Insights into the Drivers of Variations in HIV Epidemic Patterns Among People Who Inject Drugs in Pakistan

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Background

- The injecting epidemic in **people who inject drugs (PWID) in Pakistan** is an increasing public health emergency
  - Associated with blood-borne infections, e.g. HIV, HBV, HCV
  - PWID population size estimates[1,2]: 100,000-430,000

[1]IBBS Surveys 2005-2017; [2]UNODC 2013

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  - Associated with blood-borne infections, e.g. HIV, HBV, HCV
  - PWID population size estimates[1,2]: 100,000-430,000
- **HIV prevalence** among PWID[1]: 38% overall
  - Varies across cities: 1% in Gujranwala to 53% in Faisalabad
  - Multiple risk factors: Injecting practices, N-S sharing, poly drug, etc.

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  - Multiple risk factors: Injecting practices, N-S sharing, poly drug, etc.
- Intervention coverage is **very low**
  - Anti-retroviral therapy (ART)[1-3]: 0-5% of PWID
  - Needle-syringe provision (NSP)[4]: 18 needle-syringes per PWID per yr
  - Opioid substitution therapy (OST)[4]: Non-existent

[1]IBBS Surveys 2005-2017; [2]UNODC 2013; [3]National AIDS Control Programme, Pakistan; [4]Larney et al. (Lancet Global Health 2017)

Objective

- **How can we use quantitative analyses methods to understand how the HIV epidemic is evolving among PWID in Pakistan?**

Main Aims

- **Aim 1:** Examine differences in the HIV epidemics among PWID between different cities across time.
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  - How ”risky” is high-risk?

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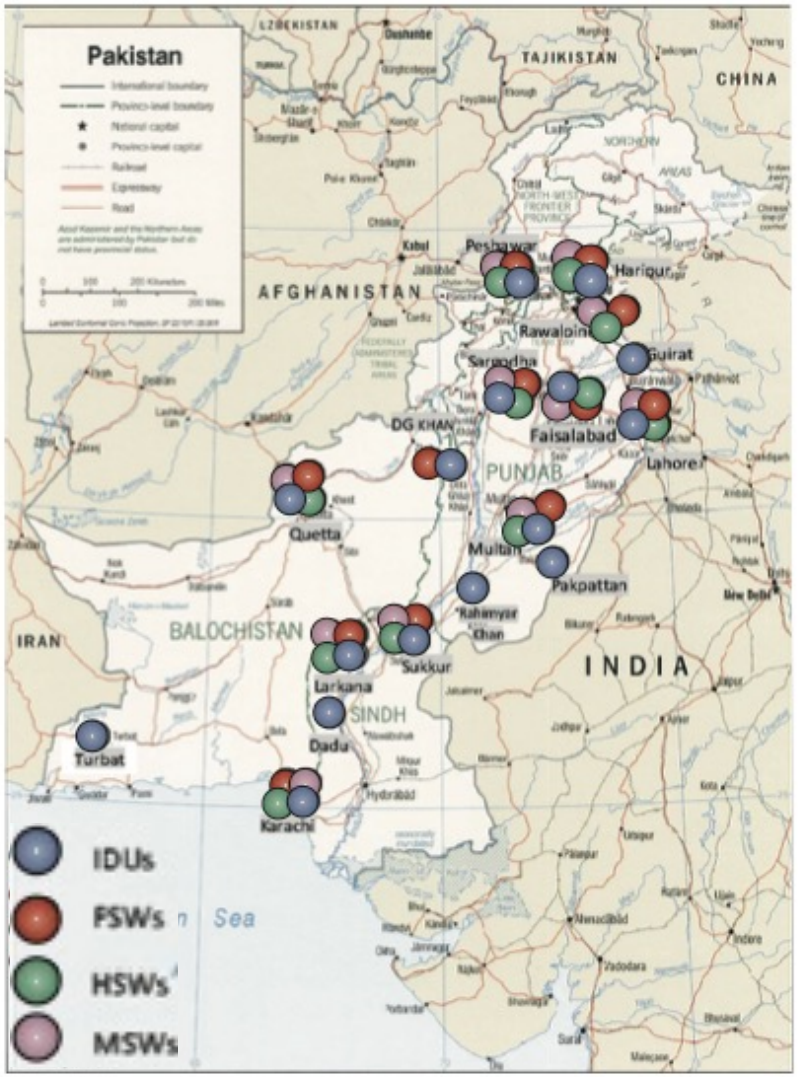
  - What are the main reasons for these differences?
- **Aim 2:** Use mathematical modelling to estimate the contribution of high-risk factors on HIV transmission in different cities.
  - How ”risky” is high-risk?
- **Aim 3:** Project the potential impact of changes in prevalence of high-risk factors on the trajectory of the HIV epidemic.
  - How do changing risk patterns affect HIV prevalence and incidence?

