HIV PREVALENCE AMONG KEY POPULATIONS IN THE ASIA PACIFIC REGION: A STATISTICAL ANALYSIS

Mia Gabriella Escobar
Mathematics
March, 2025

Faculty Adviser(s): Dr. Anna M. Groat Carmona, Dr. Yajun An, and Su Miao Lai

Essay completed in partial fulfillment of the requirements for graduation with Global Honors, University of Washington, Tacoma

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Approved:

Faculty Adviser	3/14/25 Date
DocuSigned by: Divya McMillin 261564B519C646F... Associate Vice Chancellor, IIGE	5/27/2025 Date

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1 Introduction

1.1 Background and Virology

Human immunodeficiency virus (HIV) infections can be extremely dangerous if left untreated. HIV is commonly transmitted through sexual contact, but people can also become infected through other means such as sharing needles with an HIV positive person or mother-to-child transmission via breastfeeding [1]. Once contracted, the virus will attack specific white blood cells, breaking down the immune system and leaving the host vulnerable to secondary infections [10]. At the acute infection state, the disease consists of mainly flu-like symptoms, so the only way to know if someone has HIV is to get tested [1]. Once symptoms subside, the chronic stage of the infection begins, where the virus continues to replicate in the body asymptomatically [1]. If left untreated, the increase in viral load leads to the final stage, acquired immunodeficiency syndrome (AIDS), which leaves the person defenseless to infection, and can be fatal if left untreated [1]. While currently there is no cure for HIV, if treated properly the viral load can become undetectable and people can still live a full life. Antiretroviral therapy (ART) is the most common form of treatment for HIV and prevents the virus from multiplying by targeting key stages in the viral life cycle [10]. However, ART must be taken every day for the rest of patient's lives, as the virus would continue to multiply if they stopped the drug regimen [10].

1.2 Key Populations

HIV is, and has always been, an inherently political issue. This is in part due to the over-representation of key populations among new cases. A key population, in the context of this study, is defined as a group of people who have an increased risk of HIV exposure due to their identity. While one of the most frequently discussed key populations is gay men, or more formally men who have sex with men (MSM) [14], many other groups are also at an increased risk of exposure due to their identity.

Some of these key populations include sex workers (SW), people who inject drugs (PWID), transgender people (TG), or more specifically transgender women (TGW), incarcerated people (PR), and adolescents [14]. These groups often face discrimination on both a social and political level, making access to health services more difficult and increasing fear of personal repercussions if they are to seek help. The Joint United Nations Programme on HIV/AIDS (UNAIDS) states that as of 2017, 44 percent of new HIV cases worldwide were among key populations and their sexual partners [4][28]. This is a significant percentage of infected people, especially when considering the relatively small size of these key populations within the general population. For example, PWID can be up to 24 times more likely to contract HIV then the general public due to their increased frequency of exposure to others who are HIV positive or the use of contaminated needles, but it can also be explained by their lowered immune response as a result of drug use [28][1]. The same can be said for SW, who are ten times more likely to contract HIV than the general population globally [28]. Again, this could be because of increased HIV exposure through frequent sexual contact, but also stems from their risk of contracting other sexually transmitted diseases (STDs) that could lower their immune response [28].

1.3 Current State of the Pandemic

While new HIV infections have gradually decreased over the past decade, not all progress has been equal across regions [25]. In Eastern and Southern Africa, which accounts for the majority of new cases as of 2021, new infections decreased by 43 percent from 2010 to 2020 [25]. In comparison, the Asia Pacific region, which ranks second in new HIV cases, only decreased new infections by 21 percent from 2010 to 2020 [25]. Additionally, more than 94 percent of new HIV infections in the Asia Pacific region were among key populations and their sexual partners in 2021, which is 50 percent more than the global average [25]. This is a staggering statistic, highlighting the need for research focused in this region. As of 2021, some countries in the Asia

Pacific also have reported increasing numbers of new cases among key populations, including Pakistan, the Philippines, and Indonesia [25]. If HIV cases in Eastern and Southern Africa continue to decrease, it is possible that the Asia Pacific region could be the next major roadblock in reaching the United Nations' (UN's) goal of ending the HIV pandemic by 2030 [8].

The UN has detailed multiple goals that must be achieved for the HIV epidemic to be declared "over". These include keeping the number of new infections per 1000 individuals in the population sufficiently low, and reaching the 95-95-95 goals in impacted regions [5]. The 95-95-95 goals consist of having 95 percent of HIV positive people aware of their status, 95 percent of infected individuals on a drug treatment regimen such as ART, and 95 percent having reached the point where their viral load is undetectable [7]. As of 2023, the Asia Pacific region was at 78-67-65, in comparison to the global average of 86-77-72 [26].

The lack of a cure or vaccine for HIV means that alternate preventative measures are some of the only options available to stop the spread of the disease. These interventions often take the form of social programs funded by foreign aid organizations such as the United States Agency for International Development (USAID), the President's Emergency Plan for AIDS Relief (PEPFAR), and UNAIDS [22]. However, recent developments under the Trump administration have threatened the reliability of USAID and PEPFAR, which could severely impact these HIV prevention programs[22]. This once again risks an increase in new HIV cases, especially among key populations, and threatens the livelihoods of those living with HIV globally. In the face of major political change, it is important to allocate what resources we have available wisely.

1.4 Purpose and Scope

The Asia Pacific region was chosen for this study because of the strong representation of key populations among reported new cases and the comparably low decline in new cases compared to the global average. This and the lack of quantitative studies

focused in the region served as motivations for further analysis. The goal of this study is to identify possible intervention strategies that would be effective across both the general public and specific key populations. While these goals are not mutually exclusive, some interventions may be more or less effective depending on the targeted population. This is an important consideration as it would allow for a strategic use of funds in the constantly changing landscape of HIV policy. First, we reviewed previous literature surrounding HIV prevalence among key populations in the Asia Pacific to identify potential intervention services recommended by experts. Next, we gathered what data is available relating to these interventions. After eliminating any unusable data, we utilized statistical methods to analyze the correlations between different interventions and the rates of HIV prevalence among both the general public and key populations. Data surrounding the criminalization and use of discriminatory policies in these countries was included in the analysis to provide context for why these interventions may or may not be as effective in preventing cases. Finally, with these results, we evaluate which intervention strategies are most viable and identify which key populations they should be aimed towards in the current political climate.

2 Methodology

2.1 Data Acquisition

Datasets from multiple sources were considered including various annual data reports from UNAIDS [25], the UNAIDS Key Population Atlas [26], the Sustainable Development Goals (SDG) Gateway for the Asia Pacific region [21], and the UNAIDS Asia Pacific Data Hub [24]. Ultimately, variables for the analysis were selected from the UNAIDS Data Report for 2021[1] [25] and the SDG Gateway for the Asia Pacific[2] [21] based on accessibility and relevance. Key populations for this study were chosen

[1]Data in the report for 2021 surrounding HIV prevalence was acquired in the year 2020. This was not accounted for in the initial analysis, and is noted as a limitation for the study.
[2]All data collected from SDG Gateway was acquired in the year 2021.

based on the five main high risk populations identified by UNAIDS [14]: MSM, SW, PWID, TG, and PR. HIV prevalence rates for these key populations were sourced from the UNAIDS Data Report for 2021 [25]. UNAIDS states in their indicator registry that the HIV prevalence for these key populations was calculated using data collected from testing sites and behavioral surveys, where the numerator is the number of people in the key population who tested positive for HIV, and the denominator is the total number of people in the key population who were tested [11].

