The Impact of Air Pollution on Global Mortality Rates

Ganjiyev, Javid*

Abstract

The paper aims to scrutinize whether air pollution impacts all regions of the world indiscriminately or whether it is contingent on the development rate of the countries and regions. Initially, scouring Google Scholar reveals that air pollution is among the primary culprits that impair human health and lead to fatalities. While it may not directly cause human deaths, it is often one of the foremost factors. The data set employed for this research is from OECD, and after performing some alterations on the raw data to render it more case-specific and readable, 54 observations of Sweden and China and 6 variables were used in the analysis. Sweden represents developed countries, whereas China represents developing ones. Summary tables were created for two data sets extracted from the primary data set. Separate figures illustrate the change in population death rates over the years. To unravel the research question, visual representations and Ansari-Bradley tests were used to check the variances. After verifying that a standard two-sample t-test was appropriate, a hypothesis test, specifically a two-sample t-test, was performed. The results indicated that the p-value = 1.025e-15 is less than 0.05, signifying that the averages of the samples are significantly different, thereby leading to the conclusion that the pollution and death rates are dependent on the level of development of the countries and regions. Graphical representation was implemented to comprehend the differences more lucidly and easily and to better interpret the results of the entire analysis. In the future, if the data on air quality and level of development is available, this work could be improved.

1 Introduction

How does air pollution impact human health? Numerous researchers have sought to address this inquiry, with varying degrees of success. The progressive escalation of air pollution has been linked to a growing number of human fatalities over time. This paper aims to elucidate the effects of air quality on human well-being.

Air pollution continues to pose one of the most significant global threats, constituting a major risk to global health and resulting in substantial excess mortality. As environmental degradation intensifies due to human activities, this study draws upon academic research

*20080146, Github Repo

available on Google Scholar to highlight the regions and countries most severely affected by air pollution, the diseases associated with such pollution, and the projected state of the world in the near future.

However, it remains unclear whether the prevalence and severity of air pollution are consistent across different regions and countries, contingent upon their level of development. Therefore, the primary objective of this paper is to conduct an analysis to ascertain whether such disparities exist.

1.1 Literature Review

Acids, metals, organic compounds, and soil or dust particles constitute particulate matter (PM), a complex mixture of minute particles and liquid droplets. Numerous studies have established a correlation between PM exposure and increased morbidity and mortality. Although the individual risks associated with daily PM exposure may seem negligible, when extrapolated to populations, the global healthcare burden becomes staggering. The World Health Organization reports that PM2.5 alone causes nearly 800,000 premature deaths annually, ranking it as the 13th leading cause of death worldwide (Anderson et al., 2012,).

Although one might assume that air pollution stems solely from human activity, it's crucial to note that natural sources like volcanoes, fires, dust storms, and aerosolized sea salt also contribute. In certain circumstances, future ozone concentrations relative to the year 2000 could lead to excessive global premature mortality, particularly in RCP8.5 in 2100, which is likely driven by a significant surge in methane emissions and the net effect of projected climate change (Silva et al., 2016,). The movement and dispersion of air pollutants in the atmosphere are impacted by winds, vertical mixing, and precipitation, and all of these factors are anticipated to shift as the climate changes. Recent research suggests that if anthropogenic air pollution emissions remain constant, ozone levels in inhabited areas will tend to rise in future climatic scenarios (Kinney, 2018,).

As highlighted in the study by (Lelieveld et al., 2020,), major health risk factors include tobacco use, unhealthy diets, overweight conditions, hypertension, diabetes, high cholesterol, and air pollution. Air pollution manifests through various adverse effects on the respiratory system, immune system, cancer development, reproduction, skin, mucous membranes, sensory functions, cardiovascular system, and systemic functions of the liver, kidney, and gastrointestinal system (Berglund et al., 1992,). The regions with the highest rates of air pollution-related mortality are East Asia (35 percent) and South Asia (32 percent), followed by Africa (11 percent) and Europe (9 percent). While excess deaths generally increase with age, child mortality under the age of 5 can be significant in low-income countries, particularly in Africa and South Asia, often associated with lower respiratory infections (LRI). Although air pollution may not always be the direct cause of death, it frequently serves as a leading risk factor.

The combustion of fossil fuels, encompassing emissions from power generation, industrial processes, transportation, and residential energy use, stands as the primary source of air pollution.The consequences of air pollution spikes, such as those witnessed in Donora, Pennsylvania, in 1948 and London, England, in 1952, are multifarious and extend beyond mere discomfort to include disease and even death. The relationship between air pollution and health is evident in the immediate reaction of the body to high levels of such pollutants. Moreover, benzopyrene's carcinogenic properties have been demonstrated in laboratory animals, while other studies have suggested that acute irritation can exacerbate the symptoms of respiratory conditions, potentially leading to their deterioration (Lave & Seskin, 2013,).

