North American HIV Data Analysis Report From 2007 to 2020

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Introduction:

This team project aims to analyze HIV-related indicators in designated regions (Bermuda, Canada, and the United States) from 2007 to 2020, explore the relationship between HIV infection rates and economic and social factors (such as GDP and unemployment), and recommend future HIV intervention policies. By analyzing public data, we compiled the following key data points: key indicators such as the number of HIV infections, the number of deaths, the proportion of female infected people, and the mother-to-child transmission rate, and supplemented additional performance indicators such as HIV mortality and the proportion of female infected people.

The data sources primarily include globally recognized organizations. Key contributors are the World Health Organization (WHO), which provides annual HIV data and statistics for strategic global health programs, and UNICEF, which offers comprehensive data on HIV trends and gender-specific effects. The Centers for Disease Control and Prevention (CDC) is a primary source for U.S. HIV data. Data from the World Bank includes analyses of socioeconomic metrics. Additional resources include the National Institutes of Health (NIH), Health Resources and Services Administration (HRSA), and Canadian Institute for Health Information (CIHI) support regional data searches.

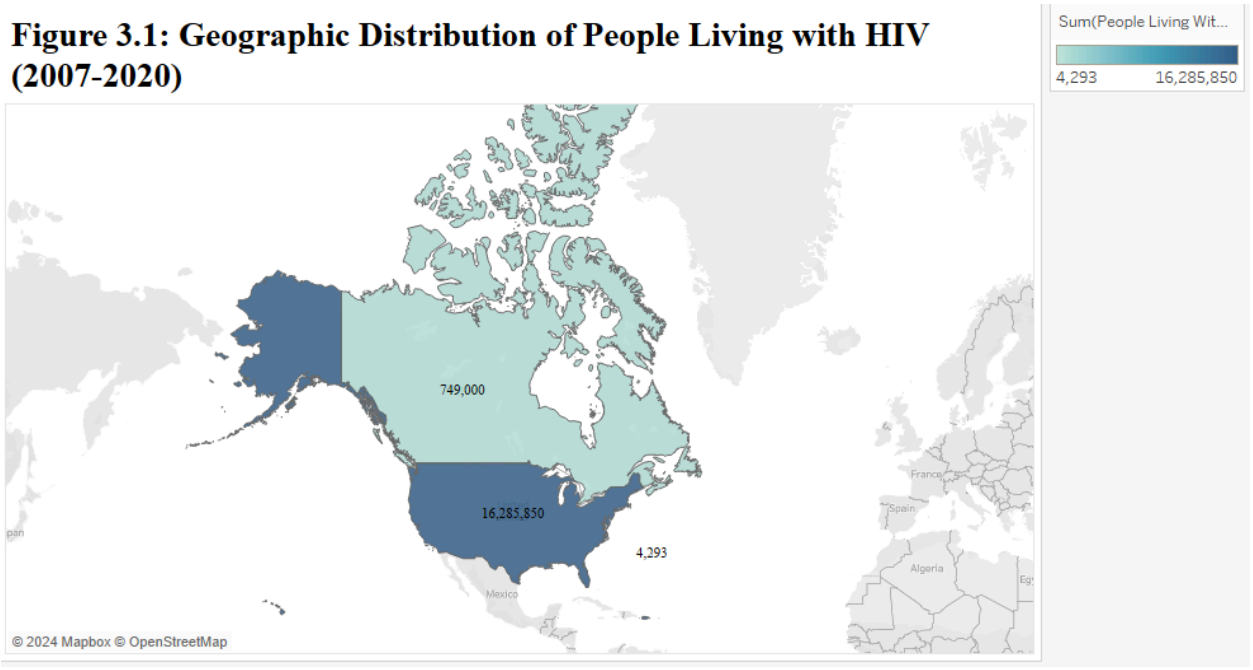
Methods:

Our team first collected HIV-related data from 2007 to 2020 in the three countries, including population, GDP, unemployment rate, etc. The raw data from various sources required cleaning to ensure accuracy and consistency. Missing values were addressed by filling gaps using trends from surrounding years. Outliers were identified and checked, obvious errors were corrected, and valid extreme values were retained. Duplicate data from different sources were resolved by prioritizing the most reliable source. Finally, the cleaned dataset was reviewed to ensure it was accurate, complete, and ready for analysis. The percentage data such as mother-to-child transmission rate and the proportion of pregnant women with known HIV status were converted into numerical format for easy analysis.

In addition to the specified original indicators, our team searched for two new KPIs: - HIV mortality rate: the proportion of HIV-related deaths to the total population. - Female HIV percentage: the proportion of female-infected people to the total number of HIV-infected people. Through SQL, we created tables to store the different data in the HIV dataset and economic dataset. HIV_Dataset is combined with data from multiple source tables and calculates the percentage of the data we need, such as people living with HIV relative to the total population. We created a Full_Dataset table called Full_Dataset combining HIV_Dataset and GDP_Dataset. The final combined dataset table includes a comprehensive view of statistics on economic indicators and details on HIV information in North America.

