Childhood Tuberculosis: Epidemiology, Etiology, Pathophysiology, Pathogenesis, Risk Factors, Prevention and Diagnosis: A Narrative Review

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Abstract: *Background*: Tuberculosis is a chronic infectious disease caused by Mycobacterium tuberculosis bacteria. These bacteria are rod-shaped and acid-resistant, so they are often known as acid-resistant bacilli (BTA). Children are at high risk of TB infection, especially infants and toddlers. Children infected with TB are at risk of developing severe TB disease that can lead to death or long-term disability. This article review focuses on a brief introduction to anemia, its etiology, pathophysiology, impact and preventive measures.

Methods: Major databases including Scopus, Pubmed, Proquest, Google Scholar, and Science Direct were searched for articles related to pediatric tuberculosis. The keyword used in the literature search was “pediatric tuberculosis”. The time frame of the articles obtained ranged from 2016 to 2023.

Results: This study shows that the burden of pediatric tuberculosis (TB) remains high globally and nationally. WHO reported 1.2 million cases of pediatric TB with more than 200,000 deaths, mainly in children under five. In Indonesia, pediatric TB cases increased from 110,881 (2022) to 129,798 (2023), with bacteriological confirmation still low, especially in children <5 years. In South Sulawesi, the trend of cases is decreasing, but in Parepare City it has increased from 16 to 21 cases. The main obstacles include difficulty in diagnosis, limited facilities, low coverage of TB preventive therapy (TPT), and suboptimal handling of drug-resistant TB.

Conclusion: Diagnosing TB in children remains difficult due to limited tools and low bacterial presence. Many cases go underdiagnosed or overdiagnosed, while drug-resistant TB poses added risks. Prevention includes BCG vaccination, controlling risk factors, and TPT. Disparities in diagnosis and treatment persist. Early detection, family education, and access to care are vital. Strengthening community and household approaches can narrow diagnostic gaps and prevent complications in childhood TB.

Keywords: Chilhood Tuberculosis, Epidemiology, Pathogenesis, Diagnosis, Prevention.

INTRODUCTION

Tuberculosis (TB) is a chronic infectious disease caused by Mycobacterium tuberculosis (MTb) and is a serious global public health issue. According to the WHO (2022), MTb can affect various organs in the body, particularly the lungs, brain, lymphatic system, digestive tract, bones, and joints [1]. Tuberculosis (TB) generally affects the lungs (pulmonary TB), but it can also affect other organs (extrapulmonary TB), and is transmitted through the air when the patient coughs or through close contact with people around them [2-5].

Globally, in 2021, there were an estimated 10.6 million TB cases, an increase of 600,000 cases compared to the previous year. Of these, 6.4 million were diagnosed and treated, while 4.2 million remained undetected or unreported. TB-related deaths also increased, from 1.3 million in 2020 to 1.6 million in 2021 [6].

TB can affect people of all ages. Of the total 10.6 million cases, approximately 6 million occurred in adult men, 3.4 million in adult women, and 1.2 million in children aged 0–14 years (KNCV Indonesia Foundation, 2022). In developing countries, children under the age of 15 account for 40–50% of the population. Although TB bacteria are less prevalent in children, their weakened immune systems make them vulnerable [7].

The burden of TB is measured based on incidence, prevalence, and mortality. In 2020, the global incidence of TB was recorded at 121 per 100,000 population. Ten

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countries accounted for 74% of global cases, with India (24%), Indonesia (11%), and the Philippines (8.3%) as the main contributors (WHO, 2021). There were 1.1 million cases of childhood TB in 2020 [6].

In Indonesia, the incidence of TB in 2021 is estimated at 354 per 100,000 population, up from 301 per 100,000 in 2020. The TB mortality rate is estimated at 52 per 100,000. In 2022, there were 677,464 TB cases, up from 397,377 cases in 2021. Childhood TB cases reached 110,881 in 2022 and increased to 129,798 in 2023, with a significant distribution among the 0-4 and 5-14 age groups [8].

