HMS_520_TB_Final

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Final Project - Global Mortality and Risk Factor Contributions for Tuberculosis Estimates from 2015 and 2020

Abstract

The World Health Organization (WHO) End TB Strategy set ambitious targets to reduce tuberculosis (TB) mortality by 35% and incidence by 20% between 2015 and 2020. While global progress has been reported, age-specific and regional analyses remain limited. This study utilizes the Global Burden of Disease 2021 (GBD 2021) Tuberculosis Estimates to assess trends in TB mortality and the contributions of smoking, alcohol use, and diabetes as risk factors.

Our analysis examines TB mortality trends from 2015 to 2020 across age groups, regions, and risk factors using mortality counts from the GBD data set.

Introduction

Tuberculosis (TB) continues to be one of the leading causes of infectious disease mortality globally, posing significant challenges to public health systems. In response, the World Health Organization (WHO) launched the End TB Strategy, aiming to reduce TB mortality by 35% and TB incidence by 20% between 2015 and 2020. While global progress has been documented, there is a limited understanding of how these trends vary by age and region, as well as the role of modifiable risk factors such as smoking, alcohol use, and diabetes. Age-specific evaluations are critical to inform tailored interventions and ensure equitable progress across populations.

In this study, we leverage the Global Burden of Disease 2021 (GBD 2021) Tuberculosis Estimates to examine TB mortality trends from 2015 to 2020 across different age groups and regions. The data set includes mortality counts stratified by location, year, and age, as well as estimates of deaths attributable to smoking, alcohol use, and diabetes.

Our primary research questions include:

1. How have mortality rates changed from 2015 to 2020 across different age groups and regions?
2. What is the relative contribution of different risk factors (e.g., smoking, alcohol use, and diabetes) to TB mortality in 2015 and 2020?
3. Do regions or age groups with higher reductions in TB mortality also show lower contributions of risk factors?

By addressing these questions, this project seeks to fill critical gaps in understanding TB mortality trends and their driving factors. Our findings will provide evidence to guide targeted interventions and strengthen global efforts toward achieving the WHO End TB Strategy goals.

Data Description

For this project we are using the data set from IHME titled: Global Burden of Disease 2021 [GBD 2021] Tuberculosis Estimates 1990-2021

This data set includes estimates of burden associated with all-form tuberculosis for GBD countries between 1990 and 2021. Tuberculosis mortality was informed by vital registration, verbal autopsy, sample-based vital registration and mortality surveillance data. TB morbidity data includes annual case notifications, data from prevalence surveys, and estimated cause specific mortality [CSMR] of TB among HIV-positive and HIV-negative individuals (IHME GBD 2021).

For our project we are utilizing the `IHME_GBD_2021_TB_MORTALITY_RISK_Y2024M03D19.XLSX` which contains risk deleted deaths due to all-form tuberculosis for alcohol use, smoking, and diabetes and all three risk factors combined by adult age groups by country for 2015, 2020 and 2021.

Methods

The variables of interest in our project were the mortality counts, risk factors and geographic and age group stratification. We pre-processed the data by:

1. Importing data set and filtering relevant columns
2. Checking and address missing data
3. Creating calculated variables

- Percent change in mortality between 2015 and 2020
- Proportional contribution of each risk factor to attributable TB deaths

We also conducted the following analyses

1. Trend Analysis

- Calculate percent change in mortality by region and age group from 2015 - 2020
- Visualize the trend using bar plot and line plot to highlight the change in mortality

2. Attributable Risk Factor Analysis

- Summarize the contribution of smoking, alcohol use and diabetes to TB mortality across age groups and regions
- Use grouped bar plots to visualize attributable mortality by risk factor

3. Association Between Mortality Reduction and Risk Factor Contribution

- Assess relationship between reduction in mortality rate and average risk factor contribution using linear regression model
- Visualize the association with scatter plot and regression line

