Assessing Life Expectancy and Healthcare Access in the Americas

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Introduction:

Access to healthcare plays a vital role in shaping key health outcomes, such as life expectancy, which serves as a fundamental measure of public health in any society. The analysis focuses on the relationship between healthcare access and life expectancy in the Americas, with a specific focus on comparing the USA and Brazil. Key factors under consideration include immunization rates, the prevalence of hypertension, and the Universal Health Coverage (UHC) index. By exploring the correlation between life expectancy. Examining the correlation between life expectancy and these variables provides insights into the disparities between the healthcare systems of the two countries and highlights the broader impact of public health policies in different geographic contexts. Through data analysis, the aim is to answer a central question: "Does healthcare access influence life expectancy in the Americas, specifically in the USA and Brazil?" The findings aim to offer valuable perspectives on healthcare disparities and their effects.

Used Data

The data used for the analysis are shown in the Table 1.0 below which is the merging of different variables of different data sources of World Health Organization (WHO) and World Bank Group. The output dataset is structured as tabular and stored in both Comma Separated Values (CSV) and SQLite.
The columns in the table represent the following: N is the central estimate of the prevalence rate, NL is the lower bound, and NU is the upper bound of the confidence interval. Each variable is carefully defined to represent key health metrics:

- DIM_TIME (string): The specific year in which each health variable is measured.
- Prevalence of Hypertension (float): Percentage of adults diagnosed with hypertension. Mentioned as HYP.
- UHC Index Score (float): A measure of the coverage of essential health services.
- DTP3 Immunization (float): Percentage of one-year-olds who have received three doses of the combined diphtheria, tetanus toxoid, and pertussis vaccine.
- MCV2 Immunization (float): Percentage of children who have received two doses of the measles-containing vaccine by the recommended age.
- Life expectancy (float): The expected number of years a person is projected to live.

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To fulfill the obligations of the licenses:

- Acknowledge the sources in all publications and analyses using the data.
- Include the required citations in any reports or presentations.

DIM_TIME	Life Expectancy	HYP_PER_100_N	HYP_PER_100_NL	HYP_PER_100_NU	UHC_INDEX_N	DTP3_100_N	MVC2_PER_100_N
1990	65.985	39.45	30.4	48.5	68.0	98.0	95.0
1991	66.31	39.8	31.6	48.0	68.0	98.0	95.0
1992	66.708	40.15	32.8	47.5	68.0	98.0	95.0
1993	67.109	40.5	33.9	47.1	68.0	98.0	95.0
1994	67.568	40.849999999999994	34.9	46.8	68.0	98.0	95.0
1995	67.919	41.3	35.9	46.7	68.0	98.0	95.0
1996	68.409	41.75	36.8	46.7	68.0	98.0	95.0
1997	68.813	42.1	37.6	46.6	68.0	98.0	95.0
1998	69.189	42.55	38.4	46.7	68.0	98.0	95.0
1999	69.524	42.9	39.0	46.8	68.0	98.0	95.0
2000	69.737	43.35	39.7	47.0	68.0	98.0	95.0
2001	70.195	43.8	40.3	47.3	69.0	98.0	95.0
2002	70.41	44.15	40.8	47.5	70.0	99.0	80.0
2003	70.72	44.599999999999994	41.4	47.8	71.0	99.0	74.0
2004	71.131	44.95	41.8	48.1	72.0	99.0	68.0
2005	71.753	45.35	42.2	48.5	73.0	99.0	61.0
2006	72.037	45.650000000000006	42.6	48.7	73.6	99.0	55.0
2007	72.365	45.8	42.8	48.8	74.2	99.0	49.0
2008	72.715	46.05	43.1	49.0	74.8	99.0	56.0
2009	72.948	46.1	43.2	49.0	75.4	99.0	55.0
2010	73.182	46.099999999999994	43.3	48.9	76.0	99.0	53.0
2011	73.343	46.05	43.3	48.8	77.2	99.0	71.0
2012	73.552	46.0	43.2	48.8	78.4	95.0	70.0
2013	73.918	45.85	43.0	48.7	79.6	97.0	69.0
2014	74.306	45.7	42.7	48.7	80.8	93.0	89.0
2015	74.332	45.55	42.3	48.8	82.0	96.0	80.0
2016	74.442	45.4	41.9	48.9	82.0	89.0	77.0
2017	74.827	45.3	41.3	49.3	82.0	83.0	67.0
2018	75.109	45.2	40.7	49.7	81.5	87.0	76.0
2019	75.338	45.05	39.9	50.2	81.0	70.0	54.0
2020	74.009	45.05	39.9	50.2	80.5	77.0	44.0
2021	72.75	45.05	39.9	50.2	80.0	68.0	46.0
2022	73.425	45.05	39.9	50.2	80.0	77.0	58.0

Table 1.0: Output shape of Brazil data.

Analysis

1. Life Expectancy

Method: Life expectancy trends were plotted using line plot, as illustrated in the top-left plot of Figure 1, from 1990 to 2022 for both Brazil and the USA.
Result: Both the USA and Brazil have improved life expectancy significantly over years. Although the USA has a higher relative life expectancy, Brazil showed a higher growth over the years from 66 years in 1990 to nearly 76 years by 2018. Also, both have a slight decline between 2018 and 2022.
Interpretation: The higher growth in Brazil's life expectancy indicates a good progress in public health and living conditions while USA's slower growth might indicate issues that affect longevity.

