HIV Analysis In Western Africa

A Database-Driven Study (2007-2016)

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Introduction

This project focuses on collecting and analyzing health-related HIV indicators data for the Western Africa region from 2007 to 2016. Western Africa, as defined by the World Bank, includes 20 countries: Benin, Burkina Faso, Burundi, Chad, Congo, Côte d'Ivoire, Democratic Republic of Congo, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo. Data for key HIV indicators were sourced from publicly available databases, including those maintained by the World Bank, WHO, UNAIDS, and UNICEF.

In addition to HIV indicators, supplementary data such as population size, GDP per capita, and unemployment rates were collected to provide a broader socio-economic context. A comprehensive HIV database was created for these countries, enabling detailed analysis of trends and ratios across various indicators over the study period.

Using SQL queries and data visualization techniques, we examined the trends and distribution of HIV-related indicators to gain meaningful insights. Based on our findings, we developed actionable and innovative policy recommendations aimed at improving HIV interventions and health outcomes across the Western Africa region.

Part 1: Create Table1

Create Table 1 with following indicators which are related to HIV for countries in Western Africa Region.

(1) Estimated number of people living with HIV.
(2) Estimated number of deaths due to HIV.
(3) Estimated number of women (15 and older) living with HIV.
(4) Percent (%) of pregnant women with known HIV status.
(5) Final mother-to-child transmission rate including breastfeeding period.

```
CREATE TABLE Research_HIV_Data (
   Country_ID INTEGER NOT NULL,
   Year INTEGER NOT NULL,
   Es_People_Living_HIV INTEGER,
   Es_Death_Due_to_HIV INTEGER,
   Es_Women_Living_HIV INTEGER,
   Perc_Pregnant_Women_Known_HIV_Status INTEGER,
   Final_MTCT_Rate REAL,
PRIMARY KEY("Country_ID","Year"),
FOREIGN KEY("Country_ID") REFERENCES "Country"("Country_ID")
);
```

Create 3 performance indicators (KPIs) (which are listed below) and add them into Table 1.

(6) Estimated number of children (aged 0-17) who have lost one or both parents due to AIDS.
(7) All ages incidence (per 1000 uninfected population).
(8) Number of pregnant women living with HIV needing ART to prevent vertical transmission of HIV.

```
ALTER TABLE Research_HIV_Data
ADD COLUMN Es_Children_Orphant_AIDS INTEGER;
ALTER TABLE Research_HIV_Data
ADD COLUMN All_Ages_Incidence REAL;
ALTER TABLE Research_HIV_Data
ADD COLUMN N_Pregnant_Women_HIV_Needing_ART INTEGER;
```

Table 1 - Research_HIV_Data and it's fields.