Data Analysis:

Figure 3.1: Geographic Distribution of People Living with HIV (2007-2020)



As represented in Figure 3.1, the major thing being shown is the number of HIV infections documented in selected countries. The up-beat look of the chart brings out the discrepancies, with darker shades showing a higher number of people living with HIV. The United States emphasizes those divergences, in the number of cases (over 16 million) and inconsistency in access to medical infrastructure, because of its huge population and differences. On the other hand, Canada (749,000 cases) and Bermuda (4,293 cases) report numbers that are lower.

Figure 3.2: People Living with HIV as A Proportion of Country Population (2007-2020)

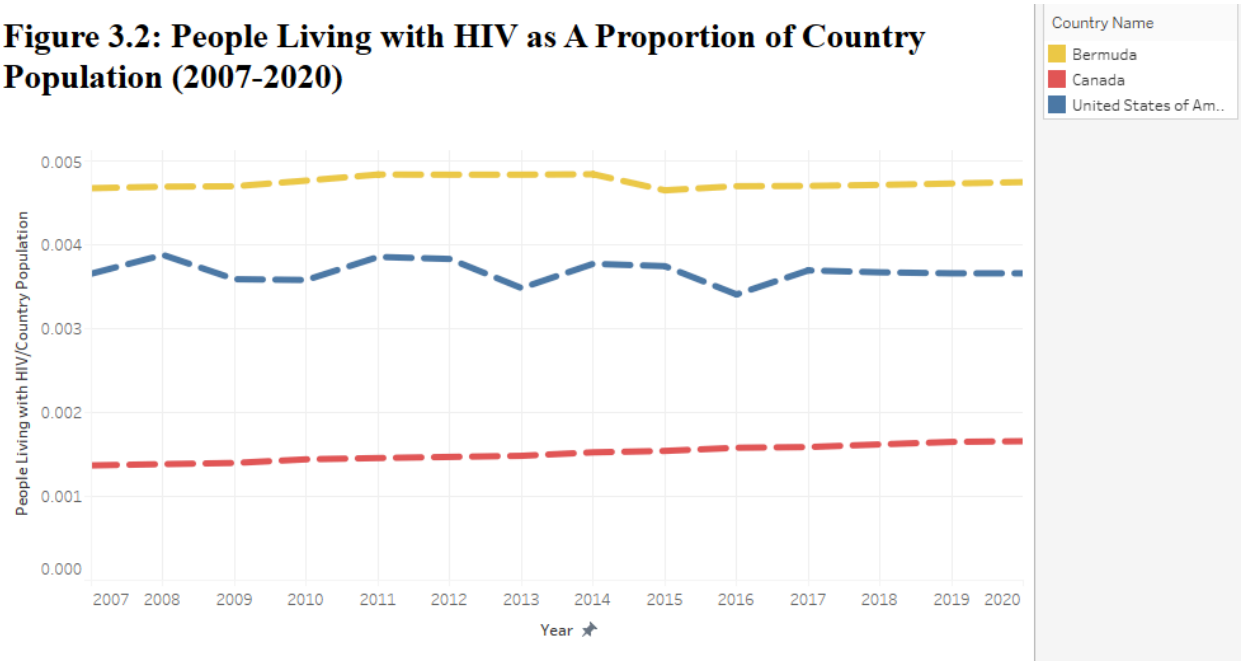


Figure 3.2 compares the HIV people proportion to the total population in three countries from 2007 to 2020. Bermuda (Yellow): Shows almost consistently rising values of people living with HIV proportionately, and the highest values maintained throughout the period. In consequence, the HIV prevalence is constantly far above the general estimation, even accounting for its size of the population. Canada (Blue): Shows a consistent trend with slightly varying numbers, settling in between the two extremes of the prevalence scale. Proportion changes very little, and it implies a stable balance of population and infection processes. United States of America (Red): It has the lowest rate of HIV prevalence among its population. The tendency shows a steady growth that can be traced, but it is clear that the overall data obtained remain lower than those of the other two countries. The current map illustrates the geographical disparities of the HIV epidemic in terms of its scale and trends relative to the population size across the countries.

