

Comparison of Tuberculosis and COVID-19 Prevention and Control Policies: A Systematic Review

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Abstract:

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Tuberculosis, is a contagious respiratory condition caused by infection with the bacterium *Mycobacterium tuberculosis*. With the rapid prevalence of COVID-19, the multifaceted public health interventions, including non-pharmaceutical measures have been conducted. Results showed that the public health policies implemented by China during the COVID-19 outbreak have had a positive impact on controlling the development of tuberculosis. This paper explores the interplay between tuberculosis (TB) control and the public health measures implemented during the COVID-19 pandemic in China. It highlights how non-pharmaceutical interventions (NPIs) such as travel restrictions, social distancing, mask-wearing, and early case detection, initially designed to contain COVID-19, also contributed to reducing TB transmission. Additionally, the rapid development of China's public health infrastructure and the use of digital technologies during the pandemic enhanced TB surveillance, diagnosis, and treatment adherence. Key interventions included electronic patient service systems, digital adherence technologies (DATs), and integrated digital platforms that improved treatment outcomes. However, challenges such as reduced TB notifications during COVID-19 and financial constraints in TB management were identified. The paper emphasizes the importance of policy adaptations, technological innovations, and sustainable healthcare reforms to address TB in a post-pandemic world. China's experience provides valuable insights for future infectious disease control, demonstrating how coordinated public health strategies can effectively manage multiple health challenges simultaneously.

Keywords: Tuberculosis; COVID-19; public health measures.

1. Introduction

Tuberculosis, is a contagious respiratory condition caused by infection with the bacterium *Mycobacterium tuberculosis*. The disease mainly forms in the lung tissue, trachea, bronchi, and pleural areas. Similarly, the spread of the coronavirus is also due to direct contact with the sneeze, cough droplets of the infected people, or the aerosols they form.

The application of public health policies in China during the COVID-19 outbreak from 2019 to 2022 has had a significant impact on controlling the development of tuberculosis (TB). The evidence suggests that the multifaceted public health interventions, including non-pharmaceutical measures such as cordons sanitaire, traffic restriction, social distancing, home confinement, centralized quarantine, and universal symptom survey, were effective in improving the control of the COVID-19 outbreak [1]. These measures not only helped in containing the spread of COVID-19 but also likely contributed to the control of other infectious diseases, including TB.

China's approach to COVID-19, which included mandatory citywide lockdowns and other non-pharmaceutical interventions, has been shown to be effective in controlling the epidemic [2]. These same strategies could have been beneficial in managing TB, especially given the evidence that screening those individuals who are latent but at higher risk of rapidly developing active TB is one of the intervention measures to control the spread of TB [3]. The emphasis on early detection, early reporting, early isolation, masks, social distancing, and handwashing as part of China's COVID-19 response aligns with the strategies needed for TB control [4]. China's experience during the COVID-19 pandemic also highlights the importance of smart healthcare and the use of cutting-edge health-related technology in enhancing the communication of health policy and providing insights for policymakers [5]. This technological advancement in healthcare could further aid in the control and elimination of TB by improving surveillance, diagnosis, and treatment adherence.

In conclusion, the public health policies implemented by China during the COVID-19 outbreak have had a positive impact on controlling the development of tuberculosis. The multifaceted approach taken to manage COVID-19, including non-pharmaceutical interventions and the strengthening of public health infrastructure, has likely contributed to the control of TB. The lessons learned from the COVID-19 response, particularly regarding the use of technology in healthcare and public health management, offer valuable insights for future efforts to eliminate TB as a major public health problem in China [6].

2. The Development of Public Health Infrastructure in China

Since the SARS epidemic in 2003, China has significantly improved its public health infrastructure, particularly in terms of TB control, through a series of strategic reforms and investments.

Firstly, the Chinese government enacted significant reforms following the SARS crisis. These reforms included the establishment of a unified public health emergency management system, which was crucial for better handling subsequent outbreaks such as H1N1 and H7N9 avian flu [7]. This system likely contributed to more effective and coordinated responses to public health emergencies, including TB control.

Secondly, there was a prioritized funding increase for biotechnology and biomedicine industrialization. This investment was particularly focused on areas such as pathogen identification, drug production, and the development of vaccines and diagnostics [7]. For TB control, this means that there has been an enhancement in the tools available for diagnosis and treatment, which are essential components of any successful TB management strategy.

Thirdly, the establishment of a rapid-response infectious diseases prevention and control system is another critical improvement. This system would facilitate quicker and more effective responses to TB and other infectious diseases by ensuring that resources are quickly mobilized and that appropriate measures are implemented at the first signs of an outbreak [7].

These improvements in China's public health infrastructure have not only enhanced the country's ability to manage TB but also other infectious diseases.