In South Sulawesi, there were 17,885 TB cases in 2019, decreasing to 11,361 in 2020, then increasing to 13,271 in 2021. The city of Makassar recorded the highest number of pulmonary TB cases with 3,908 cases in 2021. Child TB cases decreased from 1,067 in 2020 to 386 in 2021 and 380 in 2022. Facilities with high case numbers include Labuang Baji General Hospital, RSTC, and BBPKM.

The Ajatappareng region also reported childhood TB cases in 2023–2024: Barru District (11 cases), Sidrap (44), Pinrang (54), Enrekang (43), and Parepare City (45). In Parepare City, childhood TB increased from 16 cases in 2022 to 21 in 2023. This increase requires attention to prevent further spread.

TB transmission in children is similar to that in adults, influenced by exposure duration, immune status, and the infectivity level of the index patient. Patients with positive sputum smear results have a transmission risk of 65%, higher than those with negative sputum smear but positive culture results (26%) or negative culture with positive radiological findings (17%) [9].

Another issue is the increasing number of drug-resistant TB (DR-TB) cases in adults, which pose a risk of transmission to children. Although precise data on pediatric DR-TB is not yet available, the number is estimated to be increasing [10]. Diagnosing pediatric TB is also challenging because children have difficulty producing sputum, necessitating a more specific clinical approach [11].

Chilhood Tuberculosis has far-reaching effects, not only physically but also psychologically and socially. If left untreated, it can lead to complications such as miliary TB, TB meningitis, and even death. Risk factors include malnutrition, incomplete immunization, inadequate housing, poverty, overcrowding, and HIV status [12].

SEARCH METHOD

In this study, various databases such as Scopus, PubMed, ProQuest, Google Scholar, and ScienceDirect were used as research sources. The main keywords used in the literature search were “Etiology, Pathophysiology, Impact, and Prevention of TB Incidence in Children.” The timeframe for the articles accessed ranged from 2016 to 2025.

DEFINITION OF TUBERCULOSIS

Tuberculosis is a chronic infectious disease caused by the bacterium Mycobacterium tuberculosis. This bacterium is rod-shaped and acid-fast, hence it is often referred to as Acid-Fast Bacillus (AFB). Most TB bacteria are commonly found infecting lung parenchyma and causing pulmonary TB; however, this bacterium also has the ability to infect other body organs (extrapulmonary TB) such as the pleura, lymph nodes, bones, and other extrapulmonary organs [13].

Childhood Tuberculosis is not considered a priority in national TB programs in most countries, as children are not the primary source of TB transmission in the community. This view is not entirely incorrect, but managing TB in children plays a crucial role in TB control programs for several reasons.

Children are at high risk of TB infection, especially infants and toddlers. Children infected with TB are at risk of developing severe TB, which can lead to death or long-term disability. Adolescents (ages 10-19) are also a vulnerable group for TB, mostly in the form of infectious adult-type TB that can be transmitted to those around them. Difficulties in obtaining sputum samples for bacteriological examination and the frequent occurrence of negative sputum test results (pausibacillary condition) make TB diagnosis in children challenging, leading to most cases being diagnosed clinically, which may result in overdiagnosis or underdiagnosis. Despite improved sputum collection techniques and molecular-based microbiological testing, logistical challenges and limited facilities in the field have hindered the optimal implementation of bacteriological confirmation in children [14].

EPIDEMIOLOGY CHILHOOD TUBERCULOSIS

In 2021, the WHO estimated that approximately 1,150,000 children under the age of 15 were infected with TB globally, an increase of 3.6% during the pandemic. This number represents 11% of all global TB cases, and 47.5% of these cases were in children under the age of 5. Other data indicate that the number of TB cases among adolescents (10–19 years old) is estimated to be around 727,000. There were also 209,000 deaths due to TB in children under 15 years old, or approximately 13% of total TB deaths worldwide, with 80% of these occurring in children under 5 years old and 21,000 deaths in children with HIV/AIDS [15].

