

Determinants of the Long-term Impacts of Tuberculosis in Poverty-stricken Areas

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Tuberculosis (TB) is an infectious respiratory disease that is caused by the bacteria *Mycobacterium tuberculosis*. Due to its infectious nature, many populations in various parts of the world have been struck by TB epidemics, leading to the loss of many lives. However, TB treatments have been developed and improved much since its discovery. For example, isoniazid and ethambutol are common antibiotics used to treat TB today. TB diagnostic exams such as sputum smear microscopy have also improved the accuracy and efficiency of TB diagnoses. As a disease easily spreads in large and dense populations, tools like these treatments and diagnostic tests have saved many lives. However, TB research is most often confined to those who are actively infected, while the lasting symptoms post-treatment are not extensively studied. Also, these studies are usually performed in a high-income setting with limitless resources. Communities with limited resources such as those in crisis-stricken areas have higher morbidity and mortality rates of tuberculosis (Zenner, 2017). Unlike relatively stable countries such as the United States, where research for infectious diseases such as TB usually takes place, these communities have completely different variables that affect how people experience TB. Furthermore, even less data is recorded about the long-term effects of TB due to a lack of resources. The goal of this review is to identify the factors that determine the long-term effects of tuberculosis in low-income areas.

Tuberculosis Epidemiology

TB is an infectious disease that attacks the function of the respiratory system, though only some who come in contact develop the disease. TB-infected individuals typically suffer symptoms such as coughs, fevers, chills, difficulty breathing, and fatigue. The bacterium specifically targets the lungs, which in turn causes lung function to deteriorate through the destruction of endothelial and macrophage cells. Pulmonary cavities (gas-filled pockets in the lung) are formed as lung tissues are damaged. Additionally, the bacteria can spread to other parts of the body, such as the kidneys or the brain. The spread of TB to these body parts will also cause their functions to deteriorate. Though TB treatments have existed for many years, the evolution of the TB bacteria gives rise to new strains that display different characteristics. These characteristics include virulence, growth, immunogenicity (the ability to trigger an immune response), and transmissibility (Murray & Nardell, 2002). Drug resistance is also a characteristic that, when taken in by an individual, produces dire effects due to the inability of TB treatments to work. This characteristic in particular is growing more common due to the evolution of TB bacteria. The ineffectiveness of treatments against drug-resistant strains poses a great concern, as those infected suffer prolonged symptoms and increase the risk of death as a result.

Differences in Underrepresented Areas

Resources such as money and transportation are relatively abundant in developed and high-income countries, such as the United States. In areas of lower income, however, the development of effective treatments and the means to administer them are scarce. As a consequence, research in TB treatments is limited to high-income areas, and those in less-represented areas are not taken into account. However, these areas must be taken into account for the research of TB. These areas are typically not only low-income but also have less

available healthcare due to lack of funding as well as higher rates of risk factors such as HIV. Low-income areas with higher HIV incidence typically have a higher TB incidence rate in comparison to that of high-income, low-HIV incidence areas (Brinkhof et al., 2007). In addition, low-income areas with high levels of air pollution also suffer much higher numbers of TB diagnoses. For example, a comparison of districts in Lima, Peru showed that lower-class districts with more polluted air have much higher TB-positive tests (Carrasco-Escobar et al., 2020). In addition, low-income countries tend to have lower literacy rates due to lack of education. Due to the lack of information surrounding healthcare, treatment abandonment rates are much higher in these countries in comparison to regions where education is more common. In Fortaleza, Brazil, the lack of education combined with few available public services and generally unsafe environments in certain areas were reflective of higher case rates and abandonment rates (Harling et al., 2017). Treatment abandonment is especially concerning in the long term, since TB-infected individuals who do not complete treatment risk spreading it to others, especially in low hygiene or undeveloped areas. As a result, the threat of infection lingers in the population far longer than in countries with low treatment abandonment rates. Between regions, rates of TB are heavily influenced by migration, especially in poorer countries facing a humanitarian crisis. Migration of infected people is not strictly regulated during a crisis, which increases the risk of infection to others. When faced with the breakdown of infrastructure (such as lack of water, nutrition, and shelter), the rate of susceptibility also rises, posing an even greater risk to the population. As Figure 1 suggests, lower-income and underdeveloped countries lack the resources to lessen the spread of TB despite having a higher prevalence of it due to the environment.