Undoubtedly, air pollution poses a significant threat to humanity, although it may not directly lead to the extinction of all individuals but renders the environment increasingly inhospitable. The studies mentioned above substantiate a direct correlation between air pollution and human life expectancy, highlighting an inescapable and inevitable reality. Although no single entity possesses the power to halt this process entirely, collective efforts can be made to mitigate its progression and secure a better world for future generations.

2 Data

The source of the used data set is the website OECD. This data set has 6468 observations and 7 variables. The type of the data is quantitative. Used variables from the data set are; Entity, Year, Air Pollution, Household Air Pollution, Ambient Ozone Pollution, Ambient Particulate Matter. A total of 54 observations were utilized in this study, spanning multiple years in Sweden and China. The observations were categorized into distinct groups and analyzed accordingly. Variable names were modified to facilitate calculations and enhance the overall analysis. To gain further insights, summarized tables for Sweden(Table 1) and China(Table 2) are presented. Moreover, graphical representations of death rates through years for Sweden(Figure 1) and China(Figure 2) depict a consistent downward trend, attributed to advancements in technology and medical practices.

Table 1: Summary Statistics - Sweden

	Mean	Std.Dev	Min	Median	Max
air_pol	15.73	3.97	9.28	15.64	22.54
ambient_op	1.18	0.14	0.87	1.25	1.29
ambient_pm	14.06	3.73	7.91	13.98	20.33
hh_air_pol	0.62	0.38	0.18	0.53	1.44

Table 2: Summary Statistics - China

	Mean	Std.Dev	Min	Median	Max
air_pol	121.99	36.09	72.68	120.16	184.41
ambient_op	21.64	8.50	11.12	20.93	35.27
ambient_pm	57.23	3.07	49.37	58.58	60.55
hh_air_pol	51.52	29.64	15.80	46.67	107.97