Figure 3.3: Trends in Deaths Due to HIV (2007–2020)

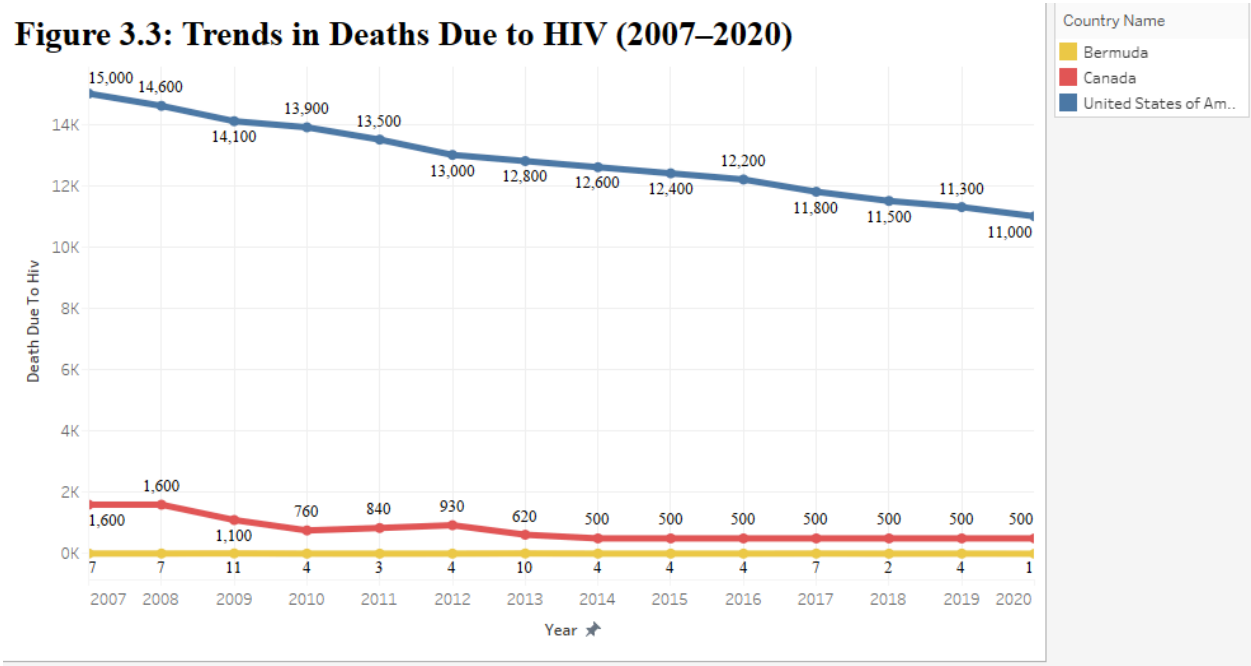
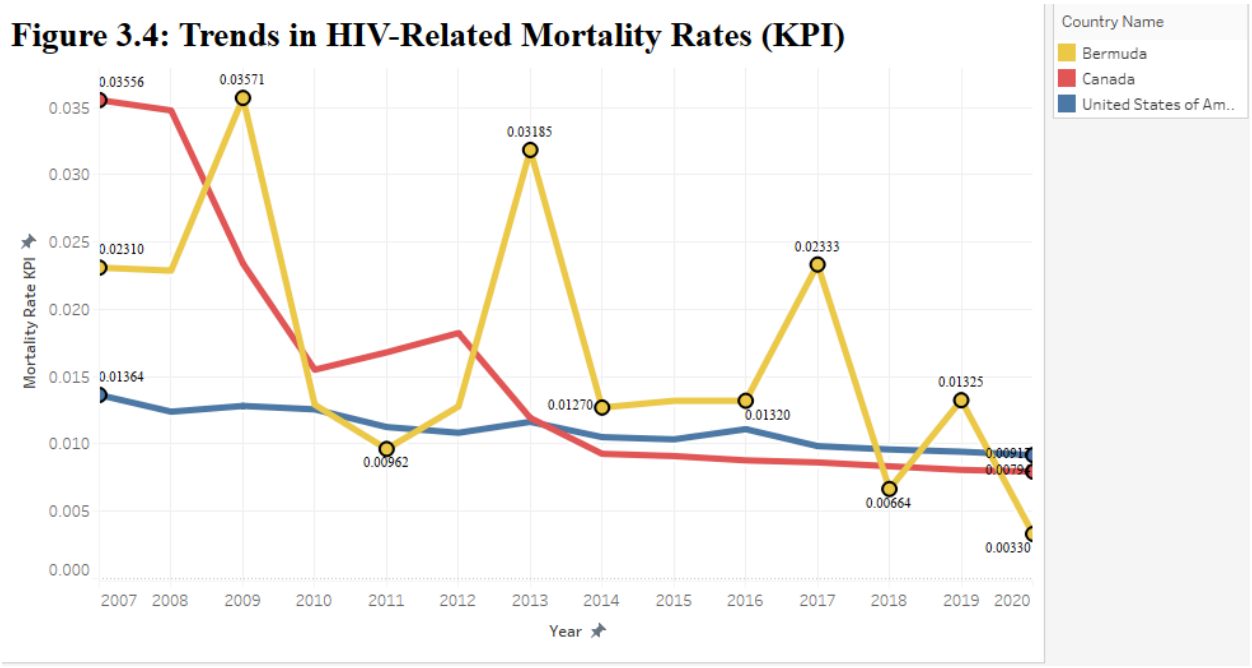