Presentation Outline

- Data sources and multivariable statistical analyses
- Dynamic model structure
  - Risk factors & epidemic aspects
  - Estimating relative risks
- City-level modelling analyses
  - Contribution of high-risk
  - Scenario analyses – Reducing risk
- Conclusions

Data Sources

- **Integrated Biological & Behavioural Surveillance (IBBS)** in Pakistan
  - Five rounds of IBBS conducted from 2005 to 2017 **across 25 unique cities**
  - Key populations* (**PWID**, FSW, H/MSW)
  - We used data from Rounds 1-5 for PWID only to perform the analyses presented here (n = 18,467 across 57 "cities")



e.g. HASP/IBBS Round 5 Report
*KP: Key Populations; PWID: People Who Inject Drugs,;FSW: Female Sex Worker; H/MSW: Hijra/Male Sex Worker

Data Analyses Summary

- From the multivariable statistical model, **three "high-risk"** factors were associated with HIV prevalence at city-level
  - Proportion injected by a **professional injector** last time (*"ProfInjUse"*)
  - Proportion injecting **heroin** in the past month (*"HeroinUse"*)
  - Proportion **injecting frequently** (4+times/day) past month (*"Inj4xpd"*)

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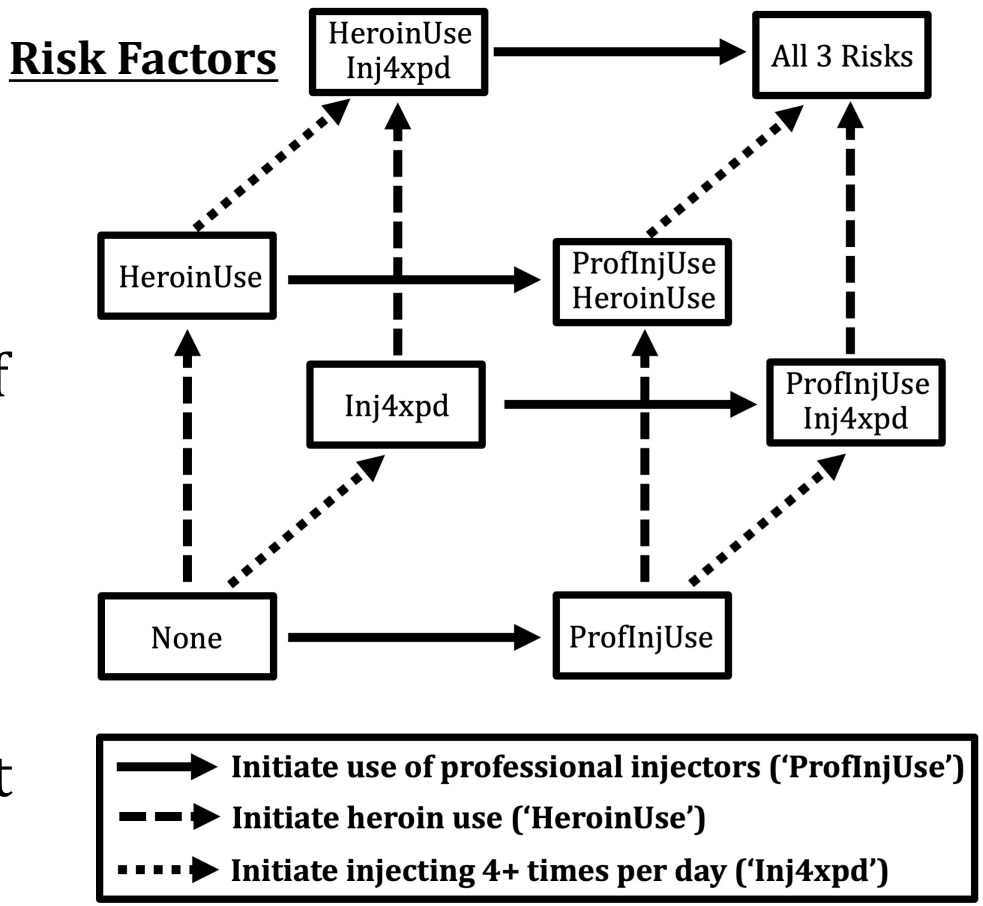
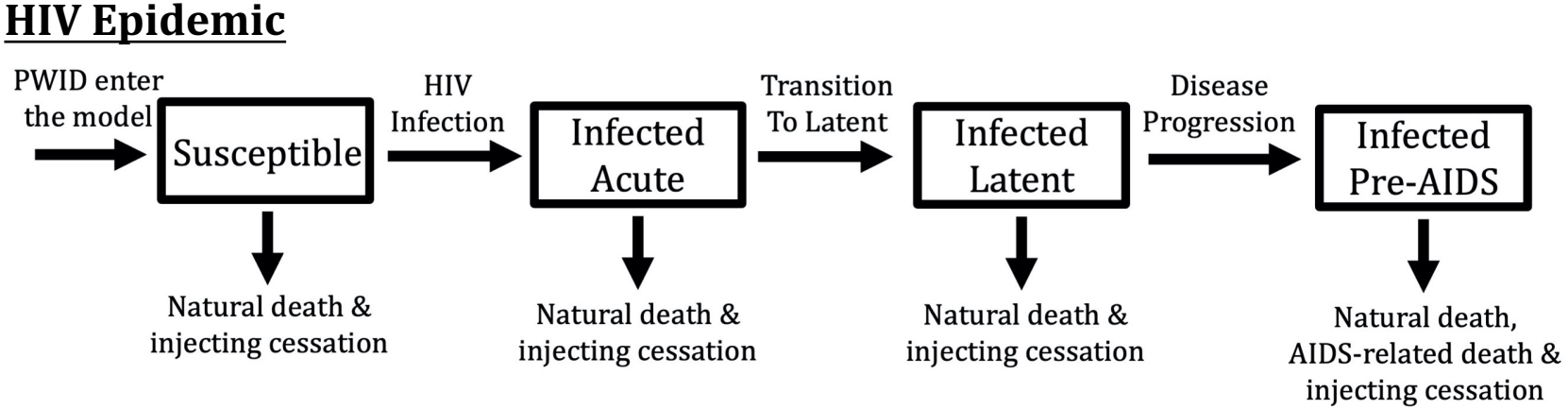
- These three variables explained most of the variance of HIV prevalence across cities and round ($\boldsymbol{R^2 = 60\%}$)
- The regression coefficients define the relationship below:
  - Professional injector use: 0.25 (95%CI 0.10, 0.40), p<0.001
  - Heroin injecting use: 0.19 (95%CI 0.11, 0.26), p<0.001
  - Frequent injecting: 0.47 (95%CI 0.23, 0.71), p<0.001

$$\boldsymbol{HIV\ Prevalence = -0.05 + 0.25(ProfInjUse) + 0.19(HeroinUse) + 0.47(Inj4xpd)}$$