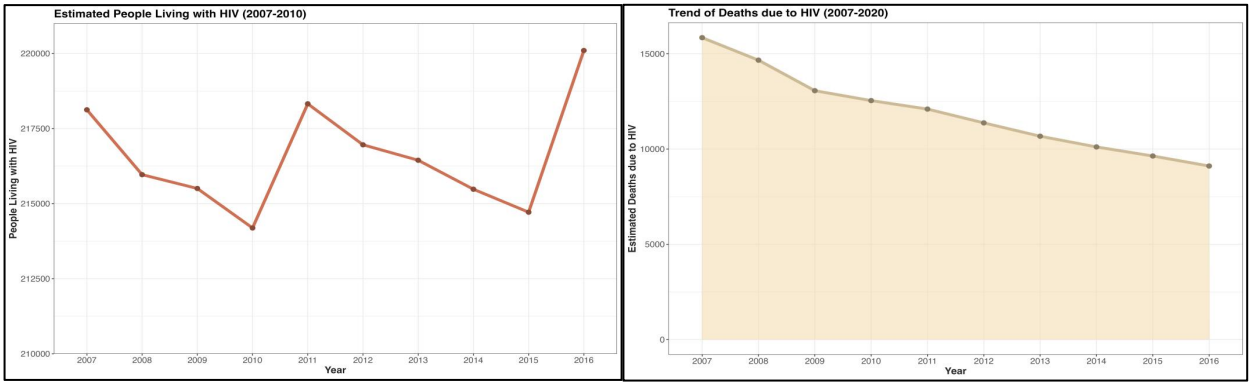
Research_HIV_Data		CREATE TABLE "Research_HIV_Data" ("Country_ID" INTEGER NOT NULL, '
Country_ID	INTEGER	"Country_ID" INTEGER NOT NULL
Year	INTEGER	"Year" INTEGER NOT NULL
Es_People_Living_HIV	INTEGER	"Es_People_Living_HIV" INTEGER
Es_Death_Due_to_HIV	INTEGER	"Es_Death_Due_to_HIV" INTEGER
Es_Women_Living_HIV	INTEGER	"Es_Women_Living_HIV" INTEGER
Perc_Pregnant_Women_Known_HIV_Stat...	INTEGER	"Perc_Pregnant_Women_Known_HIV_Status" INTEGER
Final_MTCT_Rate	REAL	"Final_MTCT_Rate" REAL
Es_Children_Orphant_AIDS	INTEGER	"Es_Children_Orphant_AIDS" INTEGER
All_Ages_Incidence	REAL	"All_Ages_Incidence" REAL
N_Pregnant_Women_HIV_Needing_ART	INTEGER	"N_Pregnant_Women_HIV_Needing_ART" INTEGER

Import data for each indicator from Research_HIV.csv file which contains all Western African's data that we collected from database websites.

	Country_ID	Year	s_People_Living_HI	_Death_Due_to_I	_Women_Living_I	ant_Women_Known_	Final_MTCT_Rate	s_Children_Orphant_AID	All_Ages_Incidence	egnant_Women_HIV_Needing_
	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	1	2007	66000	6000	39199	13	38.33	49000	0.68	6600
2	1	2008	65000	4200	39343	16	31.15	52000	0.56	6700
3	1	2009	67000	3100	40762	19	31.25	51000	0.53	6700
4	1	2010	68000	2800	41602	54	30.2	51000	0.53	6600
5	1	2011	70000	2700	43055	56	28.9	50000	0.48	6400
6	1	2012	71000	2700	43904	58	28.2	49000	0.42	6300
7	1	2013	71000	2800	44216	59	29.7	48000	0.39	6300
8	1	2014	72000	2900	45172	62	25.9	48000	0.34	6100
9	1	2015	71000	2700	44835	66	17.7	48000	0.26	6000
10	1	2016	71000	2400	45097	70	15.5	48000	0.23	6000

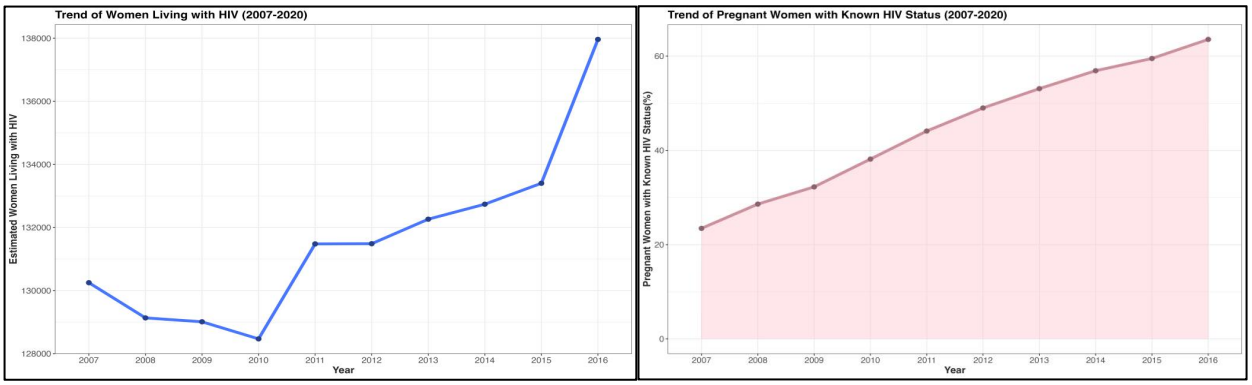
Part 2: Data Visualization for Table1 Indicators