Figure 3.2 highlights the trends in HIV-related deaths across Bermuda, Canada, and the United States from 2007 to 2020. The United States saw a decline from 15,000 deaths in 2007 to 11,000 in 2020, reflecting the success of its National HIV/AIDS Strategy, which emphasized prevention, treatment, and healthcare accessibility (U.S. Department of Health and Human Services, 2022). Canada similarly reduced deaths from 1,600 in 2007 to 760 by 2010, stabilizing at 500 by 2016, consistent with its efforts to meet UNAIDS 90-90-90 targets through improved testing and treatment coverage (Public Health Agency of Canada, 2020). Bermuda reported fewer than 10 deaths annually throughout this period, attributed to its small population and effective local HIV management programs, which focus on comprehensive healthcare and education initiatives (Government of Bermuda, 2020).

Figure 3.4: Trends in HIV-Related Mortality Rates (KPI)



The mortality rate attributable to HIV in Bermuda, Canada, and the United States is shown in Figure 3.4 for the years 2007 to 2020. Bermuda is known to vary heavily, experiencing high peaks in the mortality rate repeatedly in some years, such as 2009 (0.03571), or 2017 (0.03333). However, on the contrary, Canada reveals a steady decline from 0.03556 in 2007 to 0.00794 in 2020 on the same scale. Comparing the United States with other nations, variations in mortality rates are less pronounced. In 2007, the rate was 0.01364, while the rate has dropped to 0.00917 in 2020. This figure illustrates the geographical variations in HIV mortality rates against the background of population size and healthcare systems. Canada achieved both the first and third UNAIDS 90-90-90 targets, that help control this condition based on the national level. (Public Health Agency of Canada, 2020). (*The global 90-90-90 targets state that by 2020, 90% of all PLHIV know their status, 90% of those diagnosed receive antiretroviral treatment (ART), and 90% of those on treatment achieve viral suppression.)

Figure 3.5: Number of Women (15 years and above) Infected with HIV (2007-2020)

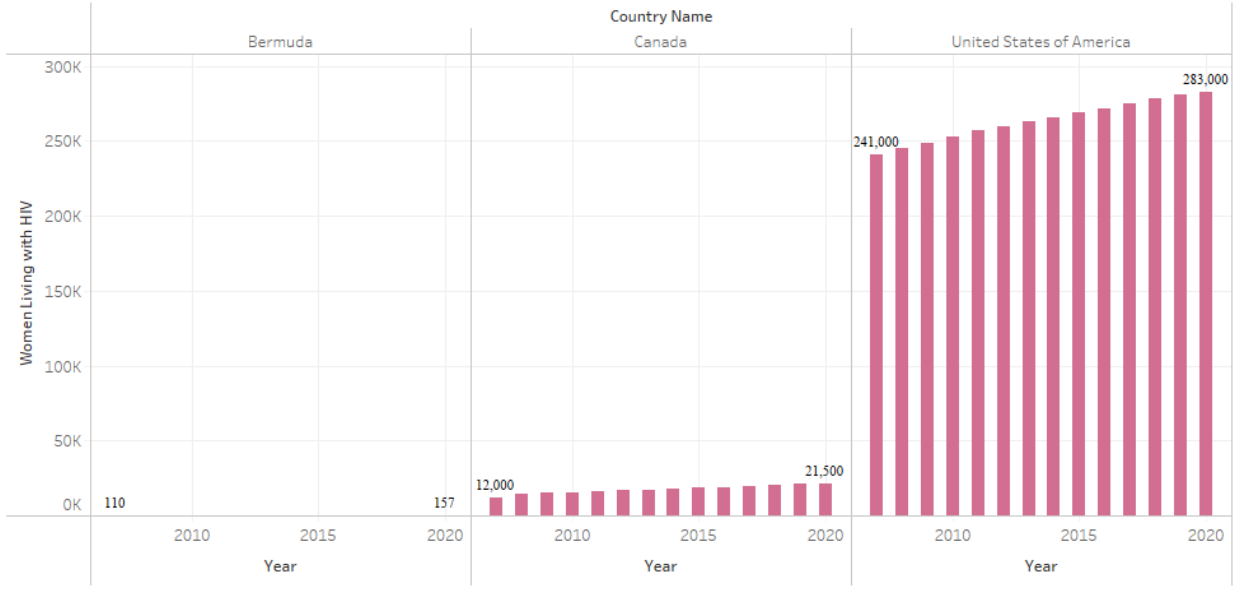


Figure 3.5 illustrates the number of women aged 15 and older living with HIV across Bermuda, Canada, and the United States from 2007 to 2020. The number of HIV-infected women in the United States increased from 241,000 in 2007 to 283,000 in 2020, showing a steady growth trend. Canada increased from 12,000 to 21,000, with a small increase, but the trend continued. Bermuda also increased from 110 to 157. The absolute value of the data is small, but the increase is relatively obvious.

