Exploring the Influence of Income Inequality and Healthcare Access on Life Expectancy in the Americas

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This analysis explores the relationship between life expectancy and key socioeconomic factors, such as healthcare access, education expenditure, CO2 emissions, undernourishment, and unemployment, across countries in the Americas from 2000 to 2019. It identifies patterns and drivers influencing life expectancy, highlighting areas for targeted public health interventions. The findings offer a data-driven foundation for policymakers and healthcare professionals to address health disparities and improve life expectancy across diverse regions in the Americas.

1. Introduction

Life expectancy as an indicator of how well a country is faring has many determinants, such as socioeconomic status, healthcare facilities, and the environment, that complexly interact with one another. The correlation heat map indicates that countries across the Americas had significant variables in some, if not all, critical factors determining health conditions: Health expenditure, sanitation, and undernourishment. Again, it was observed that people in regions where health and education spending were higher trend to have a longer or higher longevity at the expense of the shorter living things associated with high undernourishment and inequality between incomes. Similarly, high CO2 emissions have strong links to some chronic non-communicable diseases which may be linked to life expectancy issues.

2. Data Sources

In this project, we are using datasets from the World Bank, which are provided in CSV format, these datasets are highly relevant for analyzing key socio-economic and health-related questions. The data covers maximum countries from 2000 to 2019.

2.1 Data 1: Life Expectancy and Socio-Economic Data (World Bank): This dataset contains socio-economic indicators from the World Bank, including life expectancy, healthcare access, income inequality, and other relevant data for countries globally.

2.2 Data 2: World Bank Life Expectancy Data: Life expectancy at birth data for countries worldwide, useful for analyzing health outcomes in relation to income inequality and healthcare investments across North and South America.

3 Methodology

3.1 Life Expectancy Trend by Income Group

Fig 1 shows (Life expectancy trend by groups) an increasing trend in life expectancy across all income groups from 2000 to 2018, reflecting global improvements in healthcare, sanitation, and living conditions. High-income countries

consistently lead with an average life expectancy of 80 years by 2018, indicating better healthcare access and higher living standards. Despite the positive trend, a notable gap remains, with low-income countries averaging around 60 years, underscoring persistent health inequalities. The trend highlights a clear link between income levels and life expectancy, where higher income generally correlates with better health outcomes.

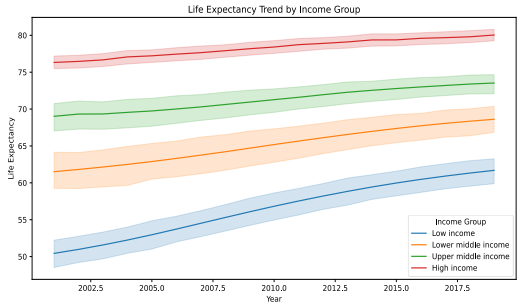

Fig 1: life expectancy trend by group

The bar chart (fig 2) illustrates the average life expectancy for different income groups: lower middle income, upper middle income, and high income. The trend clearly shows that higher income groups have better life expectancy outcomes. Specifically, life expectancy rises from 72.1 years in lower middle-income countries to 75.2 years in upper middle-income countries, and further to 79.2 years in high-income countries. This correlation highlights the role of economic status in improving health conditions and access to healthcare resources, which positively influences life expectancy.

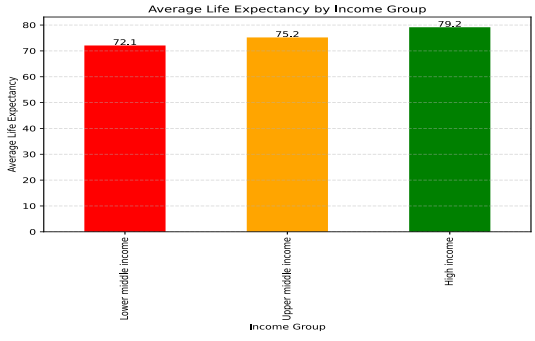

Fig 2: average life expectancy

3.2 Health Expenditure and Life Expectancy

The Fig 3 "Health Expenditure and Life Expectancy" by Income Group highlights the positive relationship between health expenditure and life expectancy across different income groups. High-income countries exhibit both higher health expenditure and life expectancy, with a relatively flatter trend, indicating that further increases in spending may have diminishing returns. In contrast, upper-middle and lower-middle-income countries show steeper trends, suggesting that increased health spending has a more significant impact on life expectancy in these regions. This analysis underscores that while higher health expenditure generally correlates with better life expectancy, the degree of improvement varies based on a country's income level.

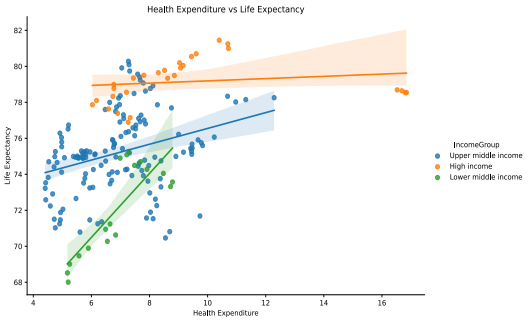

Fig 3: health expenditure and life expectancy

3.3 Education and Life Expectancy

A positive correlation is observed for both regions, indicating that higher education expenditure is associated with increased life expectancy. However, North America exhibits higher life expectancy across a narrower range of education expenditure, while Latin America & Caribbean shows a broader range of expenditure with slightly lower life expectancy. The trend line for Latin America & Caribbean suggests a gradual increase in life expectancy as education spending rises, highlighting

regional disparities in the impact of educational investment.