Approximately 96% of TB-related deaths in children occur among those who cannot access TB treatment. Globally, there is a significant gap between the number of reported TB cases in children and the estimated number of cases (under-reporting), with the majority of cases occurring in the under-5 age group, accounting for nearly 70%. Global coverage of Tuberculosis Prevention Therapy (TPT) also remains below target, reaching only around 42% of the UN High-Level Meeting target (30 million for the 2018–2022 period). Approximately two-thirds of the 1.2 million children under the age of 5 who are contacts cannot access TPT [16].

Indonesia is currently the second-highest country in the world for TB cases, with an estimated 1,060,000 cases. Although the number of cases decreased during the pandemic, in 2022, the total number of TB patients reported to the national TB program was 724,309, with 110,881 cases among children under 15 years of age (15.3% of all TB cases) and 40,976 cases among those aged 15-19 years, as shown in Figure **1**. 110,881 (15.3% of all TB cases) and 40,976 cases were in the 15-19 age group, as shown in Figure **1**.

The national TB case detection rate for children was 158.5%, exceeding the target of 90% of estimated cases. However, this rate varies between provinces, ranging from the lowest in Bali Province (30.2%) to the highest in West Java (401.5%). Some provinces have achieved a target of ≥90% (Figure **2**). There are several possible causes for this situation, such as increased efforts to detect TB cases in children, delayed diagnosis due to previous Covid-19 infections, or ongoing transmission due to insufficient case detection and treatment of adult TB (underdiagnosis or under-reporting), as well as the possibility of overdiagnosis.

Based on age group and gender, TB case notifications for the 0-19 age group decreased in 2019-2020 from 158,006 cases (2019, 0-24 age group) to 61,015 cases due to the COVID-19 pandemic. However, this figure increased again to 70,539 cases (2021) and 151,857 cases (2022). Among all reported TB cases in 2022, the proportion of bacteriologically confirmed TB cases in children under 5 years old was 1.2% lower than in the 5-19 age group, which was 17.4%.

In 2022, 143 cases of RO TB were identified in children under 15 years of age, but only 67 cases began treatment. Given the high mortality rate among TB RO patients and the high infectiousness of TB, particularly among those not receiving treatment, serious efforts are needed to address the treatment

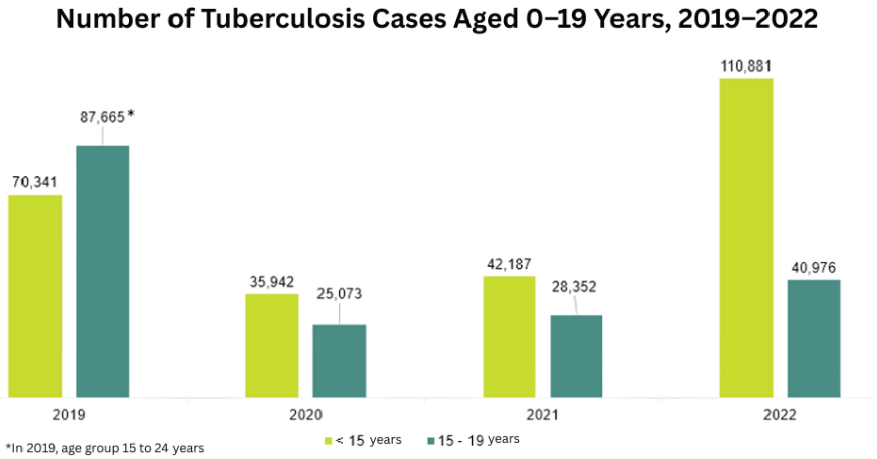

Figure 1: Reported Cases of TB in 0-10 years old, 2019-2022[16].