Data for women's participation in formal and non-formal education and training programs within the previous 12 months aged 15-24 (PFNFET) and the Universal Health Coverage Service Coverage Index (SCI) for 2021 were sourced from the SDG Gateway for the Asia Pacific region [21] which is funded by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) [21]. The SDG Gateway for the Asia Pacific region tracks the progress of various SDGs, including the indicators listed under their targets. Availability of data regarding key populations in the Asia Pacific region posed a barrier during the data acquisition process. Of the 39 countries considered for this study from the Asia Pacific region, the number of available data points (n) per variable varied significantly. This can be seen in Table 1 along with other important information regarding the acquired data.

Table 1: Description of Available Data on HIV Prevalence in Key Populations in the Asia Pacific Region and Other Relating Factors HIV prevalence rates were pulled from the UNAIDS data report for 2021 [25] while data for PFNFET and SCI was pulled from the SDG Gateway for the Asia Pacific region [21]. HIV Rate=HIV prevalence in key population, MSM=men who have sex with men, SW=sex workers, PWID=people who inject drugs, TG=transgender people, PR=incarcerated people, PFNFET=Participation rate in education and training programs in the previous 12 months (percentage of women aged 15-24), and SCI (Service Coverage Index)=Universal Health Coverage. Units for HIV Rates are the "number of people in a specific key population who test positive for HIV" over "the number of people in a specific key population tested for HIV" [11].

	HIV Rate PWID %	HIV Rate SW %	HIV Rate PR %	HIV Rate MSM %	HIV Rate TG %	PFNFET %	SCI (Index, 1-100)
n	12	16	10	18	10	18	39
Mean	9.34	3.83	1.26	7.22	6.49	51.02	60.21
Std	7.34	4.22	1.41	5.81	4.47	15.41	14.01
Min	0	0	0	0	0	18.90	30.00
25 %	2.45	0.68	0.33	3.78	3.30	46.98	52.00
50 %	9.50	2.95	0.90	5.50	7.00	55.60	58.00
75 %	14.08	4.73	1.78	8.63	10.58	63.35	67.50
Max	21.00	15.50	4.70	21.60	11.90	66.80	89.00

Multiple countries reported data for some indicators (eg. HIV Prevalence in MSM) but not for others (eg. PFNFET), so this also reduced the number of unique data points when comparing variables in this analysis. These constraints in data acquisition should be considered during the interpretation of study results.

2.2 Data Analysis

The primary tools used for this analysis were `Python`, `Jupyter Notebook`, and `Excel` to generate data visualizations and compute calculations. `Pandas` was used for data analysis and cleaning, including reading and interpreting data from excel and

.csv files to analyze via `Jupyter Notebook`. `Seaborn` and `MatPlotLib` were used for generating graphs, and `NumPy` was used for calculations. HIV prevalence rates were determined using reported values, but when a range was given, the upper bound value was taken. This was done to account for the chance of under-reporting due to stigma and possible avoidance of testing. When transcribing the existence of a criminalizing policy in countries listed in the UNAIDS data report for 2021 [25], 1 was assigned to any country that had at least one criminalizing policy, and 0 was assigned if these policy types were absent. Missing data was considered missing at random (MAR) due to the inconsistency in years where countries reported data for different reasons (e.g. was not collected, was not reported, etc.). When comparing variables, countries that did not have data available were dropped. Correlation coefficients for Figure 1 were calculated via `Seaborn`, and those with the strongest correlations were chosen for closer examination. `NumPy` poly-fit [18] was used for all trend lines, which calculates a polynomial p(x) for which the squared error is minimized.

$$E = \sum_{j=0}^{k} |p(x_j) - y_j|^2 \tag{1}$$

For a degree of one, `NumPy` generates a regression line where X is all points for the independent variable, which would be from either PFNFET or SCI. Y represents all points for the dependent variable, which would include the HIV prevalence within a given key population (MSM, SW, PWID, TG, and PR). Finally, β_1 is the slope of the trendline and β_0 is the y-intercept.

$$Y = \beta_0 + \beta_1 X \tag{2}$$

This data was then plotted with a 95 percent confidence interval using `Seaborn`.

3 Results

3.1 Literature Review

We began our investigation with a literature review of articles surrounding HIV/AIDS prevalence among key populations in the Asia-Pacific region with the goal of identifying commonly proposed interventions. Articles were selected from after 2010 via Google Scholar and PubMed to account for possible recent shifts in recommended HIV interventions. Sources were categorized based on which key populations were discussed, whether they were considering the Asia Pacific region as a whole or specific countries therein, and the type of study conducted (Table 2). The majority of the selected studies were qualitative, and the studies that included quantitative methods were generally focused on HIV prevalence in individual countries. Key populations that were mentioned frequently and were of interest to our investigation included MSM, SW, PWID, TG, PR, and adolescents.

Table 2: Literature Review of Studies on Key Populations in the Asia Pacific Region. MSM=men who have sex with men, SW=sex workers, FSW=female sex workers, PWID=people who inject drugs, TG=transgender people, TGW=transgender women, PR=prisoners and incarcerated people, PrEP= pre-exposure prophylaxis. Studies were acquired using *Google Scholar or **PubMed.

No.	*Citation*	*Key Populations*	*Study Type*	*Country/Region*	*Proposed Solutions*
1	Murphy et al., 2021*	MSM, SW, PWID, TG	Qualitative	Asia-Pacific (General)	Preventative care and treatment, community activism and service, dismantling punitive laws, and people-centered public and universal healthcare.
2	Schunter et al., 2014*	Adolescents	Systematic Review	Asia-Pacific (General)	Design of public services, peer education, condom use policies, sexuality education, rights-based enforcement of anti-trafficking laws, and addressing violence and abuse.
3	Yang et al., 2020*	MSM, SW, PWID, TG, PR	Qualitative	Asia-Pacific (General)	Legal reform, key population led health services, crowdsourcing, and stigma reduction.
4	Vannakit et al., 2020*	MSM, SW, PWID, TG	Qualitative	Asia-Pacific (General)	Health and HIV services for key populations, HIV financing for key populations, accessible financial data, and in-depth research on key population-led programs.
5	Janamnuaysook et al., 2021*	MSM, SW, TGW	Qualitative	Asia-Pacific (General)	De-medicalization of HIV interventions, reducing stigma, and key population-led services.
6	Lemons-Lyn et al., 2021**	MSM, FSW, PWID, PR, TG	Quasi-Experimental	Myanmar	Key population sensitization training for healthcare workers.
7	Januraga et al., 2018**	MSM, FSW, PWID, TGW	Prospective Cohort Study	Indonesia	Education (general), and interventions to increase treatment retention and viral suppression rates.
8	Solomon et al., 2019**	MSM, PWID	Respondent-Driven Sampling Surveys	India	Use of key population size estimates to inform HIV interventions.
9	Choi et al., 2023**	MSM, TG, SW	Qualitative	China, Hong Kong, Singapore, South Korea, Taiwan and Thailand	Reduce stigma, scale up PrEP services, integrate health services to improve quality of life, strengthen key population lead services.

