**HIV Patients analysis in India**

**1.0 Introduction**

HIV (Human Immunodeficiency Virus) continues to be a significant public health concern in India, affecting a diverse population across different age groups, genders, and socioeconomic backgrounds. Despite advancements in antiretroviral therapy (ART) and public health interventions, challenges such as late diagnosis, poor treatment adherence, and high viral loads remain prevalent among many patients. Understanding the demographic characteristics, treatment patterns, and health outcomes of individuals living with HIV is essential for designing more effective strategies to improve patient care and reduce the spread of the virus.

This report presents an in-depth analysis of HIV patients in India based on key factors such as **age, gender, region, CD4 count levels, viral load, treatment status, adherence percentage, transmission routes, and comorbidities**. By evaluating these variables, we aim to uncover critical insights into disease progression, patient engagement in treatment, and potential gaps in healthcare services. Additionally, this analysis explores how socioeconomic factors, including **education level, employment status, and marital status**, influence treatment outcomes and adherence levels.

One of the key aspects of managing HIV is maintaining a healthy **CD4 count** while keeping **viral load levels low** through consistent treatment and care. Patients with low adherence to ART or inadequate follow-up visits are at greater risk of disease progression and opportunistic infections. This study will highlight patterns in **ART regimen usage, adherence rates, and follow-up visits** to understand how well patients are responding to treatment and identify areas where healthcare interventions can be improved.

Furthermore, the report examines the primary **modes of HIV transmission** among the studied population, shedding light on risk factors such as **sexual transmission, mother-to-child transmission, and needle sharing**. This information is crucial for tailoring awareness campaigns and preventive measures to high-risk groups. Additionally, by analyzing common **comorbidities** like **Diabetes, Hepatitis, and Tuberculosis**, the study emphasizes the need for integrated healthcare approaches to manage HIV patients more effectively.

The insights from this analysis will be valuable for **health care professionals, policymakers, and public health organizations** working towards improving HIV care in India. By identifying trends in patient demographics, treatment adherence, and disease management, this study will provide evidence-based recommendations to enhance **treatment programs, reduce transmission rates, and improve patient outcomes**.

Through this report, we aim to contribute to ongoing efforts in strengthening HIV care strategies, addressing barriers to treatment, and ensuring that individuals living with HIV receive the necessary medical and social support to lead healthier lives.

* 1. **Brief description of the data set**

The data set used in this analysis was sourced from **Kaggle**, a well-known platform for open data sets and data science projects. It contains detailed information on **HIV patients in India**, covering various demographic, clinical, and treatment-related variables.

The data set includes key attributes such as **age, gender, region, CD4 count, viral load, treatment adherence, ART regimen, transmission route, and comorbidities**. These variables provide valuable insights into **disease progression, treatment effectiveness, and factors influencing patient health outcomes**.

By analyzing this data set, we aim to identify patterns and trends related to **treatment adherence, disease management, and the impact of socioeconomic factors on HIV care in India**. The findings will help in understanding **gaps in health care services and areas for improvement in HIV treatment strategies**.

* 1. **: Research Objective**

1. What is the distribution of CD4 count levels across different age groups?
2. How does employment status affect adherence to ART treatment?
3. What is the adherence percentage distribution by ART regimen type?
4. What is the relationship between viral load and treatment status?
   1. **: Significance of the study**

This study is essential in providing **data-driven insights into the management and treatment of HIV patients in India**, addressing critical challenges such as **disease progression, treatment adherence, and public health interventions**. By analyzing patient characteristics, treatment patterns, and health outcomes, this research contributes significantly to health care improvement in multiple ways.

First, the study is valuable to **health care providers**, as it helps them assess the effectiveness of antiretroviral therapy (ART) by analyzing **CD4 count levels and viral load trends**. Understanding these factors enables medical professionals to identify patients at risk of disease progression and take timely interventions. Additionally, evaluating **treatment adherence patterns** provides insights into the challenges patients face in maintaining their medication schedules, helping clinicians design **targeted strategies to improve compliance and reduce HIV-related complications**.

Beyond direct patient care, this research supports **public health policies and intervention strategies**. By analyzing **socioeconomic factors** such as employment status, education level, and marital status, the study highlights how these variables influence treatment adherence. These insights enable policymakers to **design tailored support programs** for different patient groups, ensuring that vulnerable populations receive the necessary assistance. The study also plays a crucial role in **strengthening HIV treatment and management strategies**. Understanding **the types of ART regimens used and their effectiveness** can help in optimizing treatment protocols for improved patient outcomes. Additionally, an analysis of **follow-up visit patterns** emphasizes the need for **better patient engagement and monitoring systems**, ensuring long-term treatment success.

Another key contribution of this research is its role in **expanding global HIV research and data-driven decision-making**. By providing real-world evidence on **HIV patient care in India**, the study allows for comparisons with findings from other countries, contributing to **a broader understanding of HIV treatment challenges worldwide**. Researchers and health care organizations can leverage these insights to improve **data-driven decision-making in HIV treatment programs**, ensuring that best practices are adopted to enhance patient care.