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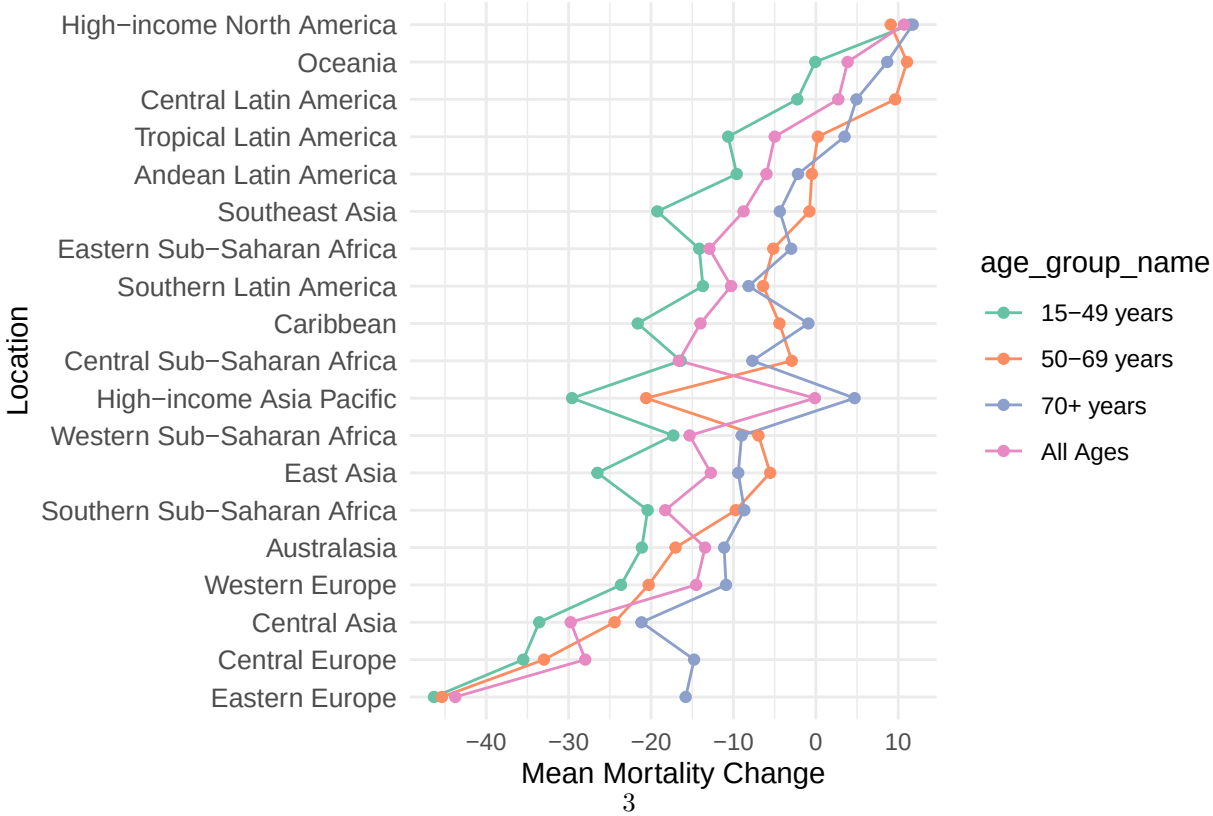
Question 1. How have mortality rates changed from 2015 to 2020 across different age groups and regions?

Fig 1. Mean Mortality Change from 2015 − 2020 (All Age

Fig 2. Trends in Mean Mortality Change by Location



Question 2. What is the relative contribution of different risk factors [ex - smoking, alcohol, and diabetes] to mortality?