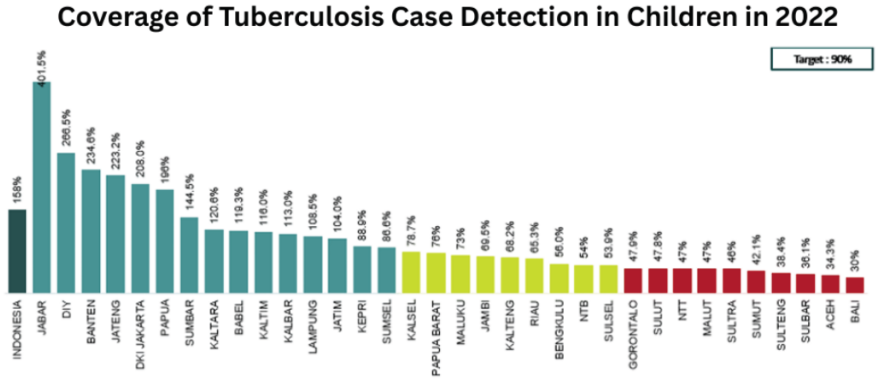

Figure 2: Child TB Case-Finding Coverage (Age <15 years) by Province, 2022 [16].

gap for TB RO in children. According to TB HIV data for children (Ministry of Health of the Republic of Indonesia, 2020–2022), 21% of TB cases in children aged 0–19 years were HIV-positive.

ETIOLOGY

Tuberculosis is caused by the bacterium *Mycobacterium tuberculosis*, which belongs to the *Mycobacteriaceae* family and is dangerous to humans. This bacterium has a lipoid cell wall that makes it resistant to acid, and it takes 12-24 hours to undergo mitosis. Although it is acid-resistant, this bacterium is susceptible to sunlight, ultraviolet rays, moist heat, 70% alcohol, and 50% lysol. Within the body, M. tuberculosis can remain dormant for years and reactivate when the immune system weakens. The bacterium is aerobic and prefers tissues with high oxygen levels, such as the apical regions of the lungs. Transmission occurs through droplet nuclei expelled when a person with pulmonary TB coughs, sneezes, or speaks. These droplets can remain airborne for several hours, especially in poorly ventilated enclosed spaces, and pose a risk of inhalation by healthy individuals. TB most commonly affects the productive age group (15-49 years) and can infect all age groups.

In addition to *M. tuberculosis*, there are four other types of bacteria associated with TB infection: *Mycobacterium bovis, Mycobacterium africanum, Mycobacterium microti*, and *Mycobacterium cannetti*i. Among these five types, *M. tuberculosis* is the most common cause and is transmitted through airborne droplets between humans, while M. bovis can be transmitted through the consumption of contaminated milk. Infection with M. bovis has decreased due to milk pasteurization and TB control in livestock. TB transmission occurs through very small droplet nuclei (<5 microns) that may contain 1-5 bacteria, making them highly infectious. Transmission is determined by three factors: the number of bacilli released into the air, the concentration of bacilli in the air, and the duration of exposure. The condition of the immune system plays a crucial role in the development of infection into active TB. Individuals with a competent immune system are unlikely to develop active disease, while those with an impaired immune system, such as HIV patients, diabetics, or immunosuppressed individuals, are at higher risk of developing active TB [17-19].

PATHOPHYSIOLOGY

Mycobacterium tuberculosis bacteria enter the human body through the respiratory tract, digestive tract, or open wounds on the skin, although most infections occur through inhalation of air droplets containing tuberculosis bacilli from active TB patients. Once they reach the alveolar surface, typically in the lower lobes of the lungs or the upper part of the lower lobes, the bacilli trigger an acute inflammatory reaction. Polymorphonuclear leukocytes phagocytose the bacteria but do not kill them. Within a few days, these leukocytes are replaced by macrophages, which may undergo consolidation, leading to cellular pneumonia. The infection may resolve spontaneously or persist, with the bacteria multiplying within cells and spreading through the lymphatic system to regional lymph nodes. Subsequently, epithelioid cells and granulomatous inflammatory reactions form, typically taking 10-20 days. This infection represents the early stages of tuberculosis pathogenesis, which begins with the inhalation of infectious particles smaller than 5 μm that can remain airborne and reach the alveoli when a person is exposed to droplets from an infected individual through coughing, sneezing, or speaking.

