**RESEARCH REPORT**

**(*STATISTICS - 2024-05*)**

# Impact of Comorbidities on Treatment Outcomes in Tuberculosis Patients: A Biostatistical Analysis


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# Abstract

This research project investigates the impact of comorbidities on treatment outcomes in tuberculosis (TB) patients in India. Leveraging data from the TB India Report 2022 and employing biostatistical methods such as survival analysis and competing risk theory, we aim to understand the complex relationships between TB and common comorbid conditions, including HIV infection, COVID-19, diabetes mellitus, alcoholism, and tobacco use. By analyzing treatment success rates, susceptibility to treatment failure and mortality, and differences in treatment response trajectories among TB patients with different comorbidities, this study seeks to provide valuable insights into factors influencing TB treatment outcomes in the Indian context. The findings are expected to inform evidence-based interventions and policies for TB control and management, contributing to efforts to mitigate the burden of TB and improve patient health outcomes.

# Introduction

Tuberculosis (TB) remains a formidable global health challenge, particularly in countries like India where its prevalence is notably high. Despite extensive efforts to combat the disease, TB continues to exert a significant burden on public health systems and individual well-being. Complicating the management and prognosis of TB are various comorbidities, including but not limited to HIV infection, COVID-19, diabetes mellitus, alcoholism, and tobacco use. Understanding the interplay between TB and these comorbid conditions is critical for optimizing treatment strategies and improving patient outcomes.

The prevalence of comorbidities among TB patients in India is substantial, contributing to the complexity of disease management. According to the TB India Report 2022, a comprehensive assessment of TB epidemiology and treatment outcomes in the country, a significant proportion of TB patients present with one or more comorbidities. These comorbid conditions not only influence the course of TB but also impact treatment responses, morbidity, and mortality rates.

The rationale behind this research project lies in the imperative to elucidate the influence of comorbidities on treatment outcomes in TB patients. By leveraging biostatistical methods, including survival analysis and competing risk theory, we aim to dissect the intricate relationships between TB and common comorbidities, shedding light on their combined effect on treatment success, mortality rates, and other pertinent clinical outcomes.

The primary objective of this study is to investigate how various comorbidities affect treatment outcomes in TB patients in India. Specifically, we seek to answer several key research questions:

1. How do comorbidities such as HIV infection, COVID-19, diabetes mellitus, alcoholism, and tobacco use influence treatment success rates among TB patients?
2. Are TB patients with comorbidities more susceptible to treatment failure or mortality compared to those without comorbidities?
3. What are the relative contributions of different comorbidities to overall treatment outcomes in TB patients?
4. Are there significant differences in treatment response trajectories between TB patients with different comorbidities?

To address these questions, we will utilize data from the TB India Report 2022, which provides comprehensive information on TB epidemiology, patient demographics, treatment regimens, and outcomes across various regions of India. By analyzing this rich dataset using advanced biostatistical techniques, we aim to uncover nuanced insights into the impact of comorbidities on TB treatment outcomes, thereby informing evidence-based interventions and policies for TB control and management.

In summary, this research project represents a critical endeavor to advance our understanding of the complex interplay between TB and comorbidities in the Indian context. By elucidating the factors influencing treatment outcomes in TB patients with comorbidities, we aspire to contribute valuable insights to the ongoing efforts to combat TB and improve the health outcomes of affected individuals. Through rigorous biostatistical analysis and interpretation, we endeavor to empower healthcare professionals and policymakers with actionable knowledge to enhance TB care delivery and mitigate the burden of this resilient infectious disease.

# Background

**Survival analysis:** Survival analysisis a statistical method used to analyze the time until an event of interest occurs in a population. It is commonly applied in medical research, particularly in studies involving time-to-event data, such as time until death, recurrence of disease, or failure of a treatment. The term "survival" does not exclusively refer to survival from mortality but can encompass various outcomes, including recovery, relapse, or progression of a disease.

Key components of survival analysis include:

1. **Time-to-Event Data:** Survival analysis involves the analysis of time-to-event data, where each observation corresponds to the time at which an event of interest occurs or is censored. Censoring occurs when the event of interest has not occurred for some individuals by the end of the study or they are lost to follow-up.
2. **Death Density Function:** The Death Density Function is generally the pdf of the survival time T. It is denoted by f(t). It provides the probability that an individual will die in the time interval $(t,t+\Delta t)$ no matter how small it is.
3. **Survival Function:** The survival function, denoted as $S(t)$, represents the probability that an individual survives beyond a certain time point $t$. It describes the cumulative probability of survival up to time $t$ and can be estimated using various statistical methods, such as the Kaplan-Meier estimator.
4. **Hazard Function:** The hazard function, denoted as $\lambda(t)$ or $h(t)$, represents the instantaneous rate of occurrence of the event of interest at time $t$, given that the individual has survived up to that time point. It describes the risk of experiencing the event of interest at any given moment in time and can be estimated using parametric or semi-parametric models, such as the Cox proportional hazards model.

**The Actuarial Method:** The Actuarial Method, often used in survival analysis, estimates survival probabilities for individuals or groups at various time points based on observed event data. It is particularly useful when dealing with censored data, where the exact event time is not known for all subjects. The Actuarial Method, also known as the Life Table Method or Product-Limit Method, is commonly applied in medical research, actuarial science, and demography.

Here's how the Actuarial Method works:

1. Data Preparation: The Actuarial Method requires a dataset consisting of survival times (time until the event of interest occurs) and censoring indicators for each subject. Censoring can occur for various reasons, such as loss to follow-up or the end of the study period.
2. Sorting Data: The dataset is sorted in ascending order based on survival times. If multiple events occur at the same time, they are sorted by censoring status, with censored observations placed before events.
3. Calculating Survival Probabilities: The Actuarial Method calculates survival probabilities at each time point of interest using the following formula:
4. $S(t)=\prod_{i:ti\leq t}(1-di/ni)$
   Where:
   - $S(t)$: is the estimated survival probability at time $t$
   - $ti$: are the observed event times.
   - $di$: are the number of events (e.g., deaths) at time $ti$
   - $ni$: are the number of individuals at risk just before time $ti$
5. Interpolation: If there are gaps between observed event times, interpolation may be used to estimate survival probabilities at intermediate time points.
6. Visualization: The Actuarial Method results in a survival curve, which plots estimated survival probabilities against time. This curve provides insights into the probability of surviving beyond various time points.
7. Analysis: Survival curves generated using the Actuarial Method can be compared between groups using statistical tests such as the log-rank test or Cox proportional hazards model. These analyses help identify factors associated with differences in survival experiences.

**Cure Rate:** The cure rate in the context of tuberculosis (TB) treatment refers to the proportion of TB patients who complete their treatment regimen and are deemed cured at the end of the follow-up period. It is an important indicator of treatment effectiveness and program performance in TB control efforts.

Here's how the cure rate is typically calculated:

- Definition of Cure: The definition of "cured" may vary depending on the TB program and guidelines followed. Generally, a patient is considered cured if they complete the entire course of TB treatment as prescribed and have documented negative bacteriological tests at the end of treatment.
- Data Collection: To calculate the cure rate, data on the number of TB patients who have completed treatment and achieved cure status are needed.
- Interpretation: A higher cure rate indicates better treatment outcomes and program performance in TB control efforts. Conversely, a lower cure rate may signify challenges in treatment adherence, drug resistance, or other systemic issues within the TB control program.

**Success Rate:** The success rate in the context of tuberculosis (TB) treatment reflects the overall effectiveness of TB treatment programs in achieving positive outcomes for patients. It encompasses various outcomes beyond just cure, such as treatment completion and improvement in patient health. The success rate is a crucial metric for evaluating TB control efforts and the quality of healthcare delivery.

Here's how the success rate is typically calculated:

- Definition of Success: The definition of "success" may vary depending on TB program guidelines and national or international standards. It often includes cured patients, those who complete treatment without evidence of failure, and possibly those who show improvement in clinical symptoms.
- Data Collection: To calculate the success rate, data on the outcomes of TB patients at the end of treatment are required. This includes information on the number of cured patients, those who completed treatment, and possibly those who improved clinically.
- Interpretation: A higher success rate indicates better overall treatment outcomes and program performance in TB control efforts. It reflects the ability of the TB program to effectively manage cases, ensure treatment adherence, and provide appropriate healthcare services. Monitoring changes in the success rate over time can help identify areas for improvement in TB control strategies.