Fig 3. Attributable Mortality by Age Group

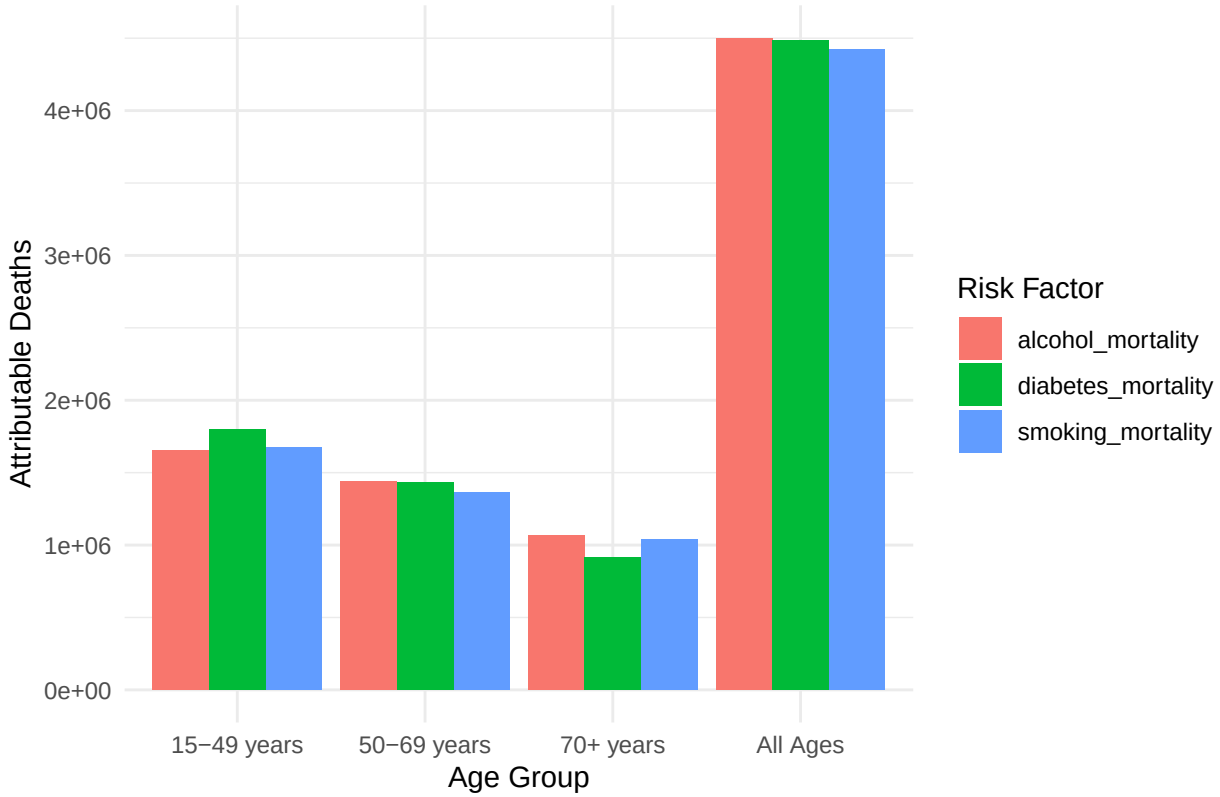
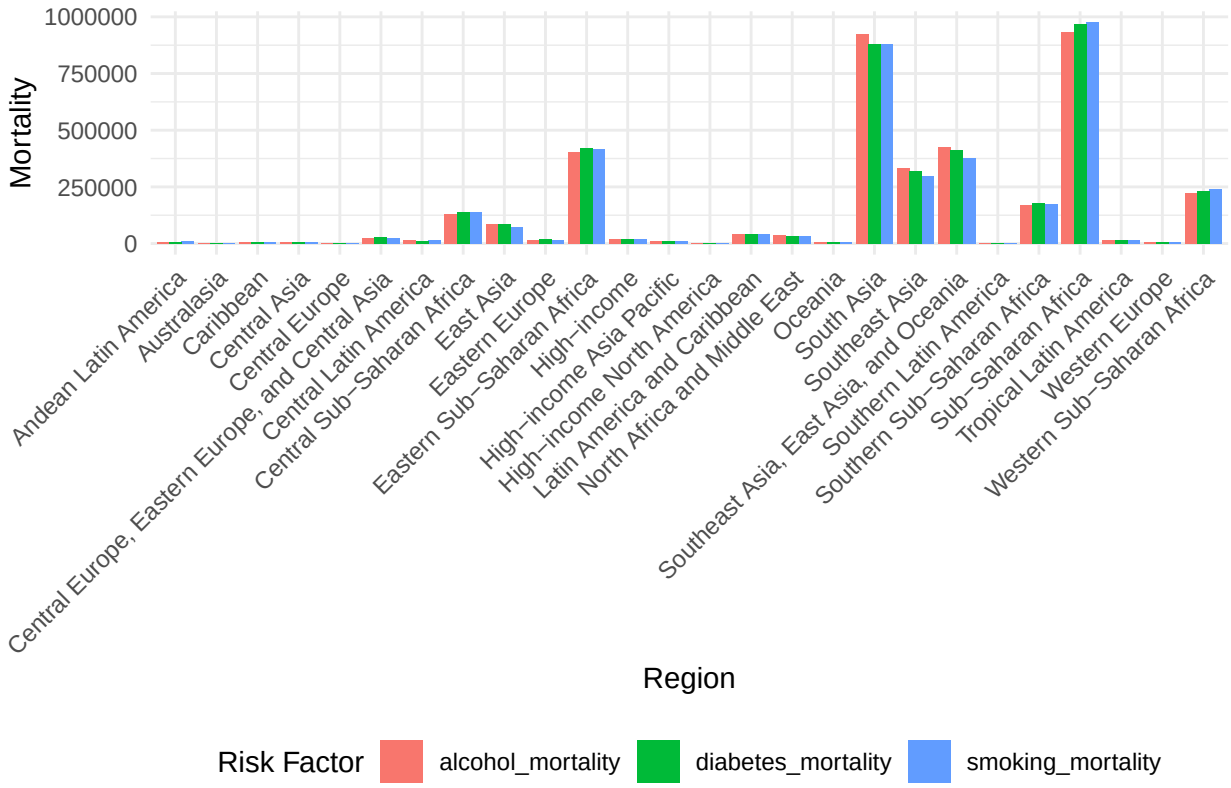


