CONTRIBUTION OF DEATHS FROM PRECIPITATION-SENSITIVE DISEASES FOR THE CHANGE IN THE BRAZILIAN LIFE EXPECTANCY FROM 2000 TO 2009

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Abstract:

This study examines the relationship between extreme weather events and public health, focusing on variations in mortality due to precipitation-sensitive diseases across different homoclimatic zones in Brazil from 2000 to 2019. Characterized by its climatic diversity and regional inequalities, Brazil faces significant challenges related to the impacts of climate change on public health. Based on zone with similar climatic conditions, the study employs the K-Nearest Neighbors (KNN) to define control groups for each homoclimatic zone. Then, life tables are estimated for each selected causes of death and then differences in life expectancies from 2000 to 2019 are decomposed for the zones and their control groups based on the Horiuchi, Wilmoth, and Pletcher decomposition. Results indicate fluctuations in life expectancy at birth among the studied zones and their respective control groups, with notable differences between genders and over time. The decomposition reveals the specific contributions of different age groups and genders to the variations in life expectancy, for instance, women in the Central-South Excess Precipitation Zone show larger positive contributions from younger age groups, with the highest single age group contribution at approximately 0.568, indicating substantial improvements in conditions affecting early life stages. Conversely, men's contributions, though positive, were generally lower, with a maximum contribution of 0.408. The study highlights the complexity of the interactions between climatic conditions and health, underlining the need for public policies and adaptation strategies that consider the specificities of each homoclimatic zone to enhance the resilience of populations to climatic extremes.

I. Introduction

Extreme weather events have been widely recognized as outcomes of global climate transformations, triggering most natural disasters, and intensifying anthropogenic events (De Medeiros et al., 2014). Annually, numerous countries face adverse meteorological conditions representing deviations from historical patterns of rainfall, cold waves, heatwaves, as well as increased occurrences of droughts and floods (UNDP, 2009). The impact of these events[1] (Kirch *et al.,* 2005), are broadly felt in various regions around the world. The projected increase in global temperatures and sea levels, as indicated by the Intergovernmental Panel on Climate Change (IPCC, 2022), intensifies these concerns.

Marked by vast regional inequalities, Brazil has undergone significant demographic and epidemiological changes over the past decades. Different

[1] Events, such as heatwaves, droughts, floods, and torrential rains (Kirch *et al.,* 2005)

regions of the country display distinct patterns, reflecting socioeconomic and health diversities (Da Silva *et al.,* 2023; Souza *et al.,* 2023). These nuances are key for understanding the impact of climate change and extreme weather events on the health of the Brazilian population.

In light of Brazil's climate variability, this study aims to analyze the association between mortality caused by precipitation-sensitive diseases and climate conditions across different homoclimatic zones from 2000 to 2019. The use of homoclimatic zones to study the mortality effects associated with precipitation offers a new perspective to measure the impacts of these events. The findings, when considered in the context of climatic zoning, can guide public policies tailored to the specific characteristics of these zones, taking into account their sociodemographic and climate risk profiles.

II. Methods

This study uses homoclimatic zones based on precipitation data, defined with the methodology described in Andrade et al. (2021), and mortality trend analyses from 2000 to 2019. The K-Nearest Neighbors (KNN) algorithm was used to define comparable control groups with similar socioeconomic characteristics and distinct precipitation features. The analysis includes the comparison of mortality patterns and both statistical and demographic models to decompose variations in life expectancy, considering key demographic contributors, such as age and gender.

In order to examine temporal trends, the Mann-Kendall Test and Sen’s Slope Estimator were used. The decomposition of the change in life expectancy from 2000 to 2019 by age and sex for each homoclimatic zone (and its control group) is based on the method proposed by Horiuchi, Wilmoth, and Pletcher (2008). This method allows the estimation of contribution of different variables for life expectancy variation. The combination of the above approaches help to better understand how precipitation extremes can impact public health and longevity.