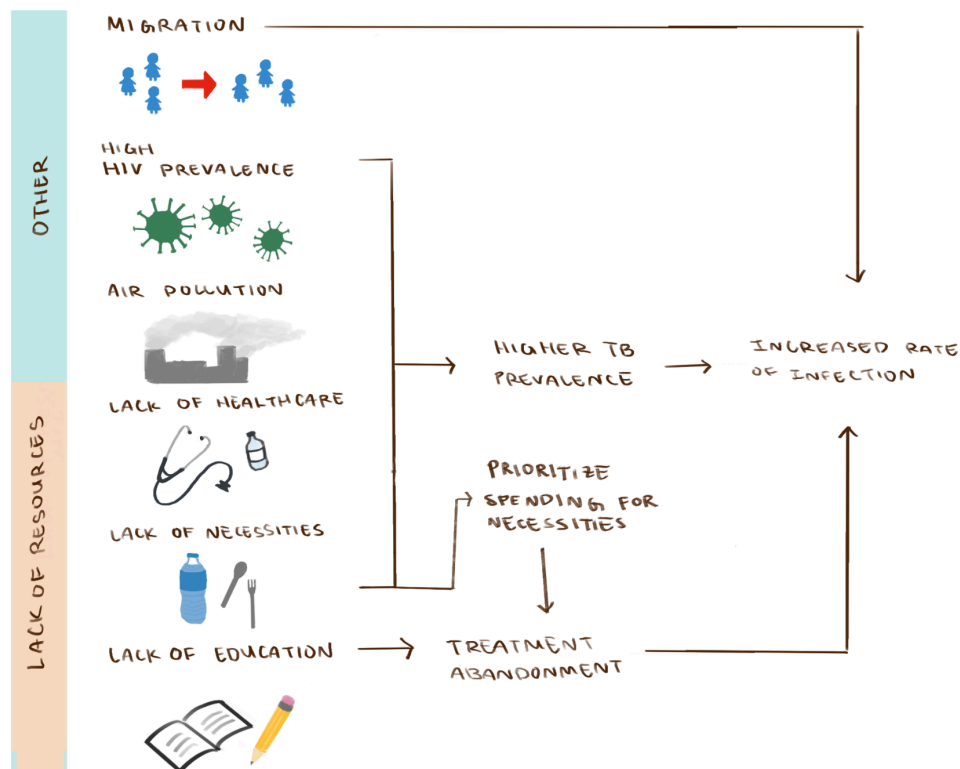


Figure 1: Factors present in low-income countries that influence the rate of infection.

Long-Term Effects In Low-Income Areas

Though TB treatments may be able to rid an individual of the bacterium, the post-treatment symptoms of the disease are a major concern due to their long-lasting nature. The most commonly sustained impacts include decreased lung function, higher incidence of chronic respiratory diseases and infections, and inability to exercise— all of which lead to a massively increased mortality rate (Tadyanemhandu, 2020). In the US, 50% of previously infected individuals had some form of lung impairment one year after being treated for TB, and the likelihood of getting lung cancer was 11 times greater (Romanowski et al., 2019). Furthermore, plain chest radiographs of those who were