3. The Non-pharmaceutical Interventions Adapted to Control TB During the Covid-19

During the COVID-19 outbreak, China implemented several specific non-pharmaceutical interventions (NPIs) to control the spread of the virus and manage its impact on public health. These interventions were crucial in containing the outbreak and preventing further spread, especially given the challenges posed by the novel coronavirus's high transmissibility and the initial lack of understanding regarding its asymptomatic transmission.

3.1 Early Case Detection and Isolation

One of the most effective strategies was the early detection and isolation of COVID-19 cases. This approach aimed to prevent more infections than travel restrictions

and contact reductions alone. By identifying and isolating infected individuals promptly, China managed to significantly reduce the number of new cases and slow down the spread of the virus [8].

3.2 Travel Restrictions

To further contain the spread, China implemented strict travel restrictions, including the closure of cities like Wuhan, which was the epicenter of the outbreak. These measures were complemented by historical and near-real-time human movement data obtained from Baidu location-based services, which helped in deriving the intensity of travel restrictions across the country [8]. The closure of cities and schools, along with the establishment of designated hospitals for COVID-19 patients, were targeted prevention and control measures that achieved remarkable results in minimizing virus spread [9].

3.3 Social Distancing

Social distancing measures were a key component of China's strategy. These included recommendations for wearing masks, personal protective equipment (PPE), and maintaining physical distance from others. The effectiveness of these measures was highlighted by their role in reducing the incidence of COVID-19 cases and other respiratory infectious illnesses during the outbreak [9].

3.4 Personal Protection Measures

Wearing masks and other forms of personal protection were emphasized as critical measures to prevent the spread of COVID-15. These measures were part of traditional infectious disease prevention strategies that were adapted and expanded during the pandemic [9].

3.5 Adaptive NPIs Based on Deep Reinforcement Learning

In response to the ongoing need to balance health outcomes with economic costs, China also explored adaptive NPIs using deep reinforcement learning (DRL). This approach involved learning optimal strategies to mitigate the outbreak of respiratory infectious diseases (RIDs) after the initial COVID-19-targeted NPIs were lifted. The DRL model helped in identifying more stringent adaptive NPIs that could suppress the outbreak while considering healthcare resources and minimizing health and economic costs [10].

In summary, China's response to the COVID-19 outbreak included a comprehensive set of non-pharmaceutical interventions focused on early case detection and isolation, travel restrictions, social distancing, personal protection measures, and the use of advanced modeling techniques

like DRL to adaptively manage NPIs.

4. The Technology Adapted to Control TB During the COVID-19

During the COVID-19 pandemic, technology played a crucial role in enhancing tuberculosis (TB) surveillance, diagnosis, and treatment adherence in China. The evidence provided highlights several key areas where technological advancements and digital innovations were instrumental.

4.1 Enhancing TB Surveillance

The global study of 43 TB centers from 19 countries demonstrated that the COVID-19 pandemic significantly affected TB services, including a reduction in newly diagnosed TB disease and drug-resistant TB cases [11-13]. This indicates a broader impact on TB surveillance globally, which likely included China. However, specific data on how China specifically managed its TB surveillance during the pandemic is not detailed in the provided evidence. It can be inferred that the overall decrease in TB notifications globally due to the pandemic could have also affected China's TB surveillance efforts.

4.2 Diagnosis Improvements through Point-of-Care (POC) Diagnostics

The scoping review protocol aimed to summarize POC molecular and antigen tests developed for COVID-19 that potentially meet WHO target product profiles (TPPs) for TB diagnosis [11]. This suggests an opportunity for innovation in TB diagnostics during the pandemic, leveraging the increased focus on developing rapid and accurate diagnostic tools for COVID-18. Although the evidence does not directly link these developments to China, it highlights a global trend that could have influenced Chinese TB diagnostic practices.

4.3 Treatment Adherence and Quality of Life Enhancements

Several pieces of evidence directly address the role of technology in improving TB treatment adherence and patient outcomes during the pandemic:

4.3.1 Electronic Monitoring Systems

A study in Wuhan city showed that digitizing TB treatment monitoring through an e-Patient Service System (e-PSS) improved medication adherence among TB patients compared to traditional paper-based systems [12]. This indicates a successful application of digital technologies in enhancing treatment adherence.

4.3.2 Integrated Digital Tools

Another study evaluated an integrated digital adherence intervention platform combining instant WeChat messages, electronic medication monitors (EMMs), and manual reminders. This platform significantly improved medication adherence rates among TB patients [13].

4.3.3 Digital Adherence Technologies (DATs)

The utilization rate of DATs in China was found to be 21.5%, with a significant increase after July 2020 [14]. Despite barriers such as lack of financial, policy, and technology support, the adoption of DATs has increased, indicating a positive step towards improving treatment adherence.