Based on the literature review, the most common suggestions for reducing HIV prevalence among these key populations both regionally and by country included access to general and health specific education, adapting healthcare settings to meet the specific needs of key populations, stigma reduction in both the general public and among healthcare workers, dismantling discriminatory policies against key populations, and community led services to reach more people (Table 2). Murphy et al. [17], Yang et al. [29], Choi et al. [3], Lemons-Lyn et al. [15], and Vannakit et al. [27] discussed healthcare changes that should be made to aid key populations. Suggested changes included implementing people-centric services and design as well as creating programs aimed to support key populations. Some of these included services that increase accessibility to PrEP and employee sensitization trainings to understand the needs of those in marginalized groups [15][3]. On a larger scale, accessibility to healthcare services stood out as a common factor. Interventions relating to shifts in education were also proposed by both Schunter et al. [20] and Januraga et al. [12] as viable solutions. Schunter et al. [20] stated, in their systematic review of key populatio-related HIV interventions, that peer education correlated with "high-impact" interventions, and that improved sexual education practices led to better safe sex practices among adolescents. Januraga et al. [12] also found through their cohort study that people in key populations who had completed secondary level eduction or higher were significantly more likely to reach a state of viral suppression, meaning educational background could also help people in key populations even after infection. Policy changes and legal reforms were suggested by Schunter et al. [20], Murphy et al. [17], and Yang et al. [29] to increase the effectiveness of different intervention strategies. Of these, a focus was placed on dismantling laws that discriminate against key populations and enforcing human rights-based polices in countries from the region.

3.2 Variables

Although multiple intervention strategies may present considerable benefits across key populations, some, such as stigma reduction and community-led services, are difficult to quantify. The UN maintains multiple databases relating to SDGs, of which multiple targets align with the proposed interventions acquired from the literature review. For example, SDG 3 aims to "ensure healthy lives and promote well-being for all at all ages", including the target of ending the HIV epidemic (Target 3.3) [5]. SDG 3 also aims to achieve universal health coverage for all (Target 3.8). This target is measured using indicator 3.8.1, "coverage of essential health services", which is recorded by the Universal Health Coverage Service Coverage Index (SCI). This measurement gives a comprehensive view of the accessibility to healthcare in any given country, and data was made publicly available for via the SDG Gateway for the Asia Pacific region [21]. For these reasons, this indicator was included in the study as a variable. SDG 4 aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" [6]. The specific target populations under SDG 4 mostly focus on access to education on the basis of sex, so the education rates for key populations are not specified. The statistics surrounding educational programs for key populations were also not widely available through other sources, so data from SDG 4 was selected. Target 4.3 which details "equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university" was chosen as a representative for accessibility to education. The indicator for this target (indicator 4.3.1) is "participation in formal and non-formal education and training in the previous 12 months for women aged 15-24" (PFNFET). Data for this measurement was also made available via the SDG Gateway for the Asia Pacific [21].

While this indicator is specific to women, women's education has also been shown to impact other key populations. In a study by the United Nations Educational, Scientific and Cultural Organization (UNESCO) Bangkok, they detail the relationship women's education has to MSM, SW, and PWID [9]. While MSM is classified as men who

have sex with men, many of these men also are in relationships with women, or engage in intercourse with both men and women [9]. In addition to this, SW are frequently coerced into sexual acts due to economic conditions or are subjected to some form of sex trafficking, of which many are women with limited access to education [9]. PWID are also commonly people with financial struggles, and often overlap with SW, leading to high risk behaviors [9].

The existence of punitive and discriminatory laws surrounding HIV prevalence by country is recorded by UNAIDS in their annual data reports, which includes the category of "laws criminalizing the transmission of, non-disclosure of or exposure to HIV transmission" [25]. Data for this indicator was pulled from the UNAIDS Data Report for 2021 [25]. HIV prevalence rates for key populations were chosen to compare across countries as the dependent variable because it is one of the most widely available measurements and captures the direct impact that HIV is having on these populations. In addition to this, it is noted by UNAIDS in their indicator registry that this measurement is not impacted by antiretroviral therapy, so it will not distort measurements because of increased lifespan when compared to historical measurements [11].

3.3 Correlation Heatmap

Using the available data for these different indicators, a correlation heat-map was generated using `Seaborn` to compare the correlation coefficients between said independent variables and the HIV prevalence among key populations in the Asia Pacific Region (Figure 1.).

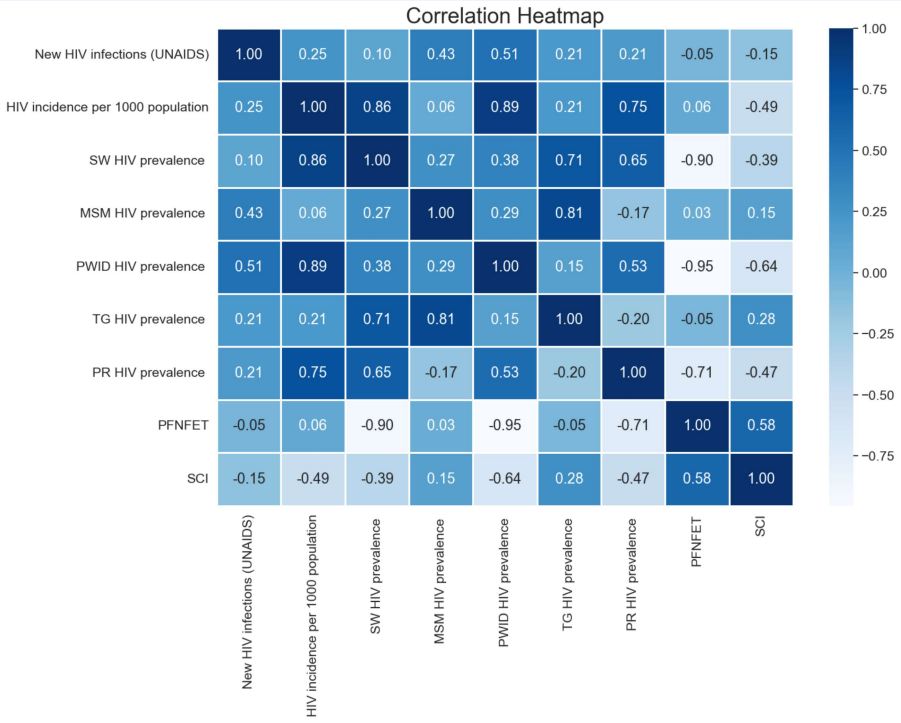


Figure 1: Correlation Heatmap For HIV Prevalence in the Asia Pacific Region. Correlation coefficients (r-values) were generated using Seaborn (SNS) and indicate the strength of the relationship between the two variables. A negative correlation ($r < 0$) indicates that when one value increases, the other decreases. A positive correlation ($r > 0$) indicates that when one variable increases or decreases, the other does as well. Any country that did not have points for both variables was dropped, as such the number of available points (n) should be considered in the interpretation of these results. The shade of blue for each coefficient was assigned based on a gradient of light to dark where a negative correlation is lighter in hue and a positive correlation is darker. The strength of the correlations were classified for both positive and negative r values: $0 \leq r < 0.2$: very weak, $0.2 \leq r < 0.4$: weak, $0.4 \leq r < 0.6$: moderate, $0.6 \leq r < 0.8$: strong, and $0.8 \leq r \leq 1$ very strong.