Figure 3.6: Percentage of Women with HIV (KPI)

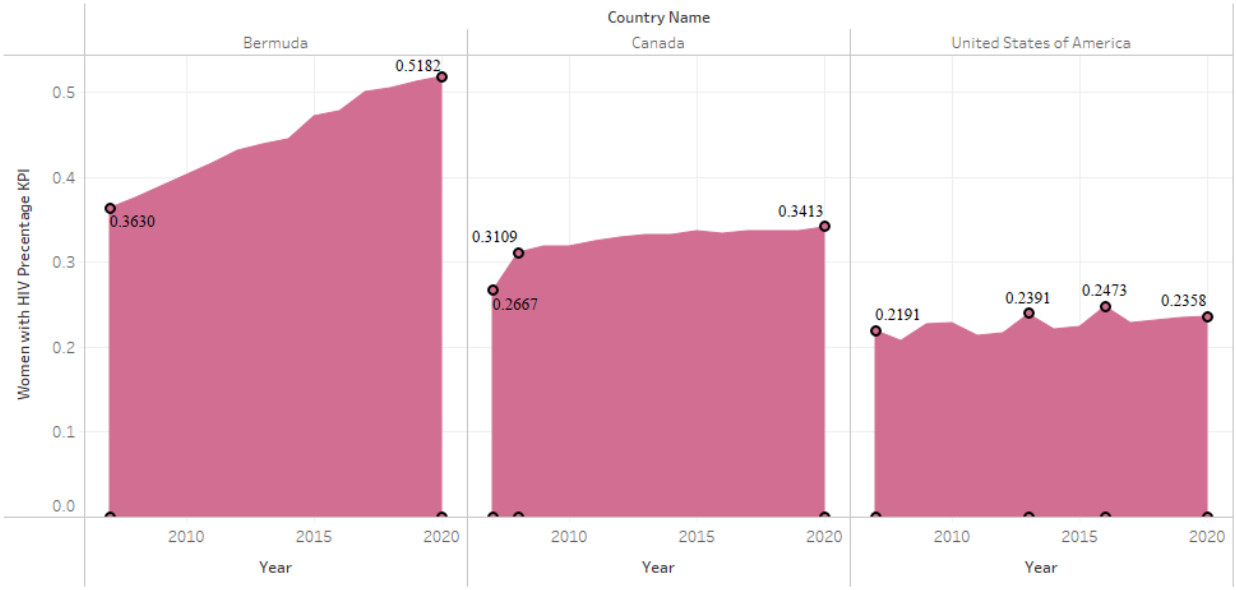


Figure 3.6 is the proportion of women infected with HIV in 2007 to 2020. The proportion of women infected with HIV in Bermuda has increased rapidly, from 36.3% in 2007 to 51.8% in 2020. Heterosexual contact has been identified as a significant mode of HIV transmission in Bermuda. As of 2020, 43% of persons living with HIV/AIDS reported heterosexual contact as their primary risk factor (Government of Bermuda, 2020). This mode of transmission disproportionately affects women, contributing to their increased representation among HIV cases. The growth in Canada and the US is relatively slow, which is also affected by the large base of infected people in the two countries. Among them, the proportion of Canada has increased from 26.6% to 34.1%, and the proportion of women infected in the US has increased from 20.9% to 23.6%, with small fluctuations. This reflects the impact of proactive public health initiatives in the United States. Key initiatives include the CDC's High Impact Prevention (HIP) strategy, which combines cost-effective and evidence-based interventions targeted at populations at risk (CDC, n.d.).

Figure 3.7: Percentage of Pregnant Women with Known HIV Status (2007-2020)