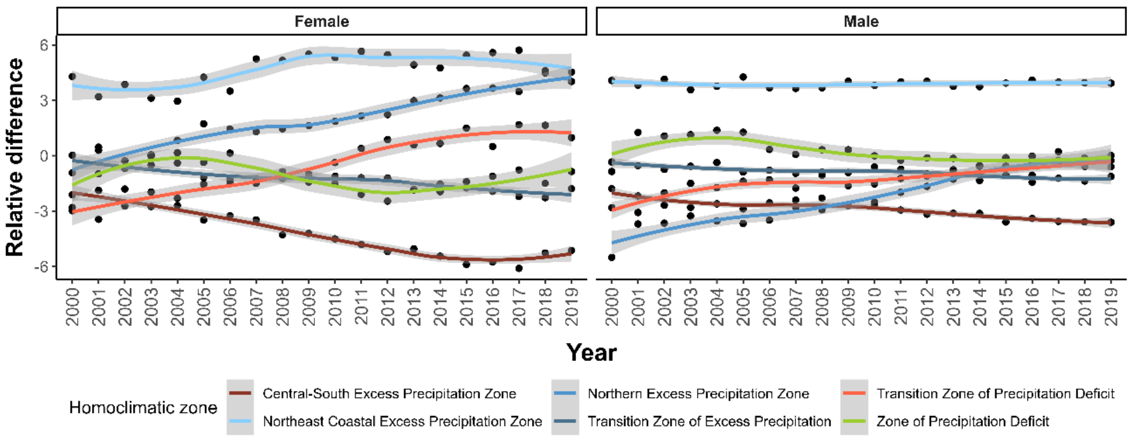
III. Results

Figure 1 illustrates the relative differences in life expectancy at birth between the population in each homoclimatic zone and its control group from 2000 to 2019, stratified by gender. Results show that the differences in life expectancy at birth fluctuate over time across all zones and control groups. For example, in the female group, the line for the Central-South Excess Precipitation Zone shows an increasing trend in relative difference, suggesting that women in the control group of a specific zone are living longer, on average, than women from the homoclimatic zone itself, indicating that the zone climate in question may have a detrimental impact on the life expectancy of women compared to those in the control.

However, for the male group the trends appear more stable over time. An increase in the relative difference may indicate that the climatic conditions of a particular zone are improving, or that the population is adapting to these conditions. The Central-South Excess Precipitation Zone and the Excess Precipitation Transition Zone show a trend of decreasing relative differences, meaning that the life expectancy at birth for both genders in these zones overlaps that of the control group. The opposite occurs for the other zones, with the exception of the Northeast Coastal Zone for males, with no statistically significant change over time.

A decline in life expectancy at birth has significant implications for the demographics of a population, affecting not only the age structure but also socioeconomic and public health aspects. If life expectancy at birth decreases, this can alter the population age balance, resulting in an older population.

Figure 1: Relative difference between life expectancy at birth between zones and control groups by gender and year, Brazil, 2000-2019.

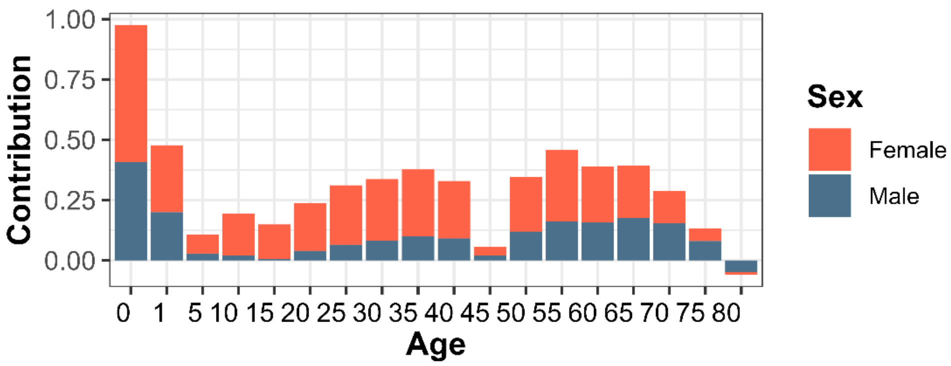


Source: All-cause deaths between 2000 and 2019 were from SIM (Sistema de Informação de Mortalidade)

The analysis of Figure 1 highlights the complex interrelationship between climatic conditions and life expectancy at birth, revealing that, from 2000 to 2019, climate characteristics may have affected the populations of the homoclimatic zones in Brazil differently. This result emphasizes the importance of public health actions and environmental adaptation policies that prioritize the resilience of populations against climate extremes to preserve and improve longevity and quality of life.

