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Applying Incidence-Prevalence Ratio to Define Epidemic Control in 6 US Fast-Track Cities

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Background

- HIV epidemic control is defined by the World Health Organization (WHO) as the reduction of disease incidence, prevalence, morbidity, and/or mortality to a locally acceptable level as a result of deliberate efforts. Continued intervention measures are required to maintain the reduction.
- SDG 3.3 calls for ending the AIDS epidemic by 2030, which involves a reduction in incidence worldwide.
- Targets including the 95-95-95 treatment targets have garnered global consensus in working towards reducing HIV incidence and mortality; yet there lacks specific consensus on an incidence-focused goal though several metrics have been proposed.
- The Incidence-Prevalence Ratio (IPR) is one such proposed metric for defining epidemic control.

Background: Incidence Prevalence Ratio

IPR provides a comprehensive view of the epidemic's dynamics.

- Incidence represents the number of new HIV infections within a specific time period
- Prevalence denotes the total number of individuals living with HIV at a given point in time.

By leveraging these two measures, health authorities can assess the rate of new infections relative to the overall number of people living with HIV.

Advantages of using IPR to measure Epidemic Control

- ease of calculation
- applicability as a milestone towards achieving epidemic control towards ending AIDS by 2030
- adaptability to various contexts, including sub-nationally and among sub-populations

Methodology

- Incidence prevalence ratio (Incidence/Prevalence) was calculated for 6 US Fast-Track Cities.
- IPR data were considered alongside proportion of PLHIV virally suppressed, which also would inform a reduction in incidence.
- Selection Criteria: Fast-Track Cities in the US were included based on availability of incidence and prevalence data; as well as viral suppression data on or after 2020.
- The IPR threshold for having reached epidemic control was defined as 0.026 in the United States based on a formula from a meeting convened by the UNAIDS Science Panel:
  - IPR Threshold = 1/D where D equals the number of years a person who has newly acquired HIV survives post acquisition.
  - The rationale is that if there are fewer than 1 HIV infections per person living with HIV over the course of their lifetime, the HIV epidemic will decline. Assuming a newly infected person survives for D years post infection, the IPR threshold is calculated as 1/D.

Methodology – Calculating IPR Threshold (2021)

- Calculation for Epidemic Control Threshold in the United States
  - National life expectancy: 77 years[1]
  - National average age at diagnosis: 35 years (avg age of diagnosis falls between 30-40)[2]
  - National average time to diagnosis: 40 months[3] (~3 years)
  - D= 77 – (35+3) = 39
  - IPR Threshold = 1/D = 1/39 = **0.026**

Our study was inspired by the paper published in 2018 by Peter Ghys and colleagues, where the IPR threshold was defined as 0.03 given a modelled estimate of D=33 years[4].

1. *https://www.cdc.gov/nchs/pressroom/nchs_press_releases/2022/20220831.htm*
2. *https://www.cdc.gov/hiv/library/reports/hiv-surveillance/vol-33/content/national-profile.html*
3. *Crepaz, et al. Estimated time from HIV infection to diagnosis and diagnosis to first viral suppression during 2014-2018. AIDS. 2021.*
4. *Ghys et al. Epidemiological metrics and benchmarks for a transition in the HIV epidemic. PLOS Medicine. 2018.*

Results

City	IPR	% PLHIV Virally Suppressed	Year
Austin	0.044	56%	2020
Charleston	0.026	50%	2020
Denver	0.027	65%	2021
Houston	0.041	39%	2020
San Antonio	0.046	67%	2020
San Francisco	0.01	70%	2021

Results

Cities Ranked by Incidence Prevalence Ratio	Cities Ranked by Viral Suppression
San Francisco (0.01)	San Francisco (70%)
Charleston (0.026)	San Antonio (67%)
Denver (0.027)	Denver (65%)
Houston (0.041)	Austin (56%)
Austin (0.044)	Charleston (50%)
San Antonio (0.046)	Houston (39%)

- Based the .026 IPR threshold for epidemic control, two of the six cities (Charleston, San Francisco) achieved epidemic control, indicating a shrinking of their epidemics; and one city is close (Denver at 0.027).
- However, these cities were not necessarily the same cities with the highest proportion of PLHIV virally suppressed, which were San Francisco (70%), San Antonio (67%), and Denver (65%).
- Cities with the same IPR in some instances varied greatly in terms of proportion of PLHIV virally suppressed. For example, Austin and Houston both have an IPR of ~.04 but have 56% and 39% of PLHIV virally suppressed, respectively.

Conclusion

- The incidence-prevalence ratio is a useful metric in considering the epidemic control. By collecting and analyzing local data on new infections and the total number of people living with HIV, health officials can measure progress towards HIV epidemic control within their specific jurisdiction
- Viral suppression (3rd 95) is an important programmatic target and can inform successes towards incidence reduction. However, it should be leveraged alongside epidemic control metrics such as IPR which additionally captures the impacts of PrEP and combination prevention on incidence reduction
- IPR threshold can be adapted to different countries with availability of average age of diagnosis, average time to diagnosis, and average life expectancy.
- Future directions: IPR can also be calculated for different sub-populations and thus can inform equity in epidemic control

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