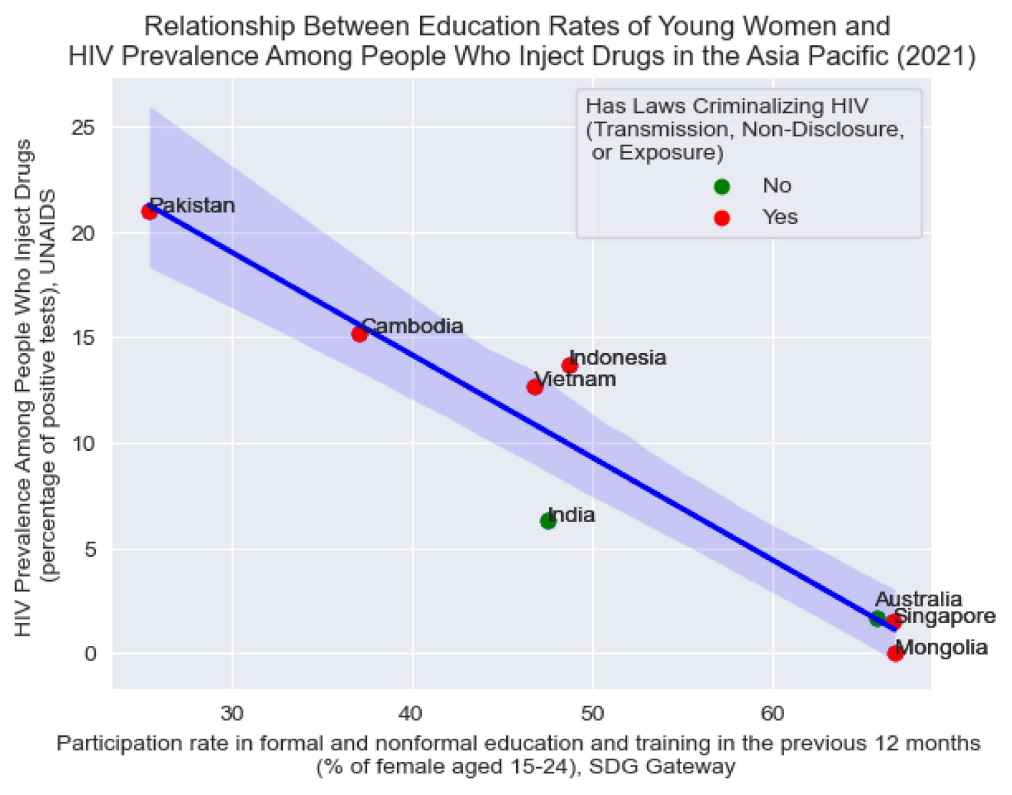
In Figure 1, each correlation coefficient (or r-value) represents the strength of the correlation between the two variables. For example, HIV prevalence among SW had a very strong negative correlation with PFNFET (r=-0.90), meaning that in countries with higher participation rates among women in tertiary education, there is reduced HIV prevalence among SW. In comparison, HIV prevalence among MSM had a near zero correlation with PFNFET (r=0.05), indicating there was no significant impact on HID prevalence for MSM from increased women's education in this region. This is understandable, as reduced participation of women in education programs may not

have a noticeable impact on key populations defined as only men. There was also a moderate positive correlation (r=0.58) between PFNFET and SCI, meaning that countries with higher universal healthcare coverage were also more likely to have higher rates of women participating in tertiary education programs. Additionally, there were significant positive correlations between the HIV prevalence in key populations such as among SW and TG (r=0.71). This was also the case for the HIV prevalence among MSM and TG (r=0.81), as well as between PR and SW (r=0.65). This is expected, as many of these identities are inherently intersectional. For example, someone may be a member of two or more key populations, such as a sex worker who was incarcerated due to laws criminalizing sex work. Another contributing factor for these positive correlations is the interactions between key populations, such as a man who is placed in the category of MSM but has also had intercourse with people who identify as TG.

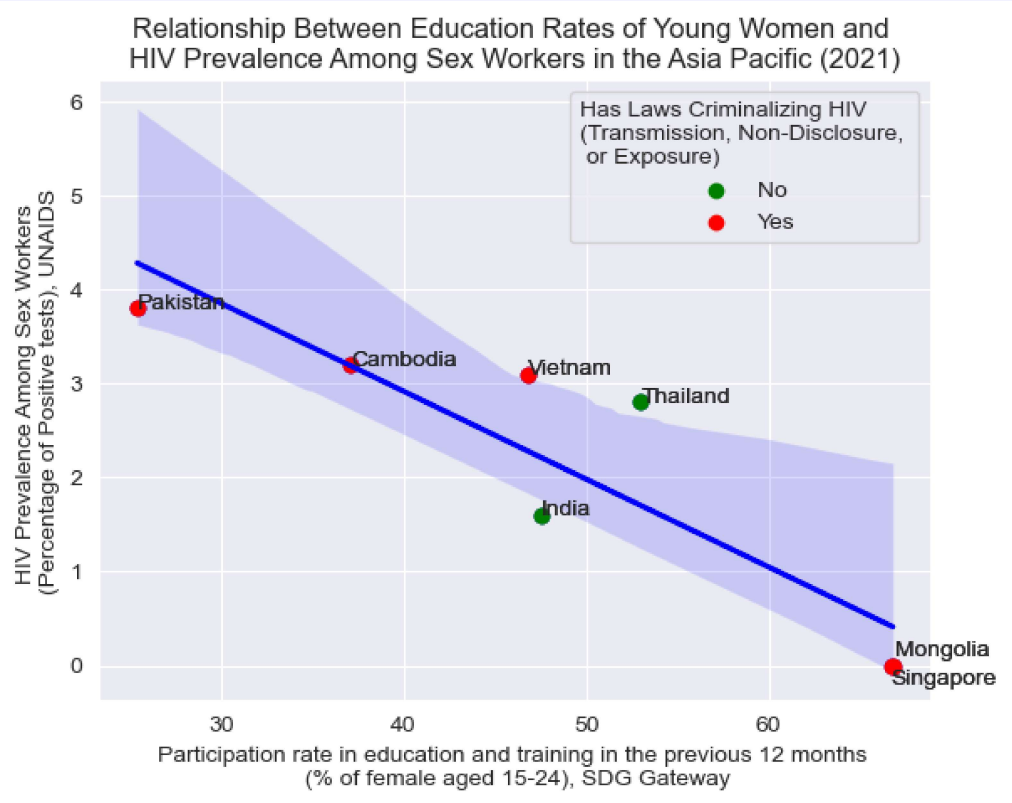
Several r-values stuck out as significant for the sake of comparing intervention strategies. Specifically, the three strongest negative correlations with both PFNFET and SCI were HIV prevalence among SW, PWID, and PR. This indicates a reduced HIV prevalence among these populations in countries with higher rates of women's education or health service coverage, which is consistent with the results previously the mentioned in the literature review (Table 2). In comparison, HIV incidence per 1000 people had a near zero correlation with PFNFET (r=0.06), and a moderate negative correlation with SCI (r=-0.49), demonstrating how these intervention strategies may need to be different for key populations versus the general public.

