Title

Climate Change & Fetal, Infant, Child, and Youth Mortality

Authors

Subijanto, Caitlin
Kelley, Hannah
Cho, Jamie
et al.

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Undergraduate Student Mentees: Hannah Kelley, Jamie Cho, and Anusha Sainarayanan

Undergraduate Student Mentor: Caitlin Subijanto

Public Health and Health Sciences

Undergraduate Laboratory at Berkeley

University of California, Berkeley

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Abstract

Climate change poses a significant challenge to global human health, particularly impacting vulnerable populations such as infants, children, and youths. Despite growing awareness of its environmental effects, the relationship between climate change and human health remains underexplored. This study aims to address this gap by conducting an observational analysis of the association between climate change, characterized by the total greenhouse gas emissions from the Worldbank database, and stillbirths, neonatal, under-5 and child and youth (ages 5 – 24) mortality rates from the UNICEF database. By stratifying the analysis based on UNICEF regions, this study seeks to explore the spatial and temporal patterns to provide insights for policymakers, non-governmental organization, and the public to target interventions effectively. The results reveal complex relationships with varying mortality rates across UNICEF regions despite the differing levels of greenhouse gas emissions. Across the four UNICEF mortality measures, East Asia and Pacific was found to have the highest total greenhouse emissions and West and Central Africa was found to have the highest fetal, infant, child and youth mortality rates. Despite limitations inherent in this observational study design, this study underscores the urgent need for proactive measures to combat climate change and to mitigate its health effects on vulnerable populations such as infants, children, and youths.

Introduction

Climate change is a growing and pressing issue of our time with far-reaching impacts on our natural and social environment. Among its numerous well-documented environmental consequences, the effect of climate change on human health is a field that is not comprehensively explored. The complex and intricate relationship between climate change and health underscores the urgent need for concerted research and actions to mitigate the adverse effects of climate change on human health. This is especially important for vulnerable populations, particularly infants, children, and youths.

This research paper aims to contribute to this field by putting forward an observational study on the relationship between climate change characterized by greenhouse gas emissions from the WorldBank database and infant, child, and youth mortality characterized by stillbirths, neonatal, under-5, and child and youth mortality from the UNICEF database. This paper aims to explore the relationship's spatial and temporal dynamics at a global scale stratified by UNICEF regions. With the stratification of UNICEF Regions, it is hoped that it will help policymakers, nongovernmental organizations, and the public to understand which UNICEF regions should be targeted for further interventions.

Hence the research question being addressed in this paper is “How does climate change (total greenhouse emissions in kt of C02 Equivalent from Worldbank) affect fetal, infant, child, and youth mortality (stillbirths, neonatal, under-5 and child and youth mortality (ages 5 - 24) mortality rates from UNICEF)?”.

Literature Review

The Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (AR6) serves as a comprehensive testament to the increasing concern surrounding climate change and its impacts (World Health Organization, 2023). This report highlights that climate change is a rising concern for human health as there continues to be increased frequency and intensity of extreme weather events, changes in disease transmissions, and more (World Health Organization, 2023). Climate change has become a threat multiplier as it impacts health in a myriad of ways. Vulnerable populations such as infants, children, and youth are especially affected by the health impacts of climate change because of their developing physiology and limited adaptive capacities (McMichael et al., 2008).

The relationship between climate change and the heightened risk of infant and child mortality rates has brought attention to the scientific community. Climate change has been linked to the increased risk of infant and child mortality rates (Rylander et al., 2013). It is estimated that as many as 7 million premature deaths globally are due to air pollution annually (Orru et al., 2017). Regions supported by the United Nations Children's Fund (UNICEF) require the development and implementation of interventions to face socioeconomic disparities and limited access to essential resources. Hence, understanding this specific relationship in this population is crucial for developing targeted interventions for UNICEF regions to protect the health and well-being of future generations.

Furthermore, according to the National Bureau of Economic Research, "rich countries could significantly understate the mortality vulnerability of poor populations" (National Bureau of Economic Research, 2018). This study sheds light on how weather impacts health in developing countries by utilizing birth history surveys from 53 nations. It reveals significant effects of heat

and humidity on infant mortality, emphasizing the need for further research. The study suggests exploring humidity-indexing and refining the understanding of heat-humidity interactions. Moreover, it highlights the potential underestimation of mortality vulnerability in poor populations based on findings from wealthier nations. The lack of data from these populations poses a challenge. It also advocates for investigating other health and human capital outcomes in developing countries where data can be gathered. Additionally, it calls for considering the social costs of climate change, including the high value of early-life deaths, and understanding the geographical distribution of damage across hot and humid regions.