1. Trend graph for indicator "Estimated number of people living with HIV" and "Estimated number of deaths due to HIV".



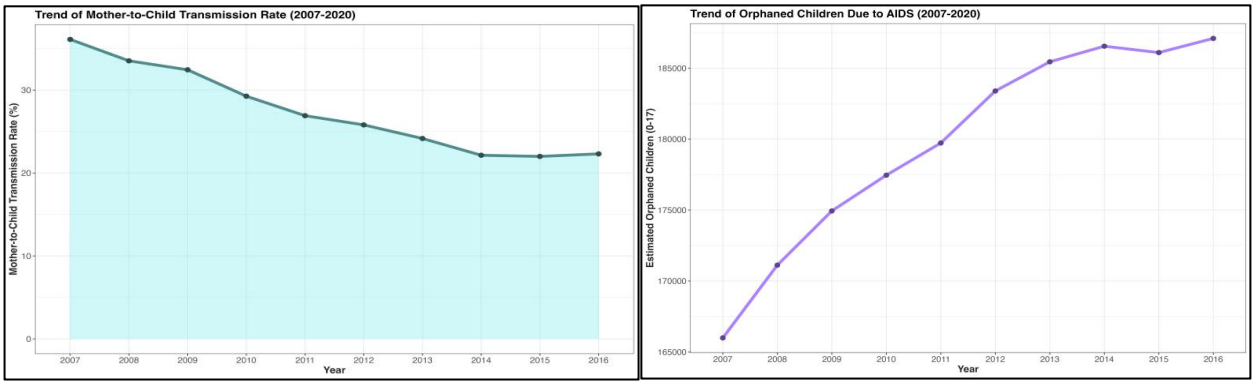
Summary: The total number of people living with HIV in the Western Africa region showed minimal variation over the study period, fluctuating within the range of 214,190 to 220,100. A significant decline in HIV-related deaths was observed, with numbers dropping from 15,846 in 2007 to 9,109 in 2016, highlighting improved treatment and intervention measures.

2. Trend graph for indicator "Estimated number of women (15 and older) living with HIV" and "Percent (%) of pregnant women with known HIV status".



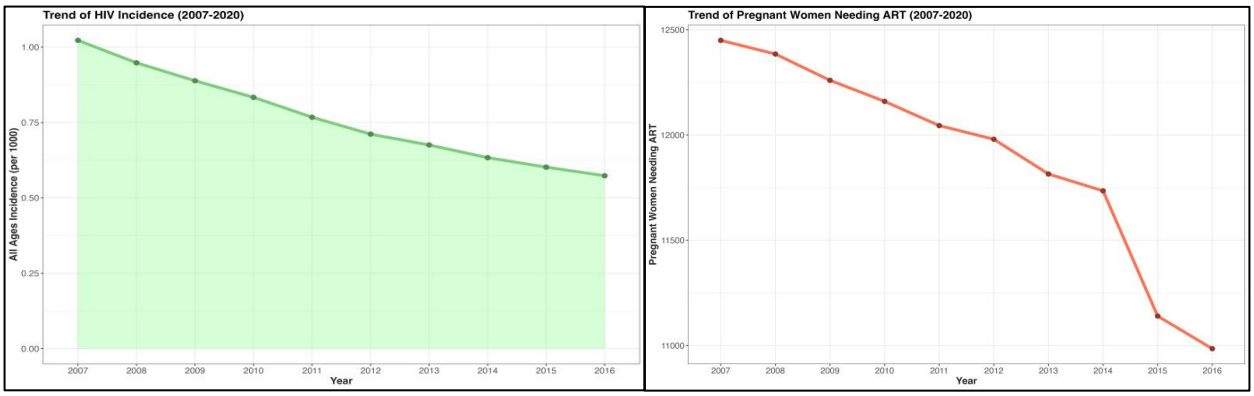
Summary: The number of women aged 15 and older living with HIV showed a slight upward trend, increasing from 128,468 in 2010 to 137,963 in 2016. The proportion of pregnant women with known HIV status increased significantly, from 23.45% in 2007 to 63.55% in 2016, indicating substantial progress in testing and awareness efforts.