Once in the alveoli, *M. tuberculosis* can establish itself and multiply, then spread to other organs such as the kidneys, bones, cerebral cortex, and other parts of the lungs via the lymphatic system and bodily fluids. The immune system responds by triggering an inflammatory reaction, where phagocytes suppress the bacilli and tuberculosis-specific lymphocytes destroy the bacilli along with healthy tissue. This reaction forms exudate in the alveoli and can cause bronchopneumonia. Initial infection typically appears 2–10 weeks after exposure. The interaction between the bacteria and the immune system forms granulomas, clusters of live and dead bacteria surrounded by macrophages, which develop into fibrous tissue with a necrotic center (Ghon focus). If the immune system weakens or the infection reactivates, the granuloma may rupture, causing caseous necrosis, spreading the bacilli through the bronchi and air, leading to secondary infections. The infected lung forms scar tissue and causes secondary bronchopneumonia [21-23].

PATHOGENESIS OF TUBERCULOSIS

RISK FACTORS

Tuberculosis (TB) is a contagious infectious disease that remains a global health problem, especially in developing countries. Children are a vulnerable group at high risk of developing active TB due to their underdeveloped immune systems. Several key risk factors contribute to TB incidence in children, including age, gender, BCG vaccination status, malnutrition, exposure to tobacco smoke, history of contact with TB-positive patients, housing density, parental knowledge, and poor socioeconomic conditions. The study reviewed in this article found that children who did not receive the BCG vaccination were three times more likely to be infected with tuberculosis compared to

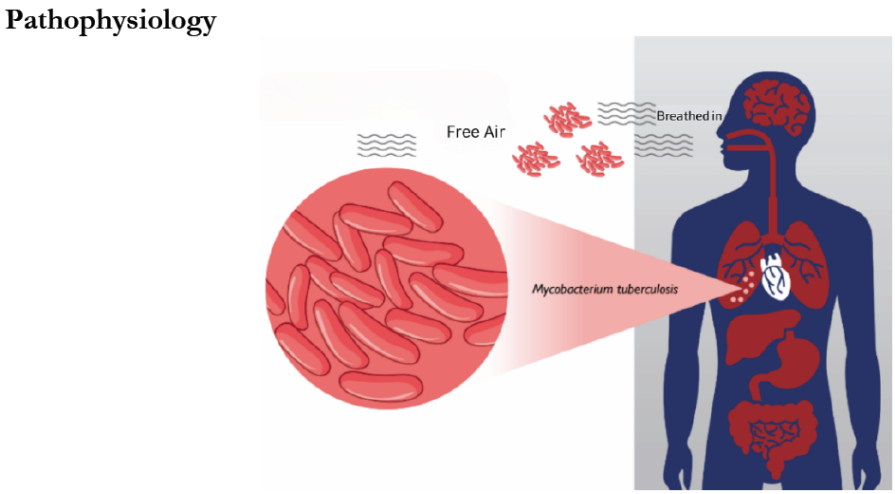

Figure 3: Transmission of Tuberculosis [20].