Figure 1: Line plots for key-health metrics with respect to time in years.

2. Universal Health Coverage (UHC)

Method: The UHC index was compared over the same period, as illustrated in the top-right plot of Figure 1, to assess access to essential healthcare services.

Result: Although the USA has a higher UHC index than Brazil, Brazil shows a better progress from 67 to 81 then a slight decline after 2015. The progress in the USA is slightly slow as it rises from 78 to 86 over 30 years.

Interpretation: Both countries follow a linear trend over years, but Brazil results suggest investments in healthcare infrastructure. The high consistent index of the USA indicates an established healthcare system.

3. DTP3 and MVC2 Immunization Rates

Method: Immunization rates of DTP3 and MVC2 vaccines were plotted, as shown in the bottom plots of Figure 1, using line plots over years 1990 to 2022 for both Brazil and the USA.

Result: Both countries achieved high immunization rates, with the USA maintaining rates around 90%. Brazil displayed variability, with DTP3 rates declining since 2011 to below 50% and MVC2 rates experiencing severe drops and fluctuations with rates below 50% since 2001.

Interpretation: Brazil faces challenges in keeping consistent immunization rates since 2011 for DTP3 and since 2001 for MVC2, unlikely the USA's stability indicates robust vaccination programs.

4. Correlation with Life Expectancy

In Brazil, life expectancy correlates strongly with the UHC index at 0.93 and hypertension management at 0.92, highlighting the importance of healthcare access. However, immunization rates (DTP3 at -0.5 and MVC2 at -0.71) show weak or negative correlations, suggesting inefficiencies in vaccination programs.
In the USA, life expectancy correlates with the UHC index (0.78) and hypertension management (0.88). Unlike Brazil, immunization rates, especially MVC2 (0.63), positively impact life expectancy, reflecting an effective vaccination infrastructure in a stable healthcare system.

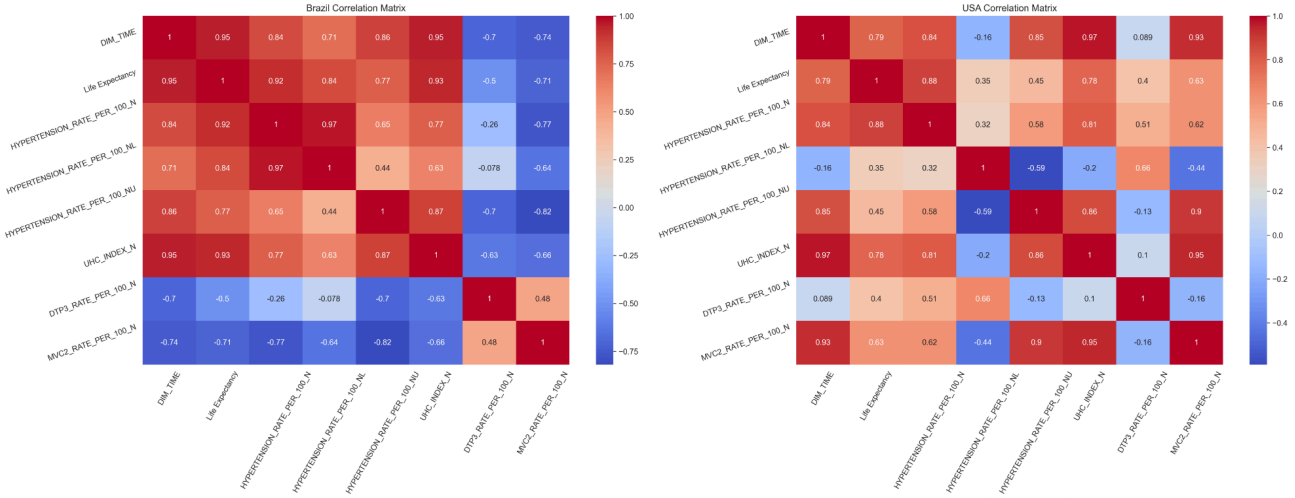

Figure 2: Heatmaps for dataset variables for Brazil and USA.

Conclusion:

The answer to the question "Does healthcare access influence life expectancy in the Americas, specifically in the USA and Brazil?" is yes based on multiple findings. Healthcare access significantly impacts life expectancy in the Americas. In Brazil, the rapid growth of healthcare coverage and management of immunization rates has driven life expectancy gains, despite challenges in immunization in the last 10 years. In contrast, the USA exhibits a more balanced healthcare system with slower growth, where both immunization rates and universal health coverage positively impact life expectancy. Heatmaps analysis of both countries showed a strong positive Pearson correlation factor between life expectancy with the Universal Health Coverage (UHC) index, and hypertension, suggesting a meaningful relationship between these factors.

Limitations of this project can be in:

- Data gaps: Some data were unavailable for all years since 1990, which were required to fill the missing values.
- Limited factors: The analysis could be enhanced by including additional variables, such as:
    - Domestic general government health expenditure.
    - Density of healthcare doctors, nurses, pharmacists, and dentists.