Methods

Our independent variable is the total greenhouse emissions (kt of C02 Equivalent) from the World Bank database that was last updated on January 10, 2023. The World Bank defines the total greenhouse gas emissions to include "CO2 totals excluding biomass burning (such as agricultural waste burning and savanna burning) but including another biomass burning (such as forest fires, post-burn decay, peat fires and decay of drained peatlands), all anthropogenic CH4 sources, N2O sources and F-gasses (HFCs, PFCs, and SF6)" (World Bank, 2024).

Our dependent variable is the stillbirths, neonatal mortality, under-5 mortality, and child and youth mortality (ages 5 - 24) from the UNICEF database that was last updated on January 10, 2023. According to the UNICEF database, the following mortality measures are defined (UNICEF, 2023): stillbirths refer to "babies born with no sign of life at 28 weeks of pregnancy or later", neonatal refers "death of an infant within the first 28 days of life", under-5 mortality refers to "probability a newborn would die before reaching exactly 5 years of age, expressed per 1,000 live births", and child and youth mortality (Ages 5 - 24) refers to "death among children and youth aged 5–24 years."

To stratify the countries into UNICEF regions, we also created a database of all country names and ISO codes with the associated UNICEF regions. With R, we matched the Worldbank and UNICEF databases by years 2013 – 2020 and by country and ISO code. Afterwards, we stratified that combined database into UNICEF regions. From this, we were able to get a dataset with the UNICEF regions the sum of the total greenhouse emissions, and the sum of the stillbirth mortality rate. Then, we were able to graph the total greenhouse gas emissions as our x-axis and total stillbirth mortality rate as our y-axis. Each trendline represents a UNICEF region and each

data point represents a year from 2013 - 2020. These steps were repeated for the neonatal, under - 5, and child and youth mortality rates.

Results

The following graphs show the spatial and temporal distribution of the relationship between total greenhouse gas emissions and the fetal, infant, child, and youth mortality rates.

Stillbirth Mortality Rates

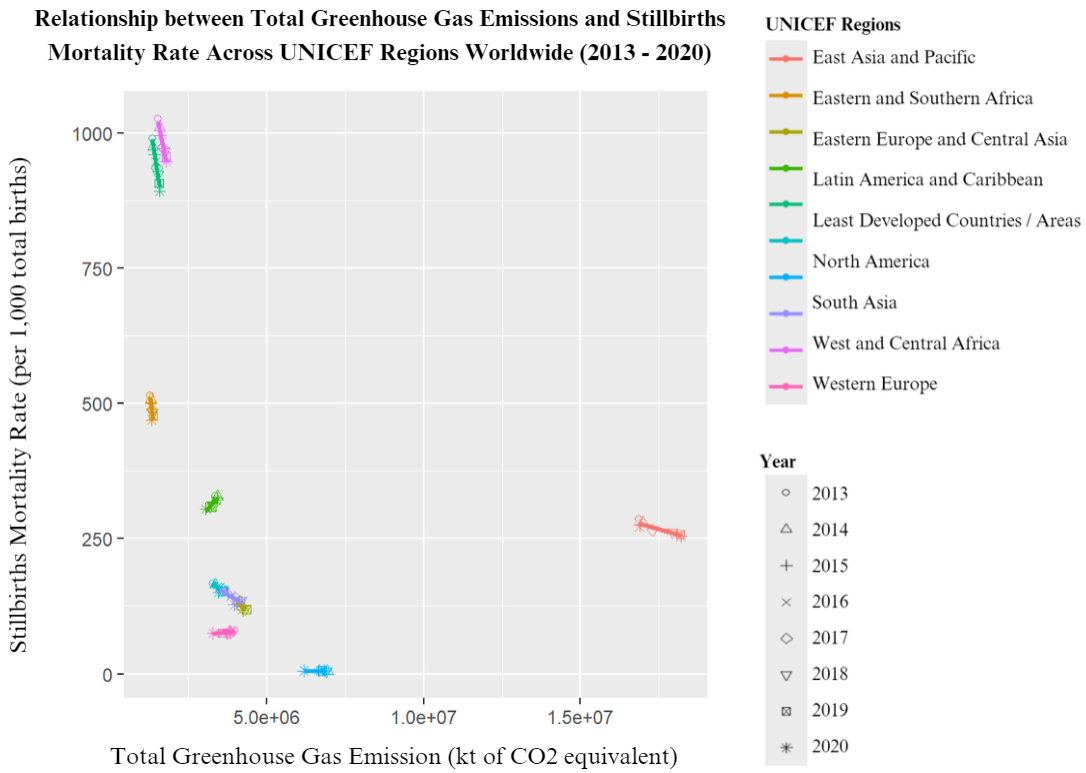

Figure 1: Relationship between Total Greenhouse Gas Emissions and Stillbirth Mortality Rates Across UNICEF Regions Worldwide (2013 – 2020)