Although some relative differences are observed, the impact of rainfall-sensitive disease mortality on life expectancy is low as number of deaths from these causes are still small in magnitude. However, if variation in life expectancy is decomposed by age and stratified by sex at birth, interesting patterns emerge. Figure 2 provides an example of these decompositions for a specific homoclimatic zone. The figure describes the contribution of each age for the change in life expectancy from 2000 to 2019, where positive values means that the age group is contributing to an increase in life expectancy, while a negative value indicates a contribution to a decrease.

Figure 2: Decomposition of variation in life expectancy from 2000 to 2019 by sex and age group for the Central-South Excess Precipitation Homoclimatic Zone, Brazil.



Source: All-cause deaths between 2000 and 2019 were from SIM (Sistema de Informação de Mortalidade)

Overall, especially in the early years of life, significant positive contributions were observed. Improvements in infant mortality and health conditions for young children generally result in substantial increases in average life expectancy. For women there are larger positive contributions compared to men in several age groups, indicating that changes in mortality caused by weather-sensitive diseases in these groups have had a greater impact on women's life expectancy increase in the last 19 years.

The average contribution for women is approximately 0.202, with a maximum contribution of about 0.568 and a minimum of -0.010, while for men the average contribution is approximately 0.103, with a maximum contribution of 0.408 and a minimum of -0.049. Negative or very low contributions at advanced ages may indicate areas where public health may need greater attention. To fully describe the likely impact of rainfall extreme events on life expectancy gains, these figures must be compared to those observed in the control group for each homoclimatic zone. These results will be included in the full version of this manuscript.

IV. Final Remarks

The incidence of some diseases can contribute directly to deaths. For example, some research indicates similar rates between both sexes (THAUNG *et al.,* 1975), while others find higher rates for women (ROSA *et al.*, 2000, KAPLAN *et al.,* 1983) r higher rates for men (ANKER e ARIMA, 2011, RODRIGUES *et al.,* 2021, GÜNTHER *et al.,* 2009). Such disparities are often attributed to different exposures to the virus, as demonstrated by Kaplan *et al.* (1983) in a study in Mexican cities. An analysis in Brazil, based on data from the Information System on Diseases of Notification (SINAN) from 2007 to 2012, highlighted a subtle difference in the concentration of cases between men (55.1%) and women (44.8%), with a significant prevalence in the productive age group of 20 to 59 years (MARTINS e SPINK, 2020).

Diarrhea is associated with children, with a particularly significant prevalence in the Northeast region of Brazil. Sastry e Burgard (2005) observed trends in the incidence and treatment of diarrhea in Brazil between 1986 and 1996, indicating a sharp reduction in the prevalence of diarrheal diseases during this period, especially in the Northeast. The implementation of public policies has contributed significantly to this reduction. An example is the conditional cash transfer program, which, according to Rasella *et al.* (2013), had a positive effect on infant mortality, demonstrating the direct impact of public policies on children's health. Despite the decrease in diarrhea mortality rates, the high morbidity still poses a significant risk of adverse nutritional and developmental effects on a large number of children.

The mortality related to schistosomiasis, as analyzed by Martins-Melo *et al.* (2014), presents distinct sociodemographic characteristics. Higher mortality in males (54.4%) and elevated rates in advanced age groups, especially from the age of 50, highlight the chronic nature of the disease and its progression to severe clinical forms. Other studies, such as Simões *et al.* (2020), corroborate this pattern, identifying a higher risk of mortality in men between 25 and 54 years, while women face a higher risk after the age of 70.

The analysis of vector-borne diseases in Brazil highlights the complex relationship between climatic conditions and the incidence of these diseases, emphasizing significant nuances. Understanding these complex interactions is crucial for the development of more effective and adaptable control strategies.

Understanding the intricate relationship between climate, natural disasters, and health is fundamental for the development of effective public health policies and climate change adaptation strategies. Investing in robust surveillance systems, early warning, resilient infrastructure, and prevention strategies adapted to each region is crucial.

In the final work, the decomposition analysis will be extended to each specific disease. This approach will allow for a detailed examination of the contribution of different diseases to changes in life expectancy across the homoclimatic zones.

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