Overall, this study contributes significantly to **evidence-based health care interventions** and the improvement of HIV treatment in India. By leveraging data analytics, it helps bridge gaps in **treatment adherence, disease management, and policy-making**, ultimately leading to **better health outcomes and a reduction in HIV transmission rates**. The findings will be invaluable to **healthcare professionals, policymakers, and researchers**, ensuring that individuals living with HIV receive the necessary medical and social support to lead healthier lives.

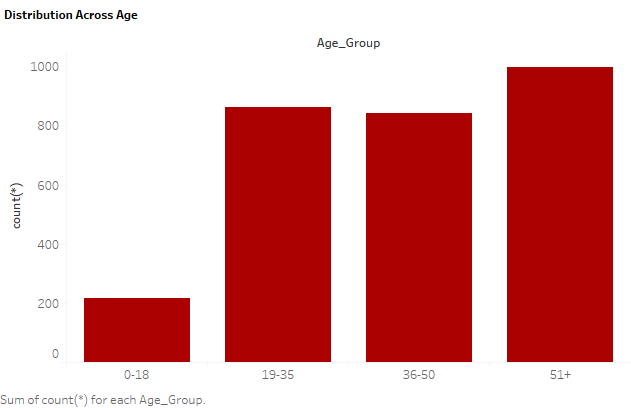
**2.0 : Key Findings and Insights**

**2.1: Demographic Overview**

The data set reveals that **a significant proportion of HIV patients are within the age group of 51 and above** , indicating that that **more people are living longer with HIV**, likely due to the **effectiveness of antiretroviral therapy (ART)** in prolonging life expectancy. It also reflects an **aging epidemic**, where individuals diagnosed earlier in life are surviving into older age. The Data set also reveals that HIV cases are predominantly concentrated in the Central and East regions indicating various reasons such as; The high concentration of cases in these regions suggests that **HIV prevalence may be higher due to socio-economic, cultural, or healthcare-related factors, it might also indicate that the** Central and Eastern regions may have **limited access to health care services**, leading to **higher rates of undiagnosed or untreated HIV cases**.

Also, Economic challenges, including **poverty, unemployment, and lower education levels**, can contribute to **reduced awareness and lower adherence to ART treatment**.

**Fig 2.1**



**Source: Tableau**

**2.2 : CD4 Count Distribution Across Different Age Groups**

The analysis of CD4 count distribution across different age groups reveals several important patterns related to **immune function, treatment effectiveness, and age-related health challenges** in HIV patients.

Overall, the **average CD4 count remains within a similar range across all age groups**, indicating that **age does not drastically influence immune strength in this dataset**. However, a concerning finding is that the **minimum CD4 count is critically low (200 cells/µL) in nearly all age groups**, suggesting that some patients, regardless of age, are at **high risk for opportunistic infections and immune system failure**. On the other hand, the **maximum CD4 count remains relatively high (1498–1499 cells/µL),** suggesting that some individuals maintain a strong immune response, likely due to **effective ART adherence and early intervention**.

When examining age-specific trends, **patients aged 36–50 have the highest average CD4 count (859.24 cells/µL),** which could indicate better treatment adherence or immune recovery within this group. Conversely, **the youngest patients (0–18) have the lowest average CD4 count (813.71 cells/µL),** suggesting potential vulnerabilities in **pediatric and adolescent HIV management**. This could be attributed to **differences in treatment responses, delayed initiation of ART, or challenges in maintaining long-term adherence in children and teenagers**.

Additionally, **elderly patients (51+) show a slight decline in average CD4 count (827.74 cells/µL) compared to the 36–50 age group**. This suggests that **immune recovery might be slower in older adults, possibly due to age-related immune decline or long-term effects of HIV on the immune system**. Given that older patients may also have **higher rates of comorbidities**, such as diabetes or cardiovascular disease, their **immune response to ART may not be as strong as in younger adults**.

From a clinical perspective, these findings highlight the **critical need for targeted interventions for patients with severe immune suppression (CD4 ≤ 200 cells/µL), regardless of age**. Special attention should also be given to **pediatric and adolescent HIV care**, ensuring early diagnosis and optimized treatment regimens. Similarly, **older adults living with HIV may require more personalized treatment plans**, including **closer monitoring of ART effectiveness and additional support for managing age-related health conditions**.

In summary, while **the distribution of CD4 count is relatively stable across age groups**, the presence of **critically low immune function in some patients underscores the importance of continued monitoring and tailored health care approaches**. These insights reinforce the need for **age-specific HIV care strategies to optimize treatment success and improve long-term health outcomes**.

**2.3 :** **What is the adherence percentage distribution by ART regimen type?**

The key findings from the analysis of adherence percentages to the different ART regimens reveal a clear trend in patient adherence. The second line ART regimen shows the highest average adherence percentage, indicating that patients on this regimen are more likely to stick to their prescribed treatment. This may be due to factors such as better tolerability, more effective monitoring, or increased support during treatment.

