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Behavior of tuberculosis mortality inequity in Colombia from 2018 to 2022 in the context of the COVID-19 pandemic

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Abstract

Introduction: Despite advances in effective therapies, tuberculosis remains one of the leading causes of death worldwide. In 2022, 10.6 million new cases and 1.3 million deaths were estimated, constituting a relevant public health problem. The COVID-19 pandemic has generated an economic crisis that has exacerbated socioeconomic gaps. Considering the established association between tuberculosis and poverty, we aimed to describe and analyze variations in the inequity of tuberculosis mortality in Colombia between 2018 and 2022, in relation to the epidemiological context of the COVID-19 pandemic.

Materials and methods: Individual-level death data from the National Administrative Department of Statistics (DANE) were accessed for the study period. Standardized mortality rates at the departmental tuberculosis level were estimated, and the departments were grouped by quintiles according to the departmental multidimensional poverty index. Statistically significant differences between the extreme quintiles were estimated using the t-test.

Results: In 2018, Colombia reported a standardized tuberculosis mortality rate of 2,199 per 100,000 inhabitants, whereas in 2022, this rate was 2,303 per 100,000 inhabitants. In 2018, quintile 1 had a mean rate of 4,09 (CI = 2,097 - 6,083) while quintile 5 had a mean rate of 1,494 (CI = 0,921 - 2,068) according to the t-test, there were statistically significant differences (p = 0,0056). In 2022, quintile 1 had a mean rate of 4,346 (CI= 1,872–6,820), while quintile 5 had a mean rate of 1,685 (CI= 0,979–2,392); according to the t-test, there were also statistically significant differences (p= 0,0162).

Discussion: The COVID-19 pandemic slightly increased tuberculosis mortality in the country and generated health inequity at the department level.

Keywords: Tuberculosis; Health Inequities; Poverty; Public Health.

Comportamiento de la inequidad en la mortalidad por tuberculosis en Colombia de 2018 a 2022 en el contexto de la pandemia de COVID-19

Resumen

Introducción: A pesar de los avances en terapias efectivas, la infección por tuberculosis sigue siendo una de las principales causas de muerte a nivel mundial. En 2022, se estimó un total de 10,6 millones de casos nuevos y 1,3 millones de muertes, lo que constituye un problema relevante de salud pública. La pandemia de COVID-19 generó una crisis económica que exacerbó las brechas socioeconómicas. Considerando la asociación establecida entre tuberculosis y pobreza, nos propusimos determinar si la pandemia de COVID-19 generó inequidad en la mortalidad por tuberculosis en Colombia entre 2018 y 2022.

Materiales y métodos: Se accedió a los datos de mortalidad a nivel individual del Departamento Administrativo Nacional de Estadística (DANE) para el período establecido. Se estimaron las tasas de mortalidad estandarizadas a nivel departamental de tuberculosis y los departamentos se agruparon por quintiles según el índice de pobreza multidimensional departamental. Posteriormente, se estimaron las diferencias estadísticamente significativas entre los quintiles extremos mediante la prueba t.

Resultados: En 2018, Colombia reportó una tasa estandarizada de mortalidad por tuberculosis de 2199 por 100.000 habitantes, mientras que para el año 2022 esta tasa fue de 2303 por 100.000 habitantes. En cambio, en 2018, el quintil 1 tuvo una tasa media de 4,09 (IC = 2097 - 6083), mientras que el quintil 5 tuvo una tasa media de 1494 (IC = 0,921 - 2068). Según la prueba t, existen diferencias estadísticamente significativas (p = 0,0056). En 2022, el quintil 1 presentó una tasa media de 4346 (IC= 1872 - 6820), mientras que el quintil 5 presentó una tasa media de 1685 (IC= 0,979 - 2,392). Según la prueba t, también se observaron diferencias estadísticamente significativas (p= 0,0162).

Discusión: La pandemia de COVID-19 incrementó ligeramente la mortalidad por tuberculosis en el país y generó inequidad en salud a nivel departamental.

Palabras clave: Tuberculosis; Inequidades en Salud; Pobreza; Salud Pública.