**Death Rate:** The death rate, also known as the mortality rate, in the context of tuberculosis (TB) treatment refers to the proportion of TB patients who die during the course of treatment. It is a critical outcome measure that reflects the severity of TB disease, the effectiveness of treatment regimens, and the overall quality of healthcare services provided to TB patients.

Here's how the death rate is typically calculated:

- Data Collection: To calculate the death rate, data on the number of TB patients who have died during the treatment period are required. This information is typically obtained from patient records, healthcare facility databases, or national TB surveillance systems.
- Interpretation: A higher death rate indicates a greater risk of mortality among TB patients and may suggest inadequacies in TB treatment protocols, healthcare access, or disease management practices. Monitoring changes in the death rate over time is essential for evaluating the effectiveness of TB control efforts and identifying areas for improvement in patient care.

**%Lost to Follow Up:** The percentage lost to follow-up in the context of tuberculosis (TB) treatment represents the proportion of TB patients who discontinue treatment or are no longer under medical supervision during the course of their treatment. Lost to follow-up individuals are those who fail to complete their prescribed treatment regimen and whose treatment outcomes are unknown. Monitoring the percentage lost to follow-up is crucial for evaluating the effectiveness of TB control programs and identifying potential gaps in patient care and support services.

Here's how the percentage lost to follow-up is typically calculated:

- Data Collection: To calculate the percentage lost to follow-up, data on the number of TB patients who discontinue treatment or are lost to follow-up during the treatment period are required. This information is typically obtained from patient records, healthcare facility databases, or TB surveillance systems.

- Interpretation: A higher percentage lost to follow-up indicates challenges in treatment adherence, patient engagement, or access to healthcare services. Individuals lost to follow-up are at risk of poor treatment outcomes, including treatment failure, disease progression, and increased transmission of TB within the community. Monitoring changes in the percentage lost to follow-up over time is essential for identifying barriers to treatment completion and implementing interventions to improve patient retention and adherence.

**The Treatment Failure Rate:** The treatment failure rate in the context of tuberculosis (TB) treatment represents the proportion of TB patients who fail to respond to the prescribed treatment regimen or experience worsening of their condition despite receiving treatment. Treatment failure is a critical outcome measure that reflects the effectiveness of TB treatment protocols and the need for alternative or more intensive treatment strategies.

Here's how the treatment failure rate is typically calculated:

- Data Collection: To calculate the treatment failure rate, data on the number of TB patients who meet the criteria for treatment failure during the treatment period are required. This information is typically obtained from patient records, healthcare facility databases, or TB surveillance systems.
- Definition of Treatment Failure: The definition of "treatment failure" may vary depending on TB program guidelines and national or international standards. It often includes criteria such as the persistence or recurrence of TB symptoms, positive bacteriological tests (e.g., sputum smear or culture), or clinical deterioration despite receiving an appropriate treatment regimen.
- Interpretation: A higher treatment failure rate indicates challenges in achieving successful treatment outcomes and may suggest issues such as drug resistance, treatment non-adherence, or inadequate treatment regimens. Monitoring changes in the treatment failure rate over time is essential for evaluating the effectiveness of TB treatment protocols, identifying patients at risk of poor outcomes, and guiding clinical decision-making.

**% Regimen Change:** The percentage of regimen change in the context of tuberculosis (TB) treatment refers to the proportion of TB patients who undergo a change in their treatment regimen during the course of treatment. Regimen change may occur for various reasons, including drug intolerance or toxicity, treatment failure, drug resistance, or clinical deterioration requiring modification of the treatment plan.

Here's how you can calculate the percentage of regimen change:

- Data Collection: To calculate the percentage of regimen change, you need data on the number of TB patients who change their treatment regimen during the treatment period. This information is typically obtained from patient records, healthcare facility databases, or TB surveillance systems.
- Interpretation: A higher percentage of regimen change indicates challenges in achieving successful treatment outcomes and may suggest issues such as drug intolerance, treatment failure, or drug resistance. Monitoring changes in the percentage of regimen change over time is essential for evaluating the effectiveness of TB treatment protocols, identifying patients at risk of poor outcomes, and guiding clinical decision-making regarding treatment modifications.

**% Not evaluated:** The percentage of "not evaluated" in the context of tuberculosis (TB) treatment refers to the proportion of TB patients for whom treatment outcomes are not assessed or documented during the specified follow-up period. This category includes patients whose treatment outcomes are unknown due to various reasons, such as loss to follow-up, incomplete medical records, or lack of follow-up assessments.

Here's how you can calculate the percentage of "not evaluated":

- Data Collection: To calculate the percentage of "not evaluated," you need data on the number of TB patients for whom treatment outcomes are not assessed or documented during the specified follow-up period. This information is typically obtained from patient records, healthcare facility databases, or TB surveillance systems.
- Interpretation: A higher percentage of "not evaluated" indicates challenges in assessing treatment outcomes and may suggest gaps in healthcare delivery, follow-up procedures, or data management practices. Monitoring changes in the percentage of "not evaluated" over time is essential for identifying areas for

improvement in TB treatment programs and ensuring comprehensive evaluation of treatment outcomes for all TB patients.

**India State-wise TB Patients Demographics Table** provides a comprehensive overview of tuberculosis (TB) patients across different states of India, considering various demographic factors such as alcohol usage, tobacco consumption, COVID-19 co-infection, and pregnancy status. TB remains a significant public health concern in India, and understanding the demographic characteristics of TB patients is crucial for effective disease management and prevention strategies. Each entry in the table corresponds to a specific state of India and provides the following information:

**1. Number of TB Patients with Alcohol Usage**: This column indicates the total count of TB patients who reported alcohol consumption as a demographic variable. Alcohol usage can impact TB treatment outcomes and disease progression, making it essential to track its prevalence among TB patients.

**2. Number of TB Patients with Tobacco Consumption**: This column presents the total count of TB patients who reported tobacco consumption. Tobacco use is a significant risk factor for TB infection and can exacerbate the severity of TB symptoms, complicating treatment regimens.

**3. Number of TB Patients with COVID-19 Co-infection:** This column showcases the total count of TB patients who were diagnosed with COVID-19 as a co-infection. The COVID-19 pandemic has posed additional challenges in managing TB, and understanding the overlap between these two diseases is critical for mitigating their impact on public health.

**4. Number of TB Patients who are Pregnant:** This column displays the total count of TB patients who are pregnant at the time of TB diagnosis. Pregnancy adds complexity to TB management due to potential risks to maternal and fetal health, necessitating specialized care for this vulnerable population.

## Methodology

**Calculation:**

**Cure Rate:** The cure rate is calculated as the number of cured TB patients divided by the total number of TB patients who completed treatment, expressed as a percentage. Cure Rate (%)=(Number of Cured Patients/Total Number of Patients)×100

**Success Rate:** The success rate is calculated as the number of successful outcomes (cured, completed treatment, or improved) divided by the total number of TB patients treated, expressed as a percentage. Success Rate (%)=(Number of Successful Outcomes/Total Number of Patients)×100

**Death Rate:** The death rate is calculated as the number of TB-related deaths divided by the total number of TB patients treated, expressed as a percentage. Death Rate (%)=(Number of TB-related Deaths/Total Number of Patients)×100

**% Lost To Follow-Up:** The percentage lost to follow-up is calculated as the number of TB patients lost to follow-up divided by the total number of TB patients treated, expressed as a percentage. % Lost to Follow-up=(Number of Patients Lost to Follow-up/Total Number of Patients Treated)×100

**Treatment Failure Rate:** The treatment failure rate is calculated as the number of TB patients who meet the criteria for treatment failure divided by the total number of TB patients treated, expressed as a percentage. Treatment Failure Rate (%)=(Number of Patients with Treatment Failure/Total Number of Patients Treated)×100

**%Regimen Change:** The percentage of regimen change is calculated as the number of TB patients who undergo a change in treatment regimen divided by the total number of TB patients treated, expressed as a percentage. Percentage of

Regimen Change (%)=(Number of Patients with Regimen Change/Total Number of Patients Treated)×100

**% Not Evaluated:** The percentage of "not evaluated" is calculated as the number of TB patients for whom treatment outcomes are not evaluated divided by the total number of TB patients treated, expressed as a percentage. Percentage of "Not Evaluated" (%)=(Number of Patients Not Evaluated/Total Number of Patients Treated)×100

**Survival Function:** S(t) = (Number of persons surviving larger than t) / (Total number of persons initially)

**Death Density Function:** f(t)=(Number of persons dying in the given interval) / (Total number of persons * Width of interval)

**Hazard Function:** $\lambda(t)$ = (Number of persons dying per unit of time in the interval) / (Number of persons surviving at time t * Width of the interval)

**Actuarial Method:** $\lambda(t)$ = (Number of persons dying per unit of time in the interval) / (Number of persons surviving at time t - 0.5 * Number of death in the interval * Width of the interval)

**Survival analysis:** The survival analysis table for TB ,TB-HIV and TB- Paediatric, we have calculated the following components :

- Cure rate
- Success rate
- Death rate
- Percentage lost to follow up
- Treatment failure rate
- Percentage regimen changes
- Percentage not evaluated

**Test hypothesis:**

- $H_{01}$: There is no significant difference between the success rates when TB is compared with TB-HIV.
- $H_{11}$:There is a significant difference between the success rates when TB is compared with TB-HIV.

