

DATA COLLECTION ON THE IMPACT OF THE BCG VACCINE ON THE RATE OF TUBERCULOSIS CASES WORLDWIDE

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Abstract: Objective: Caused by Mycobacterium tuberculosis, Tuberculosis is a contagious and infectious disease, which mainly affects the lungs. Its only form of prevention is the BCG vaccine, which was created in 1912 by Léon Calmette and Alphonse Guérin, and its mass application prevents severe forms of the disease despite not offering 100% effectiveness. The main objective of the research is to collect and analyze data on the impact and effectiveness of the vaccine concerning the rates of cases of this pathology, worldwide. Methods: The study was carried out through a bibliographic survey of articles submitted and published on official websites. Subsequently, graphs and tables were made for the analysis, illustration, and presentation of the results obtained. Results: Mass BCG vaccination positively impacts tuberculosis rates worldwide. However, the decrease in cases of this pathology is mostly present in developed countries, when compared to those that are considered as developing, as a result of efficient public policies, better awareness programs, and easy access to diagnosis and treatment. In addition, there was a significant increase in cases of the disease due to interruption of treatment and non-adherence to vaccination. Conclusion: Although the effectiveness and impact of the vaccine are positive, public awareness of the importance of getting vaccinated is essential for the reduction of tuberculosis cases, as well as a possible future eradication.

INTRODUCTION

Tuberculosis presents records in prehistoric bones found in Germany dating back to 8000 BC, being considered a pathology of millennial nature causing, to this day, great concern among health professionals and the community. In the middle of 300 BC, the view that disease was seen as a punishment was demystified by Hippocrates in Greece, where it came to be considered a natural thing and, over time, it proliferated in the most diverse corners of the

world through wars and urbanization, where it became known as the White Plague. (1,2,3)

Still on the historical aspect, in the last years of the 18th century, tuberculosis was treated as a “romantic disease” affecting artists and poets. Later, it was seen as a disease related to poor hygiene and food conditions, where the treatment was hygienic-dietary. During this time, Robert Koch discovered Koch’s bacillus, scientifically known as Mycobacterium tuberculosis, which causes tuberculosis, becoming the first in history to identify a pathogenic microorganism, which guaranteed his Nobel Prize in Medicine in 1905 and the basis of new research and future treatments for the disease. (1,2)

Regarding the pathology, the primary infection is asymptomatic in most cases or has mild symptoms such as fever and chest pain. In addition, nonspecific symptoms are observed such as sweating, weakness, and malaise. With the evolution of the pathology, the individual may have a dry cough or with secretion and blood for more than three weeks. In addition, its diagnosis is made through radiography, laboratory tests, and investigation of AFB in sputum, through Ziehl-Neelsen staining. However, if the x-ray image is unsatisfactory and the investigation is negative, a CT scan should be requested. (01, 04, 05)

Its form of transmission is through contagion with droplets of saliva that have the bacilli, and poor diet and lack of hygiene favor the evolution of the disease. In addition, the treatment of the pathology is based on antibiotics, which can last from six months to a year. However, because of the long duration of treatment, many patients give up and stop taking the appropriate medications, and may develop multidrug-resistant tuberculosis, a pathology that is on the rise worldwide. (01, 04, 06)

In addition, its only form of prevention is through the BCG vaccine, developed in the mid-19th century by Camille Calmett and

Albert Guerin at the Pasteur Institute, located in Paris, where its base was developed through the attenuation of a strain of *Mycobacterium bovis*, after 231 passages in culture media over 13 years. It began to be used in humans in the year 1921, thus receiving the name of BCG (*Bacillus Calmett-Guerin*), having its use on a large scale encouraged by the World Health Organization (WHO) after a few years. After this achievement, in 1974, the vaccine became part of the WHO Expanded Program on Immunization (PAI) calendar, with an increase of 80% in the public in its adherence until the 1990s. (7,8)

Still in this aspect, vaccine prevention is preferably carried out in children in the first months of life or up to 04 years of age, and although it is not 100% effective, it protects against miliary and meningeal tuberculosis, which are more common forms. serious illness. In addition, the vaccine does not present frequent adverse effects, only the typical scar located at the site of its application. On the other hand, some of its contraindications are its application in newborns weighing less than 2 kg, immunosuppressants, and dermatological problems at the vaccination site or in general, and its indications for application are in healthy children weighing more than 02 kg. , HIV-positive children, and children of mothers with AIDS, among others. (7)

After analyzing all these aspects, the group asked if there was a positive impact on the effectiveness of the BCG vaccine in protecting tuberculosis worldwide, having as the main objective of this research the collection and analysis of data on this impact concerning the indices of cases of this pathology.