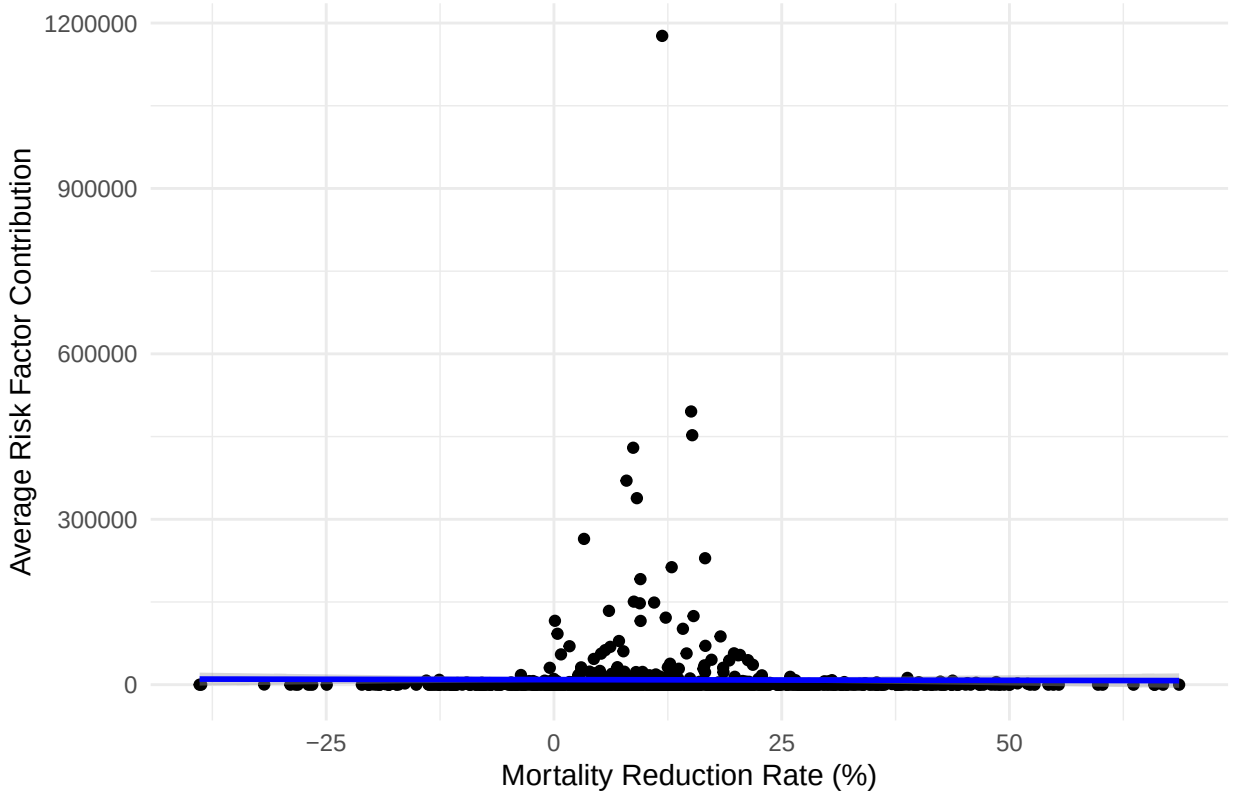
Fig 4. Attributable Mortality by Region



Question 3. Do regions or age groups with higher mortality reductions also show lower risk factor contributions?

```
##
## Call:
## lm(formula = avg_risk_factor_contribution ~ reduction_rate, data = mortality_data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
##  -10146   -8875   -8431   -7202 1167839
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     9150.16    2199.25   4.161 3.47e-05 ***
## reduction_rate   -25.88     113.62  -0.228     0.82
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 53630 on 922 degrees of freedom
## Multiple R-squared:  5.629e-05,  Adjusted R-squared:  -0.001028
## F-statistic: 0.0519 on 1 and 922 DF,  p-value: 0.8198
```

Fig 5. Linear Regression: Mortality Reduction vs. Risk Factor Contributi



Results

- Ye & Sophie