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Introduction

Tuberculosis (TB) poses a significant threat to global public health, particularly in the most vulnerable communities[1]. Despite improvements in diagnosis and treatment, TB still causes millions of deaths annually. Recent estimates indicate that in 2022, there were 10.6 million new cases and 1.5 million deaths related to TB, making it one of the leading causes of death from a single infectious agent and highlighting the severity of this global health crisis[2,3].

TB is an infectious disease caused by the bacterium *Mycobacterium tuberculosis*, primarily affecting the lungs but also capable of affecting other organs, although less frequently. The disease progresses in two phases: the latent phase, where approximately 90 % of cases reside, and the active phase, which is marked by symptoms such as persistent cough, weight loss, and night sweats, during which the bacteria multiply in the body, often in individuals with weakened immune systems[4].

Historically, TB has been known by various names, including phthisis, the great white plague, and Pott's disease, evoking the fear and suffering it has caused throughout the ages. Evidence of TB dates back to 8,000 B.C.[5], indicating its long-standing presence in human history. A significant milestone occurred on March 24, 1882, when Robert Koch identified the *M. tuberculosis* bacillus, developed a staining method for it, and laid the groundwork for understanding the disease's pathophysiology[6].

This discovery transformed treatment approaches, reaching a high point in 1952 with the introduction of isoniazid, the first drug that enabled effective TB treatment. The subsequent development of rifampicin further shortened the treatment duration, providing hope for patients[6,7].

Despite advancements in treatment options and the availability of broad-spectrum antimicrobials, various cultural, economic, and social factors have led to incomplete treatment and low adherence. This situation has resulted in the rise of multidrug-resistant strains, making TB a persistent challenge and a significant health issue globally[8]. In Colombia, the World Health Organization (WHO) estimated that in 2022, there were 21,000 new cases, with 17,460 identified, marking an increase of 3,639 cases compared to 2021, and positioning TB among the leading causes of death. This scenario highlights how social inequalities directly affect health, leaving lower-income groups facing additional barriers that increase their vulnerability[9].

The reality worsened during the COVID-19 pandemic. The necessary isolation and social distancing measures to curb the spread of the virus triggered an economic and social crisis that primarily impacted the most vulnerable populations. Health systems became overwhelmed, and resources were redirected to address the health emergency, resulting in many diseases, including TB, going undiagnosed and unrecorded in health information systems. This created a vicious cycle in which poor health stemming from poverty diminished the chances of securing stable employment, further deepening poverty and making it increasingly difficult for those affected to access appropriate treatment[6].

Poverty has a significant impact on access to health services, with factors such as education level, family income, geographic location, and household conditions creating inequalities that affect not only individuals but their families as well[10]. These issues are examined using the Multidimensional Poverty Index (MPI), which assesses deprivation in critical areas such as health and education. This helps us understand not only how many people live in poverty but also the severity of their deprivations, offering a more comprehensive view of these inequalities on global, regional, and local scales[11,12]. Additionally, the combination of limited economic resources and geographic isolation worsens these challenges, making it difficult for those in disadvantaged situations to access basic health services and increasing their vulnerability[10].

The link between TB and poverty indicators, such as overcrowding, unemployment, and limited access to health services, becomes even more pronounced during a pandemic[10]. Although programs that provide funding for TB treatment exist, many have fallen short of significantly reducing new cases because they fail to incorporate prevention strategies. Consequently, the World Health Organization has set a sustainable development goal to end the TB epidemic by 2030[2]. Achieving this will require a global coalition focused on treating the disease and addressing the social inequalities that fuel its spread[13].

In this context, the present study aims to describe and analyze variations in the inequity of tuberculosis mortality in Colombia between 2018 and 2022, in relation to the epidemiological context generated by the COVID-19 pandemic.

Materials and methods

A descriptive, cross-sectional ecological study was conducted in which non-fetal death records in Colombia were accessed, found in the vital statistics of the National Administrative Department of Statistics (DANE, by its acronym in Spanish) for the period between 2018 and 2022, within which mortality data due to TB, including sequelae, were obtained, grouped by the underlying cause of death 102 of list 6/67 of the Pan American Health Organization (PAHO). The population for the same period in each political region of Colombia was also obtained from DANE, and the world standard population was obtained from the WHO.