Finally, the work is justified by observing the scenario of current diagnostic technology, which allowed for greater ease in the detection of various diseases in addition to providing a basis for the creation and propagation of subsidies aimed at the protection of pathologies, such as vaccines. These have been improved and

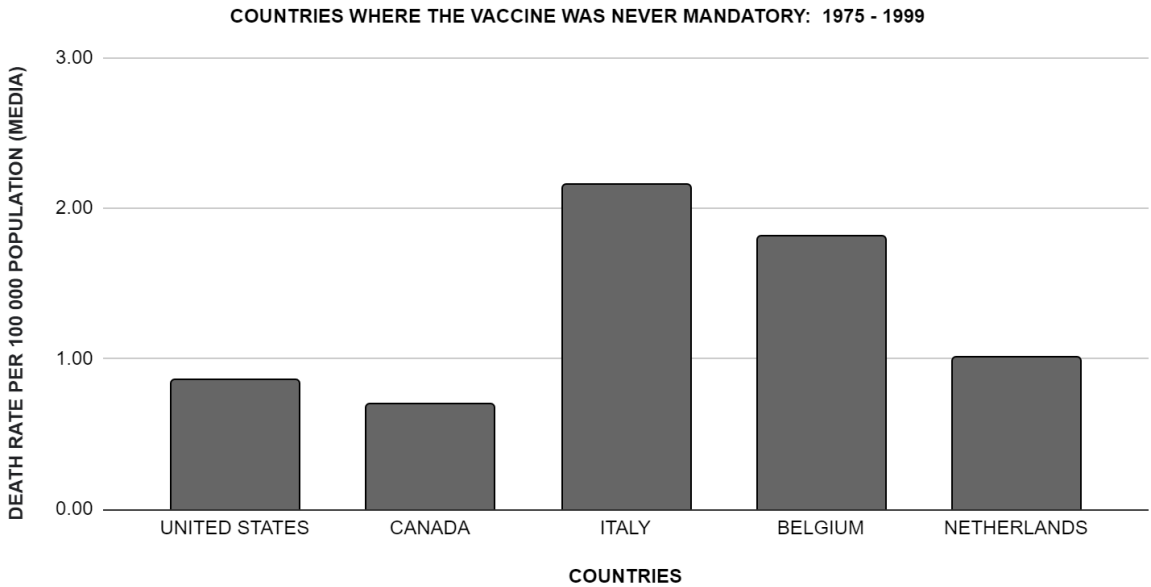
offered faster and faster and reaching the most diverse populations worldwide. On the other hand, the dissemination of fake news and anti-vaccination movements are becoming more and more frequent and gaining strength among communities, causing them to stop being vaccinated, which brings, as a consequence, the resurgence of diseases that were once eradicated. With this in mind, the work was necessary so that, through the collection of data about tuberculosis and the effectiveness of the BCG vaccine, the confirmation of the positive impact of vaccines concerning diseases circulates again in the population, causing an awareness of the importance of vaccination, especially those acquired in the first months of childhood, such as the BCG vaccine.

MATERIALS AND METHODS

This work was carried out through a bibliographic review of the literature present on sites such as Pubmed, and Google Scholar, as well as official and governmental sites, being considered articles in Portuguese and English. After collecting and analyzing the information obtained, tables and graphs were made, and developed through the EXCEL platform, with data obtained from the official website of the World Health Organization (WHO) (9), for better visualization, interpretation, and presentation of the results.