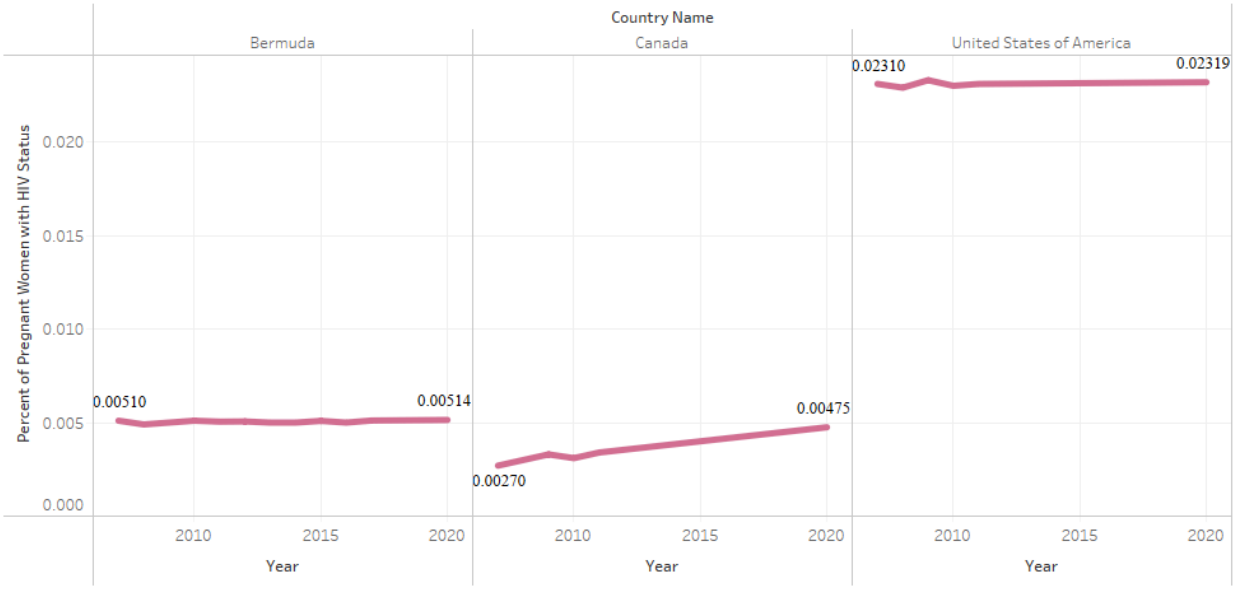


Figure 3.7 is about the proportion of pregnant women with known HIV status. In the United States, this indicator has remained stable at about 2.3% to 2.4% since 2007. In Canada, this indicator has increased slightly from 0.27% to about 0.47% year by year. , the overall proportion is lower than that in the United States. The indicator for Bermuda fluctuates less and is stable around 0.5%.

Figure 3.8: Mother to Child Transmission Rate (2007-2020)

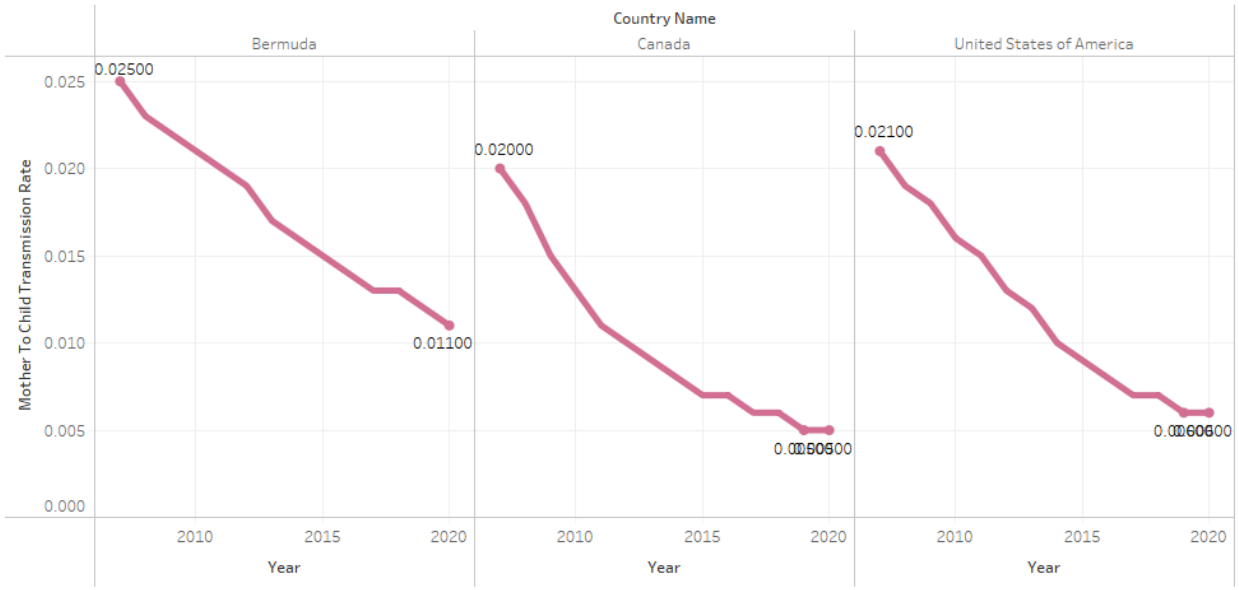


Figure 3.8 presents the mother-to-child transmission rate of HIV in Bermuda, Canada, and the United States from 2007 to 2020. The US dropped from about 2.1% in 2007 to about 0.5% in 2020. Canada also showed a downward trend, falling from about 2.0% to about 0.5%, which is similar to the decline in the United States. Bermuda also demonstrated effective mother-to-child transmission control capabilities, falling from approximately 2.5% to approximately 0.6%. North America achieved significant control over mother-to-child transmission (MTCT) of HIV. This success is attributed to the widespread implementation of antiretroviral therapy (ART) among pregnant women living with HIV, which has substantially reduced transmission rates (UNICEF, 2020).