An interrupted time series analysis of the tuberculosis mortality rate in Colombia was conducted using STATA software, taking April 2020 as the cutoff point to visualize trends before and after the onset of the COVID-19 pandemic.

The information obtained from the 32 departments of Colombia and the capital district was grouped by age, and the departments were grouped by quintiles, ordering them according to the MPI reported by DANE, which is an indicator that reflects the multiple deficiencies that poor people face in areas such as education and others[8]. Age-adjusted mortality rates (Standardized Mortality Rate, SMR) were calculated by political region and year of occurrence. To estimate whether there were statistically significant differences in TB mortality rates between quintiles 1 and 5 at the national level, Student's t-test was used for each year of the study period in the extreme quintiles. STATA v.14 was used for statistical analysis, and QGIS version 3.40.2 'Bratislava' was used to create maps.

Results

As shown in Figure 1, the initial level of Mortality Rate (MR) was estimated at 0.181, and the MR appeared to increase every month by .00029 (P=0.611, CI= [-0.0008, 0.001]), but this increase was not statistically significant. In the first month of the pandemic (2020m4), the MR appeared to be a substantial decrease of 0.045 (P<0.005, CI= [-0.076, -0.014]), followed by a significant increase in the month trend (relative to the pre-pandemic trend) of 0.002 (P<0.000, CI= [0.001, 0.004]).

There were 1 802 TB deaths documented in Colombia in 2018, 1 093 in 2019, 957 in 2020, 1 121 in 2021 and 1 336 in 2022. In 2018, Colombia reported a mean SMR for TB of 2,199 deaths per 100,000 population; in 2019, it was 2,022 deaths per 100,000 population; in 2020, it was 1,761 deaths per 100,000 population; in 2021, it was 2,046 deaths per 100,000 population; and in 2022, it was 2,303 deaths per 100,000 population. The SMR for TB by department in Colombia is illustrated in Figure 2.

The departments with the highest SMR for TB in 2018 were Vaupés (6,701 deaths per 100,000 population), La Guajira (5,674 deaths per 100,000 population) and Guainía (4,611 deaths per 100,000 population); in 2019 were Guainía (6,797 deaths per 100,000 population), La Guajira (5,394 deaths per 100,000 population) and Vichada (3,764 deaths per 100,000 inhabitants); in 2020 were Arauca (4,053 deaths per 100,000 population), La Guajira (3,951 deaths per 100,000 population) and Guaviare (3,106 deaths per 100,000 population); in 2021 were Vaupés (6,419 deaths per 100,000 population), La Guajira (4,006 deaths per 100,000 population) and Caquetá (3,584 deaths per 100,000 population) and in 2022 were Vaupés (7,946 deaths per 100,000 population), Guaviare (6,074 deaths per 100,000 population) and La Guajira (4,889 deaths per 100,000 population).

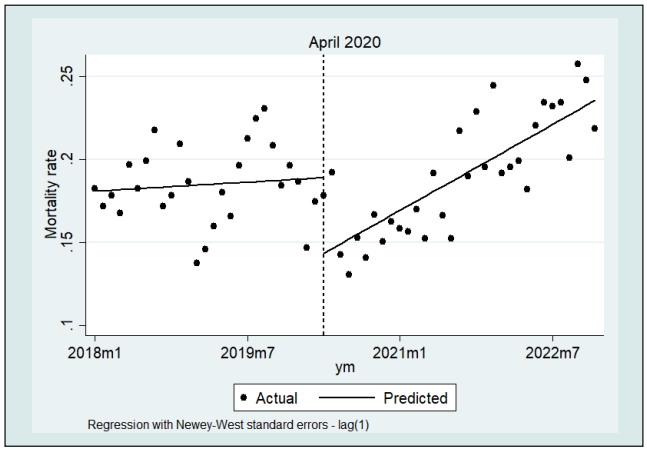

Figure 1. Monthly mortality rates for TB in Colombia between 2018 and 2022. Constant 0.181 (P<0.000, CI= [1.167, 1.194])., β1= 00029 (P=0.611, CI= [-0.0008, 0.00]) β2 =0.045 (P<0.005, CI= [-.076, -0.014]), β3 = 0.002 (P<0.000, CI= [0.001, 0.004]). Source: author's elaboration.