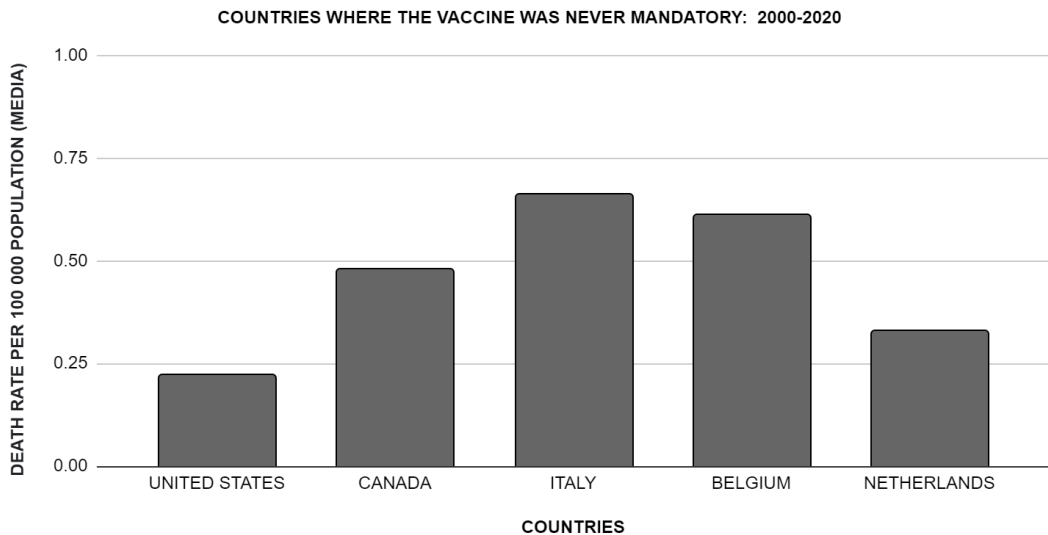
Still in this aspect, the average mortality rate per 100,000 inhabitants from 1975 to 2020 was observed in the graphs, organized into Countries where the vaccine was never mandatory (1975/1999 - 2000/2020); Countries where the vaccine is still mandatory (1975/1999 - 2000/2020) (10); Central and South America (2000/2020); Europe (2000/2020); North America and the Caribbean (2000/2020); Africa (2000/2020); Oceania (2000/2020) and Asia (2000/2020). Finally, the materials used were only the use of computers with internet access and literature books on the subject.

RESULTS



Graph developed through EXCEL with information obtained by the world health organization website.

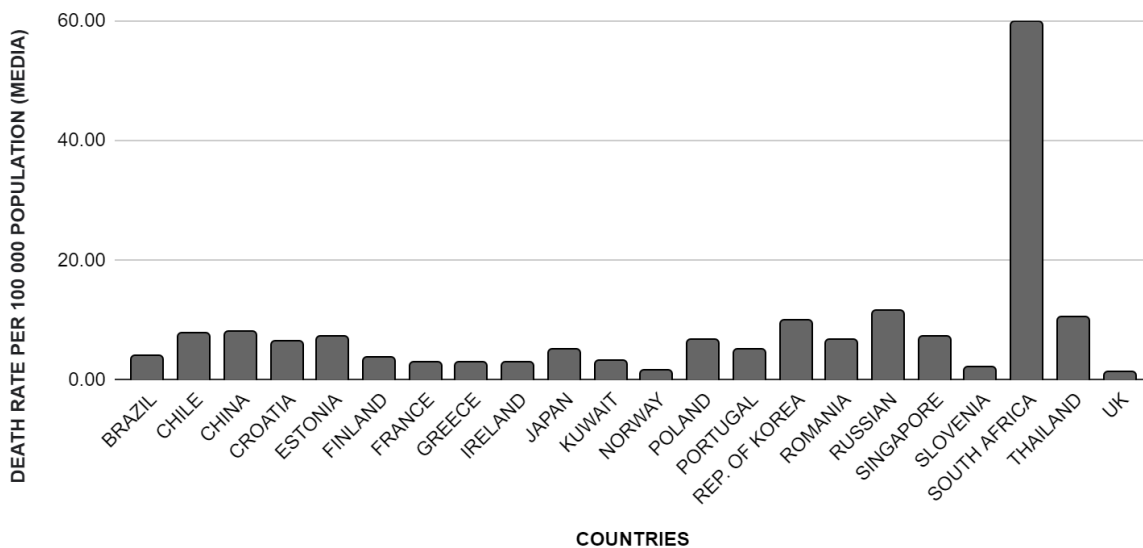
Figure 1: Average death rate (due to Tuberculosis) per 100,000 inhabitants in countries where the application of the BCG vaccine against Tuberculosis was never mandatory, from the years 1975 to 1999, these being represented by: United States of America; Canada; Italy; Belgium and Holland.



Graph developed through EXCEL with information obtained by the world health organization website.

Figure 2: Average death rate (due to Tuberculosis) per 100,000 inhabitants in countries where the application of the BCG vaccine against Tuberculosis was never made mandatory, during the years 2000 to 2020, these being represented by: the United States of America; Canada; Italy; Belgium and Holland.