- $H_{02}$:There is no significant difference between the death rates when TB is compared with TB-HIV.
- $H_{12}$: There is a significant difference between the death rates when TB is compared with TB-HIV.

**Test statistics:**

Paired t-test is a statistical test used to Define the population of each state in India concerning various diseases. Since the parent population remains the same for all these diseases, we can infer that the diseases are dependent on each other. Hence, we are employing a paired t-test." to determine whether there is a significant difference between the mean of two related groups, it is typically applied when the same subjects are measured at two different times or under two different conditions. The paired t-test compares the means of the two different groups and determines if the difference between them is statistically significant.

$$t = \frac{(\overline{x_1} - \overline{x_2}) - (\mu_1 - \mu_2)}{\sqrt{\frac{{s_1}^2}{n_1} + \frac{{s_2}^2}{n_2}}}$$

**Reason:** We are defining the population of each state in India concerning various diseases. Since the parent population remains the same for all these diseases, we can infer that the diseases are dependent on each other. Hence, we are employing a paired t-test.

$X_1$: sample mean which represent the success/death rate of the treatment who are from TB.
$X_2$: sample mean which represent the success/death rate of the treatment who are from TB-HIV.
$\boldsymbol{\mu}_1$: population mean which represent the success/death rate of the treatment who are from TB.
$\boldsymbol{\mu}_2$:population mean which represent the success/death rate of the treatment who are from TB-HIV.
$S_1^2$: sample variance which represents the success/death rates of the treatment who are from TB.
$S_2^2$: sample variance which represents the success/death rates of the treatment who are from TB_HIV.
n1: size of the sample which represents the population having TB.
n2: the size of the sample which represents the population having TB_HIV.

**Test Criteria:**

If the p-value is less than type I error ($\boldsymbol{\alpha}$) then we reject Ho and conclude that there is a significant difference between the success/death rates of TB and TB-HIV.
Otherwise, we accept Ho and conclude that there is no significant difference between the success/ death rates of TB and TB-HIV.

For Ho1: Also when we reject the Ho we conclude that there is a significant difference between the two factors. To determine which factor has a greater effect, we examine the means. If the success rate mean for TB is higher than that for TB with HIV, we can conclude that TB treatment is more successful than TB treatment with HIV.

For Ho2: When we reject the null hypothesis, it suggests a notable difference between the two factors. To ascertain which factor has a stronger impact, we analyze the means. If the

mean death rate for TB is lower than that for TB with HIV, we can deduce that TB treatment is more effective in reducing mortality compared to TB treatment with HIV.

**SPSS Procedure:**

- Start SPSS and open your dataset.
- Go to the "Analyze" menu.
- Under the "Analyze" menu, select "Compare Means".
- In the "Compare Means" sub-menu, choose "Paired-Samples T Test".
- Move the variables you want to compare from the list of variables on the left to the box labeled "Paired Variables" on the right.
- You can click on the "Options" button to specify any additional options you want.
- Once you have selected your variables and any desired options, click "OK" to run the paired sample t-test.
- SPSS will then generate output, including the t-value, degrees of freedom, and p-value, among others.

**Excel Procedure**

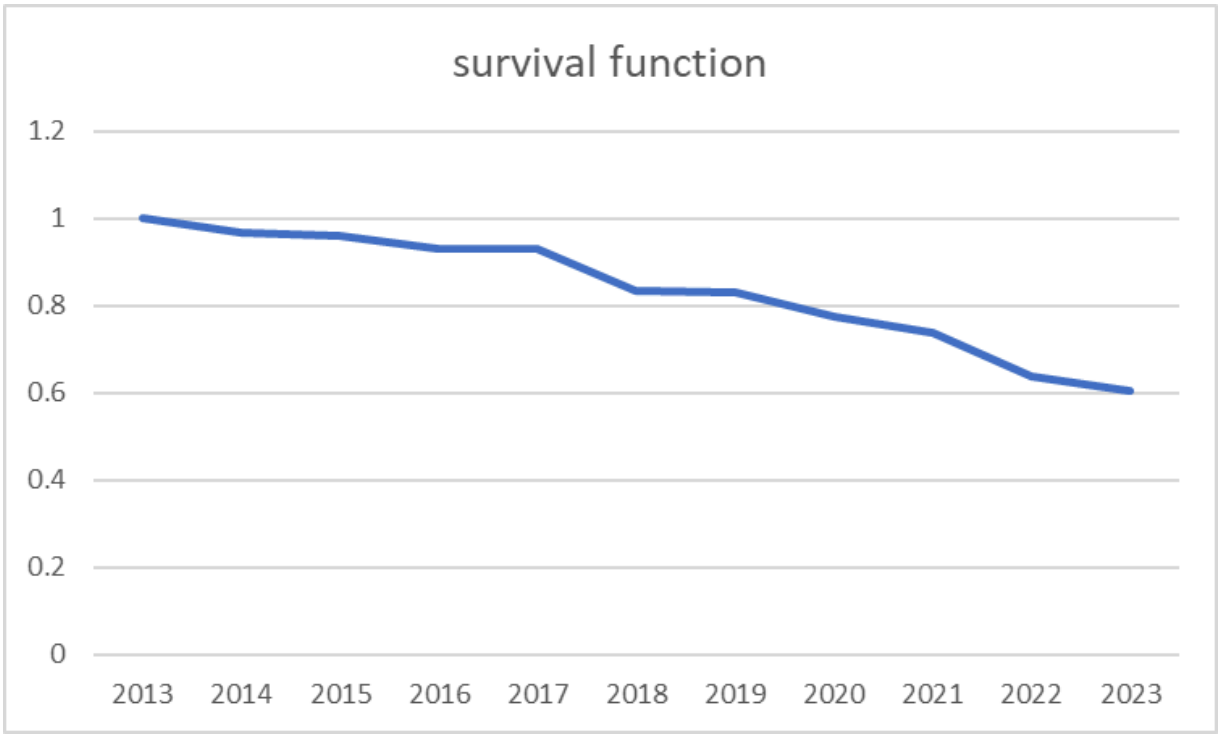
- Open the dataset containing information on li= number of patients at the beginning of the time interval, di = number of deaths & h= size of time interval
- Compute:
  - Death Density function: di/(lo*h)
  - Survival function: li/lo
  - Estimated Hazard Function: di/(li*h)
  - Actuarial Method: di/(li-di/2)
- For the graphs, select the suitable column
- Go to “Insert” menu, then select Line Chart
- The table and the chart would be plotted on the excel sheet