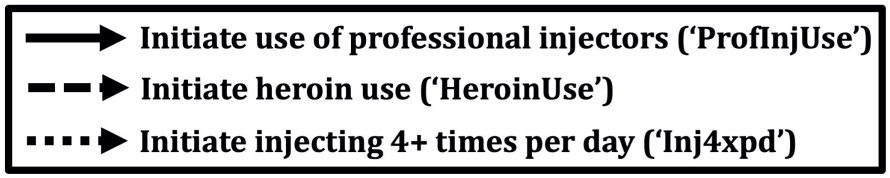
Methods – Dynamic Model Structure

- Developed a compartmental **dynamic transmission model** based on the results of multivariable data analyses
- Model compartments stratified to cover all possible combinations of HIV risk factors, assumed independent

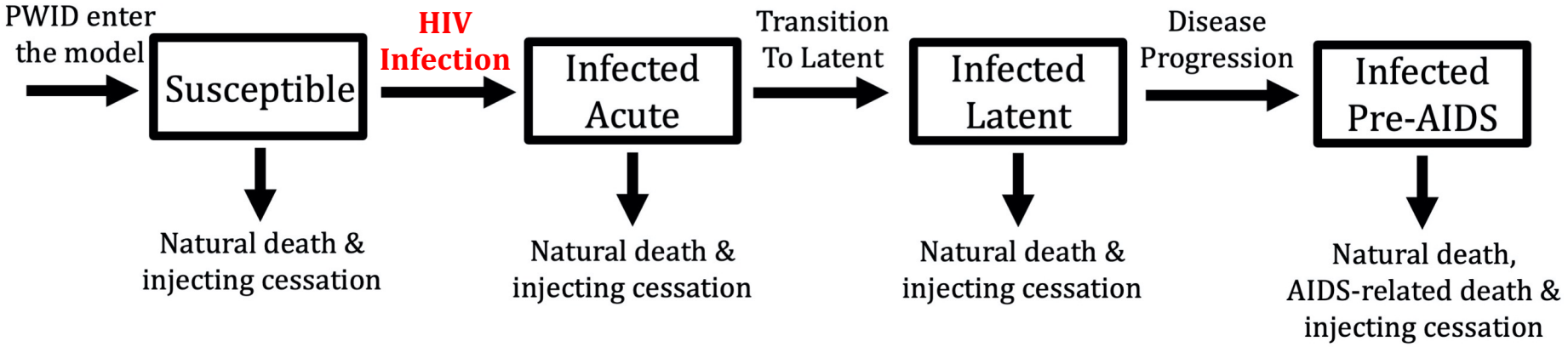




Risk Factors



HIV Epidemic



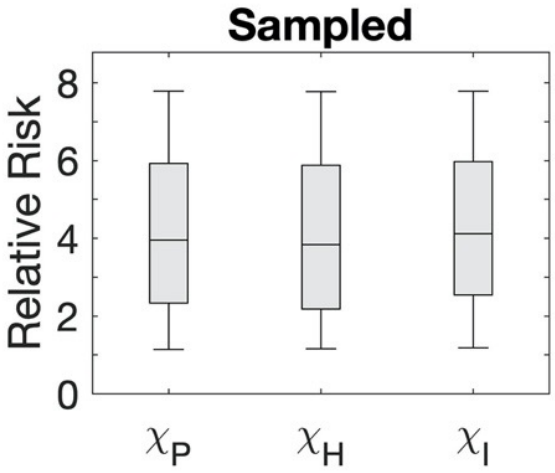
- **Key model parameters** for HIV epidemic
  - Relative risk of HIV due to professional injecting use (χ_P)
  - Relative risk of HIV due to heroin use (χ_H)
  - Relative risk of HIV due to frequent injecting (χ_I)
  - Baseline transmission coefficient (β) or "infection rate" when not taking into account the role of high-risk factors

Methods – Estimating Relative Risks

- We used a three-step algorithm to estimate relative risks of HIV infection due to professional injecting use (χ_P), heroin use (χ_H), & frequent injecting (χ_I)
  - Each of the 57 cities are characterised by different proportions of each high-risk factor (in uncertainty ranges)
  - Assume relative risks due to each risk factor are the **same across cities**
  - Meanwhile, the transmission rate parameter can vary between cities

Results – Estimating Relative Risks

- **Step 1.** Start with 50,000 parameter sets (for each city)