3. Trend graph for indicator "Final mother-to-child transmission rate including breastfeeding period" and "Estimated number of children (aged 0-17) who have lost one or both parents due to AIDS".



Summary: The final mother-to-child transmission rate saw a significant decrease, dropping from 36.1% in 2007 to 22% in 2015, reflecting progress in prevention strategies. The estimated number of orphaned children increased slightly over the study period, from 165,995 in 2007 to 187,100 in 2016.

4. Trend graph for indicator "All ages incidence (per 1000 uninfected population)" and "Number of pregnant women living with HIV needing ART to prevent vertical transmission of HIV".



Summary: A significant decrease in HIV incidence was observed, with the rate falling from 1.02% in 2007 to 0.57% in 2016, signaling a reduction in new infections. The number of pregnant women living with HIV needing ART showed a slight decline, from 12,450 in 2007 to 10,985 in 2016.

Part 3: Key Findings Description

The declining trends in deaths, mother-to-child transmission rates, and HIV incidence reflect improved healthcare systems, effective prevention programs, and expanded access to antiretroviral therapy. Nigeria consistently contributing the largest proportions across multiple indicators, focused interventions in the country are critical for achieving regional success. Indicators such as orphaned children and women living with HIV require additional attention, as they continue to show slight increases, signaling gaps in prevention and support systems. Countries like Guinea, Congo, and Mauritania, which exhibit higher transmission or incidence rates, need targeted strategies to address specific challenges.

Part 4: Create Table 2

Create Table 2 with following indicators which are related to economics for countries in Western Africa Region.

(1) Country Population. **(2)** GDP per capita. **(3)** Unemployment rate.

```
CREATE TABLE Economy_HIV_Data (
Country_ID  INTEGER NOT NULL,
Year INTEGER NOT  NULL,
GDP_Per_Capita  REAL,
Population  INTEGER,
Unemployment_Rate  REAL,
PRIMARY KEY("Country_ID","Year"),
FOREIGN KEY("Country_ID") REFERENCES "Country"("Country_ID")
);
```

Table 2 - Economy_HIV_Data and it's fields.

Economy_HIV_Data		CREATE TABLE "Economy_HIV_Data" ("Country_ID" INTEGER NOT NULL, "Year" INTEGER
Country_ID	INTEGER	"Country_ID" INTEGER NOT NULL
Year	INTEGER	"Year" INTEGER NOT NULL
GDP_Per_Capita	REAL	"GDP_Per_Capita" REAL
Population	INTEGER	"Population" INTEGER
Unemployment_Rate	REAL	"Unemployment_Rate" REAL

Import data for each indicator from Economy_HIV_Data.csv.

	Country_ID	Year	GDP_Per_Capita	Population	Unemployment_Rate
	Filter	Filter	Filter	Filter	Filter
1	1	2007	944.64	8647761	0.9
2	1	2008	1098.95	8906469	0.89
3	1	2009	1061.72	9172514	0.95
4	1	2010	1009.49	9445710	1.04
5	1	2011	1099.41	9726380	2.65
6	1	2012	1112.57	10014078	2.42

Part 5: SQL Queries and Data Analysis

Utilize SQL query to join Table 1 and Table 2 and execute SQL quires to analyze the HIV data.