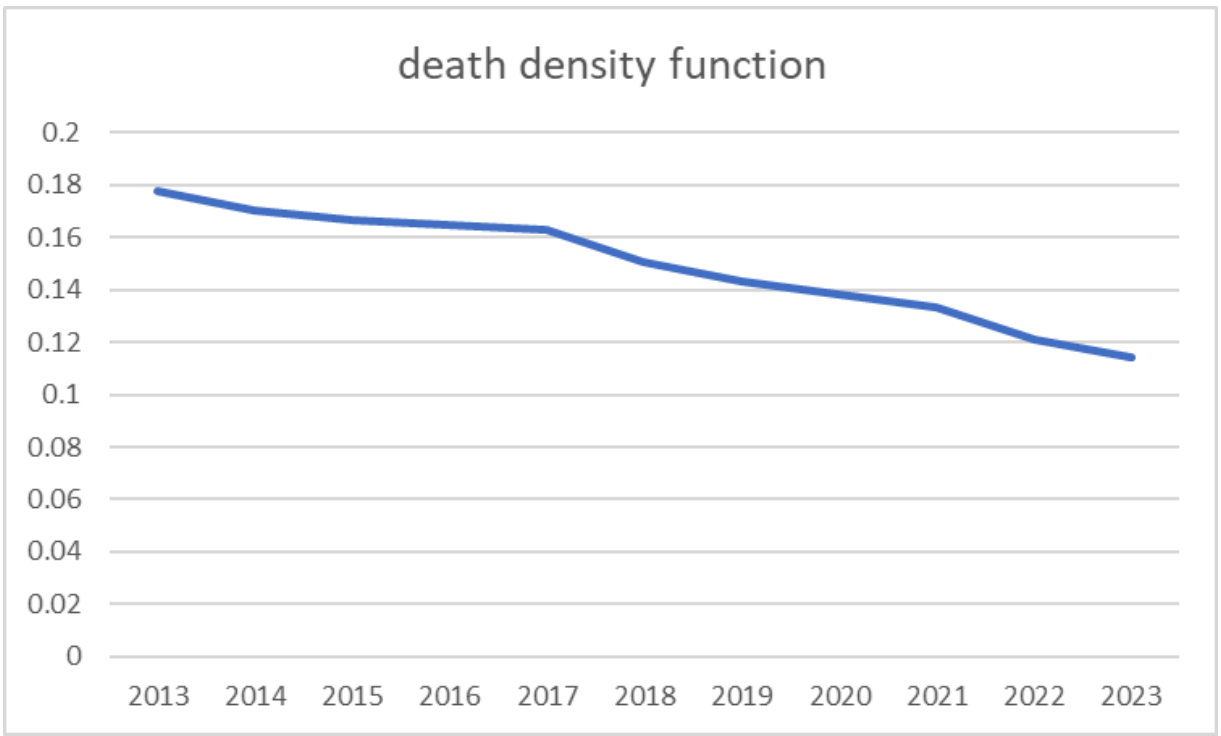
## Statistical Analysis

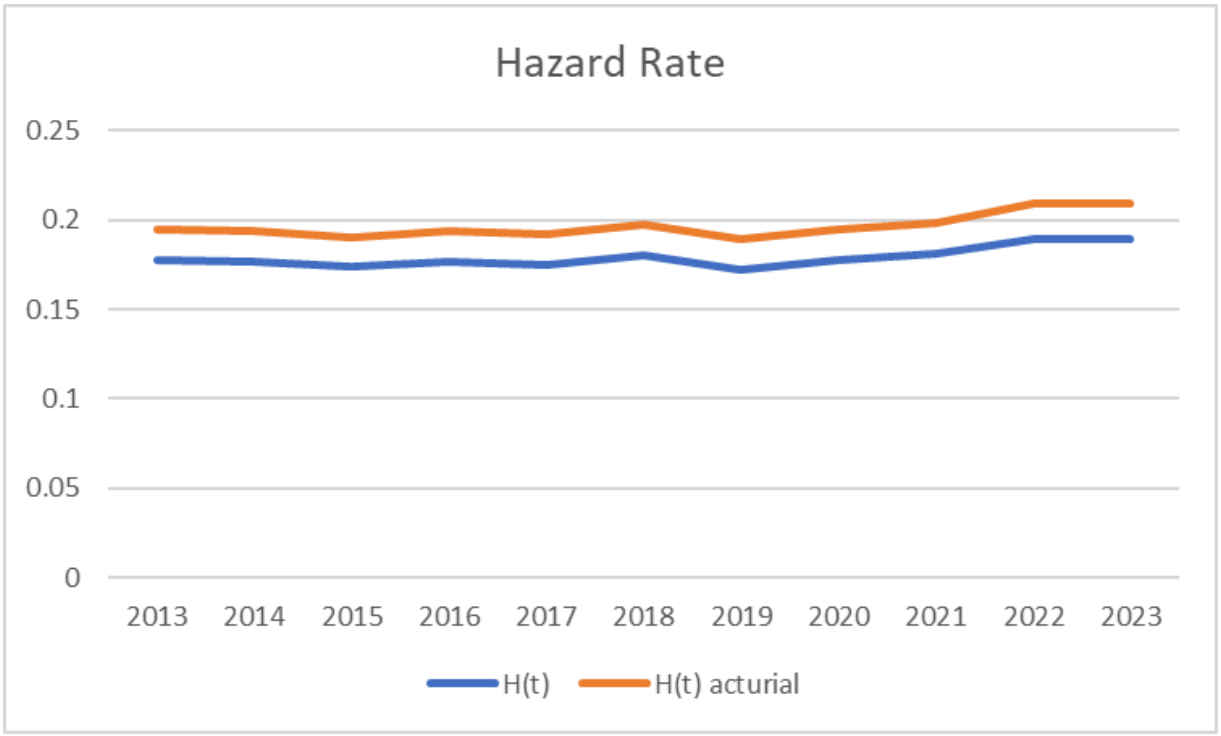
The TB Survival Analysis Table provides essential data pertaining to tuberculosis (TB) patients, including the number of patients, the number of deaths, and crucial derived metrics such as the survival function, death density function, and hazard rate. Additionally, it employs actuarial methods to calculate the hazard rate

| Year of Following (t) | Number of TB Patients at the beginning of the year (li) | Number of deaths (di) | s(t) | f(t) | H(t) | H(t) acturial |
|---|---|---|---|---|---|---|
| 2013 | 2900000 | 515000 | 1 | 0.177586 | 0.177586 | 0.1948912 |
| 2014 | 2800000 | 494000 | 0.965517241 | 0.170345 | 0.176429 | 0.19349785 |
| 2015 | 2780000 | 483000 | 0.95862069 | 0.166552 | 0.173741 | 0.19026984 |
| 2016 | 2700000 | 478000 | 0.931034483 | 0.164828 | 0.177037 | 0.19422999 |
| 2017 | 2700000 | 472000 | 0.931034483 | 0.162759 | 0.174815 | 0.19155844 |
| 2018 | 2422121 | 436000 | 0.835214138 | 0.150345 | 0.180008 | 0.19781128 |
| 2019 | 2404815 | 415000 | 0.829246552 | 0.143103 | 0.17257 | 0.18886687 |
| 2020 | 2250000 | 400000 | 0.775862069 | 0.137931 | 0.177778 | 0.19512195 |
| 2021 | 2135670 | 386000 | 0.736437931 | 0.133103 | 0.18074 | 0.19869561 |
| 2022 | 1850670 | 351000 | 0.638162069 | 0.121034 | 0.189661 | 0.20953097 |
| 2023 | 1750000 | 331000 | 0.603448276 | 0.114138 | 0.189143 | 0.20889871 |

The data above shows a decline in the number of cases and also the number of deaths due to TB in India.


survival function
1.2
1
0.8
0.6
0.4
0.2
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