3.4 Correlation Plots

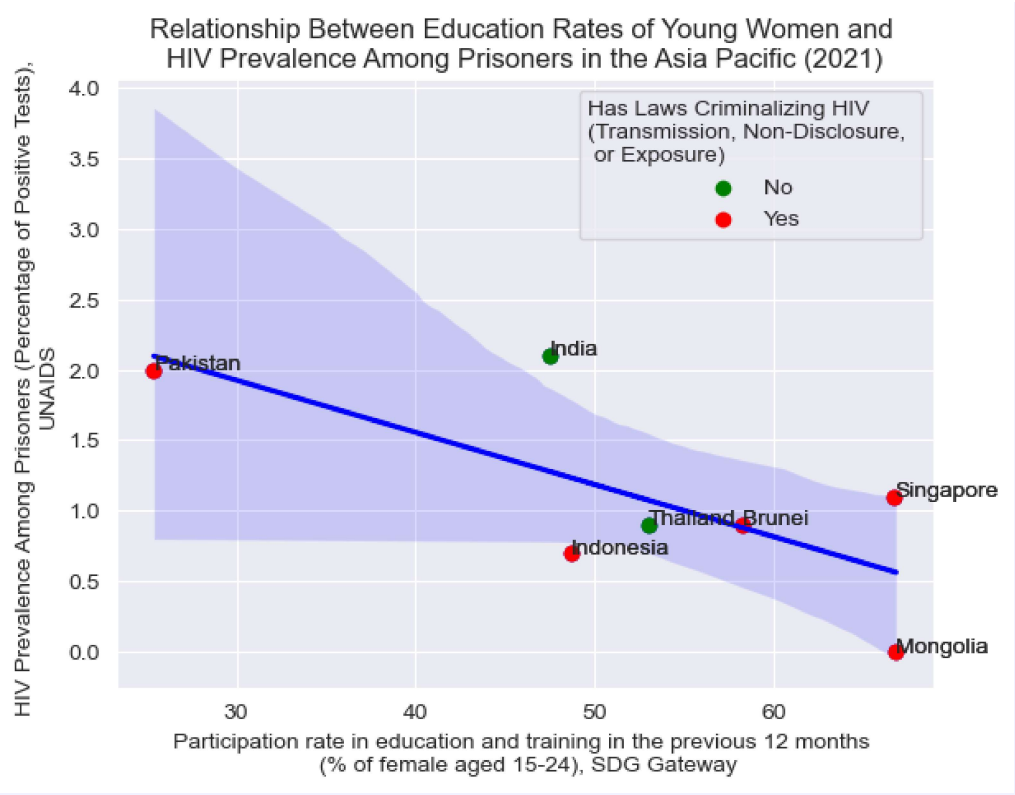
The three strongest negative correlations with PFNFET (Figure 2) and SCI (Figure 3) were plotted by country with a 95 percent confidence interval. These examined HIV prevalence among SW, PWID, and PR and their relationship with PFNFET and SCI in the Asia Pacific region. Countries that had laws criminalizing the transmission of, non-disclosure of, or exposure to HIV transmission, as defined by UNAIDS, were colored red, and those without these stigmatizing policies were colored green.


Relationship Between Education Rates of Young Women and
HIV Prevalence Among People Who Inject Drugs in the Asia Pacific (2021)
Has Laws Criminalizing HIV
(Transmission, Non-Disclosure,
or Exposure)
No
Yes
HIV Prevalence Among People Who Inject Drugs
(percentage of positive tests), UNAIDS
Pakistan
Cambodia
Indonesia
Vietnam
India
Australia
Singapore
Mongolia
0
5
10
15
20
25
30
40
50
60
Participation rate in formal and nonformal education and training in the previous 12 months
(% of female aged 15-24), SDG Gateway

(a)

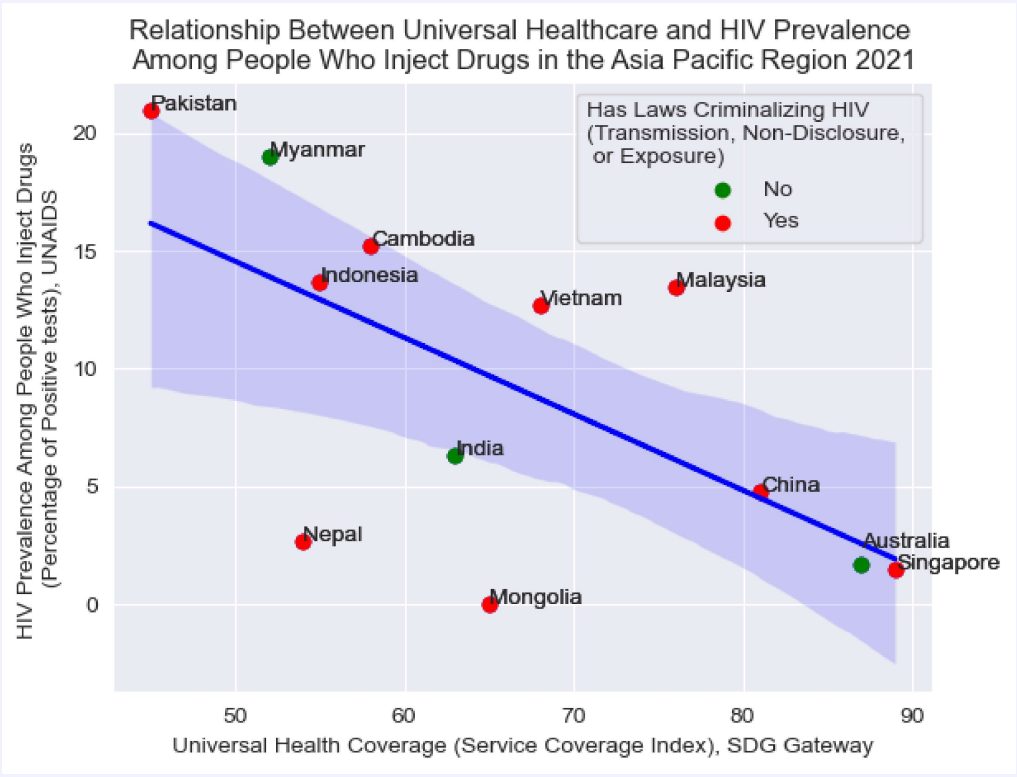

Relationship Between Education Rates of Young Women and
HIV Prevalence Among Sex Workers in the Asia Pacific (2021)
Has Laws Criminalizing HIV
(Transmission, Non-Disclosure,
or Exposure)
No
Yes
HIV Prevalence Among Sex Workers
(Percentage of Positive tests), UNAIDS
Pakistan
Cambodia
Vietnam
Thailand
India
Mongolia
Singapore
0
1
2
3
4
5
6
30
40
50
60
Participation rate in education and training in the previous 12 months
(% of female aged 15-24), SDG Gateway

(b)

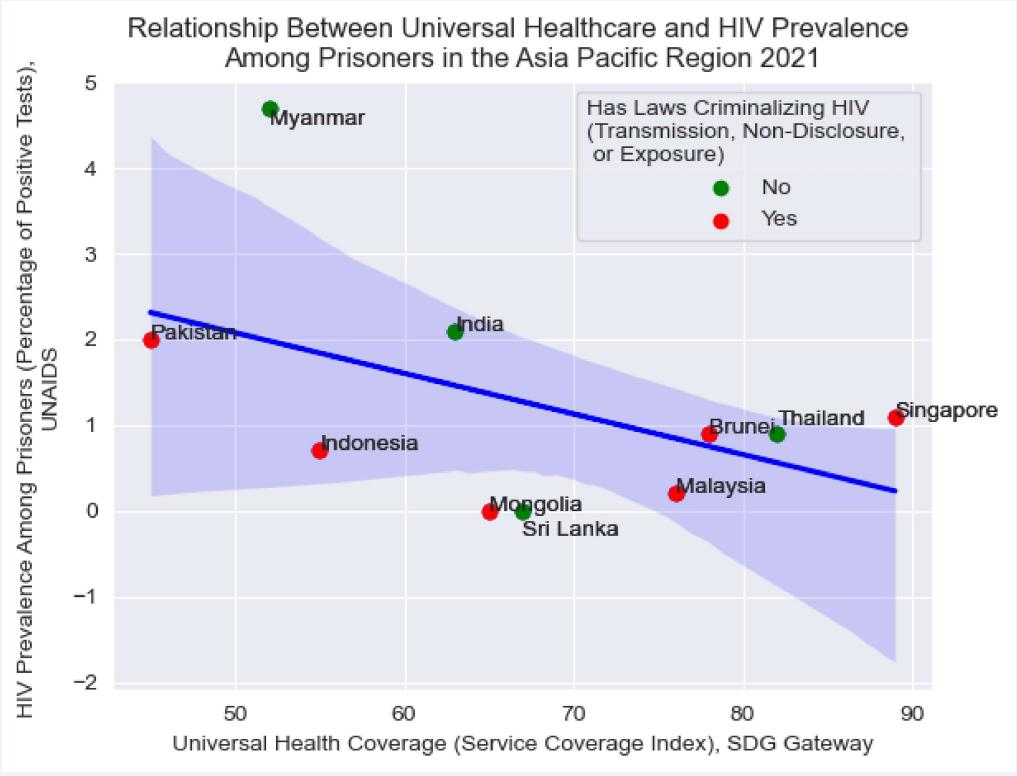


(c)