Figure 1 shows the relationship between total greenhouse gas emissions and stillbirth mortality rates across UNICEF regions worldwide from the year 2013 – 2020. East Asia and Pacific (red) has the highest total greenhouse gas emissions, but has a relatively low stillbirths mortality rate. West and Central Africa (purple pink) has the highest total stillbirth mortality rate, but a relatively low total greenhouse gas emissions.

Neonatal Mortality Rates

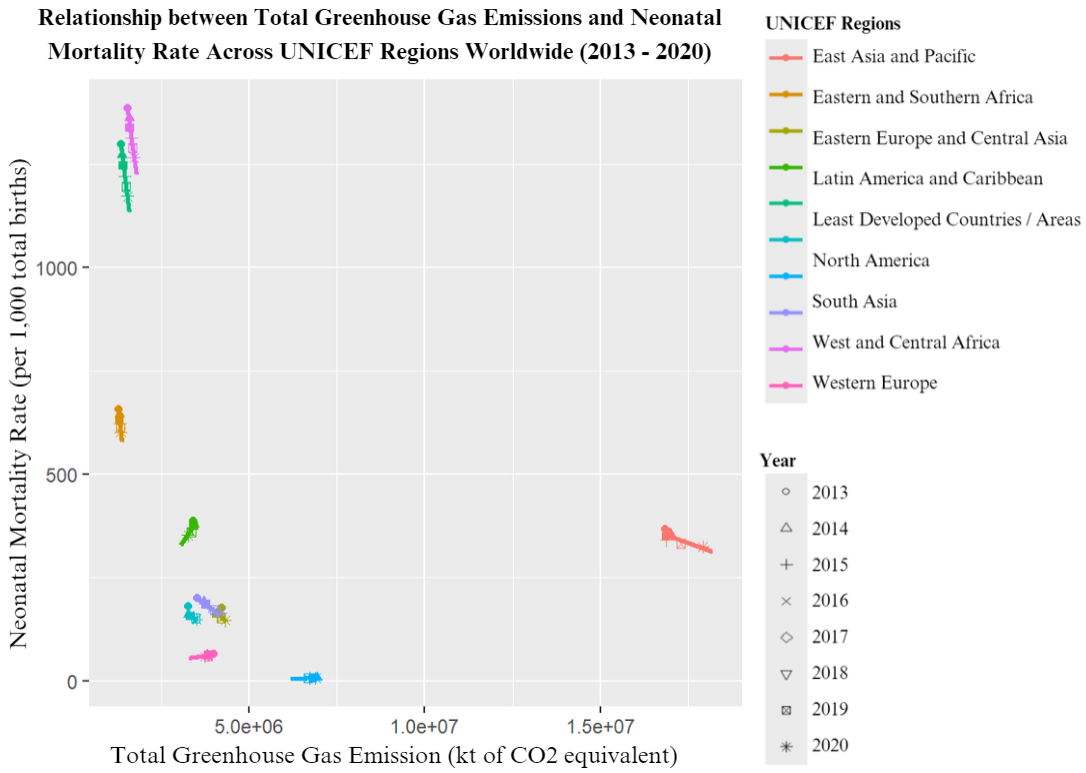

Figure 2: Relationship between Total Greenhouse Gas Emissions and Neonatal Mortality Rates Across UNICEF Regions Worldwide (2013 – 2020)

Figure 2 shows the relationship between total greenhouse gas emissions and neonatal mortality rates across UNICEF regions worldwide from the year 2013 – 2020. East Asia and Pacific (red) has the highest total greenhouse gas emissions, but has a relatively low stillbirths mortality rate. West and Central Africa (purple pink) has the highest total stillbirth mortality rate, but a relatively low total greenhouse gas emissions.