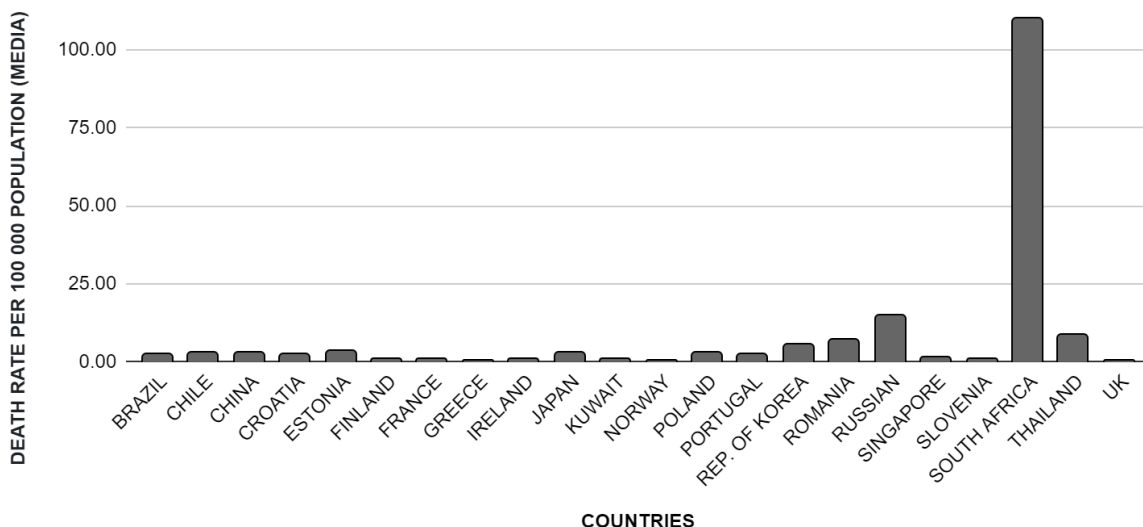
COUNTRIES WHERE THE VACCINE IS MANDATORY: 1975 - 1999



Graph developed through EXCEL with information obtained by the world health organization website.

Figure 3: Average death rate (due to Tuberculosis) per 100,000 inhabitants in countries where the application of the BCG vaccine against Tuberculosis is currently maintained as mandatory, from the years 1975 to 1999, these being represented by: Brazil; Chile; China; Croatia; Estonia; Finland; France; Greece; Ireland; Japan; Kuwait; Norway; Poland; Portugal; Republic of Korea; Romania; Russia; Singapore; Slovenia; South Africa; Thailand and UK.

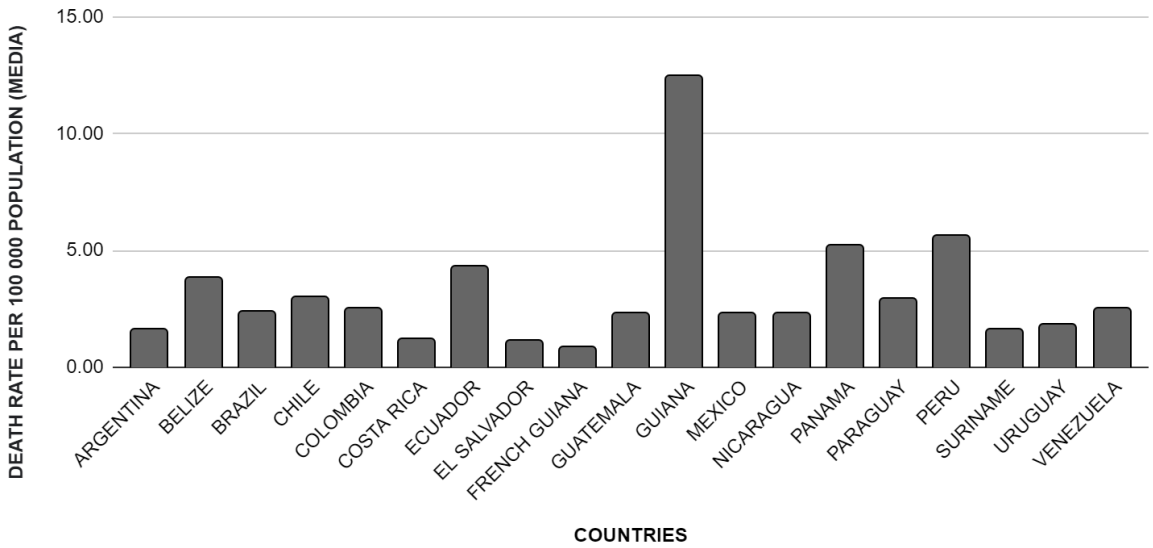
COUNTRIES WHERE THE VACCINE IS MANDATORY: 2000 - 2020



Graph developed through EXCEL with information obtained by the world health organization website.