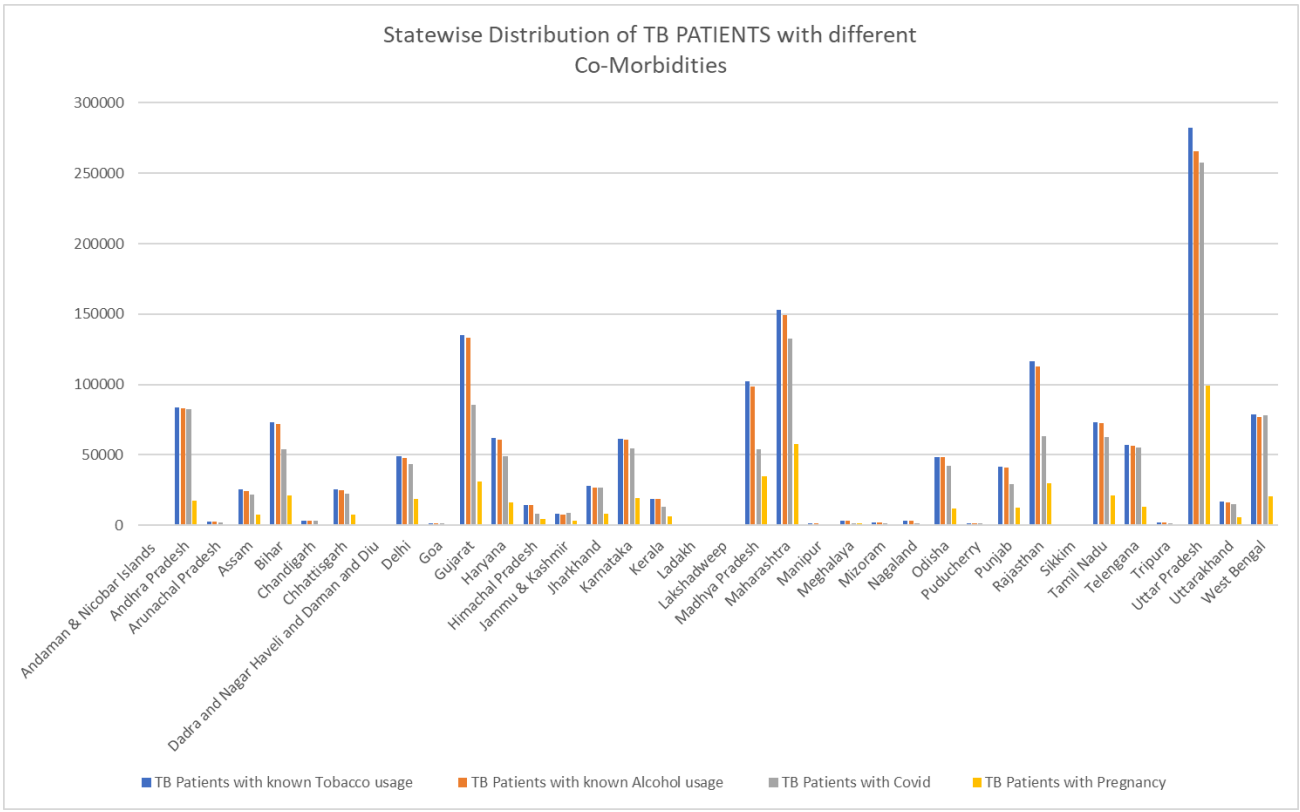

death density function
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023




The table and the bar chart below provides statistics on tuberculosis (TB) patients in various states of India, categorizing them based on multiple factors such as alcohol usage, tobacco consumption, COVID-19 co-infection, and pregnancy status.

| State | TB Patients with known Tobacco usage | TB Patients with known Alcohol usage | TB Patients with Covid | TB Patients with Pregnancy |
|---|---|---|---|---|
| Andaman & Nicobar Islands | 440 | 457 | 221 | 183 |
| Andhra Pradesh | 83848 | 82867 | 82299 | 17585 |
| Arunachal Pradesh | 2375 | 2353 | 1756 | 736 |
| Assam | 25174 | 24377 | 21861 | 7653 |
| Bihar | 73376 | 72108 | 53945 | 21058 |
| Chandigarh | 2927 | 2839 | 2902 | 668 |
| Chhattisgarh | 25488 | 24737 | 22016 | 7580 |
| Dadra and Nagar Haveli and Daman and Diu | 473 | 443 | 359 | 255 |
| Delhi | 48832 | 47402 | 43468 | 18542 |
| Goa | 1536 | 1529 | 1352 | 552 |
| Gujarat | 134694 | 133432 | 85612 | 31045 |
| Haryana | 61917 | 60717 | 48707 | 15965 |
| Himachal Pradesh | 14498 | 14396 | 8321 | 4110 |
| Jammu & Kashmir | 8013 | 7734 | 8423 | 3153 |
| Jharkhand | 27805 | 26446 | 26455 | 8263 |
| Karnataka | 61619 | 60662 | 54547 | 19050 |
| Kerala | 18688 | 18393 | 13200 | 5987 |
| Ladakh | 231 | 240 | 152 | 113 |
| Lakshadweep | 20 | 20 | 16 | 10 |
| Madhya Pradesh | 101935 | 98590 | 54064 | 34403 |
| Maharashtra | 152680 | 149363 | 132348 | 57310 |
| Manipur | 1189 | 1228 | 550 | 449 |
| Meghalaya | 3352 | 3266 | 1530 | 1168 |
| Mizoram | 1709 | 1698 | 1058 | 594 |
| Nagaland | 3004 | 2981 | 1041 | 946 |
| Odisha | 48401 | 48227 | 42230 | 11707 |
| Puducherry | 1375 | 1374 | 1128 | 384 |
| Punjab | 41454 | 40808 | 29075 | 12489 |
| Rajasthan | 116281 | 112919 | 63305 | 29759 |
| Sikkim | 866 | 817 | 591 | 552 |
| Tamil Nadu | 72962 | 72598 | 62856 | 21207 |
| Telengana | 56804 | 56303 | 55185 | 12740 |
| Tripura | 2000 | 1862 | 1582 | 565 |
| Uttar Pradesh | 282077 | 265676 | 257848 | 99051 |
| Uttarakhand | 16811 | 16221 | 14959 | 5392 |
| West Bengal | 78595 | 77045 | 77766 | 20635 |
| **India** | **1573449** | **1532128** | **1272728** | **471859** |

The highlighted areas shows the states and co morbidities with highest number of cases


Statewise Distribution of TB PATIENTS with different Co-Morbidities
300000
250000
200000
150000
100000
50000
0
Andaman & Nicobar Islands
Andhra Pradesh
Arunachal Pradesh
Assam
Bihar
Chandigarh
Chhattisgarh
Dadra and Nagar Haveli and Daman and Diu
Delhi
Goa
Gujarat
Haryana
Himachal Pradesh
Jammu & Kashmir
Jharkhand
Karnataka
Kerala
Ladakh
Lakshadweep
Madhya Pradesh
Maharashtra
Manipur
Meghalaya
Mizoram
Nagaland
Odisha
Puducherry
Punjab
Rajasthan
Sikkim
Tamil Nadu
Telengana
Tripura
Uttar Pradesh
Uttarakhand
West Bengal
TB Patients with known Tobacco usage
TB Patients with known Alcohol usage
TB Patients with Covid
TB Patients with Pregnancy