Under-5 Mortality Rates

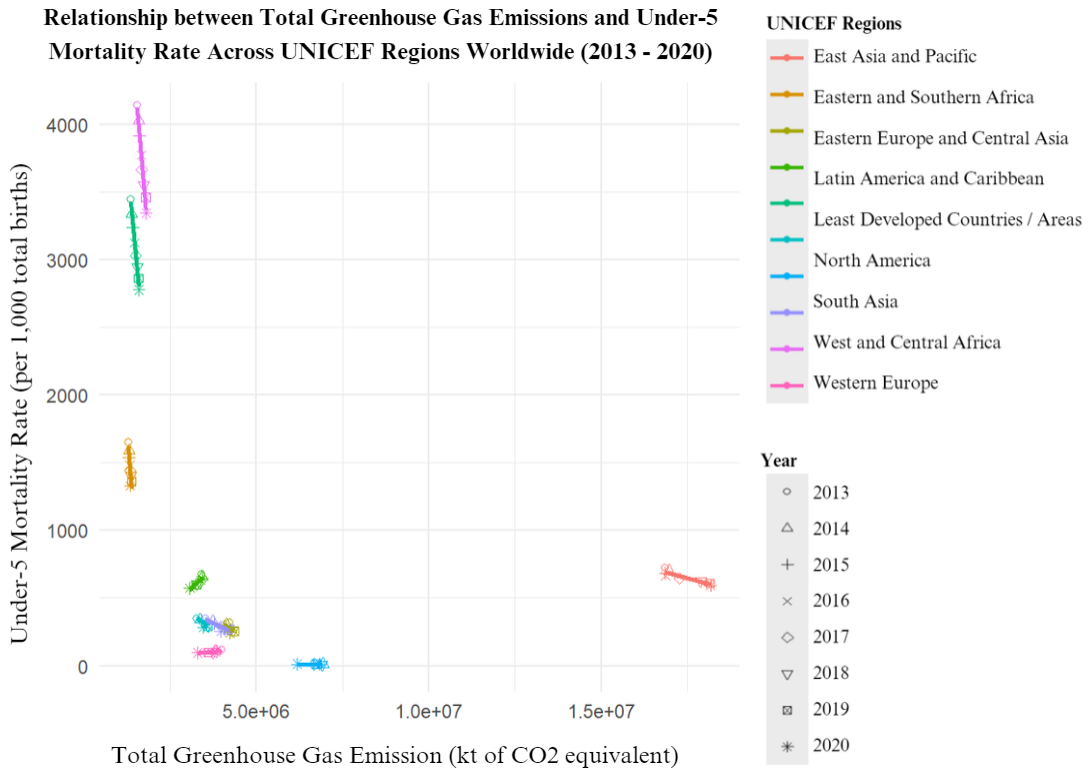

Figure 3: Relationship between Total Greenhouse Gas Emissions and Under-5 Mortality Rates Across UNICEF Regions Worldwide (2013 – 2020)

Figure 3 shows the relationship between total greenhouse gas emissions and under-5 mortality rates across UNICEF regions worldwide from the year 2013 – 2020. East Asia and Pacific (red) has the highest total greenhouse gas emissions, but has a relatively low stillbirths mortality rate. West and Central Africa (purple pink) has the highest total stillbirth mortality rate, but a relatively low total greenhouse gas emissions.