Figure 4: Average death rate (due to Tuberculosis) per 100,000 inhabitants in countries where the application of the BCG vaccine against Tuberculosis is currently maintained as mandatory, during the years 2000 to 2020, these being represented by: Brazil; Chile; China; Croatia; Estonia; Finland; France; Greece; Ireland; Japan; Kuwait; Norway; Poland; Portugal; Republic of Korea; Romania; Russia; Singapore; Slovenia; South Africa; Thailand and UK.

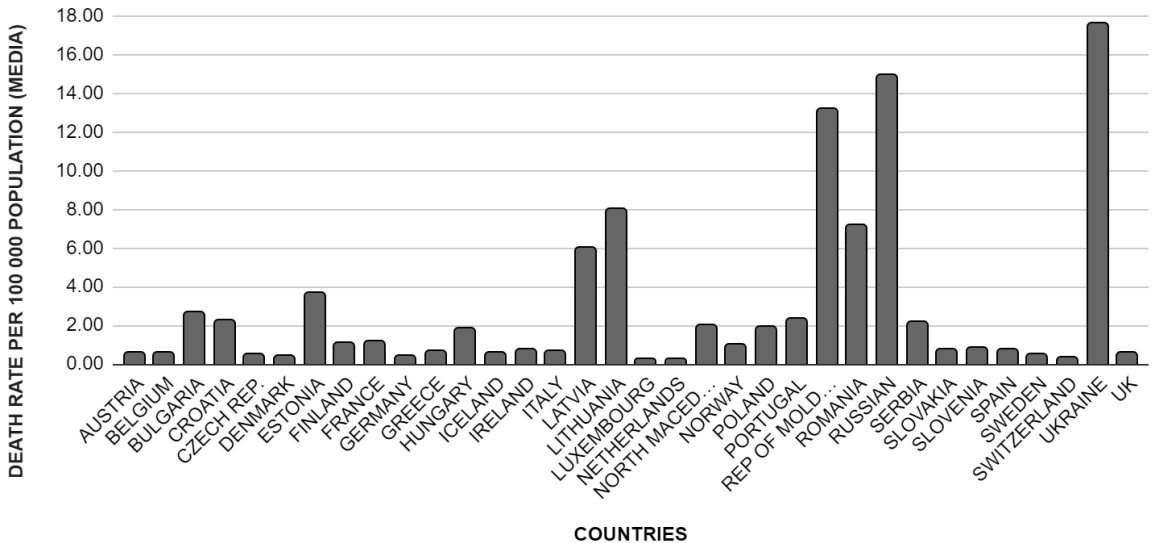
CENTRAL AND SOUTH AMERICA: 2000 - 2020



Graph developed through EXCEL with information obtained by the world health organization website.

Figure 5: Average death rate (due to Tuberculosis) per 100,000 inhabitants in Central and South American countries, from the years 2000 to 2020, these being represented by: Argentina; Belize; Brazil; Chile; Colombia; Costa Rica; Ecuador; El Salvador; French Guiana; Guatemala; Guyana, Mexico; Nicaragua; Panama; Paraguay; Peru; Suriname; Uruguay and Venezuela.

