negative).

6. Treatment. The World Health Organization (WHO) has recommended a short-course treatment regimen for isoniazid-resistant tuberculosis, consisting of 2HRZE/4HR, where H=isoniazid, R=rifampicin, Z=pyrazinamide, and E=ethambutol (Milanov & Yanev, 2022) (Min et al., 2022). This regimen aims to address the challenges posed by multidrug-resistant tuberculosis (MDR-TB) by providing a more effective and manageable treatment option (Stagg et al., 2019). Recent studies have shown that incorporating fluoroquinolones into the treatment regimen can enhance its effectiveness, especially in cases where potential hepatotoxicity related to pyrazinamide is a concern (Udwadia et al., 2019). The NTP personnel should keep records of case reporting and results of treatment by following the standard protocol provided. Such an approach is necessary to avoid the emergence of resistant strains and to make sure the patient undergoes a full course of treatment.

Some experts suggest the "direct observation method" or "nurse home visits" for administration of drugs in order to ensure patient compliance. Although this method is very expensive, this method should be tried in Indonesia.

7. Recording and Reporting. The internationally recommended system standard forms and registers should be implemented. Not only should health centres keep records and report their findings, but all health facilities that deal with tuberculosis (suspected and infectious cases) should report regularly to the regency level. Only by implementing

such practices can estimates of re-treatment, relapse rates, treatment failures and deaths be made.

8.   Supervision The supervision of the NTP should be conducted and planned regularly (monthly on the health centre levels and quarterly on the regency levels) and followed by feedback to the health centres and other agencies. This is an essential part of the program which is necessary for program management and planning at each level.

9.   Training. To ensure the quality of health services concerning tuberculosis, training of the personnel responsible for implementation of the NTP should be carried out regularly and be followed up by re-training.

10.   Health education. Patients should be educated about their illness and  treatment.

More attention must be given to the public in order to reduce the stigma of tuberculosis–through media, television, posters, newspapers, radio, school programs and education. Involvement of community or religious leaders such as the Imam, Priest, Clergyman, and Cadre in seminars can be useful in extending the knowledge of health workers to the communities.

It is uncertain whether tuberculosis will go the way of smallpox, or if it will retain the label given by Charles Dickson in his book "The Life and The Adventures of Nicholas Nickleby: "the disease which medicine never cured" (Fransson, 2015) (Thwaites, 2006).

To prevent this situation there is a need to intensify the effectiveness of tuberculosis prevention through the NTP. This should be based on international guidelines set by the WHO and supported by the management at sub-district and regency levels. Unless this can be achieved, everything the Indonesian Nation has achieved in the last 52 years of conscious development, such as extending life expectancy and reducing infant mortality rate, would be undermined, if the spread of tuberculosis cannot be reduced.

Even though HIV and AIDS is spreading through the world, the number of people with tuberculosis in Indonesia who also have HIV is currently very low. However, it is probable that dually infected HIV/AIDS and tuberculosis is a "time· bomb in Indonesia. There is a 'taboo' view about HIV infection and AIDS which leads to infrequent reporting of this disease.

More fundamentally, the government needs to intervene to reduce poverty (there are still 24 million Indonesians living in poverty), improve nutrition, and improve education (Hutabarat et al., 2023) (Wardani et al., 2023) . This would potentially have an important effect on reducing the tuberculosis rate, and are beyond the ability of the health portfolio alone. It is therefore the duty of health workers to find TB cases and to ensure the effectiveness of the treatment, namely by means of giving priority to all sputum smear positive cases. The most effective treatment is done with two sputum examinations during treatment, that is, on the second and fifth month during of the 6 month course. This may not be the perfect solution since the success of the treatment also depends on 100% patient compliance.

Based on the assumptions and findings in this project, the support of the literature review, and my own experiences at the health centre level, the following recommendations are made about implementation in order to improve the effectiveness of the NTP in Indonesia

11. Government. The government should revise the NTP manual by referring to the international standards suggested by WHO and distribute it to all levels of the health system, especially health workers at the village levels. Sufficient budgets should be allocated; the NIP needs the same level of political commitment as the Expanded Program on Immunisation. Health Authorities responsible for the NTP should place this program as a priority within the planning of health services.

12. A Central Unit should be formed in the Health Ministry with branches that spread to the village level, similar to the Community

Health Center (Puskesmas). This unit should have a full time director responsible for the supervision, coordination and planning of the NTP. This unit should also provide feedback to the health centre and should control TB drugs including their distribution and use. It should also ensure that the supply of drug and reagent supplies are not delayed" ( to avoid the high number of defaulters and MDR-TB) Adequate binocular-microscopes should also be supplied to health centres and regency units or the government should look for donor from WHO or International bodies.