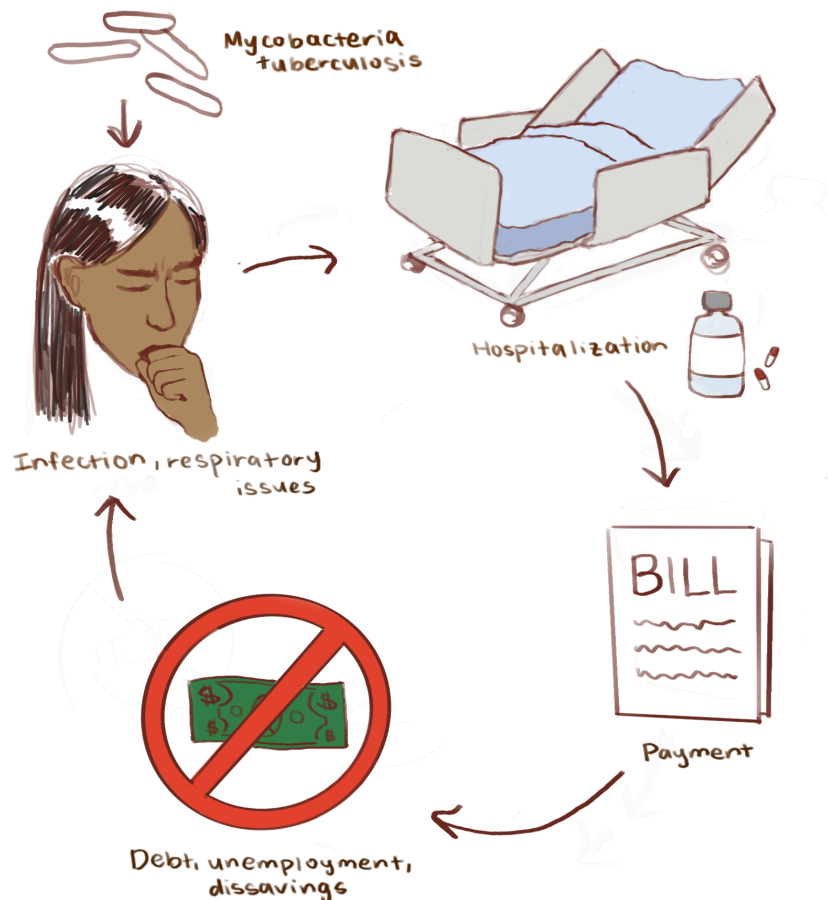


Figure 2: The cycle of infection, hospitalization, and loss of financial resources that contribute to the persistence of TB.

successfully treated had a higher prevalence of cavitation (the formation of cavities containing gas or fluids in the lungs), which further damages the lungs (Meghji et al., 2016). Overall, this translates to a higher mortality rate, which is evidence that TB heavily alters the well-being of

even those who have been successfully treated. The post-treatment consequences of TB not only affect the physical and mental well-being of afflicted individuals but also negatively impact their socioeconomic circumstances. Each physical symptom that is sustained post-treatment imposes a greater financial burden due to the cost of healthcare. This effect is amplified in low-income areas. In one study, a series of interviews following the months after TB treatment in Malawi showed that 20% of patients became unemployed by a year post-treatment. In addition, 37% of interviewed individuals reported a severe financial impact and increased dissavings (loss of personal funds) (Meghji et al., 2021). Considering that Malawi is one of the poorest countries in the world, these percentages pose a great concern. TB infection leads to a cycle of respiratory issues, hospitalizations, and payment for treatment, ultimately leading to financial losses (Figure 2). The massive increase in poverty in such areas is likely to cause many TB-afflicted individuals to refuse or abandon treatment to avoid greater poverty. This in turn would increase the spread and persistence of TB in the population.

Despite being a treatable disease, TB remains one of the most prevalent health-related dangers worldwide. Its prevalence across the globe depends on many factors, such as air pollution, comorbidities, and most notably, poverty. Though treatments exist, access to such resources also varies by region. As a result, populations in poor socioeconomic conditions tend to face amplified effects, such as greater prevalences of TB as well as higher mortality rates. In addition, individuals in poverty face far more financial losses as a result of TB treatments and diagnoses, which in turn also decreases the number of patients willing to continue treatment. The financial burden of TB is common even in individuals who have completed treatment, as treatment often drains the finances of families in poverty. As a whole, these effects cause TB to have a more long-lasting impact as untreated TB continues to circulate in such populations. Though the efficiency and effectiveness of TB treatments and diagnoses have been improving, further research must be done to increase accessibility. The production of rapid, accurate, and relatively low-cost diagnostic tests has proved to be not only a possibility but a reality as seen during the COVID-19 pandemic with rapid PCR test kits. The development of similar tests as well as treatments that remain stable in suboptimal conditions are necessary to mitigate the spread of TB in regions where it is most prevalent. Research in this field may be supplemented by long-term studies of the effects of TB spanning decades to gather lifelong data.

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