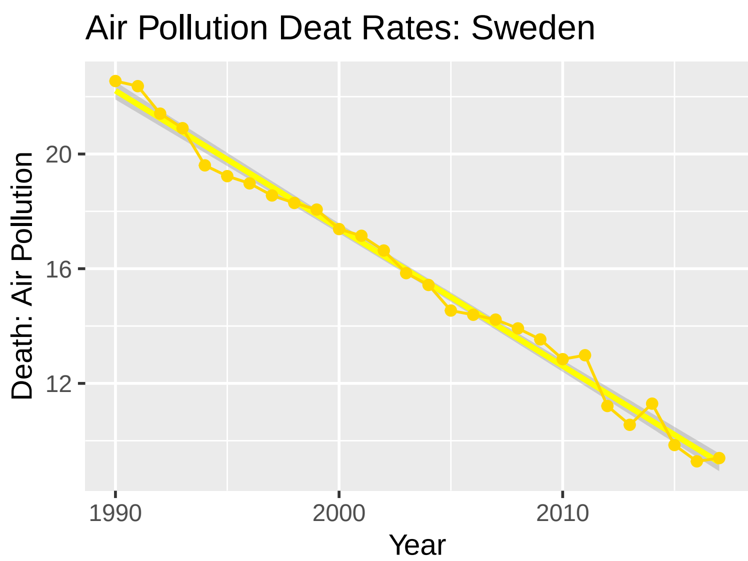

Figure 1: Air Pollution Change Through Years in Sweden

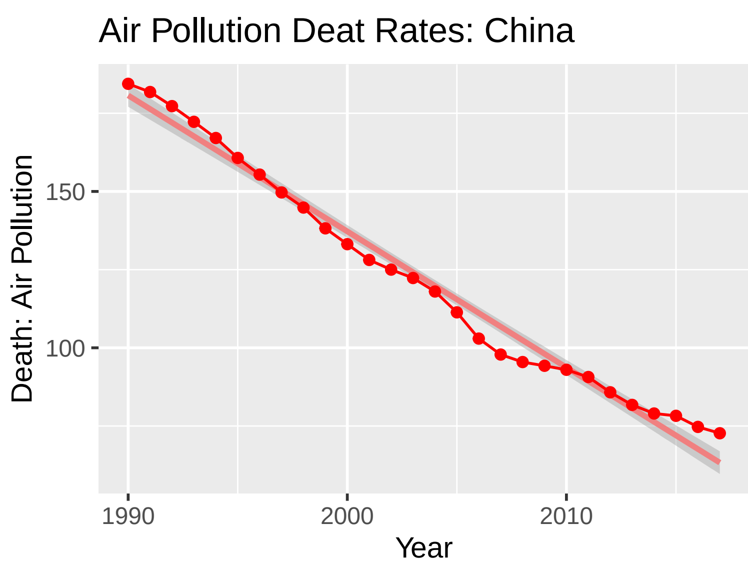

Figure 2: Air Pollution Change Through Years in China

3 Methods and Data Analysis

Based on visual inspection of the data (Figure 3)it is evident that the data does not adhere to a normal distribution. In order to analyze the data, we employed the nonparametric Ansari-Bradley test, yielding a p-value of 1. Consequently, we accept the null hypothesis, indicating equality of variances. As a consequence of the results obtained from the Ansari-Bradley test, it is reasonable to proceed with a two-sample t-test. The outcomes of the two-sample t-test were statistically significant, providing evidence to reject the notion of equal air pollution death rates between Sweden and China. The t-test is utilized to assess the disparity between the means of the populations, represented by Sweden and China in this case. The provided samples meet the necessary assumptions for conducting the t-test. With a p=1.0426e-22, we deduce that the null hypothesis should be rejected, and the means of the respective populations are significantly distinct. These findings are visually depicted through the boxplots (Figure 4), which effectively illustrate the median, 25th and 75th percentiles, as well as the maximum and minimum data points. Notably, there is a discernible disparity among the values observed across the different samples.

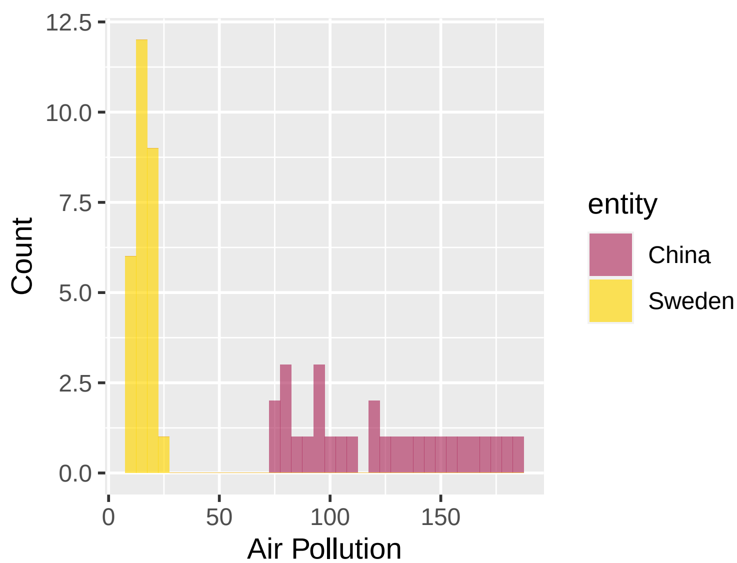

Figure 3: Count of Air Pollution Deaths in Sweden and China

4 Conclusion

In conclusion, employing the two-sample t-test method yielded statistically significant results, indicating notable disparities in pollution levels between Sweden and China. Given the divergent geographical locations and varying levels of development in these two countries, it is evident that the impact of air pollution on human health differs across different regions and nations, contingent upon their respective developmental stages. Consequently, it is observed that air pollution predominantly manifests in developing and underdeveloped

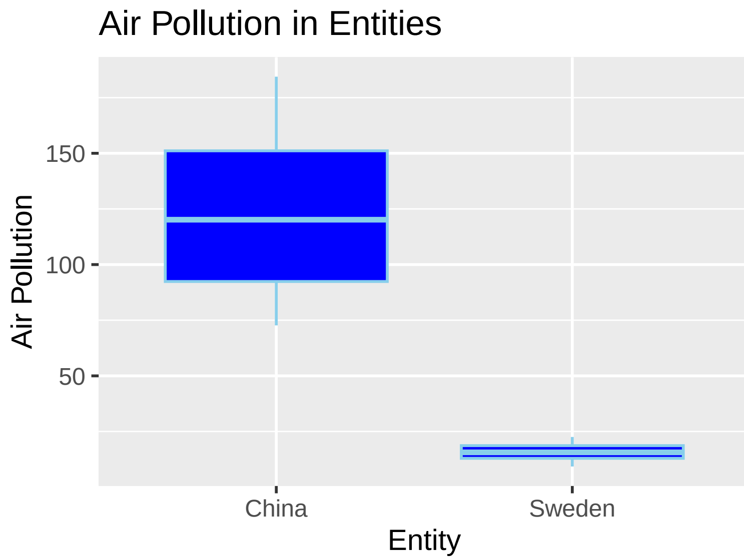

Figure 4: Sweden and China: Air Pollution

countries, as well as in global industrial hubs. Hence, our research question has been adequately addressed. Future endeavors could enhance this study by conducting comparisons on a continental scale or among distinct groups of developed, developing, and underdeveloped countries. Additionally, incorporating data on air quality and the level of development of countries and regions would contribute to the refinement of this research.

5 References

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