Regarding the stratification of the departments according to the quintiles determined by the MPI, in quintile 1 are the departments of Chocó, Vaupés, La Guajira, Guainía, Vichada and Guaviare; in quintile 2 the departments of Bolívar, Arauca, Magdalena, Sucre, Amazonas, Córdoba and Norte de Santander; in quintile 3 the departments of Casanare, Caquetá, Cesar, Cauca, Putumayo and Nariño; in quintile 4 the departments of Santander, Tolima, Huila, Risaralda, Meta and Boyacá and in quintile 5 the departments of Atlántico, Cundinamarca, Antioquia, Archipiélago de San Andrés, Valle del Cauca, Quindío and Caldas.

Figure 3 shows the association between quintiles according to the MPI and the average departmental SMR for TB during the study period. For 2018, the quintile with the highest SMR was quintile 1 (on average 4,089 deaths per 100 000 population); in 2019, it was quintile 1 (on average 3,874 deaths per 100,000 population); in 2020, it was quintile 2 (on average 2,424 deaths per 100,000 population); in 2021, it was quintile 1 (on average 3,446 deaths per 100,000 population); and in 2022, it was quintile 1 (on average 4,346 deaths per 100,000 population).

The implementation of the Student's t-test for each year of the analyzed period in the extreme quintiles revealed that there were statistically significant differences (p<0,05) in TB mortality rates between quintiles 1 and 5 at the national level (Table 1).

Discussion

This study analyzed the impact of the COVID-19 pandemic on TB mortality inequality in Colombia from 2018 to 2022. TB is a chronic infectious disease and is one of the main causes of morbidity and mortality due to infectious causes worldwide. It has also been recognized for centuries as a social disease and continues to be inexorably linked to poverty[14]. Many studies have evaluated the factors or sociocultural scenarios that could be involved, in addition to poverty, in the low diagnosis and treatment of TB patients. Stigma and poor clinical outcomes, for example, low perception of health problems, costs associated with medical care, physical distance to health care institutions, violence, socioeconomic status, housing conditions, food insecurity, malnutrition, poor