Table 1: Pathogenesis and Natural Course of Tuberculosis

Exposure with *M. Tuberculosis*	The first stage is exposure to M. tuberculosis bacteria, which occurs when a person has close contact with an active TB patient (usually an adult or adolescent), causing that person to inhale air containing M. tuberculosis bacteria. In approximately 65% of these contacts (especially children), the M. tuberculosis bacteria entering the respiratory tract reach the alveolar spaces and are phagocytosed by macrophages present in the alveoli. If the phagocytic activity of macrophages and other non-specific immune system defenses as the first line of defense are successful, M. tuberculosis can be completely eliminated without leaving any “traces” in the lungs. In this condition, the exposed individual is asymptomatic, and if tested, no evidence of infection is found (negative tuberculin skin test or IGRA), the chest X-ray is normal, and no M. tuberculosis bacteria are detected in sputum or other specimens.
Infection Stage	Macrophages containing M. tuberculosis bacteria undergo inflammation, resulting in primary foci in the alveoli. M. tuberculosis bacteria migrate to the lung parenchyma through two mechanisms: (1) direct invasion of the alveolar epithelium and (2) M. tuberculosis within alveolar macrophages being transported to the parenchyma. Dendritic cells or monocytes in the parenchyma also undergo inflammation and carry M. tuberculosis through the lymphatic channels (resulting in lymphangitis) to the lymph nodes in the lungs, leading to intrathoracic lymphadenitis. In the lung lymph nodes, macrophages present M. tuberculosis to T cells, thereby activating specific cellular immunity. The primary focus, lymphangitis, and lymphadenitis are collectively referred to as the primary complex. At this stage, M. tuberculosis may escape from the lung parenchyma into the vascular system, resulting in sporadic hematogenous spread (occult hematogenous spread). The escaped M. tuberculosis will seek out organs with high oxygen pressure and form small granulomas in those organs. These locations may be within the lungs (typically at the lung apex, referred to as the Simon focus) or in organs outside the lungs (such as the basal meninges, vertebrae, and others). These small granulomas are also called remote foci but remain in an inactive state (not proliferating). Under conditions where the host's cellular immunity remains functional, the Mycobacterium tuberculosis (MTb) bacteria within the granuloma do not replicate, maintaining a status quo referred to as a 'dormant' or 'sleeping' state. At this stage, the cellular immune system specific to MTb has formed, which can be demonstrated by positive tuberculin skin test or IGRA results. However, there are no symptoms or signs, the chest X-ray is normal, and there is no bacteriological confirmation, as the bacterial count is low. A person in this condition is referred to as being infected with TB or often referred to as latent TB infection.
Sick Stage (Active TB)	The sick stage of TB, often referred to as active TB, is characterized by the emergence of symptoms and signs, as well as abnormalities visible on chest X-rays and radiological examinations of extrapulmonary organs. The tuberculin skin test or IGRA may yield positive results; however, in severe active TB cases or in children with weakened immune systems, the tuberculin skin test or IGRA may yield negative results (anergy). Other signs of damage to extrapulmonary organs due to MTb may also be observed in pathological anatomical tissue examinations. At this stage, bacteriological confirmation of MTb is easily found, either in sputum specimens from the respiratory tract (due to the rupture of endobronchial granulomas or erosion of intrathoracic lymph nodes) or from extrapulmonary organs, such as MTb in cerebrospinal fluid. This stage is critically important for early diagnosis and prompt initiation of anti-TB medication (OAT) to eliminate the MTb bacteria.

those who had been vaccinated (PR 3.318; 95% CI 1.39–7.89; p=0.007). Although BCG effectiveness ranges from 0-80%, it reduces the risk of severe complications like TB meningitis. Its effectiveness is influenced by timing, vaccine type, bacterial exposure, genetics, nutrition, and vaccine quality. Poor nutrition weakens immunity and significantly increases TB risk in children (p=0.000; PR 5.7). The study also identified close contact with TB patients, low maternal education, and low socioeconomic status as major risk factors[24, 25].

PREVENTION

Preventing tuberculosis (TB) in children is one of the global health priorities that requires a comprehensive and integrated approach. These efforts include active screening through community-based contact investigation, which has proven to be more effective than passive facility-based approaches, with increased coverage of TB preventive therapy (TPT). The home-based contact management model has demonstrated effectiveness in expanding TPT