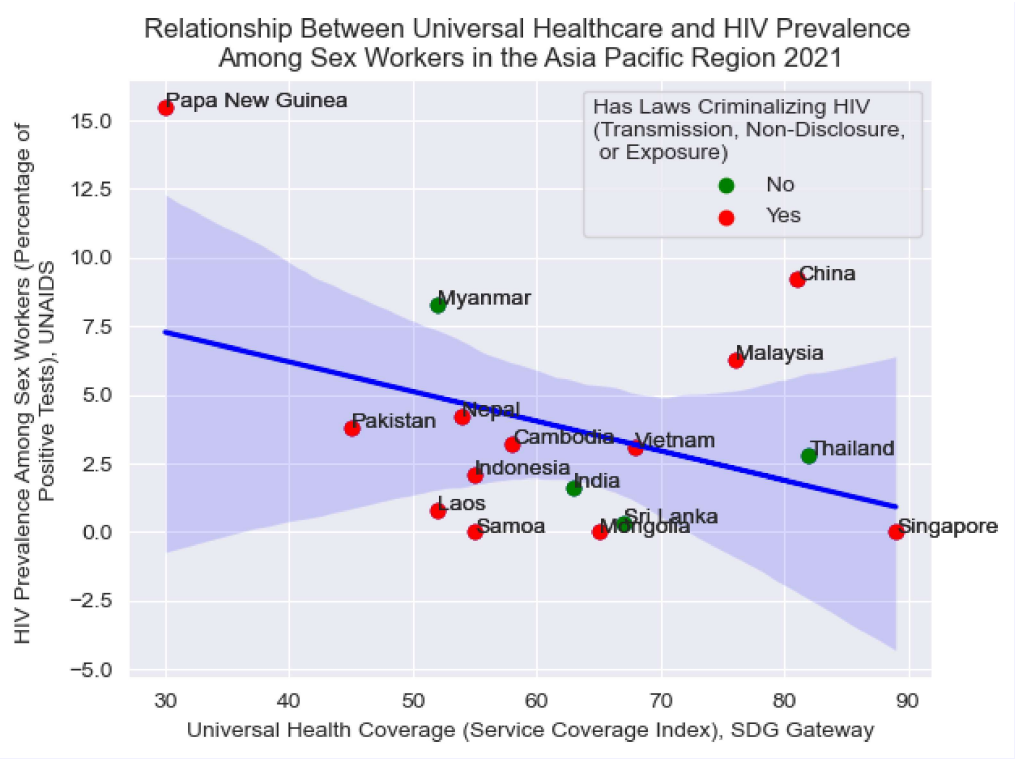
Figure 2: Relationship between HIV Prevalence Among Key Populations and Education Rates of Young Women (15-24) in the Asia Pacific Region. The three key populations with the strongest correlation to education were selected for the analysis. HIV prevalence among PWID (a: n=8) and SW (b: n=7) had r-values of -0.95 and -0.90 respectively, both falling into the 'very strong correlation' interval ($0.8 \leq r \leq 1$). HIV prevalence among PR (c: n=7) had an r-value of -0.71, which falls into the 'strong correlation' interval, $0.6 \leq r < 0.8$. For each of these, a regression line was generated where participation in education was the independent variable and HIV prevalence was the dependent variable. Data for participation in education was pulled from SDG Gateway [21]. Data for HIV prevalence was pulled from the UNAIDS Data Report for 2021 [25]. All plots were graphed with a 95 percent confidence interval calculated using NumPy. Countries with at least one policy that fell into the UNAIDS' 2021 Data Report [25] categorization of 'laws criminalizing the transmission of, non-disclosure of, or exposure to HIV transmission' were colored red, where countries that did not have such policies were colored green.


Relationship Between Universal Healthcare and HIV Prevalence
Among People Who Inject Drugs in the Asia Pacific Region 2021
HIV Prevalence Among People Who Inject Drugs
(Percentage of Positive tests), UNAIDS
Universal Health Coverage (Service Coverage Index), SDG Gateway
Has Laws Criminalizing HIV
(Transmission, Non-Disclosure,
or Exposure)
No
Yes
Pakistan
Myanmar
Cambodia
Indonesia
Vietnam
Malaysia
India
China
Nepal
Australia
Singapore
Mongolia
20
15
10
5
0
50
60
70
80
90

(a)


Relationship Between Universal Healthcare and HIV Prevalence
Among Prisoners in the Asia Pacific Region 2021
HIV Prevalence Among Prisoners (Percentage of Positive Tests),
UNAIDS
Universal Health Coverage (Service Coverage Index), SDG Gateway
Has Laws Criminalizing HIV
(Transmission, Non-Disclosure,
or Exposure)
No
Yes
Myanmar
India
Pakistan
Thailand
Singapore
Brunei
Indonesia
Malaysia
Mongolia
Sri Lanka
5
4
3
2
1
0
−1
−2
50
60
70
80
90

(b)



(c)

Figure 3: Relationship Between Universal Healthcare and HIV Prevalence Among Key Populations in the Asia Pacific Region. The three key populations with the strongest correlation to Universal Health Coverage were selected for the analysis. HIV prevalence among PWID (a: n=12) was the strongest with an r-value of -0.64, falling into the 'strong correlation' interval ($0.6 \leq r < 0.8$). HIV prevalence among PR (b: n=10) had an r-value of -0.47, falling into the 'moderate correlation' interval ($0.4 \leq r < 0.6$). Finally, HIV prevalence among SW (c: n=16) had an r-value of -0.39, falling into the 'weak correlation' interval, ($0.2 \leq r < 0.4$). For each of these, a regression line was generated where SCI was the independent variable and HIV prevalence was the dependent variable. Data for universal health coverage was pulled from the SDG Gateway for the Asia Pacific region [21]. Data for HIV prevalence was pulled from the UNAIDS Data report for 2021 [25]. All plots were graphed with a 95 percent confidence interval calculated using NumPy. Countries with at least one policy that fell into the UNAIDS' 2021 Data Report [25] categorization of 'laws criminalizing the transmission of, non-disclosure of, or exposure to HIV transmission' were colored red, and countries that did not have such policies were colored green.