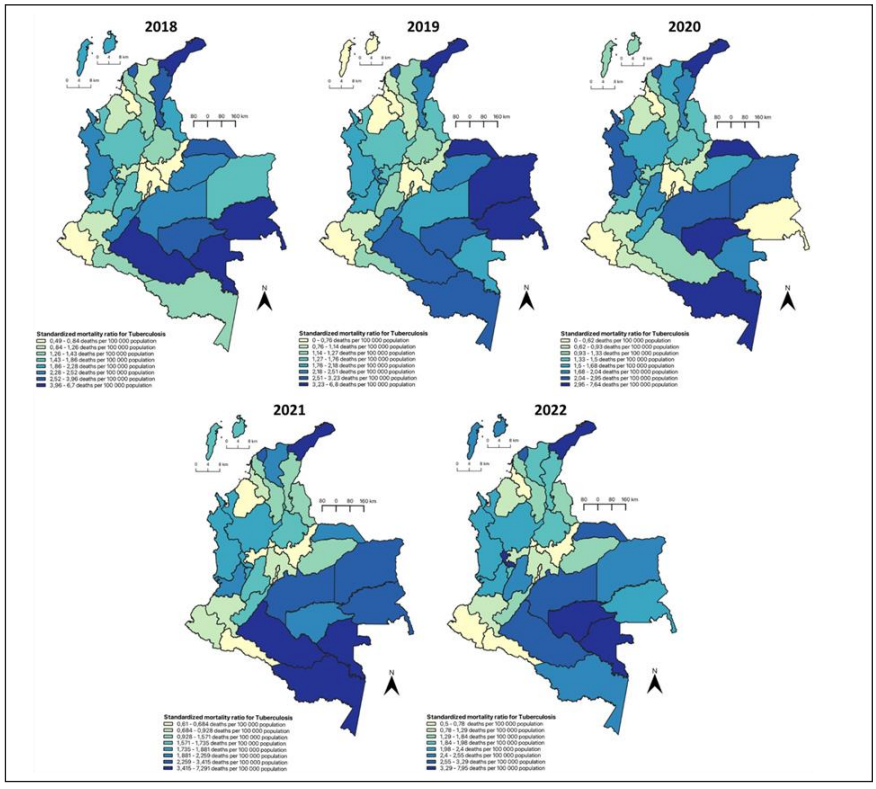

Figure 2. Standardized mortality ratio for TB in Colombia by department between 2018 and 2022. Source: author's elaboration.

health habits such as alcohol consumption, smoking, drug abuse, poorly controlled or neglected comorbidities, including mental illness, increased overcrowding in prison populations, among others[15].

These social factors have been described as influential in accessing TB diagnosis and treatment. A study published in 2018, supported by the WHO as part of the end TB strategy, showed that reducing extreme poverty and establishing government policies aimed at social protection in health and other social and cultural levels could reduce the incidence of TB by more than 84 %[13].

In our study, it is evident that those departments or states of the country where the MPI is higher are directly related to increased mortality and perhaps worse clinical outcomes in patients with TB. In addition, regions outside large urban centers are plagued by violence, difficulties in transportation or access routes, and limitations on the free mobility of patients by armed groups[14].

We also developed an interrupted time series analysis of the tuberculosis Mortality Rate the cutoff point to visualize the trend before and after the onset of the COVID-19 pandemic. The initial level of Mortality Rate (MR) was estimated at 0.181, and MR appeared to increase every month by .00029 (P=0.611, CI= [-0.0008, 0.001]), but this increase was not statistically significant. In the first month of the pandemic (2020m4), the MR appeared to decrease substantially by 0.045 (P<0.005, CI= [-0.076, -0.014]), followed by a significant increase in the month trend (relative to the pre-pandemic trend) of 0.002 (P<0.000, CI= [0.001, 0.004]). The time periods involved with overlapping pre-pandemic, pandemic, and post-pandemic periods allowed us to establish the true influence of the pandemic on tuberculosis mortality.

The outbreak of the COVID-19 pandemic and the policies implemented by each country, many of which are restrictive, had a direct impact on specific contexts and certain population groups, not only in terms of economic and food security, but also in terms of health, affecting socially disadvantaged or marginalized populations, with a negative impact on their health and perpetuating the cycle of disease and poverty.

Certain infectious or non-infectious diseases were neglected, with disproportionate incidence rates, others without diagnoses or underestimated, such as TB and HIV. The most immediate consequence of the large drop in the number of people newly diagnosed with TB in 2020 was an increase in the number of people who died from TB in 2020 at the global, regional, and national levels. The global number of deaths caused by TB in 2020 was 1.3 million, almost double the number of deaths reported for HIV/AIDS (0.68 million). However, it should be noted that in 2020, TB mortality was affected by the COVID-19 pandemic rather than by HIV/AIDS[15].

A study that evaluated the mortality characteristics of 333 people with TB and covid 19 in the United States found that people disproportionately affected by both diseases inclu-