Figure 3.9: Economic Trends (2007–2020)

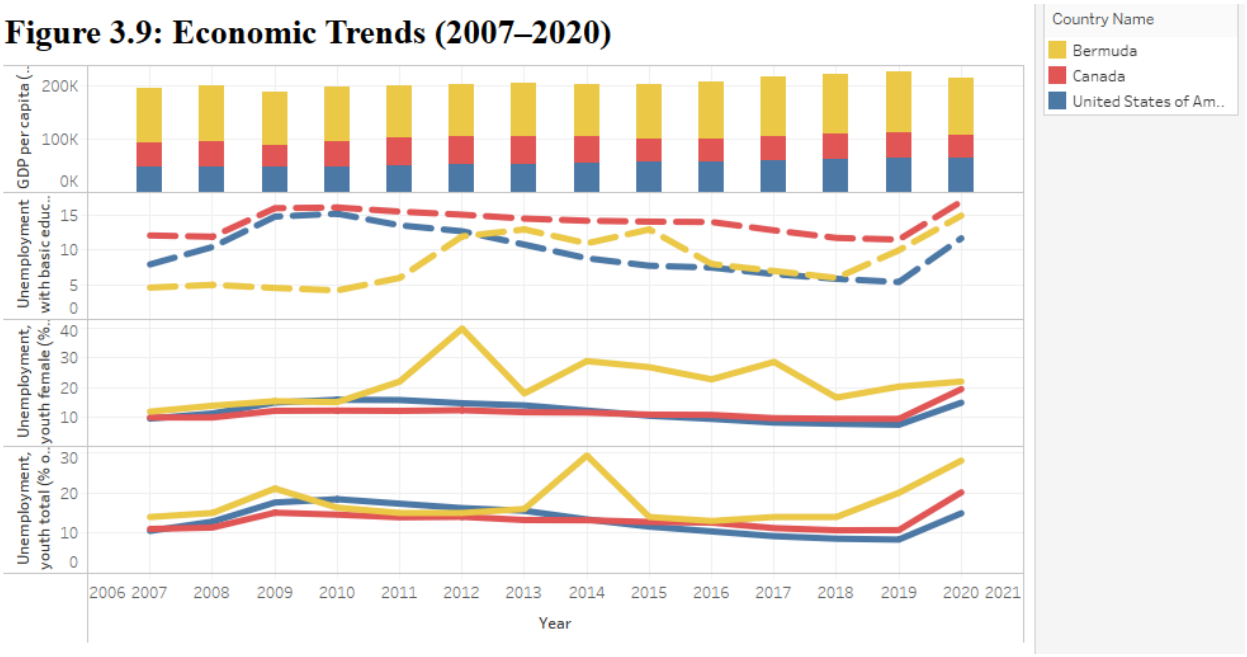


Figure 3.9 highlights key economic indicators—GDP per capita, unemployment rates, and female unemployment rates—across Bermuda, Canada, and the United States from 2007 to 2020.

GDP Per Capita**:** Bermuda consistently exhibits the highest GDP per capita, followed by the United States and Canada. Bermuda's GDP shows less volatility, while the United States and Canada display slight fluctuations and an increase in the later years. Higher GDP per capita often correlates with better healthcare infrastructure. Research indicates that higher national income contributes to improved healthcare access and better outcomes for individuals living with chronic illnesses, including HIV (UNAIDS, 2020).

Unemployment Rate (General)**:** Bermuda experiences moderate volatility, while Canada and the United States show a steady decline in unemployment over time. Studies have shown that employment status impacts individuals' ability to afford healthcare services,

including antiretroviral therapy, which is critical for managing HIV (Norton & McGrath, 2021).

Female Unemployment Rate**:** Bermuda shows the most fluctuations in female unemployment, peaking significantly in some years. Canada and the United States demonstrate gradual declines in female unemployment, indicating more stable labor market conditions for women. Women with consistent employment are more likely to access preventative healthcare services, which are essential for reducing HIV transmission rates, particularly mother-to-child transmission (WHO, 2021).

Recommendations for future HIV interventions:

Bermuda: The economic trend shows that Bermuda has the highest GDP per capita compared to the rest of the North American countries we have analyzed. However, the fast increase in the proportion of women living with HIV in Bermuda does not have a direct correlation with the increase in GDP. Bermuda needs to implement more public health programs for specific groups of people, such as HIV prevention for pregnant women. The unemployment with basic education trend shows the rate is slowly increasing over time, although it has no direct correlation with the general education of HIV, it shows that people are required to have a higher education level to get a job. This increase suggests people tend to pursue a higher level of education, so institutions should provide more HIV-related education to the students and public.

Canada and the U.S.: Although Bermuda shows a higher GDP than the US and Canada, it doesn't mean that the healthcare infrastructure is more advanced than these two countries. And looking at the unemployment rate for all categories has been steady over time in both countries.

The US and Canada both show a slow and steady decrease in HIV mortality rate, which indicates medical improvement over some time. With similar economic trends, the percentage of people living with HIV in Canada is significantly lower than in the USA. We suggest the healthcare system leverage economic stability to improve access for those who are at risk of HIV.