Child and Youth Mortality Rates

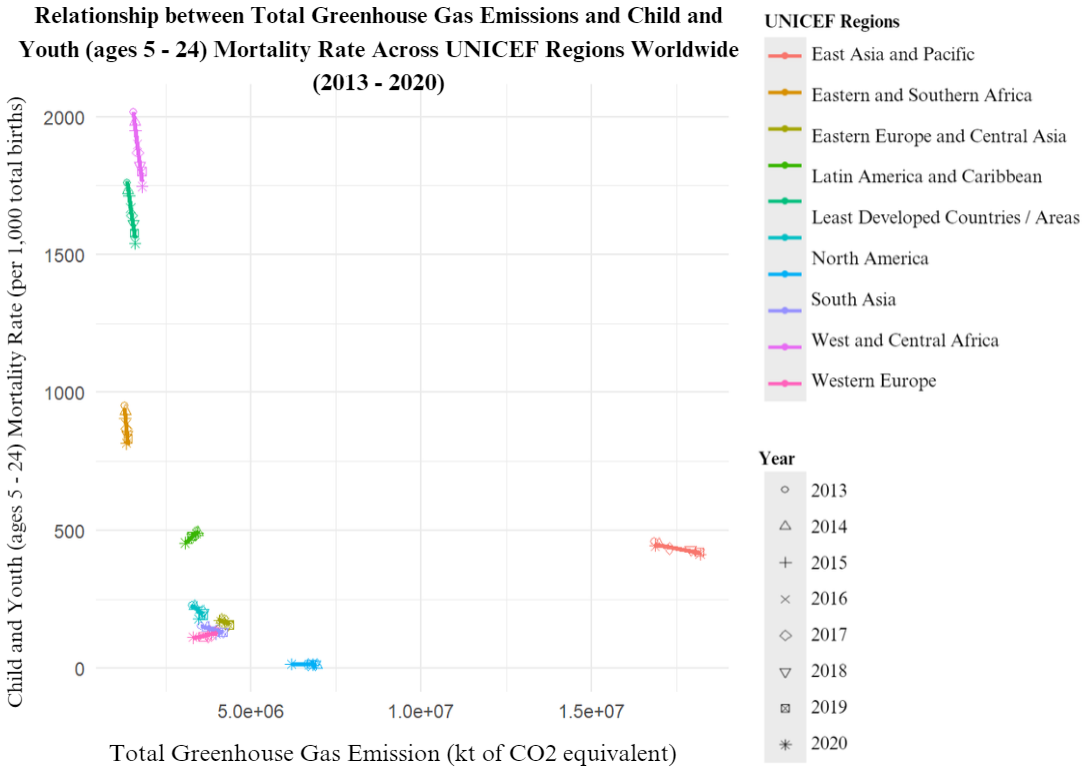

Figure 4: Relationship between Total Greenhouse Gas Emissions and Child and Youth (Ages 5 – 24) Mortality Rates Across UNICEF Regions Worldwide (2013 – 2020)

Figure 4 shows the relationship between total greenhouse gas emissions and under-5 mortality rates across UNICEF regions worldwide from the year 2013 – 2020. East Asia and Pacific (red) has the highest total greenhouse gas emissions, but has a relatively low stillbirths mortality rate. West and Central Africa (purple pink) has the highest total stillbirth mortality rate, but a relatively low total greenhouse gas emissions.

Discussion

Spatial Analysis

The pattern in the four graphs above are that East Asia and Pacific had the highest total greenhouse gas emissions, while West and Central Africa had the highest infant, fetal, child and youth mortality rates.

Temporal Analysis

Most UNICEF regions show a negative temporal relationship between total greenhouse gas emissions and mortality rates. However, current literature goes against this observed relationship as the increased total greenhouse gas emissions have been linked to the increased mortality rates. This is possibly due to the limitations in our observational design wherein we combined two databases that may not be inherently from the same population. Furthermore, over time, most UNICEF regions have an increasing total greenhouse gas emissions due to increasing industrialization, deforestation, and more. Over time, most UNICEF regions also have a decreasing fetal, infant, child, and youth mortality rate, possibly due to medical innovations, increased health interventions, increased social programs, and more.

Conclusion

Although it is hard to determine which UNICEF region is doing the worst overall because although regions have high greenhouse gas emissions, they do not have the highest mortality rate. However, this spatial and temporal distribution of graphs still has significant implications about climate change and infant, fetal, child, and youth mortality. Regions with high total greenhouse gas emissions including East Asia Pacific that should have targeted efforts towards reducing greenhouse gas emissions. Furthermore, regions with high mortality rates for stillbirths, infants, children, and youth including West and Central Africa should have targeted efforts towards reducing these mortality rates.

Limitations of our study includes its observational study design wherein we combine two datasets from completely different sources. Hence, we can only assume the correlation and causation of our relationship between climate change and stillbirths, infants, children, and youth mortality rates. Furthermore, taking the data of our two variables from two different datasets also brings in ecological fallacy wherein the people included in the first dataset, may not be included in the second dataset. Our study also takes into account the limitations of each dataset. For example, we constricted our data to include the years 2013 - 2020 because these years are the only ones available for both datasets. Furthermore, there were also missing data points from each data set.

Despite this, our highlights the imperative need for East Asia and Pacific to implement targeted efforts toward reducing greenhouse gas emissions. Given its significant contribution to global emissions, East Asia and Pacific holds responsibility for addressing climate change through proactive measures. In addition, regions characterized by elevated mortality rates for infant, fetal,

children, and youth, such as those observed in West and Central Africa require targeted efforts to alleviate these critical health disparities. Addressing these mortality rates through incorporating improvements in healthcare infrastructure, access to essential medical services, and health programs will greatly benefit the health of these vulnerable regions. Moving forward, a holistic approach to addressing climate change and health disparities will promote a more resilient and equitable future for communities worldwide.

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