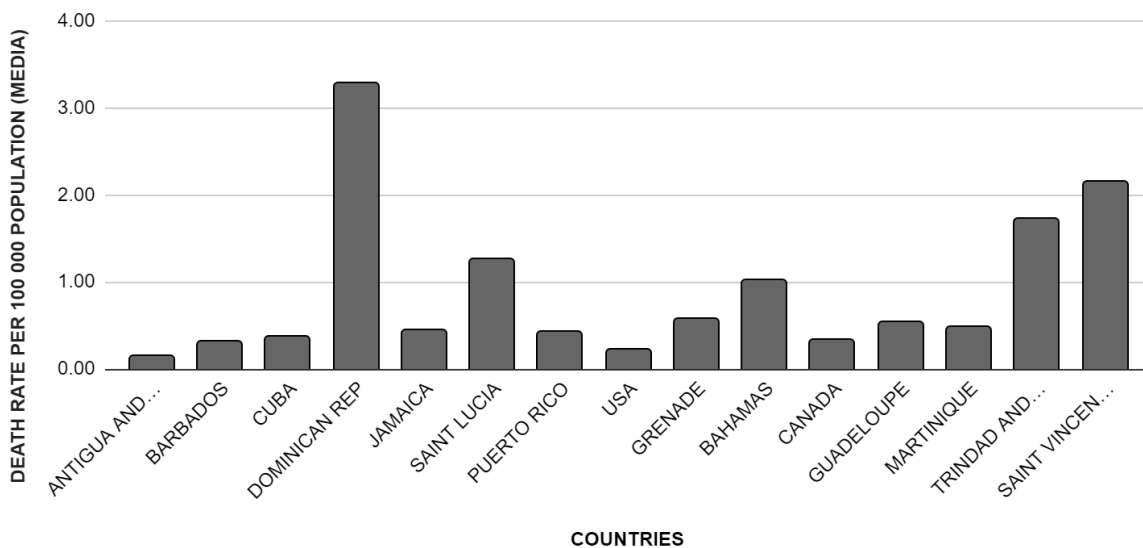
EUROPE: 2000 - 2020



Graph developed through EXCEL with information obtained by the world health organization website.

Figure 6: Average death rate (due to Tuberculosis) per 100,000 inhabitants in European countries, from the years 2000 to 2020, these being represented by: Austria; Belgium; Bulgaria; Croatia; Czech republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Latvia; Lithuania; Luxembourg; Netherlands; North Macedonia; Norway; Poland; Portugal; Republic of Moldova; Romania; Russia; Serbia; Slovakia. Slovenia; Spain; Sweden; Switzerland; Ukraine and UK.

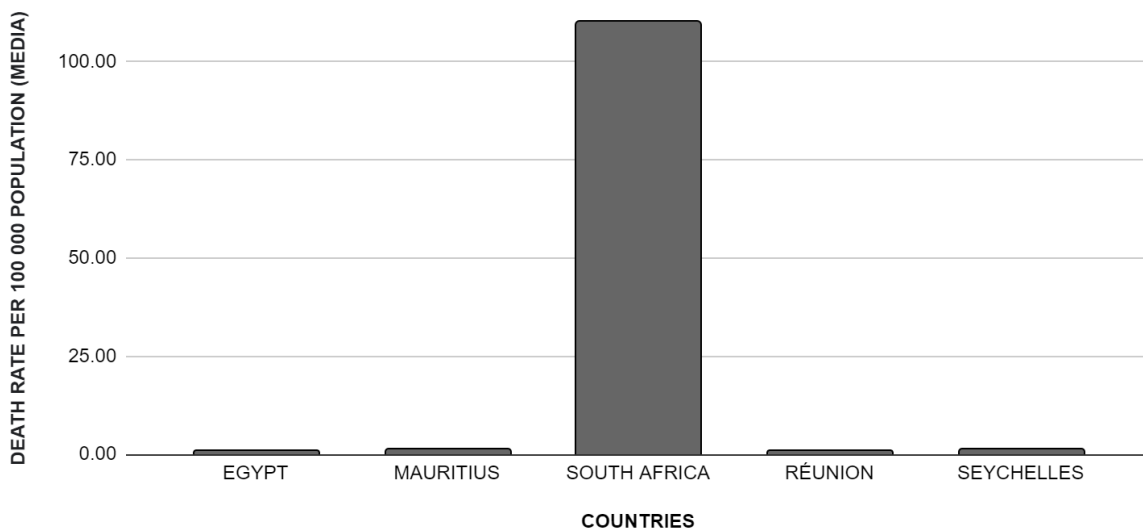
NORTH AMERICA AND CARIBBEAN: 2000 - 2020



Graph developed through EXCEL with information obtained by the world health organization website.

Figure 7: Average death rate (due to Tuberculosis) per 100,000 inhabitants in North American and Caribbean countries, during the years 2000 to 2020, represented by: Antigua and Barbuda; Barbados; Cuba; Dominican Republic; Jamaica; Saint Lucia; Puerto Rico; United States of America; Grenada; Bahamas; Canada; Guadeloupe; Martinique; Trindad and Tobago and Saint Vincent and the Grenadines.