Conclusion:

The investigation of the HIV-related data in Bermuda, Canada, and the United States during the time period of 2007-2020 gives us a chance to view the dynamics, including the advantages and issues related to the control of this epidemic. Critical components, such as the number of people living with HIV, mortality rates, mother-to-child transmission rates, and economic stability, provide clear indicators that the health policies and interventions have contributed to a notable amount of progress.

Bermuda, which has a small population, shows the capability to manage it, although it is more necessary for a higher focus on women's employment and maternal health programs. On the other hand, Canada presents constant improvement, an indicator of the nation trying to meet the global HIV targets, although gender-specific vulnerabilities are starting to gain interest. The United States, despite its massiveness, has been able to cut these rates drastically, proving the advantages of its national strategy.

The recommendations that are made aim to solve the differences by Economic stabilization, scaling of maternal and child health programs, and bringing in gender-sensitive interventions and technology for better data collection and dissemination. This approach, together with, the three states may become a life-ongoing process, which sustains the progress, reduces the rate of HIV

infection, and ceases to be a public health threat. The evaluation shows us the merge of healthcare alongside socioeconomic conditions to get a complete and just outcome in HIV combat.

SQL Statements:

```sql
CREATE TABLE HIV_Dataset (
    country_name TEXT,
    year INTEGER,
    people_dying_with_hiv INTEGER,
    people_living_with_hiv INTEGER,
    pregnant_women_living_with_hiv INTEGER,
    mother_to_child_transmission_rate REAL,
    mortality_rate_KPI REAL,
    female_HIV_percentage_KPI REAL,
    male_HIV_percentage_KPI REAL,
    country_population INTEGER,
    percentage_of_people_living_with_hiv REAL
);
```

```sql
INSERT INTO HIV_Dataset (
    country_name,
    year,
    people_dying_with_hiv,
    people_living_with_hiv,
    pregnant_women_living_with_hiv,
    mother_to_child_transmission_rate,
    mortality_rate_KPI,
    female_HIV_percentage_KPI,
    male_HIV_percentage_KPI,
    country_population,
    percentage_of_people_living_with_hiv
)
```

```sql
SELECT
    plh.country_name,
    plh.year,
    pdh.pdwhiv AS people_dying_with_hiv,
    plh.plwhiv AS people_living_with_hiv,
    pwl.pwlwhiv AS pregnant_women_living_with_hiv,
    pwl.mother_to_child_transmission_rate,
    pwl.mortality_rate_KPI,
    pwl.female_HIV_percentage_KPI,
    pwl.male_HIV_percentage_KPI,
    Population_And_Percentage.country_population,
    plh.plwhiv / Population_And_Percentage.country_population AS percentage_of_people_living_with_hiv
FROM people_living_with_hiv plh
LEFT JOIN people_dying_with_hiv pdh
    ON plh.country_name = pdh.country_name AND plh.year = pdh.year
LEFT JOIN pregnant_women_living_with_hiv pwl
    ON plh.country_name = pwl.country_name AND plh.year = pwl.year
LEFT JOIN Hand_Entry_Dataset AS Population_And_Percentage
    ON plh.country_name = Population_And_Percentage.country_name AND plh.year = Population_And_Percentage.year
WHERE plh.country_name IN ("Bahamas", "Canada", "Mexico", "United States of America")
ORDER BY plh.country_name, plh.year;
```

```sql
INSERT INTO Full_Dataset (
    country_name,
    year,
    death_due_to_hiv,
    people_living_with_hiv,
    pregnant_women_living_with_hiv,
    percent_of_pregnant_women_with_hiv,
    mother_to_child_transmission_rate,
    mortality_rate_KPI,
    female_HIV_percentage_KPI,
    GDP_per_capita,
    unemployment_youth_female,
    unemployment_with_basic_education,
    unemployment_youth_total,
    current_health_expenditure,
    country_population,
    percentage_of_people_living_with_hiv
)
SELECT *
FROM GDP_Dataset;
```

```sql
CREATE TABLE Full_Dataset AS
SELECT
    hiv.country_name,
    hiv.year,
    hiv.people_dying_with_hiv,
    hiv.people_living_with_hiv,
    hiv.pregnant_women_living_with_hiv,
    hiv.mother_to_child_transmission_rate,
    hiv.mortality_rate_KPI,
    hiv.female_HIV_percentage_KPI,
    hiv.male_HIV_percentage_KPI,
    hiv.country_population,
    hiv.percentage_of_people_living_with_hiv,
    gdp.GDP_per_capita,
    gdp.unemployment_youth_female,
    gdp.unemployment_with_basic_education,
    gdp.unemployment_youth_total,
    gdp.current_health_expenditure,
    gdp.country_population AS gdp_country_population
FROM HIV_Dataset hiv
LEFT JOIN GDP_Dataset gdp
    ON hiv.country_name = gdp.country_name AND hiv.year = gdp.year;
```

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