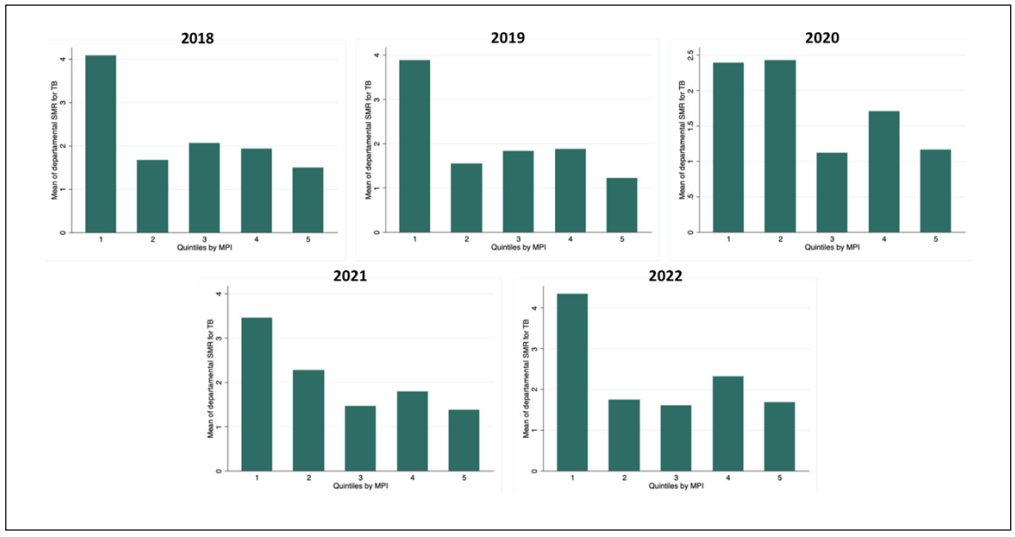

Figure 3. Association of quintiles by MPI and mean departmental SMR for TB between 2018 and 2022. MPI: Multidimensional Poverty Index; SMR: Standardized Mortality Rate; TB: Tuberculosis.
Source: author's elaboration.

Table 1. T test applied to extreme quintiles by MPI between 2018 and 2022.

Year	Quintil	Mean SMR	95% confidence interval	t-Test
2018	1	4,090	2,097 - 6,083	p=0,0056
	5	1,494	0,921 - 2,068	
2019	1	3,874	1,883 - 5,865	p=0,0055
	5	1,214	0,538 - 1,890	
2020	1	2,389	0,973 - 3,806	p=0,0431
	5	1,166	0,775 - 1,557	
2021	1	3,446	1,707 - 5,186	p=0,0111
	5	1,381	0,773 - 1,989	
2022	1	4,346	1,872 - 6,820	p=0,0162
	5	1,685	0,979 - 2,392	

SMR: Standardized Morality Rate; MPI: Multidimensional Poverty Index.

ded Hispanic people, people with comorbidities such as uncontrolled diabetes and those who lived in neighborhoods with low levels of health equity according to a local index[16].

In the United States, the incidence of reported TB decreased by approximately 20% in 2020 compared to 2019, and limited information suggests that some people with TB in the United States may have had more clinically severe disease in 2020 than before the COVID-19 pandemic and that TB diagnoses may have been delayed[17].

As demonstrated in our study, in the years of the covid 19 pandemic, those departments with a higher multidimensional poverty index showed an increase in the SMR over the years, reflecting the direct impact. for each year of the analyzed period in the extreme quintiles revealed that there were statistically significant differences (p<0,05) in TB mortality rates between quintiles 1 and 5 at the national level (Table 1).

Evidently, COVID-19 had catastrophic effects on TB, and it is not a coincidence that both diseases affected more those areas of the world with greater social and economic inequalities. TB, besides being a disease associated with poverty, is an impoverishing disease, affecting disadvantaged people in densely populated areas with low incomes and causing stigma and discrimination. Poverty remains a goal to overcome, as demonstrated in multiple studies, and the incidence of the disease is inversely proportional when socioeconomic development and social protection measures are established.

Ethical considerations

Protection of People and Animals. No ethical review or consent statement was obtained as the analyzed data were anonymized. the study did not involve any experimental procedures on living beings.

Protection of Vulnerable Populations. The study used data from a public database, which avoided the need for direct contact with vulnerable patients.

Confidentiality. The data analyzed were obtained from a public and anonymized database, without information that could identify the subjects.

Privacy. The data used came from a public and anonymized source, individual informed consent was not required.

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Conflicts of Interest. The authors have no conflict of interest to declare

Acknowledgments. No apply

Authors´ Contribution. All authors contributed to read and approved the version of the submitted manuscript.

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