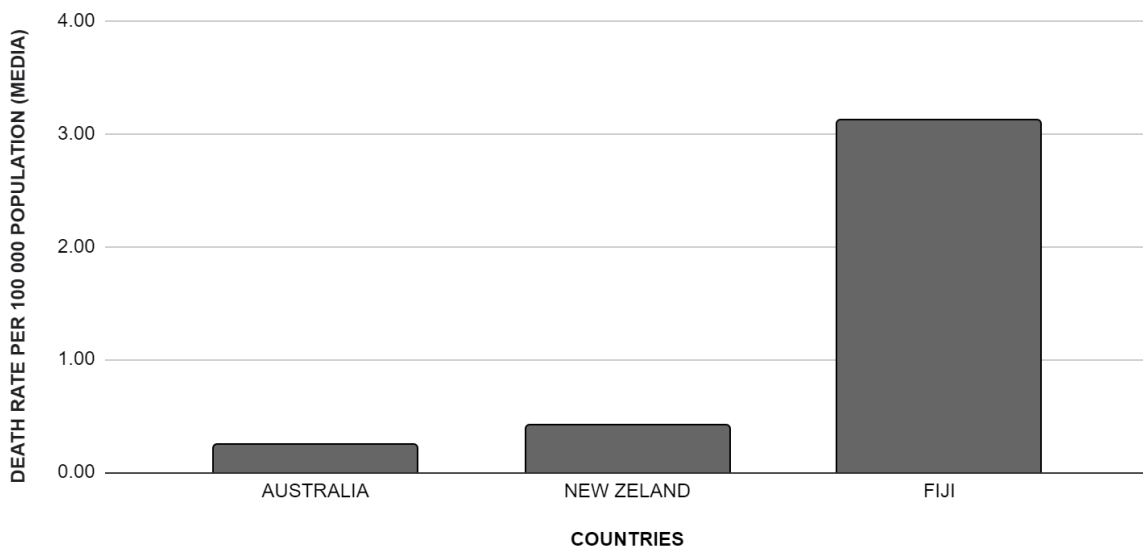
AFRICA: 2000 - 2020



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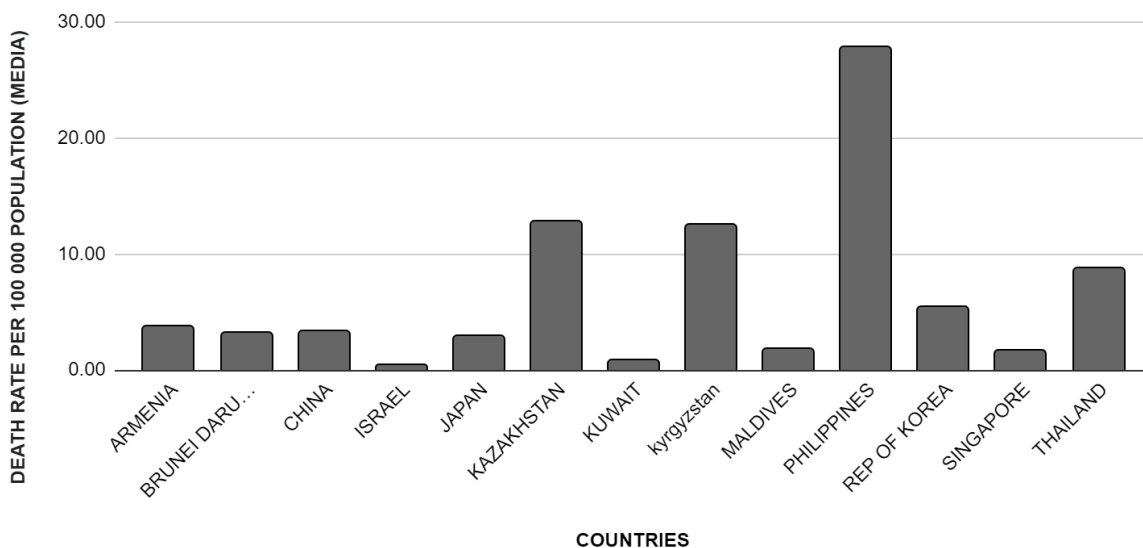
Figure 8: Average death rate (due to Tuberculosis) per 100,000 inhabitants in African countries, from the years 2000 to 2020, these being represented by: Egypt; Mauritius; South Africa; Reunion, and Seychelles.

OCEANIA: 2000 - 2020



Graph developed through EXCEL with information obtained by the world health organization website.
 Figure 9: Average death rate (due to Tuberculosis) per 100,000 inhabitants in Oceania countries, during the years 2000 to 2020, these being represented by: Australia; New Zealand, and Fiji.