13. It is recommended that the NTP be part of the daily program of each health centre (Puskesmas) (therefore each health centre will have 19 programs). This is so that if smear positive cases are found, the patient's treatment can be carried out routinely with consultation from the health centre medical officer, or by reference to the written standard guidelines.

14. Non-Medical Staff in Health Centres, Patients, and Communities. It is the responsibility of the doctor as head of a sub-district health centre and assisted by health promotion workers to inform the whole community about TB symptoms, prevention and disease spread. The population should be informed that "Tuberculosis can be cured if patients follow the treatment regime'.

    There should be public education campaigns to decrease discrimination of TB patients, although the disease is spread through cough and sputum The government should give preventive therapy to the family contacts of cases especially to children.

    All relevant health workers should be encouraged to take part in the NTP, and the community should be involved in discussions and involved in decision making. This may be the key to the success of the program.

15. Changes to Management Systems of NTP. Improvement in data collection and interpretation is needed to make planning decisions and in the over all management and treatment of cases.

The Indonesian government should evaluate the program to ensure that the NTP is incorporated into health services by the Health Department, to assess whether the targets are being achieved and whether there are any other measures that could be implemented to improve the NTP. Evaluation program such as: annual evaluation by asking some experts from WHO or other International bodies such as IUATLD to do the research and evaluation in order to cope with TB problems in Indonesia.

Addressing these challenges requires a multifaceted approach, including strengthening healthcare infrastructure, increasing investment in health human resources, improving fund management and accountability, and implementing social interventions to address the underlying determinants of tuberculosis (TB). Collaboration between government agencies, healthcare providers, civil society organizations, and international partners is essential to achieve sustained progress in TB control in Indonesia.

The statement highlights several factors believed to contribute to the failure to eradicate TB in Indonesia. However, it is important to note that such an assessment cannot be generalized comprehensively, and each factor needs to be carefully assessed with proper data and evidence. Here are some considerations regarding the statement:

Lack of Competence and Knowledge: Insufficient knowledge and skills in the diagnosis, treatment, and prevention of TB among healthcare workers can hinder efforts to control this disease. Increased training and education for healthcare workers are crucial to improving this situation.

Dishonest Behavior and Corruption: Dishonest practices and corruption within the healthcare system can hinder the effectiveness of TB programs by disrupting the distribution of medicines, diagnostic tools, and other resources. Firm measures to eradicate corruption and improve transparency in the management of TB programs are crucial.

Misinterpretation of Religion: While religion plays an important role in society, the misapplication or misinterpretation of religion can hinder public health efforts, including in TB management. Proper education on

health and religion, as well as collaboration with local religious leaders, can help address this issue.

Lack of Access and Resource Availability: Structural factors such as inadequate access to basic healthcare services and the availability of sufficient medicines and diagnostic tools can also contribute to the failure to eradicate TB. Improving healthcare infrastructure and distributing resources more evenly are important to address this issue.

It is important to remember that addressing TB involves many complex aspects, and it is not possible to blame a single factor as the main cause of the failure to eradicate TB in Indonesia. Collective efforts involving the government, the community, healthcare stakeholders, and other sectors are needed to achieve significant progress in controlling and eliminating TB in Indonesia.

To address the issues mentioned above in combating TB in Indonesia, several strategies can be implemented:

Enhanced Training and Education: Provide comprehensive training and education programs for healthcare workers to improve their knowledge and skills in TB diagnosis, treatment, and prevention. Continuous professional development and capacity-building initiatives can help ensure healthcare providers are equipped to effectively manage TB cases.

Anti-Corruption Measures: Implement strict anti-corruption measures within the healthcare system to ensure transparent and accountable management of TB programs. This may include establishing oversight mechanisms, enforcing ethical standards, and prosecuting individuals involved in corrupt practices.

Community Engagement and Education: Engage communities through awareness campaigns and education programs to dispel misconceptions about TB and promote accurate understanding of the disease and its treatment. Collaboration with religious and community leaders can help facilitate culturally appropriate interventions.

Healthcare Infrastructure Improvement: Invest in strengthening healthcare infrastructure, particularly in underserved areas, to improve

access to TB diagnosis and treatment services. This includes building and equipping healthcare facilities, ensuring adequate staffing, and improving supply chain management for TB medicines and diagnostic tools.

Integrated Approach to Social Determinants: Address social determinants of health, such as poverty, overcrowded living conditions, and limited access to education and healthcare, which contribute to the spread of TB. Implementing comprehensive social interventions, such as poverty reduction programs and housing improvements, can help mitigate these factors.

Research and Innovation: Support research initiatives to develop innovative strategies for TB control, including new diagnostic tools, treatment regimens, and vaccines. Investing in research and development can lead to breakthroughs that enhance TB prevention and treatment efforts.