# Treatment Outcome of TB patients

| State | TB patients Notified | Bacteriologically Confirmed | Cure Rate | Success Rate | Death Rate | % Lost to follow up | Treatment Failure Rate | % Regimen Change | % Not evaluated | Death Rate TB |
|---|---|---|---|---|---|---|---|---|---|---|
| Andaman & Nicobar Islands | 434 | 242 | 141 (58%) | 370 (85%) | 16(3.7%) | 6(1.4%) | 3(0.7%) | 8(1.8%) | 1(0.2%) | 3.7%) |
| Andhra Pradesh | 62914 | 31349 | 24379(78% | 56675 (90%) | 2490 (4.0%) | 499 (0.8%) | 122(0.2%) | 1012(1.6%) | 855 (1.4%) | 4.0%) |
| Arunachal Pradesh | 2424 | 1247 | 816(65%) | 2014(83%) | 78(3.2%) | 123 (5.1%) | 23 (0.9%) | 76(3.1%) | 24 (1.0%) | 3.2%) |
| Assam | 34540 | 16225 | 9386(58%) | 28896 (84%) | 1422(4.1%) | 634 (1.8%) | 125(0.4%) | 450(1.3%) | 1372(4.0%) | 4.1%) |
| Bihar | 99731 | 34789 | 14429(41%) | 77503 (78%) | 3341 (3.4%) | 3751(3.8%) | 516(0.5%) | 1068(1.1%) | 6743 (6.8%) | 3.4%) |
| Chandigarh | 2829 | 1380 | 950(69%) | 2278(81%) | 129(4.6%) | 104(3.7%) | 14(0.5%) | 53 (1.9%) | 64 (2.3%) | 4.6%) |
| Chhattisgarh | 29104 | 11358 | 8434(74%) | 25080(86%) | 1380 (4.7%) | 685(2.4%) | 137(0.5%) | 261 (0.9%) | 1072(3.7%) | 4.7%) |
| Dadra and Nagar Haveli and Daman and Diu | 735 | 314 | 285(91%) | 686 (93%) | 17 (2.3%) | 5(0.7%) | 2(0.3%) | 2(0.3%) | 8(1.1%) | 2.3%) |
| Delhi | 73390 | 34843 | 13261(38%) | 52893(72%) | 2008(2.7%) | 3448(4.7%) | 388 (0.5%) | 1645(2.2%) | 1862(2.5%) | 2.7%) |
| Goa | 1584 | 844 | 348 (41%) | 1338 (84%) | 89 (5.6%) | 48(3.0%) | 8(0.5%) | 26(1.6%) | 8(0.5%) | 5.6%) |
| Gujarat | 115345 | 40867 | 31626(77%) | 101484 (88%) | 5472(4.7%) | 2410(2.1%) | 876(0.8%) | 2074 (1.8%) | 744 (0.6%) | 4.7%) |
| Haryana | 63036 | 34466 | 19119(55%) | 49505 (79%) | 2638(4.2%) | 2005(3.2%) | 395(0.6%) | 575 (0.9%) | 2720(4.3%) | 4.2%) |
| Himachal Pradesh | 13299 | 8715 | 5704(65%) | 11643(88%) | 723(5.4%) | 144(1.1%) | 48(0.4%) | 244 (1.8%) | 161(1.2%) | 5.4%) |
| Jammu & Kashmir | 8800 | 4291 | 172(74%) | 7290 (83%) | 309 (3.5%) | 120(1.4%) | 49 (0.6%) | 73(0.8%) | 503(5.7%) | 3.5%) |
| harkhand | 45660 | 18601 | 10097(54%) | 38041(83%) | 1568(3.4%) | 2378(5.2%) | 169(0.4%) | 309 (0.7%) | 1405(3.1%) | 3.4%) |
| Karnataka | 62534 | 35409 | 23508(66%) | 50756(81%) | 4490(7.2%) | 1555(2.5%) | 368(0.6%) | 1518(2.4%) | 873(1.4%) | 7.2%) |
| Kerala | 20641 | 12137 | 8114(67%) | 16770(81%) | 1668(8.1%) | 371(1.8%) | 131(0.6%) | 234(1.1%) | 607(2.9%) | 8.1%) |
| Ladakh | 243 | 127 | 56(44%) | 188 (77%) | 19 (7.8%) | 4(1.6%) | 2(0.8%) | 1(0.4%) | 18(7.4%) | 7.8%) |
| Lakshadweep | 17 | 8 | 9(113%) | 15(88%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 2(11.8%) | 0.0%) |
| Madhya Pradesh | 135759 | 53234 | 31912(60%) | 108006(80% | 4795(3.5%) | 6092(4.5%) | 767(0.6%) | 1431 (1.1%) | 8957(6.6%) | 3.5%) |
| Maharashtra | 147420 | 63467 | 33072(52%) | 124317(84% | 6988(4.7%) | 3088(2.1%) | 716(0.5%) | 3324(2.3%) | 858(0.6%) | 4.7%) |
| Manipur | 1564 | 851 | 533(63%) | 1245(80%) | 55 (3.5%) | 43 (2.7%) | 6(0.4%) | 17 (1.1%) | 89(5.7%) | 3.5%) |
| Meghalaya | 3864 | 2090 | 1206(58%) | 3109(80%) | 185(4.8%) | 148(3.8%) | 27 (0.7%) | 89 (2.3%) | 83 (2.1%) | 4.8%) |
| Mizoram | 1988 | 981 | 676(69%) | 1773(89%) | 50(2.5%) | 31 (1.6%) | 5(0.3%) | 27 (1.4%) | 52 (2.6%) | 2.5%) |
| Nagaland | 3518 | 1658 | 1232 (74%) | 2841 (81%) | 97 (2.8%) | 90 (2.6%) | 26 (0.7%) | 24 (0.7%) | 368(10.5%) | 2.8%) |
| Odisha | 44995 | 24976 | 20307(81%) | 39995(89%) | 2506(5.6%) | 584(1.3%) | 107(0.2%) | 248(0.6%) | 526(1.2%) | 5.6%) |
| Puducherry | 1220 | 827 | 543 (66%) | 994 (81%) | 80 (6.6%) | 28(2.3%) | 14 (1.1%) | 37 (3.0%) | 3(0.2%) | 6.6%) |
| Punjab | 46491 | 25932 | 13694(53%) | 37006(80%) | 2667(5.7%) | 1172(2.5%) | 204(0.4%) | 494(1.1%) | 2374(5.1%) | 5.7%) |
| Rajasthan | 133460 | 61688 | 37501(61%) | 109972 (82%) | 4616(3.5%) | 5375(4,0%) | 756(0.6%) | 1539(1.2%) | 2348(1.8%) | 3.5%) |
| Sikkim | 1139 | 670 | 49 (67%) | 1022 (90%) | 45(4.0%) | 9(0.8%) | 1(0.1%) | 19(1.7%) | 15(1.3%) | 4.0%) |
| Tamil Nadu | 68943 | 41948 | 28686 (68%) | 56885(83%) | 4050 (5.9%) | 1712(2.5%) | 342 (0.5%) | 2036(3.0%) | 1308(1.9%) | 5.9%) |
| Telangana | 60857 | 27933 | 23681(85%) | 54176(89%) | 1876(3.1%) | 376(0.6%) | 226(0.4%) | 1156(1.9%) | 1537 (2.5%) | 3.1%) |
| Tripura | 2137 | 1412 | 1043(74%) | 1739(81%) | 159(7.4%) | 50(2.3%) | 9(0.4%) | 60 (2.8%) | 42 (2.0%) | 7.4%) |
| Uttar Pradesh | 363664 | 131799 | 75880 (58%) | 303785 (84%) | 14913(4.1%) | 11880(3.3%) | 2049 (0.6%) | 4967(1.4%) | 4223(1.2%) | 4.1%) |
| Uttarakhand | 19681 | 8142 | 4267(52%) | 16412 (83%) | 743(3.8%) | 614(3.1%) | 104(0.5%) | 350(1.8%) | 595(3.0%) | 3.8%) |
| West Bengal | 77477 | 49961 | 35563 (71%) | 65165 (84%) | 4320(5.6%) | 1556(2.0%) | 467(0.6%) | 1222(1.6%) | 1421 (1.8%) | 5.6%) |
| INDIA | 1751437 | 784781 | 484079(62%) | 1451867 (83%) | 76002(4.3%) | 51138(2.9%) | 9202(0.5%) | 6669(1.5%) | 43841 (2.5%) | 4.3%) |