Of these, the strongest correlation with PFNFET (r=-0.95) was HIV prevalence among PWID (Figure 2a). Eight countries had available data for both (n=8), of which the country with the highest HIV prevalence was Pakistan at 21 percent and the country with the lowest was Mongolia at 0 percent. Pakistan was also the lowest in PFNFET values at 25.4 percent while Mongolia was the highest at 66.8 percent. This trend was

consistent with HIV prevalence among SW (Figure 2b) and PR (Figure 2c), each with seven data points (n=7), where again Pakistan had among the highest HIV prevalence rates and Mongolia among had the lowest. The correlation with SW HIV prevalence (Figure 2b) and PR HIV prevalence (Figure 2c) fell into the very strong and strong intervals, respectively. Countries such as Cambodia and Singapore also remained consistent across populations, where Cambodia had a high HIV prevalence among both PWID (Figure 2a) and SW (Figure 2b) while having a low PFNFET value. Singapore also had a low to zero HIV prevalence rate among both PWID and SW, while having a high participation rate in women's education programs.

SCI had somewhat more countries with available data, with the HIV prevalence for PWID (Figure 3a) at twelve (n=12), SW (Figure 3b) at ten (n=10), and PR (Figure 3c) at sixteen (n=16). HIV prevalence among PWID had a moderate negative correlation with SCI (r=-0.64), and rates for SW and PR HIV prevalence both had weak negative correlations with SCI (r=-0.39 and r=-0.47, respectively). Countries such as Pakistan that had low PFNFET rates also tended to rank lower in SCI scores. However, Myanmar and Papua New Guinea, which did not have data available for PFNRET, were over-represented in HIV prevalence when compared to other countries. More data on these countries for PFNFET would be beneficial in comparing the trends between PFNFET and SCI to see if the results remain consistent. Once again, multiple countries reported having a zero percent HIV prevalence among certain populations, such as Sri Lanka, Mongolia, Singapore, and Samoa.

4 Discussion

The availability of data for the Asia Pacific region posed a significant barrier when interpreting results from this analysis. However, we can still observe trends in the data that was available and make connections to previous studies. A notable trend that was present across key populations was the number of countries reporting a zero percent HIV prevalence. The chance of there being zero cases of HIV in a group

that is generally considered high risk is questionable, especially when comparing the countries that reported zero prevalence to other surrounding countries in the region. A visualization of the HIV prevalence among sex workers by country can be seen in Figure 4.

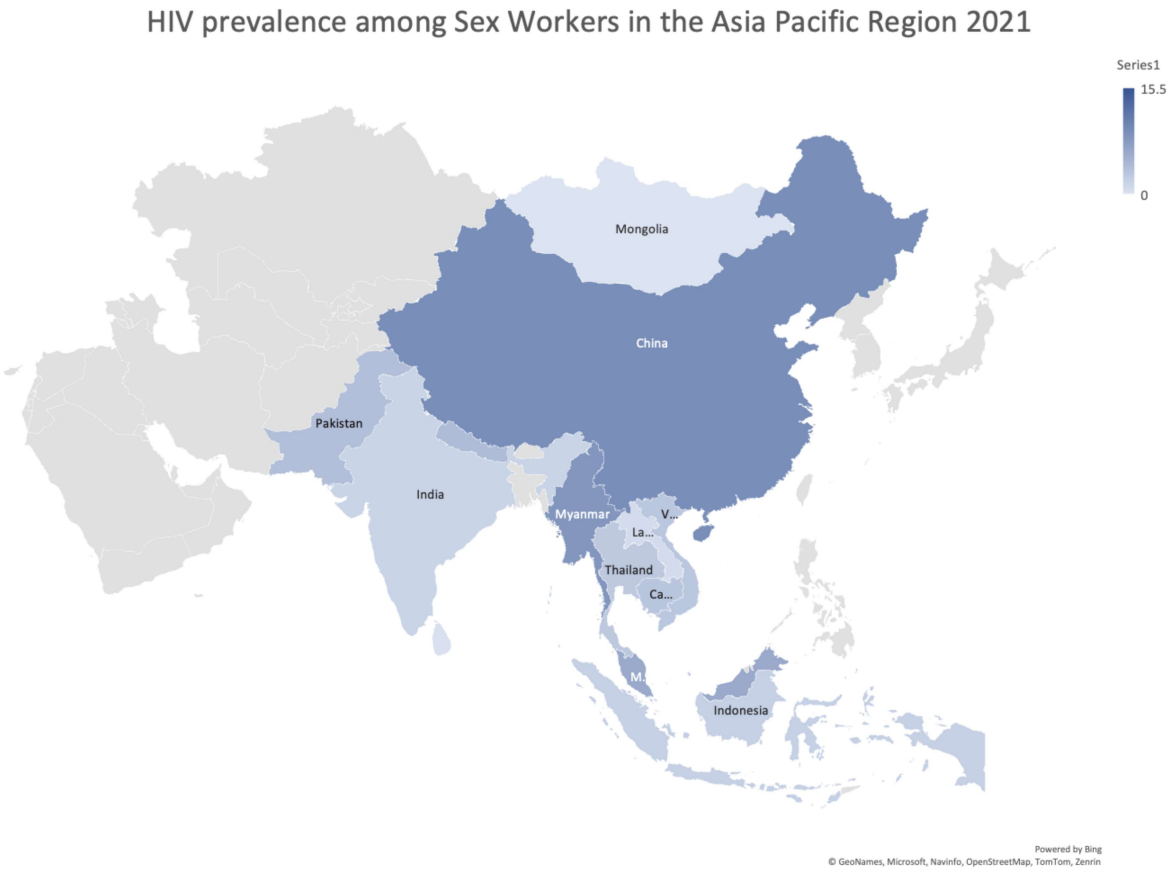


Figure 4: HIV Prevalence among Sex Worker by Country, 2021.

Singapore was one of the countries that reported a zero percent HIV prevalence among SW. This contrasts bordering and nearby countries such as Malaysia and Indonesia, which reported a 6.3 percent and 2.1 percent SW HIV prevalence in that key population, respectively. Mongolia also reported a zero percent HIV prevalence for SW, while bordering China reported a 9.2 percent HIV prevalence for SW. It is important to note the number of new infections per year in these countries, because in 2021 Singapore reported only 500 new cases of HIV, and Mongolia reported even less at 100 new cases [26]. So, under-reporting or miss-classification in the reported figures from these countries could have a significant impact on the final HIV prevalence rates. The

number of new infections could also be under-reported, which reduces the chance that none of these new cases are among key populations. These zero percent HIV prevalence rates among key populations may not be an intentional misrepresentation, in fact there are multiple reasons why this might be possible, including restrictive policies.

4.1 RQ1: How does policy impact HIV prevalence rates and accuracy of data?

Referring back to Figures 2 and 3, Singapore, Mongolia, and Samoa, each of which reported at least one zero percent HIV prevalence among key populations, all had laws that were categorized as criminalizing HIV transmission, non-disclosure, or exposure by UNAIDS. The only country that reported a zero percent HIV prevalence among a key population and had no discriminatory policies in this category was Sri Lanka. However, this does not mean there were no other restrictive policies. For example, according to the UNAIDS data report for 2021, Sri Lanka had laws criminalizing same sex sexual acts and sex work, which falls into the more general umbrella of discriminatory policies as defined by the UN [25].

Wolf et al. details how data surrounding HIV can be impacted by discriminatory policy [28]. Specifically, they describe how punitive and discriminatory policies can lead to increased stigma, including self stigma, which deters members of key populations from disclosing their HIV status. It can also impact whether people report that they are in a key population, further skewing statistics. They also state that there is an increased chance that those in key populations may receive treatment from anonymous sources, meaning that treatment and testing is not recorded by official sources, and therefore would not appear in the final reported HIV prevalence in that region. Wolf et al. [28] proposes that there must be alternate methods of data collection so that the impact of discriminatory policies and stigma is minimized, and reported values are more accurate to what those in key populations are experiencing.