1. Calculate the "number of people living with HIV" by country's Population.

```
SELECT c.Country_Name, SUM(e.Population) AS Total_Population,
SUM(r.Es_People_Living_HIV) AS Total_People_Living_HIV,
ROUND((SUM(r.Es_People_Living_HIV)*1.0/ NULLIF(SUM(e.Population), 0)) * 100, 2) AS
HIV_Prevalence_Percentage
FROM Economy_HIV_Data e
JOIN Research_HIV_Data r ON e.Country_ID = r.Country_ID
JOIN Country c ON e.Country_ID = c.Country_ID
GROUP BY c.Country_Name
ORDER BY Total_People_Living_HIV DESC;
```

	Country_Name	Total_Population	Total_People_Living_HIV	HIV_Prevalence_Percentage
1	Nijeria	16805326770	187000000	1.11
2	Congo, Dem. Rep.	7024362640	52000000	0.74
3	Cote d'Ivoire	2187087650	51600000	2.36
4	Ghana	2657717880	30500000	1.15
5	Mali	1631171260	11800000	0.72
6	Burkina Faso	1692380060	11600000	0.69
7	Togo	684450000	11400000	1.67
8	Chad	1259316370	11000000	0.87
9	Guinea	1068811000	10730000	1.0
10	Congo	460626550	9710000	2.11
11	Burundi	955848660	9240000	0.97
12	Benin	990293540	6910000	0.7
13	Sierra Leone	670417680	6130000	0.91
14	Gabon	181074080	4820000	2.66
15	Senegal	1309430720	4150000	0.32
16	Liberia	421196760	4060000	0.96
17	Guinea-Bissau	163596860	3670000	2.24
18	Niger	1773511050	3650000	0.21
19	Gambia	203442720	2360000	1.16
20	Mauritania	358735260	832000	0.23

Summary: The query reveals the percentage of people living with HIV in each country, highlighting countries with high prevalence, disparities in HIV burden, and the relationship between population size and HIV cases.

2. Calculate the ”number of people living with HIV” by country’s population, and compare the result with average unemployment rate for each country.

```
SELECT c.Country_Name,
AVG(e.Unemployment_Rate) AS Avg_Unemployment_Rate,
SUM(r.Es_People_Living_HIV) AS Total_People_Living_HIV,
ROUND((r.Es_People_Living_HIV*1.0 / NULLIF(e.Population, 0)) * 100, 2) AS
HIV_Prevalence_Percentage
FROM Economy_HIV_Data e
JOIN Research_HIV_Data r ON e.Country_ID = r.Country_ID AND e.Year = r.Year
JOIN Country c ON e.Country_ID = c.Country_ID
GROUP BY c.Country_Name
ORDER BY Avg_Unemployment_Rate DESC;
```

	Country_Name	Avg_Unemployment_Rate	Total_People_Living_HIV	HIV_Prevalence_Percentage
1	Congo	19.856	971000	2.22
2	Gabon	19.711	482000	2.77
3	Mauritania	9.954	83200	0.3
4	Gambia	9.174	236000	1.19
5	Cote d'Ivoire	5.229	5160000	2.98
6	Guinea	5.016	1073000	1.0
7	Ghana	4.696	3050000	1.27
8	Sierra Leone	4.413	613000	0.94
9	Congo, Dem. Rep.	4.175	5200000	0.93
10	Senegal	4.001	415000	0.36
11	Burkina Faso	3.929	1160000	0.81
12	Nijeria	3.881	18700000	1.21
13	Guinea-Bissau	3.214	367000	2.48
14	Togo	2.574	1140000	1.98
15	Liberia	2.307	406000	1.18
16	Benin	1.655	691000	0.75
17	Burundi	1.64	924000	1.38
18	Mali	1.425	1180000	0.78
19	Niger	1.109	365000	0.3
20	Chad	0.917	1100000	1.03

Summary: The query displays how unemployment rates correlate with the estimated number of people living with HIV across countries. It highlights country-level trends, compares HIV prevalence at varying unemployment rates, and provides insights for potential policy interventions.