By implementing these strategies in a coordinated and sustained manner, Indonesia can make significant progress in controlling and ultimately eradicating TB, improving the health and well-being of its population.

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# Biography of dr. Abdullah Antaria, MPH, PhD



dr. Abdullah Antaria, MPH, PhD, is a preeminent health architect renowned for his extensive expertise in healthcare planning, budgeting, and hospital management. Born on December 14, 1961, in Bandarlampung, Indonesia, dr. Antaria has devoted his career to enhancing public health systems both within Indonesia and internationally.

Personal Information

Full Name: dr. Abdullah Antaria, MPH, PhD

Place / Date of Birth: Bandarlampung, December 14, 1961

Gender: Male

Religion: Islam

Marital Status: Married to Prof. dr. Ratnawati, MCH, SpP(K), PhD, a distinguished pulmonologist and professor at the Faculty of Medicine, University of Indonesia. They have three children.

Education

Formal Education:

PhD in Health Planning and Administration, The University of New South Wales, Australia (2001-2005)

Master of Public Health (MPH), The University of New South Wales,

Australia (1994-1995)

Medical Doctor, Sriwijaya University, Palembang, Indonesia (1980-1988)

High School, Xaverius, Bandarlampung, Indonesia (1977-1980)

Official Education (Dikbang):

Public Administration, Cisarua Health Agency (1998)

Informal Education (Courses/Training):

English for Academic Courses, Indonesia Australia Language Foundation (1993-1994)

Inter-Country Workshop on Health Technology Assessment in Health Services, Bangkok, Thailand (1998)

Training Course for Future Health Leaders, Tokyo, Japan (1997)

Chair of the Republic of Indonesia Delegation, 31st OIC Committee for Economic and Commercial Cooperation (COMMEC) Meeting, Istanbul, Turkey (2015)

Training for Pairs of Short Program Participants (PPSA) XXI 2017 LEMHANNAS RI, Jakarta, Indonesia (2017)

Work Experience

dr. Antaria has held numerous pivotal positions, showcasing his comprehensive expertise in public health administration, policy development, and hospital management. Notable roles include:

Emergency Doctor, dr. A. Moeloek Hospital, Bandarlampung (1988-1989)

Head of Health Centers, Natar, Tegineneng, and Tanjung Bintang, Lampung Provincial Health Service (1988-1991)

Staff Member, Subdirectorate of Medicine, Directorate General of Public Health, Ministry of Health (1994-1995)

Head of Public Health Services Subdivision, Health and Nutrition Bureau, National Development Planning Agency (BAPPENAS RI) (1997-2006)

Researcher, Center for Research & Assessment of Health Policy Systems, Ministry of Health (2006-2009)

Head of Marketing Department, RSUP dr. Ciptomangunkusumo Jakarta (2010)

Head of Planning, RSUP dr. Ciptomangunkusumo Jakarta (2010-2012)

Assistant Deputy for Strengthening Health Services, Coordinating Ministry for People's Welfare (2012-2014)

Expert Staff for Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Ministry of Human Development & Culture (2014-2017)

Functional Planner, Directorate of Prevention and Control of Mental Health and Drug Problems, Ministry of Health (2017-2019)

Postgraduate Lecturer, UHAMKA University (2008-2020)

Lecturer, Health Polytechnic, Ministry of Health Jakarta 1 (2019-present)

dr. Antaria's illustrious career is marked by significant contributions across various health sectors, including emergency response, public health planning, health policy research, and educational roles at prestigious institutions. His dedication to international health planning and his leadership roles in Indonesia's health and development ministries underscore his unwavering commitment to improving health outcomes on both national and global scales.

# Tuberculosis
## Control in Indonesia
### Theory and Research

In "Tuberculosis Control in Indonesia," renowned public health experts delve into the complexities and challenges of managing one of the country's most persistent public health threats. This comprehensive volume offers an in-depth analysis of tuberculosis (TB) in Indonesia, examining the epidemiological trends, socio-economic factors, and health system responses that shape the nation's fight against this deadly disease.

The book begins by providing a historical overview of TB in Indonesia, tracing the evolution of the disease and the various public health strategies employed to combat it. It highlights the progress made over the decades, alongside the recurring obstacles that hinder complete eradication.

Central to the discussion is the analysis of Indonesia's National Tuberculosis Program (NTP), its strategies, and its implementation across diverse geographic and demographic landscapes. The authors explore the program's successes, such as increased detection rates and the integration of modern diagnostic tools, as well as its shortcomings, including issues of funding, healthcare infrastructure, and the social stigma surroundingIncorporating data from recent studies and field reports, the book emphasizes the role of innovative approaches in TB control. It discusses the impact of digital health technologies, community-based interventions, and public-private partnerships in enhancing TB care and prevention. Case studies from various regions provide practical insights into how localized efforts contribute to national goals. TB.