ASIA: 2000 - 2020



Graph developed through EXCEL with information obtained by the world health organization website.
 Figure 10: Average death rate (due to Tuberculosis) per 100,000 inhabitants in Asian countries, from the years 2000 to 2020, these being represented by: Armenia; Brunei Darussalam; China; Israel; Japan; Kazakhstan; Kuwait; Kyrgyzstan; Maldives; Philippines; Singapore and Thailand.

DISCUSSION

The discovery of Koch's bacillus brought to the scientific community the development of the vaccine, the hope of health professionals, and the commitment to the manufacture of medicines and treatments with great advances, bringing with it the reduction of cases as can be seen in figure 1 to the compared to Figure 2, with few exceptions. (01, 02)

Among these exceptions is Russia, which had an average increase from 11.61 (1975/1999) to 14.96 (2000/2020) (figure 3 and figure 4) as a result of multidrug-resistant tuberculosis that attacked overcrowded prisons in 1999 (11), where those who were serving their sentences lived in precarious conditions. Despite being among the countries that still have mandatory vaccination, this increase in deaths lasted until 2005 with a mortality rate of 22.5, demonstrating the importance of hygienic-dietary habits during treatment. It is worth mentioning that due to the conflicts with Ukraine, the advances in the reduction of cases in both countries were interrupted, causing great concern among the affected population and government bodies. (12)

From another point of view, despite the great positive impact obtained with mass vaccination, this result is present mostly in developed countries, when compared to those considered developing (figures 5,6,7,8, 9, and 10). An example of this situation is the United States of America, where even though BCG vaccination is not mandatory, the average mortality rate (2000/2020 - figure 2) is 0.22, with its last record in 2020 with a rate of 0.2, in addition to countries with Sweden, Switzerland (Figure 6) with an average rate of 0.53 and 0.34, respectively. This fact is the result of efficient public policies, better awareness programs, and easy access to diagnosis and treatment, as we can see the evolution of mortality rates in Australia, which in 2000 was 1.2 and in

2016, its last record, is at 0.3, demonstrating its effectiveness. (13)

Still in this sense, the WHO stipulated in 2001 that 98% of deaths from tuberculosis in the world would be in developing countries (14), where we can observe countries such as Brazil, China, and South Korea (figure 4) that remain with mandatory vaccination. against TB and still have an average mortality rate of 2.68, 3.30, and 5.48, respectively.

Furthermore, even though the efficacy of drugs and vaccines for the pathology had been proven, in the 20th century, with a large number of HIV cases, tuberculosis was associated with AIDS, where it was proven that the immunosuppressive patient is 28 times more likely to catch it. tuberculosis and that it is still one of the leading causes of death in AIDS patients (5). This situation can be observed in South Africa, which to this day is the country most affected by the disease, accounting for 25% of cases globally in 2019 (15). With an average mortality rate of 110.16, South Africa is the country that suffers most from AIDS/HIV cases, where in the year 2021 about 1400 people were diagnosed daily. This correlation of both pathologies causes the infected population to lose their financial income and not get adequate treatment, which, according to the World Health Organization (2021), only 56% of the infected population has access to. As a result, the number of cases of multidrug-resistant tuberculosis has been increasing in the country where every 3 people infected, 1 is diagnosed with its drug-resistant version. (15,16).

CONCLUSION

Through the data presented, it is possible to observe that although the vaccine's effectiveness is not 100%, it presents significant results for the most aggressive forms of Tuberculosis (TB) and is still the only form of prevention for this pathology.

Furthermore, it is important to emphasize that their relationship with immunosuppressed patients continues fatally to this day, making it necessary to control AIDS cases for the progress and reduction of TB cases.

In addition, tuberculosis cases are increasing after the COVID-19 pandemic (17), with some of the reasons being the interruption of adequate treatment, the lack of demand for hospitals and health units when presenting symptoms due to isolation, in addition to non-adherence to the treatment, vaccination and increase in supporters of the

anti-vaccine movement. Furthermore, the number of cases and deaths due to the disease were compromised in the last two years with the pandemic, which may have future consequences concerning the containment of diagnoses. Finally, it can be observed that the awareness of governments, especially those in developing countries, and the population about the importance of getting vaccinated and the appropriate therapeutic resource is essential for global public health so that there is a decrease in cases of tuberculosis, as well as its possible future eradication.

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