The first line ART regimen follows closely, recording the second highest adherence rate. Although the first line is commonly prescribed as the initial treatment option and is often simpler with fewer side effects, factors like disease progression, side effects, or drug resistance may lead to a shift to the second line, which could affect adherence levels.

On the other hand, the third line ART regimen has the lowest adherence percentage. This could be attributed to the complexity of the regimen, the higher likelihood of side effects, and the potential for reduced availability of third line options. Additionally, patients on third line treatment may experience challenges related to frustration from previous treatment failures or difficulty accessing the required medications, contributing to the lower adherence rates observed.

**2.4: The Impact of Employment Status on Adherence to ART Treatment**

The key findings from the analysis of the impact of employment status on adherence to ART treatment indicate a slight difference between employed and unemployed individuals. The average adherence percentage for unemployed individuals is 74.69%, which is slightly higher than the 74.11% recorded for employed individuals. This suggests that unemployed individuals, on average, exhibit slightly better adherence to their ART regimen.

The difference, though minimal, highlights the potential influence of employment status on adherence. Employed individuals may face challenges such as time constraints, work-related stress, and limited access to health care, which could negatively affect their adherence. In contrast, unemployed individuals may have more time to prioritize their health and treatment, which could explain their higher adherence rates.

Although the gap is small, these findings suggest that employment status could play a role in ART adherence, and understanding these dynamics can help tailor interventions to improve adherence for both groups.

**2.5: The Relationship Between Viral Load and Treatment Status**

The analysis of the relationship between viral load and treatment status reveals that individuals receiving ART treatment have a higher average viral load compared to those not on treatment. This finding may seem unexpected but can be explained by the fact that ART is often initiated for individuals with higher viral loads, meaning those in the "Yes" category are more likely to have had severe cases before starting treatment.

In contrast, individuals not receiving ART treatment tend to have lower viral loads on average. This could be due to several reasons, such as being in the early stages of infection or not yet meeting the clinical threshold for treatment initiation. Additionally, some individuals in this group may naturally maintain lower viral loads without treatment.

The findings also highlight the importance of monitoring treatment effectiveness over time. Although individuals on ART currently exhibit higher viral loads, long-term adherence to treatment is expected to lead to viral suppression. Factors such as treatment adherence and potential drug resistance may also influence viral load levels, underscoring the need for continuous patient support and regular viral load testing to ensure effective disease management.

**3.0 : Conclusion**

The findings from this analysis provide valuable insights into key factors influencing ART adherence, immune response, and treatment outcomes. The distribution of CD4 count across different age groups highlights the need for age-specific interventions, particularly for pediatric, adolescent, and elderly patients who may face unique challenges in immune recovery and treatment adherence. The adherence analysis by ART regimen type reveals that second-line regimens show the highest adherence, while third-line regimens have the lowest, likely due to treatment complexity and side effects.

Furthermore, employment status appears to have a minor impact on ART adherence, with unemployed individuals showing slightly higher adherence rates than their employed counterparts. This suggests that time constraints and work-related stress may hinder adherence among employed patients, emphasizing the need for workplace-based interventions and flexible treatment access options.

The relationship between viral load and treatment status underscores the importance of monitoring treatment progress over time. While individuals on ART tend to have higher viral loads initially, long-term adherence is expected to lead to viral suppression. This finding reinforces the necessity of sustained support for ART adherence, regular viral load testing, and proactive measures to address potential drug resistance.

Overall, these insights highlight the importance of personalized and targeted strategies to improve ART adherence and treatment effectiveness. Strengthening patient support systems, ensuring timely intervention for vulnerable age groups, and addressing socioeconomic barriers to adherence will be crucial in optimizing long-term health outcomes for individuals living with HIV.

**3.1: Recommendation:**

Based on the key findings from this research, the following recommendations are proposed to enhance ART adherence, optimize treatment outcomes, and improve patient management:

**Targeted Support for Patients with Critically Low CD4 Counts**

Patients with CD4 counts at or below 200 cells/µL should receive priority intervention, regardless of age.

Regular follow-ups, intensified adherence counseling, and early initiation of prophylaxis against opportunistic infections should be emphasized.

**Strengthening Pediatric and Adolescent HIV Management**

Given the lower average CD4 counts in younger patients (0–18 years), pediatric-specific interventions should be strengthened.

Improved caregiver education, child-friendly ART formulations, and psychosocial support can enhance treatment adherence and immune recovery.

**Age-Specific HIV Care Approaches**

Older patients (51+) may require tailored interventions to address age-related health complications affecting ART effectiveness.

Comprehensive care models integrating HIV treatment with management of comorbidities should be adopted for better health outcomes.

**Enhancing Adherence to Third Line ART Regimen**

Since third-line ART adherence is the lowest, strategies should focus on improving medication availability, side effect management, and patient counseling.

More research should be conducted on the barriers preventing patients on third-line regimens from achieving higher adherence.

**Workplace HIV Treatment Support Programs**

Since employed individuals have slightly lower adherence rates, workplace-based ART support programs should be considered.

Employers and health organizations can collaborate to provide flexible treatment schedules, workplace counseling, and medication reminders.