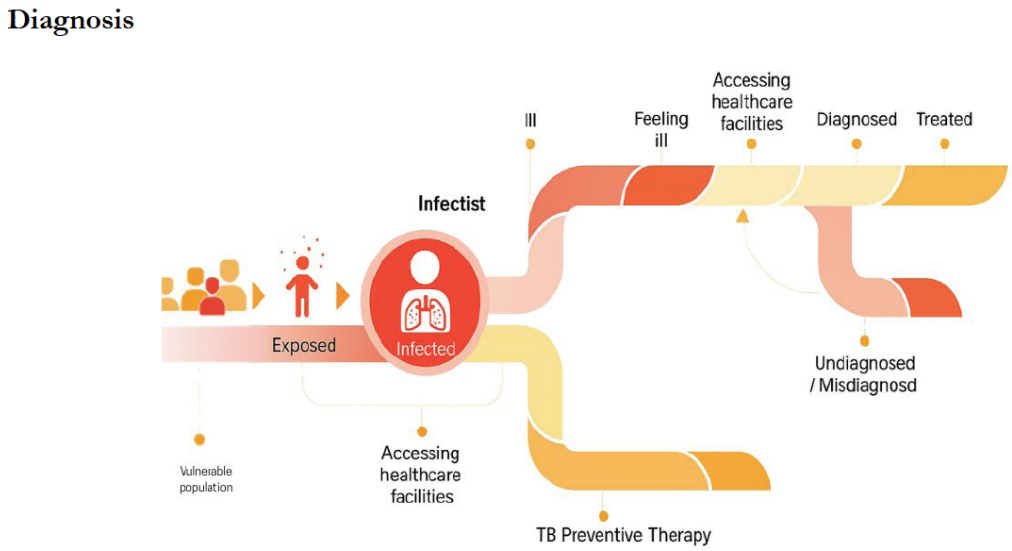

Figure 4: Pathway of infection and TB disease: Prevention [16].

coverage among children living with active TB patients. The affordability of community-based services is key to success, especially in areas with limited access to formal health facilities. Additionally, the development of new-generation TB vaccines, such as the M72/AS01E subunit vaccine and BCG revaccination programs, shows great potential in reducing active TB incidence among latent-infected adolescents and young adults, while also providing indirect protective effects for children. Therefore, an effective TB prevention strategy for children must integrate BCG immunization for newborns, rifapentin-based TPT administration, nutritional interventions for at-risk children, and innovative booster vaccinations. The integration of TPT, BCG immunization, and booster vaccine development represents a strategic step in strengthening TB prevention for children, particularly in low-income countries still grappling with a high TB disease burden [26-31].

The physical environment of a home is a crucial factor in the transmission of tuberculosis (TB) in children, especially in developing countries with high population densities. Inadequate ventilation and excessive housing density significantly increase the risk of TB transmission, with poorly ventilated homes and crowded living conditions increasing the risk by nearly fourfold. Several studies in Indonesia have shown that homes with natural cross ventilation, adequate natural lighting, and low housing density are significantly correlated with lower incidence of TB among school-aged children, underscoring the importance of the concept of healthy housing in TB prevention efforts. Cross ventilation plays a role in reducing the risk of disease transmission by improving air circulation. The WHO itself recommends a minimum ventilation standard of 12 air changes per hour (ACH) in homes or facilities occupied by TB patients. Thus, housing design and the number of occupants have a significant impact on TB transmission, where inadequate housing conditions, such as poor ventilation and high density, not only increase the risk of pulmonary TB infection but also accelerate its transmission at the household level, particularly among more vulnerable groups of children [32-35].

Recent studies confirm that reducing exposure to cigarette smoke in the home environment is an important strategy in preventing tuberculosis (TB) in children. Children exposed to cigarette smoke are up to 3.93 times more likely to develop TB, especially if there is more than one smoker in the household. The combination of exposure to cigarette smoke and poor housing conditions can more than double the risk of TB in children. A report from BMC Public Health indicates that exposure to secondhand smoke significantly contributes to lower respiratory tract infections in children, which indirectly increases their susceptibility to TB. The presence of tobacco smoke in the home also influences TB prevention behaviors within families, with smoke-free households tending to exhibit better preventive practices. Additionally, the use of solid fuels that produce indoor air pollution reduces children's lung function and increases the risk of TB infection. Therefore, efforts to reduce tobacco smoke in the home environment are not only important for protecting children's respiratory health in general but also a key component of family-based TB prevention strategies and public health policies [36-40].