# Treatment Outcome of TB - HIV patients

| State | TB patients Notified | Bacteriologically Confirmed | Cure Rate | Success Rate | Death Rate | % Lost to follow up | Treatment Failure Rate | % Regimen Change | % Not evaluated |
|---|---|---|---|---|---|---|---|---|---|
| Andaman & Nicobar Islands | 4 | 2 | 2(100%) | 3(75%) | 1(25.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) |
| Andhra Pradesh | 3413 | 2168 | 1378(64%) | 2691(79%) | 462(13.5%) | 32 (0.9%) | 9(0.3%) | 55(1.6%) | 60(1.8%) |
| Arunachal Pradesh | 5 | 3 | 3(100%) | 4(80%) | 1(20.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) |
| Assam | 212 | 71 | 31 (44%) | 140 (66%) | 28(13.2%) | 5(2.4%) | 2(0.9%) | 2(0.9%) | 21 (9.9%) |
| Bihar | 1492 | 661 | 202(31%) | 933(63%) | 103(6.9%) | 65 (4.4%) | 9(0.6%) | 11 (0.7%) | 202(13.5%) |
| Chandigarh | 154 | 21 | 6(29%) | 59 (38%) | 26(16.9%) | 28(18.2%) | 0(0.0%) | 3(1.9%) | 15(9.7%) |
| Chhattisgarh | 490 | 269 | 144 (54%) | 359(73%) | 65(13.3%) | 15(3.1%) | 4(0.8%) | 4(0.8%) | 36(7.3%) |
| Dadra and Nagar Haveli and Daman and Diu | 13 | 3 | 3(100%) | 10(77%) | 3(23.1%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) |
| Delhi | 928 | 352 | 130(37%) | 597(64%) | 57(6.1%) | 72 (7.8%) | 9(1.0%) | 8(0.9%) | 127(13.7%) |
| Goa | 49 | 28 | 6(21%) | 39 (80%) | 6(12.2%) | 0(0.0%) | 0(0.0%) | 1(2.0%) | 0 (0.0%) |
| Gujarat | 2697 | 1072 | 591(55%) | 1940 (72%) | 426(15.8%) | 121(4.5%) | 31 (1.1%) | 26(1.0%) | 22 (0.8%) |
| Haryana | 596 | 331 | 160 (48%) | 435(73%) | 64(10.7%) | 22 (3.7%) | 5 (0.8%) | 3 (0.5%) | 28(4.7%) |
| Himachal Pradesh | 108 | 69 | 33 (48%) | 79(73%) | 20(18.5%) | 1(0.9%) | 10.90% | 2(1.9%) | 3(2.8%) |
| Jammu & Kashmir | 60 | 19 | 6(32%) | 46(77%) | 3(5.0%) | 1(1.7%) | 0(0.0%) | 0(0.0%) | 7(11.7%) |
| Jharkhand | 301 | 146 | 43 (29%) | 195(65%) | 24(8.0%) | 19(6.3%) | 3(1.0%) | 5(1.7%) | 12(4.0%) |
| Karnataka | 4187 | 2386 | 1222(51%) | 2826(67%) | 827(19.8%) | 195(4.7%) | 18(0.4%) | 84 (2.0%) | 47 (1.1%) |
| Kerala | 245 | 81 | 33(41%) | 137(56%) | 71 (29.0%) | 9(3.7%) | 2(0.8%) | 10.40% | 9(3.7%) |
| Ladakh | 1 | 0 | NA | 0(0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 1(100.0%) |
| Lakshadweep | 0 | 0 | NA | NA | NA | NA | NA | NA | NA |
| Madhya Pradesh | 1264 | 527 | 229(43%) | 910(72%) | 155 (12.3%) | 63 (5.0%) | 6(0.5%) | 12 (0.9%) | 62(4.9%) |
| Maharashtra | 5517 | 1948 | 900(46%) | 4081(74%) | 765(13.9%) | 209(3.8%) | 19(0.3%) | 81(1.5%) | 88(1.6%) |
| Manipur | 105 | 54 | 32(59%) | 80 (76%) | 13(12.4%) | 7(6.7%) | 0(0.0%) | 2(1.9%) | 2(1.9%) |
| Meghalaya | 127 | 53 | 29(55%) | 89(70%) | 20(15.7%) | 10 (7.9%) | 0(0.0%) | 10.80% | 3(2.4%) |
| Mizoram | 244 | 94 | 51 (54%) | 208(85%) | 12 (4.9%) | 3(1.2%) | 10.40% | 2(0.8%) | 12(4.9%) |
| Nagaland | 268 | 95 | 58(61%) | 173(65%) | 17(6.3%) | 3(1.1%) | 3(1.1%) | 3(1.1%) | 55 (20.5%) |
| Odisha | 573 | 304 | 156(51%) | 435(76%) | 89(15.5%) | 11(1.9%) | 0(0.0%) | 7(1.2%) | 10(1.7%) |
| Puducherry | 20 | 12 | 7(58%) | 13(65%) | 2(10.0%) | 1(5.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) |
| Punjab | 946 | 551 | 203(37%) | 619(65%) | 141(14.9%) | 52 (5.5%) | 11(1.2%) | 11(1.2%) | 54 (5.7%) |
| Rajasthan | 1233 | 647 | 288(45%) | 917(74%) | 123(10.0%) | 55(4.5%) | 9(0.7%) | 9(0.7%) | 28(2.3%) |
| Sikkim | 6 | 1 | 0(0%) | 3(50%) | 3(50.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) |
| Tamil Nadu | 2300 | 1388 | 653(47%) | 1592 (69%) | 392 (17.0%) | 61 (2.7%) | 9(0.4%) | 64 (2.8%) | 39(1.7%) |
| Telangana | 1831 | 1202 | 770(64%) | 1405(77%) | 193(10.5%) | 15(0.8%) | 8(0.4%) | 44 (2.4%) | 73(4.0%) |
| Tripura | 23 | 9 | 4(44%) | 15(65%) | 6(26.1%) | 1(4.3%) | 0(0.0%) | 1(4.3%) | 0(0.0%) |
| Uttar Pradesh | 2243 | 919 | 248(27%) | 1505(67%) | 261 (11.6%) | 107(4.8%) | 19(0.8%) | 26(1.2%) | 59(2.6%) |
| Uttarakhand | 216 | 76 | 30 (39%) | 160 (74%) | 29(13.4%) | 11 (5.1%) | 0(0.0%) | 3(1.4%) | 7(3.2%) |
| West Bengal | 746 | 476 | 183(38%) | 461(62%) | 117(15.7%) | 23(3.1%) | 5(0.7%) | 6(0.8%) | 54(7.2%) |
| INDIA | 32617 | 16038 | 7834(49%) | 23159 (71%) | 4525(13.9%) | 1217(3.7%) | 83(0.6%) | 477(1.5%) | 1136(3.5%) |

# Treatment outcome of TB - Paediatric patients

| State | TB patients Notified | Bacteriologically Confirmed | Cure Rate | Success Rate | Death Rate | % Lost to follow up | Treatment Failure Rate | % Regimen Change | % Not evaluated |
|---|---|---|---|---|---|---|---|---|---|
| Andaman & Nicobar Islands | 17 | 2 | 0(0%) | 17(100%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0 (0.0%) | 0(0.0%) |
| Andhra Pradesh | 2275 | 334 | 258 (77%) | 2148 (94%) | 34(1.5%) | 12(0.5%) | 3(0.1%) | 7(0.3%) | 27(12%) |
| Arunachal Pradesh | 276 | 87 | 49(56%) | 237 (86%) | 6(22%) | 10(3.6%) | 3(1.1%) | 7(25%) | 4(1.4%) |
| Assam | 1113 | 378 | 215(57%) | 942 (85%) | 27(2.4%) | 12(1.1%) | 4(0.4%) | 6 (OS%\| | 47(4.2%) |
| Bihar | 8694 | 1169 | 446(38%) | 6840(79%) | 160(1.8%) | 279(32%) | 30(0.3%) | 41 (05%) | 986(113%) |
| Chandigarh | 232 | 80 | 51 (64%) | 199(86%) | 7(3.0%) | 6(26%) | 0(00%) | 6 (26%) | 4(1.7%) |
| Chhattisgarh | 1303 | 193 | 169 (88%) | 1176(90%) | 22 (1.7%) | 23(1.8%) | 2(02%) | 1 (0.1%) | 63 (43%) |
| Dadra and Nagar Haveii and Daman and Diu | 49 | 14 | 11 (79%) | 48 (98%) | 0(0.0%) | 0 (0.0%) | 0(0.0%) | 0 (0.0%) | 0 (0.0%) |
| Delhi | 8412 | 2875 | 868(30%) | 6591 P8%) | 84(1.0%) | 216(26%) | 40(05%) | 144(1.7%) | 201 (24%) |
| Goa | 56 | 22 | 6(27%) | 51 (91%) | 3(5.4%) | 0 (0.0%) | 0 (0.0%) | 1 (1.8%) | 1 (1.8%) |
| Gujarat | 5904 | 727 | 482 (66%) | 5548 (94%) | 132(2.2%) | 60(15%) | 17(03%) | 28 (05%) | 38(05%) |
| Haryana | 3433 | 1128 | 602 (53%) | 2897 (84%) | 32 (0.9%) | 79(23%) | 9(03%) | 24 (0.7%) | 150(4.4%) |
| Himachal Pradesh | 535 | 220 | 131 (60%) | 477(89%) | 14 (2.6%) | 8(15%) | 0 (0.0%) | 4(0.7%) | 6(1.1%) |
| Jammu 8 Kashmir | 510 | 144 | 102 (71%) | 437(86%) | 12 (2.4%) | 2 (0.4%) | 1 (02%) | 0 (0.0%) | 31 (6.1%) |
| Jharkhand | 2265 | 398 | 187 (47%) | 1956 (86%) | 47(2.1%) | 133 (5.9%) | 7 (0.3%) | 9 (0.4%) | 49(22%) |
| Karnataka | 2990 | 555 | 341(61%) | 2714(91%) | 72 (2.4%) | 38(13%) | 2(0.1%) | 22 (0.7%) | 46(1.5%) |
| Kerala | 788 | 132 | 77(58%) | 719(91%) | 6(08%) | 13(15%) | 2(0.3%) | 4(0.5%) | 25(32%) |
| Ladakh | 5 | 0 | NA | 5(100%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0 (0.0%) | 0 (0.0%) |
| Lakshadweep | 0 | 0 | NA | NA | NA | NA | NA | NA | NA |
| Madhya Pradesh | 10360 | 1249 | 765 (61%) | 9077(88%) | 152(15%) | 416(4.0%) | 26 {0.3%) | 33(03%) | 429(4.1%) |
| Maharashtra | 9056 | 2575 | 853 (33%) | 7943 (88%) | 158(1.7%) | 112(12%) | 22(02%) | 193 (21%) | 57(0.6%) |
| Manipur | 73 | 16 | 11 (69%) | 56 (77%) | 1(1.4%) | 2(27%) | 0(0.0%) | 0 (0.0%) | 5 (6.8%) |
| Meghalaya | 256 | 94 | 49(52%) | 211 (82%) | 4(1.6%) | 10(3.9%) | 3(1.2%) | 4(1.6%) | 11 (43%) |
| Mizoram | 117 | 29 | 17(59%) | 105(90%) | 0(0.0%) | 2(1.7%) | 0(0.0%) | 3(26%) | 1 (0.9%) |
| Nagaland | 191 | 56 | 43(77%) | 152(80%) | 4(2.1%) | 7 (3.7%) | 1 (05%) | 2(1.0%) | 23(120%) |
| Odisha | 1762 | 476 | 392 (82%) | 1593 (90%) | 62 (3.5%) | 25(1.4%) | 7(0.4%) | 3(0.2%) | 23(1.3%) |
| Puducherry | 44 | 11 | 6(55%) | 42 (95%) | 1 (23%) | 0 (0.0%) | 0(00%) | 0(00%) | 0 (0.0%) |
| Punjab | 2852 | 1002 | 566(56%) | 2482 (87%) | 85 (3.0%) | 47(1.6%) | 13(0.5%) | 11 (0.4%) | 119(4.2%) |
| Rajasthan | 6912 | 1298 | 865 (67%) | 5888 (85%) | 101 (15%) | 300(43%) | 63(0.9%) | 43(0.6%) | 150(22%) |
| Sikkim | 56 | 21 | 13(62%) | 53 (95%) | 0(0.0%) | 1 (1.8%) | 0(0.0%) | 0 (0.0%) | 2 (3.6%) |
| Tamil Nadu | 2978 | 485 | 392 (81%) | 2776 (93%) | 24 (0.8%) | 43(1.4%) | 2 (0.1%) | 12(0.4%) | 51 (1.7%) |
| Telangana | 1932 | 585 | 509 (87%) | 1746 (90%) | 42 (2.2%) | 7(0.4%) | 6 (0.3%) | 21 (1.1%) | 50(25%) |
| Tripura | 44 | 22 | 12(55%) | 33 (75%) | 4(9.1%) | 0 (0.0%) | 0 (0.0%) | 3(63%) | 1 (23%) |
| Uttar Pradesh | 21323 | 3820 | 2196 (57%) | 18625(87%) | 457(2.1%) | 541 (25%) | 74 (03%) | 175 (0.8%) | 238(1.1%) |
| Uttarakhand | 947 | 200 | 89(45%) | 822 (87%) | 17(1.8%) | 21 (22%) | 5 (05%) | 14(15%) | 31 (33%) |
| West Bengal | 2472 | 773 | 469 (61%) | 2085 (84%) | 92 (3.7%) | 45(13%) | 12(05%) | 24(1.0%) | 71 (29%) |
| INDIA | 100232 | 21170 | 11242(53%) | 86691 (86%) | 1862(1.9%) | 2470 (25%) | 354 (0.4%) | 845(08%) | 2940 (29%) |