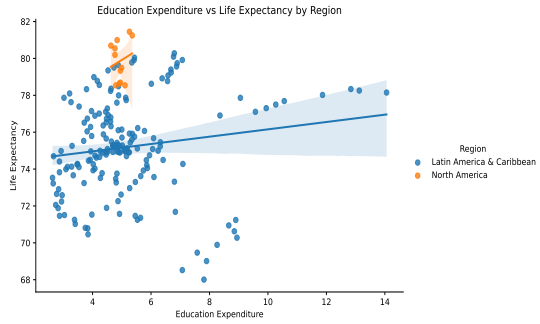

Fig 4: education expenditure vs life expectancy

3.4 CO2 Emissions and Life Expectancy

The scatter plot (fig 5) of CO2 emissions versus life expectancy shows that high-income groups maintain high life expectancy despite higher emissions, likely due to advanced healthcare systems. In contrast, lower-income groups display lower and more varied life expectancies, indicating that socioeconomic factors play a more significant role than CO2 emissions alone. High-income (orange) maintain a consistently high life expectancy despite varying levels of CO2 emissions, implying that advanced healthcare and infrastructure mitigate the potential negative impacts of pollution.

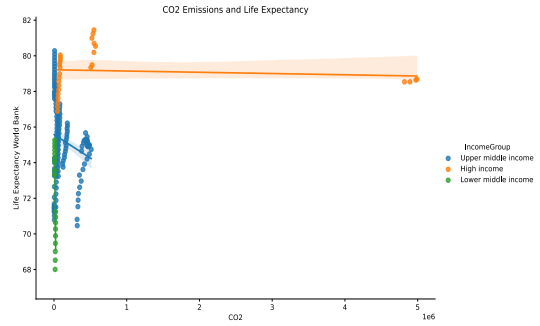

Fig 5: co2 emissions and life expectancy

3.4 Correlation Heatmap

The correlation heatmap reveals key relationships between various socioeconomic factors and life expectancy. Notably, life expectancy shows a strong positive correlation with health expenditure (0.43) and sanitation (0.39), indicating that improved healthcare services and hygiene significantly enhance longevity. Conversely, there is a notable negative correlation between life expectancy and the prevalence of undernourishment (-0.63), highlighting the critical role of nutrition. CO2 emissions exhibit a weak positive correlation (0.19) with life expectancy, suggesting that wealthier, industrialized countries with higher emissions tend to have better healthcare infrastructure, which offsets the potential negative impact of pollution. Additionally, unemployment shows little correlation, implying that its direct impact on life expectancy may be less pronounced compared to other factors. Overall, the correlation analysis confirms that health expenditure plays a crucial role in improving life expectancy, particularly in middle-income countries, where returns on investment in healthcare are more pronounced.

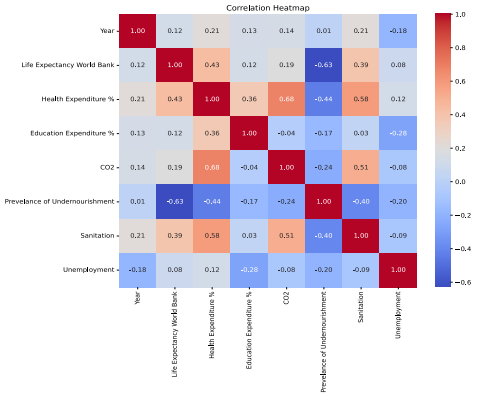

Fig 6: correlation heatmap

4 Discussion

The analysis highlights that income level significantly influences life expectancy, with high-income countries enjoying longer lifespans due to better healthcare, education, sanitation, and living conditions. A positive correlation between health expenditure and life expectancy is evident in low- and middle-income countries, indicating that increased healthcare

investment can improve health outcomes. However, diminishing returns in high-income countries suggest that beyond a certain level, simply raising expenditure does not further extend life expectancy, emphasizing the need for efficient healthcare management. Addressing disparities in income, education, healthcare access, and infrastructure is crucial for improving life expectancy in lower-income regions.

5 Limitations

- **Data Availability and Quality** The quality and completeness of the data used in the analysis may vary across countries. Some countries, especially lower-income ones, may have limited or outdated data, which can affect the accuracy of the findings.
- **Causality vs Correlation** The analysis focuses on correlations, but it does not establish causality. While relationships between variables such as health expenditure and life expectancy are observed, it cannot be concluded that increased expenditure directly causes longer life expectancy without controlling for other factors.
- **Omission of Key Variables** Some factors that may significantly affect life expectancy, such as political stability, healthcare quality, access to clean water, and social factors (e.g., inequality), were not included in the analysis.

5.1 Conclusion

In conclusion, the analysis reveals that life expectancy is closely linked to socioeconomic factors, with higher-income countries generally achieving better outcomes due to improved healthcare access, education, and living conditions. While increased health expenditure positively impacts life expectancy in low- and middle-income countries, diminishing returns in high-income regions highlight the need for more efficient healthcare systems. Additionally, although CO2 emissions show minimal immediate correlation with life expectancy, their potential long-term health impacts warrant further investigation. These insights emphasize the importance of targeted public health strategies and sustainable development to enhance life expectancy across different regions.

5.2 Future Work

Expanded Variable Analysis: Future studies could incorporate additional variables such as healthcare quality indices, access to clean water, and levels of physical activity to gain a more holistic view of life expectancy determinants.

Longitudinal Analysis: Performing a time-series analysis could help identify long-term trends and changes in life expectancy relative to key indicators over decades.

Regional Comparisons: More detailed regional studies (e.g., comparing continents or climate zones) could provide deeper insights into localized factors influencing health outcomes.

References:

[1]https://www.kaggle.com/datasets/mjshri23/life-expectancy-and-socio-economic-world-bank

[2]https://www.worldbank.org/en/about/legal/terms-of-use-for-datasets

[3] World Development Indicators | DataBank