5. The Effectiveness of Public Health Policies on TB

The use of mathematical modeling to develop targets and policies for TB control in China indicates an ongoing effort to understand and predict the effectiveness of various interventions [15]. Although this model suggests that achieving the post-2015 global targets for TB reduction might be challenging under current programs, it also highlights the potential for reducing multidrug-resistant TB incidence, suggesting some level of effectiveness in certain areas of policy implementation. The panel data from 2005 to 2019 shows a gradual decrease in TB incidence rates following the increase in multisector participation (MP) and the Assessable Public Health Service Coverage Rate (ASCR) [16]. This evidence directly supports the effectiveness of public health services in controlling TB, emphasizing the importance of multiple departmental participation and quality health service delivery. Historical data from a new tuberculosis control project introduced in half of China in 1991 further illustrates the success of short-course chemotherapy based on WHO guidelines in significantly reducing the prevalence of TB between 1990 and 2000 [17]. This historical perspective underscores the effectiveness of specific control measures over time.

A long-term trend study covering the period from 1992 to 2017 using Join point regression analysis confirms a significant decreasing behavior in TB incidence rates in China, India, and the United States, with China showing a negative age effect and a cohort effect that decreased from earlier birth cohorts to recent ones [18]. This analysis provides a broader context for understanding the trends in TB incidence and the impact of age and cohort effects. Comparative studies of different hospital and TB collaboration models in China reveal significant differences in patient experience, health expenditure, and adherence to national guidelines among the three existing models [19]. These findings suggest that the integrated model may offer a

more effective approach to TB health reform in China, despite challenges related to financial expenditure and deviation from guidelines.

In summary, the evidence collectively demonstrates that public health policies and interventions, including mathematical modeling for policy development, increased public health services coverage, short-course chemotherapy, and collaborative models between hospitals and TB dispensaries, have had a positive impact on reducing TB incidence rates in China. However, challenges remain, particularly in terms of drug-resistant TB, financial burdens on patients, and the need for improved service delivery and guideline adherence.

6. The Adaption of Legal and Political Framework to Better Support TB

China's adaptation of its legal and political framework to better support TB control efforts post-COVID-19 involves several strategic and systemic changes, primarily aimed at enhancing the effectiveness of public health governance and addressing the challenges posed by both the COVID-19 pandemic and the resurgence of tuberculosis (TB).

Firstly, the Chinese government has leveraged its institutional strengths to ensure a robust response to public health crises, including TB. The rapid development of China's rule of law system during the COVID-19 pandemic, which focused on controlling the pandemic, effectively ensured the quality of public health and life in various areas [20]. This approach indicates a broader application of strong institutional frameworks in managing public health emergencies, which likely extends to TB control measures.

Secondly, the introduction of a new financing model for TB care by the China CDC, supported by the Gates Foundation, represents a significant shift in policy and funding mechanisms. This model proposed case-based payments based on TB treatment clinical pathways, increased reimbursement rates, and financial assistance for the poorest TB patients [21]. Although this intervention faced challenges such as hospital managers' concerns about reduced revenue generation and the exclusion of patients with complications or comorbidities from the program, it underscores an effort to make TB care more accessible and financially sustainable for affected populations.

Moreover, the analysis of COVID-19 prevention and control policies highlights the importance of scientific policymaking, efficient policy implementation, and strict oversight in achieving effective governance during public health crises [22]. These principles are crucial for the on-

going adaptation of China's legal and political framework to support TB control efforts, ensuring that policies are scientifically sound, efficiently implemented, and rigorously monitored.

The collateral impact of the COVID-19 pandemic on TB control in Jiangsu Province, where there was a significant drop in tuberculosis notifications and a decrease in treatment completion and screening for drug resistance, further illustrates the need for urgent attention to TB control efforts during and after the pandemic [23]. This situation necessitates a flexible and adaptive legal and political framework that can quickly respond to changing public health landscapes.

In summary, China's adaptation of its legal and political framework to better support TB control efforts post-COVID-19 involves strengthening institutional strengths, implementing innovative financing models for TB care, and ensuring efficient policy implementation and oversight.

7. Conclusion

During COVID-19, digital technologies have played a key role in facilitating the surveillance, diagnosis, and treatment of tuberculosis (TB). China has significantly improved the efficiency of TB management through enhanced case tracing, improved rapid diagnostic tools, improved patient adherence to treatment, and the promotion of digital treatment adherence technologies (DATs). These measures not only help address the challenges of TB during the pandemic, but also provide lessons for long-term health policies in the future. Despite these advancements, there are challenges and future prospects to consider. The cluster-randomized superiority trial found that while medication monitor interventions reduced non-adherence, they did not impact unfavorable outcomes such as lost-to-follow-up or recurrence. Additionally, the current status of DAT use in China shows that while there has been progress, more financial, policy, and technology support is needed to facilitate wider adoption. In conclusion, technology played a pivotal role in enhancing TB surveillance, diagnosis, and treatment adherence during the COVID-19 pandemic in China. Digital monitoring systems, integrated digital tools, and the adoption of DATs have all contributed to improved TB management.

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