## 1st output

**Paired Samples Statistics**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | TB | 83.31 | 36 | 4.241 | .707 |
| | HIV | 67.64 | 36 | 14.602 | 2.434 |

**Paired Samples Test**

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference Lower | Upper | | | |
| Pair 1 | TB - HIV | 15.667 | 13.506 | 2.251 | 11.097 | 20.236 | 6.960 | 35 | .000 |

## 2nd output

**Paired Samples Statistics**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | TB | 4.5556 | 36 | 1.50265 | .25044 |
| | HIV_TB | 14.7528 | 36 | 8.63460 | 1.43910 |

**Paired Samples Test**

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference Lower | Upper | | | |
| Pair 1 | TB - HIV_TB | -1.019E1 | 8.46598 | 1.41100 | -13.06170 | -7.33275 | -7.227 | 35 | .000 |

# Conclusion

**TB Survival Analysis Table**

- The number of TB patients in India has been gradually decreasing over the years, from around 2,900,000 in 2013 to 1,750,000 in 2023.
- The number of deaths due to TB has also been decreasing, from around 515,000 in 2013 to 331,000 in 2023.
- The survival function s(t) has been increasing over time, indicating a higher probability of surviving beyond a given time.
- The death density function f(t) and cumulative hazard rate H(t) have been decreasing, reflecting a lower risk of dying from TB in more recent years.
- The hazard rate calculated using the actuarial method, H(t) actual, shows a similar decreasing trend as the other measures.

**India State-wise TB Patients Demographics Table**

- States with the highest number of TB patients include Uttar Pradesh, Maharashtra, Madhya Pradesh, Rajasthan, and Tamil Nadu.
- Among the listed states, Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, and Tamil Nadu have a relatively higher number of TB patients with known tobacco usage.
- States like Andhra Pradesh, Assam, Gujarat, Haryana, and Madhya Pradesh have a notable number of TB patients with known alcohol usage.
- The number of TB patients co-infected with COVID-19 is relatively lower across most states, with Uttar Pradesh, Maharashtra, and Rajasthan having slightly higher counts.
- The number of TB patients who are pregnant is generally low across all states, with Karnataka, Maharashtra, and Uttar Pradesh having somewhat higher counts.
- In conclusion, the table highlights the varying prevalence of TB and associated risk factors across different states in India. States with higher numbers of TB patients, particularly those with known tobacco or alcohol usage, may require targeted interventions and public health measures to address these comorbidities and improve TB management. Additionally, monitoring and supporting TB patients co-infected with COVID-19 or who are pregnant is crucial to ensure appropriate care and treatment outcomes.

**Treatment Outcome Tables**

The three tables provide data on treatment outcomes for different groups of tuberculosis (TB) patients in India in 2020 - TB-HIV co-infected patients, overall TB patients, and paediatric TB patients. By comparing these tables, we can gain insights into the challenges and variations in managing TB across different patient populations.

**Cure rates and success rates:**

- For TB-HIV co-infected patients, states like Andhra Pradesh, Gujarat, and Maharashtra had higher cure rates and success rates, while states like Bihar, Chhattisgarh, and Uttar Pradesh had lower rates.
- In the overall TB patient population, states like Arunachal Pradesh, Mizoram, and Nagaland showed higher cure rates and success rates, whereas Bihar, Jharkhand, and Uttar Pradesh had lower rates.
- For paediatric TB patients, states like Andhra Pradesh, Arunachal Pradesh, and Bihar had relatively higher cure rates and success rates, while Chhattisgarh, Delhi, and Uttar Pradesh had lower rates.

**Death rates:**

- TB-HIV co-infected patients generally had higher death rates compared to the overall TB patient population and paediatric TB patients.
- States like Chhattisgarh, Delhi, and Nagaland had higher death rates across all three populations, indicating challenges in managing TB in those regions.

**Treatment failure, regimen change, and lost to follow-up:**

- TB-HIV co-infected patients had higher percentages of treatment failure, regimen change, and lost to follow-up compared to the overall TB patient population and paediatric TB patients.
- States like Arunachal Pradesh, Meghalaya, and Nagaland showed higher rates of treatment failure, regimen change, and lost to follow-up for TB-HIV co-infected patients.
- Paediatric TB patients generally had lower rates of treatment failure, regimen change, and lost to follow-up compared to the other two populations

**Paired t-tests and the comparison of mean success rates and death rates**

**1. For Ho1 (Hypothesis related to success rates):**
The p-value of 0.000 indicates a statistically significant difference in success rates between patients with TB alone and those with both TB and HIV co-infection. The rejection of the null hypothesis leads to the conclusion that there is a substantial variance in treatment success rates between these two groups.

Further examination of the mean success rates reveals that patients with TB alone have a higher mean success rate of 83.31%, compared to a mean of 67.64% for patients with both TB and HIV. This stark contrast suggests that the presence of HIV co-infection has a detrimental impact on the successful treatment of TB.

The lower success rates for TB-HIV co-infected patients could be attributed to various factors, such as interactions between the two diseases, compromised immune systems, challenges in adhering to complex treatment regimens, and potentially higher rates of drug resistance or adverse effects. These findings highlight the need for specialized care and interventions to improve treatment outcomes for TB-HIV co-infected patients.

**2. For Ho2 (Hypothesis related to death rates):**
The p-value of 0.000 also indicates a statistically significant difference in death rates between patients with TB alone and those with TB and HIV co-infection, leading to the rejection of the null hypothesis.

The comparison of mean death rates shows that patients with TB alone have a lower mean death rate of 4.556%, while patients with both TB and HIV have a significantly higher mean death rate of 14.75%. This substantial difference suggests that the co-infection of TB and HIV leads to a higher mortality risk compared to TB alone.

The higher death rates among TB-HIV co-infected patients could be attributed to the compounding effects of the two diseases, weakened immune systems, increased susceptibility to opportunistic infections, and potentially greater complexity in managing and treating both conditions simultaneously. These findings underscore the importance of early detection, prompt treatment, and comprehensive care for TB-HIV co-infected patients to improve survival rates.

# References


- https://tbcindia.gov.in/
- www.ncbi.nlm.nih.gov
- https://indianexpress.com/article/explained/explained-health/indias-tb-mortality-report-2023-explained-9023266/
- www.deccanherald.com
- https://thewire.in/health/india-tuberculosis-who-report/
- https://bmcpulmmed.biomedcentral.com/articles/10.1186/s12890-021-01740-y