With the trends we see from our limited data set, it is clear that there is a need

for more studies and improved data collection so that the proposed interventions can be verified and implemented. Alternate methods of recording data could help with this limitation, and is especially important for education as the strongest correlations with HIV prevalence across key populations appeared to be PFNFET (Figure 1).

4.2 RQ2: How does education (PFNFET) impact HIV prevalence rates among key populations?

As previously stated, due to lack of data points we are unable to draw formal conclusions about the relationship between HIV prevalence and women's education. However, based on what we can see, the trends seem to show a strong negative linear relationship between PFNFET and the HIV prevalence of select key populations. This supports the findings from previous studies that show access to education impacts HIV prevalence, and this could be useful in validating education-based interventions if the trend remains consistent with the addition of more data.

Previous literature surrounding HIV and women's education outside of the Asia Pacific region includes a study by Jukes et al. [13], which details the importance of women's education in preventing new HIV infections in Southern Africa. They suggest that implementing expansions to educational programs at both the primary and secondary level would help to reduce girl's risk of HIV exposure [13]. More recently, Nutakor et al. [19] published a quantitative study looking at the connection between education and wealth with HIV-related knowledge and outcomes among Ghanan women. This study again found a significant correlation between those engaged in higher education and their knowledge surrounding HIV, which is essential in designing prevention strategies. However, few studies have been conducted surrounding women's education in the Asia Pacific region. There is also a lack of focus on how this could impact specific key populations. Referring back Figure 1, both new HIV infections and HIV incidence per 1000 in the population had a near zero correlation with PFNFET, yet multiple key populations had very strong correlations, showing how key population-

centric studies are necessary in addition to more general studies. As may be expected, PFNFET appears to have a strong correlation with HIV prevalence in key populations that include people who were assigned female at birth such as SW, PWID, and PR. One issue with this though is that the details surrounding PFNFET do not include how gender is defined, which is important when comparing key populations that are restricted on the basis of gender. For example, if PFNFET only considered the education of those assigned female at birth, then transgender women who were assigned male at birth would be excluded from this measurement, complicating the relationship between HIV prevalence among transgender people and PFNFET. So, participation in education could be as important for transgender individuals, but it would not be represented by the correlation between TG and PFNFET in these analyses. This is also the case for MSM, because it is unclear if this only those assigned male at birth or also includes transgender men who were assigned female at birth. It is possible that a more general indicator of education would be beneficial when studying these key populations, but an alternative that may prove to be more accurate in the long-term is to have more specific indicators of education for each of these key populations that align with the same key population demographics as HIV prevalence. Further clarification on the classification of populations surrounding gender would also help in future analyses.

In comparison to PFNFET, SCI did not have major gender restrictions, but it also had a significant correlation with HIV prevalence among SW, PWID, and PR.

4.3 RQ3: How does universal healthcare (SCI) impact HIV prevalence rates among key populations?

While the correlation was not as strong as PFNFET, SCI had more data points and still demonstrated a moderate negative correlation with HIV prevalence among both SW and PWID (Figure 3). SCI represents the service coverage for four specific categories: reproductive health, infectious disease, non-communicable disease, and service capacity/access [23]. However, multiple countries such as China and Malaysia both had

relatively high SCI scores and a high HIV prevalence for some key populations. Both of these countries had laws categorized as criminalizing HIV transmission, non-disclosure, or exposure by UNAIDS, once again highlighting the issue of stigma when it comes to accessing care. Even if healthcare is covered monetarily, people in key populations are likely to still avoid medical settings due to self stigma or fear of repercussions, as was previously discussed. According to UNAIDS, in 2022 at least one third of countries globally reported that 10 percent or more of people in key populations avoided healthcare settings [16]. This avoidance can skew data, but it is especially important when considering the quality of services. This is because if the healthcare systems in a country have a bad reputation among marginalized people, they may avoid services at higher rates leading to countries with less resources appearing as though they have less cases. This is also true for countries with higher SCI scores, because countries with more resources could have increased capabilities for recording data, but that does not matter if people refuse to identify themselves because of fear from criminalizing policy.

Despite these obstacles, it is apparent that service coverage and universal healthcare plays a role in lowering HIV prevalence, however it is important that this is combined with a non-threatening environment and reduced fear of political repercussion.

4.4 Global Implications

As with any region, the state of HIV in the Asia Pacific has major implications on HIV prevalence globally. For example, Indonesia where HIV cases have been rising among key populations is also seeing an increase in tourism with 12.66 million international tourists reported in 2024 [30]. This could lead to tourists becoming infected and returning to their respective countries with HIV. However, tourism also can also impact HIV locally. Apenteng et al. [2] modeled how tourism impacts HIV incidence in Malaysia and found that factors such as the duration of stay and number of incoming HIV positive tourists significantly impacted the cumulative HIV incidence in the region. This demonstrates how HIV in one region can impact other countries globally, as well

as how outside influences can impact the region locally.

With increasing globalization, travel has become unavoidable, so to prevent both global and regional spread it would be ideal that countries support each other in reducing HIV prevalence. However, this hinges on political and economic support, which is not guaranteed. This would also rely on countries allowing for the implementation of these social programs, which cannot happen on a larger scale if there are already policies discriminating against those with HIV.

4.5 Conclusion

Our findings support the recommendations of experts to utilize education-related intervention techniques and to expand the accessibility to healthcare services (Table 2). Beyond this, centering related programs around sex workers, people who inject drugs, and prisoners appears that it would have greatest impact in reducing their HIV prevalence. Further studies focusing on education and healthcare-related interventions for MSM and TG would be beneficial in providing more accurate recommendations for these key populations. Ideally, educational interventions would alleviate the barriers to secondary and tertiary education, both financial and socially, but this is a long-term solution and additional interventions must be made to address the urgency of the problem. These short-term solutions could include education at the secondary level surrounding safe sex and contraceptives, how HIV spreads, and potential high risk situations. Diversity, equity, and inclusion training for educators could also help in stigma reduction. In countries with discriminatory policies, promoting these practices in a classroom setting may not be feasible, so other means may be more effective in conveying information to the general public. For healthcare, the accessibility of services is a necessity both in prevention and treatment. However, accessibility on its own may not be enough if there are discriminatory policies interfering with procuring treatment.

For these reasons, experts have advocated for dismantling these discriminatory policies (Table 2), but it may not be a realistic goal in our current geopolitical landscape.

Logically, this would be a net positive and allow for more effective programs, but again, referring back to the recent actions of the Trump administration, it does not seem we are at a point where we can achieve this overarching goal in a timely fashion, especially if we are to react to the cuts in funding to HIV-related programs. In a recent report from UNAIDS, all community programs funded through USAID have been frozen due to the US withdrawing funding [22]. In countries such as Indonesia where only 31 percent of people living with HIV had access to treatment, this could be catastrophic [22]. Now, instead of focusing on Indonesia having discriminatory policies relating to HIV (Figure 2), we must focus on the fact that the limited number of programs they did have are now gone. In a situation where these countries still had access to aid, advocating for local policy reform could be feasible. However, after taking such a hit, advocates and healthcare workers are likely to be preoccupied with the immediate impacts. To prevent cases from rising, and to see the impact of these interventions on HIV prevalence, financial aid must be reinstated so that we do not reverse the progress that has already been made.

In the future, possible ways to expand upon this research include looking at other regions to see if these factors have a similar impact on HIV prevalence among key populations there. More data points would also allow for a more formal regression analysis where we can predict trends among these populations.

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