3. Calculate the average GDP for each country and compare the result with HIV prevalence rate.

```
SELECT c.Country_Name,
e.GDP_Per_Capita,
SUM(r.Es_People_Living_HIV) AS Total_People_Living_HIV,
ROUND((SUM(r.Es_People_Living_HIV)*1.0/ NULLIF(SUM(e.Population), 0)) * 100, 2) AS
HIV_Prevalence_Percentage
FROM Economy_HIV_Data e
JOIN Research_HIV_Data r ON e.Country_ID = r.Country_ID
JOIN Country c ON e.Country_ID = c.Country_ID
GROUP BY c.Country_Name
ORDER BY e.GDP  Per  Capita;
```

	Country_Name	GDP_Per_Capita	Total_People_Living_HIV	HIV_Prevalence_Percentage
1	Burundi	170.71	9240000	0.97
2	Congo, Dem. Rep.	277.61	52000000	0.74
3	Sierra Leone	358.08	6130000	0.91
4	Liberia	377.95	4060000	0.96
5	Niger	384.72	3650000	0.21
6	Burkina Faso	516.75	11600000	0.69
7	Guinea-Bissau	519.22	3670000	2.24
8	Mali	579.26	11800000	0.72
9	Togo	621.73	11400000	1.67
10	Guinea	657.99	10730000	1.0
11	Gambia	725.09	2360000	1.16
12	Chad	806.71	11000000	0.87
13	Benin	944.64	6910000	0.7
14	Ghana	1047.2	30500000	1.15
15	Senegal	1210.17	4150000	0.32
16	Mauritania	1378.22	832000	0.23
17	Cote d'Ivoire	1451.23	51600000	2.36
18	Nijeria	1876.41	187000000	1.11
19	Congo	2219.91	9710000	2.11
20	Gabon	8036.92	4820000	2.66

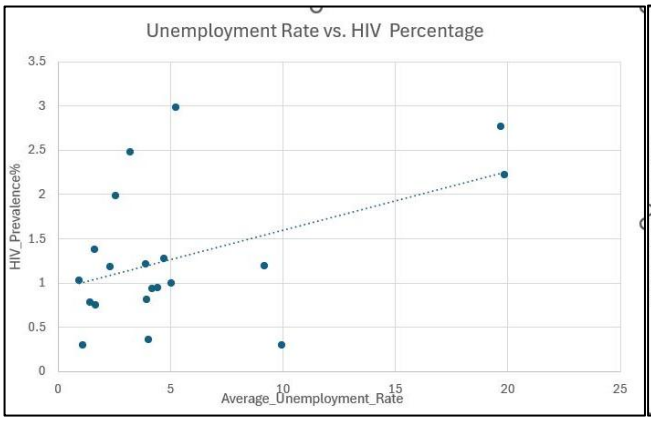
Summary: This query helps analyze the correlation between a country's economic status and the impact of HIV by providing a comprehensive view of the total HIV cases among countries.