Parent education and empowerment have proven effective in improving early detection and prevention of tuberculosis (TB) in children. Parents' lack of understanding of the benefits of TB screening and preventive therapy (TPT) is a major obstacle to prevention efforts, making community education

through local media and the active involvement of health workers very important. The role of mothers as primary education agents within the family significantly contributes to the success of childhood TB prevention, through early recognition of symptoms, support for PTP implementation, and reduction of stigma associated with TB. Additionally, effective communication between parents and children plays a vital role in improving adherence to PTP, particularly among preschool-aged children. The use of persuasive communication methods and interactive media can increase children's engagement during treatment, thereby strengthening the effectiveness of family-based prevention interventions [41-45].

DIAGNOSIS

Children with positive screening results or who come to a health facility with symptoms of TB will be assessed by a doctor to determine whether they are suspected of having TB and, if so, will undergo further examination to confirm the diagnosis. As with adult TB, confirmation of TB in children requires the detection of Mycobacterium tuberculosis bacteria in bacteriological tests (TCM, culture, or microscopy). However, these test results are often negative in children, especially infants, because TB in children is paucibacillary (low bacterial load) and obtaining sputum from infants is challenging.

This makes bacteriologically confirmed TB diagnosis in children difficult to establish, so diagnosis is often made clinically based on a combination of: 1) symptoms; 2) evidence of TB infection; and 3) chest X-ray examination. Trial treatment with anti-tuberculosis drugs (OAT) is not recommended for establishing TB diagnosis in children.

Establishing a clinical diagnosis of TB in children is also challenging, as TB symptoms are also found in other diseases and there is low agreement among readers in interpreting chest X-rays. In everyday cases, there is often uncertainty about whether to initiate TB therapy for a child because the findings do not fully support the diagnosis or not all supportive diagnostic facilities are available. Therefore, when making diagnostic decisions (and prescribing treatment), a comprehensive consideration is required, not only regarding clinical issues but also epidemiology and risk factors (how high the risk of TB is in the patient we are dealing with).

In life-threatening conditions, doctors should not delay the decision to administer anti-TB medication (OAT), especially in children at high risk of developing severe TB, such as infants, children with HIV infection, or those with malnutrition [16].

CONCLUSION

Diagnosing TB in children remains a significant challenge due to the paucibacillary nature of childhood TB and the limited diagnostic tools available in healthcare facilities. This leads to many cases being underdiagnosed or even overdiagnosed. The increasing number of drug-resistant TB (DR-TB) cases also poses a serious threat to the success of childhood TB control. TB prevention in children can be achieved through BCG vaccination, risk factor control, and the provision of tuberculosis preventive therapy (TPT) for high-risk groups. There remain disparities between regions and low access to diagnostic and treatment services, particularly for MDR-TB and TB-HIV. Addressing childhood TB requires greater attention in terms of early detection, accurate diagnosis, access to treatment, and social protection to mitigate long-term impacts, both physical, psychological, and social.The transmission pathway of TB in children follows a complex trajectory: from exposure to active cases, latent infection, to illness requiring diagnosis and treatment. Early intervention is crucial, particularly through TB preventive therapy (TPT) for children who have been infected but have not yet shown symptoms. Parent and family education has proven to play a significant role in promoting early detection, timely treatment, and completion of TB therapy in children.

Data indicate that there remains a gap in the coverage of TB case detection among children, which has not yet reached the 90% target for 2022. While the number of cases in the 0-19 age group from 2019 to 2022 shows fluctuations, the 15-24 age group also exhibits a significant TB burden. Therefore, integrating active TB screening, family education, and improving access to healthcare services are key strategies for controlling childhood TB in the future. Community- and household-based approaches need to be further strengthened to narrow the diagnostic gap and prevent serious complications from TB.

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