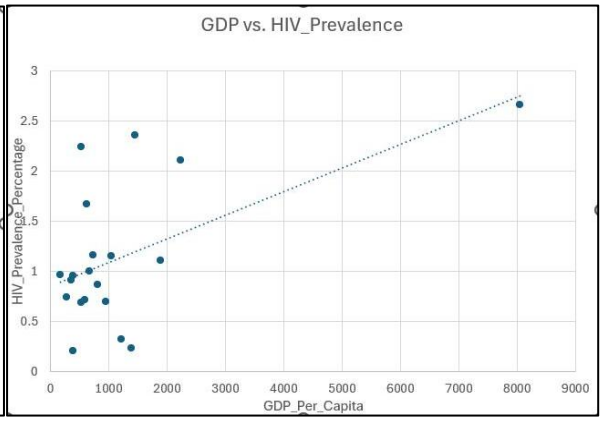
Part 6: Key Findings Description

After examining various queries over a given decade, we found that in many cases there is no clear relationship between attributes, including economic indicators such as GDP per capita and unemployment rates and the HIV incidence rate. This lack of correlation underscores the complex nature of the HIV epidemic, where factors like healthcare accessibility, cultural beliefs, education, and government policies play significant roles. For instance, countries with similar economic conditions exhibited varying HIV prevalence rates, suggesting that wealth alone does not guarantee effective HIV control. Additionally, cultural stigmas and gaps in public health education often hinder testing and treatment access, further complicating the situation. These findings highlight the need for a multifaceted approach, integrating both economic and socio-cultural factors to address the HIV epidemic effectively.

Part 7: Correlation Analysis

Create scatter plot to analysis the relation between HIV prevalence and economic indicators.





Summary: The scatter plots show that higher unemployment rates often correlate with higher HIV prevalence, as seen in Congo (19.86% unemployment, 2.22% prevalence), while countries like Chad and Niger, with unemployment below 1%, maintain much lower prevalence rates. Similarly, GDP shows a weak positive correlation, with outliers like Gabon (GDP $8036.92, prevalence 2.66%) highlighting that wealth alone does not reduce HIV rates, likely due to healthcare inequality and social barriers. Low-GDP countries like Niger and Mali achieve low prevalence through targeted prevention efforts. These findings underscore the need to address structural barriers, ensure equitable healthcare access, and invest in community-driven prevention programs.

Part 8: HIV Policy recommendations

- **Inclusive Care:** Establish safe, judgment-free spaces for LGBTQ+ individuals to access testing and counseling. Ensuring privacy and accessibility in these facilities encourages individuals to seek care without fear of discrimination.
- **Education and Awareness:** Leverage mobile apps, games, and social media to deliver engaging, stigma-free education about HIV prevention and management. Platforms like Instagram and TikTok can debunk myths, promote PrEP, and encourage regular testing, especially for younger audiences.
- **Accessible Treatment:** Make ART and PrEP universally affordable or free, ensuring everyone can access life-saving medications. Use community health centers and telemedicine platforms to improve accessibility, offering services like medication reminders and virtual consultations.
- **Tackle Stigma:** Combat HIV stigma through education in schools, workplaces, and healthcare settings. Focus on empathy-driven awareness campaigns, particularly in rural and underserved areas where misinformation often limits access to care.
- **Empower Women and Girls:** Provide women with tools like female condoms and PrEP to take control of their health. Address systemic gender inequities by improving education and economic opportunities. Expand male circumcision programs in culturally appropriate settings to reduce transmission rates.
- **Harm Reduction:** Offer needle exchange programs to reduce risks for drug users, while connecting them to counseling and addiction treatment. Tailor interventions for vulnerable groups, including sex workers and prisoners, to ensure equitable care.
- **Lower Medication Costs:** Partner with governments and pharmaceutical companies to lower medication costs via subsidies, generics, or free distribution, ensuring affordability for all.
- **Collaborative Action:** Strengthen partnerships between NGOs, healthcare providers, leaders, and influencers to fund research, scale effective interventions, and promote innovative solutions.

Individual Contribution

- Farnaz Nekuie: Collected data for Table 1 and Table 2, created ERD and Database, executed SQL queries to explore data, came up with HIV policies for further improvement.
- Zaili Gu: Created data visualization graphs for each indicator's trends across study period, written the final team assignment report and included all the steps of data analysis.
- Hongru Chen: Created the PowerPoint presentation and comprised every team member's audio narration together to create digital presentation. Created scatter plots to analyze correlation of HIV indicators.

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