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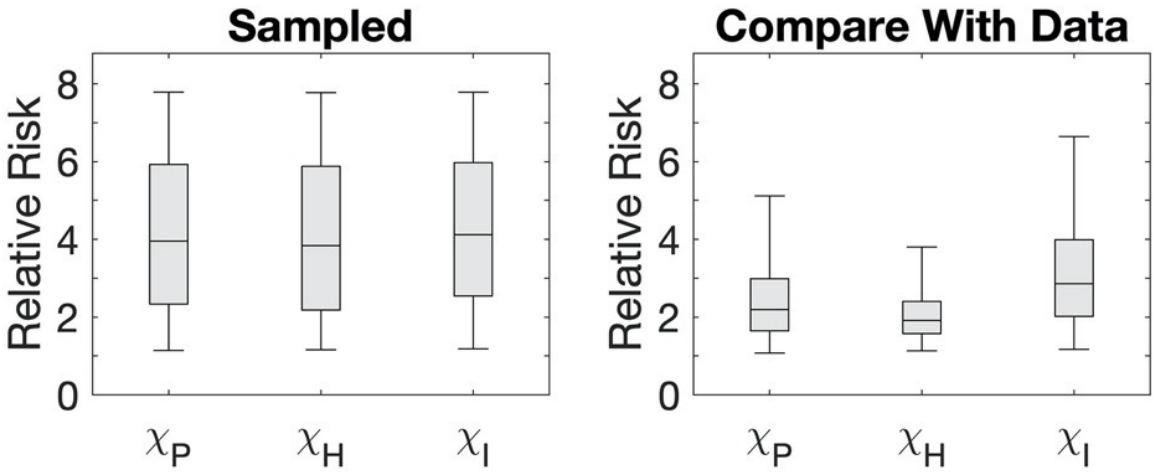
- **Step 2.** Compare regression coefficients: model versus data



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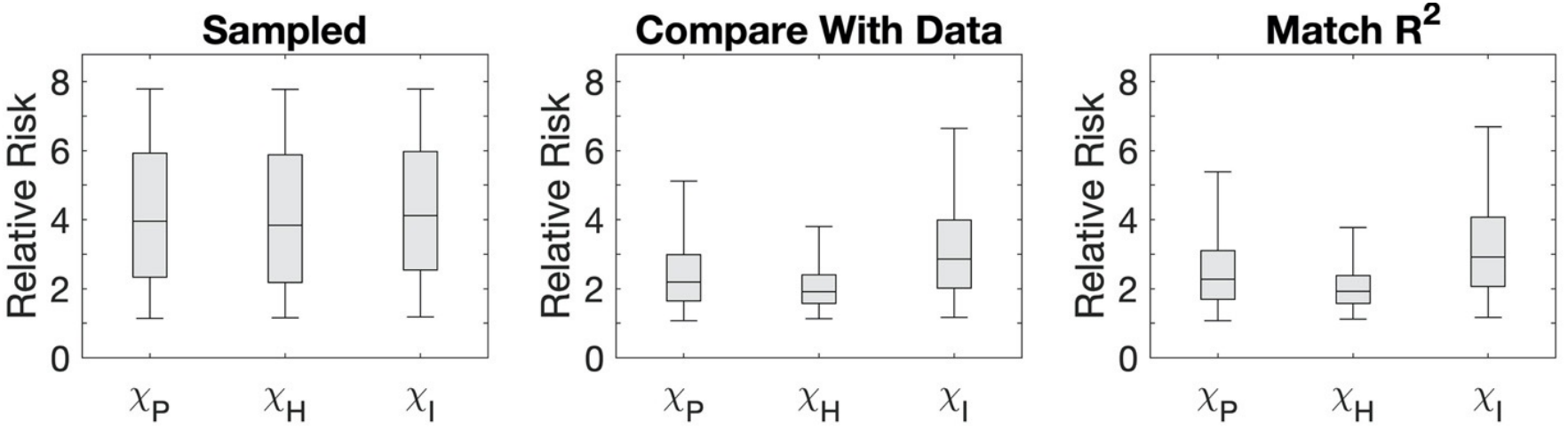

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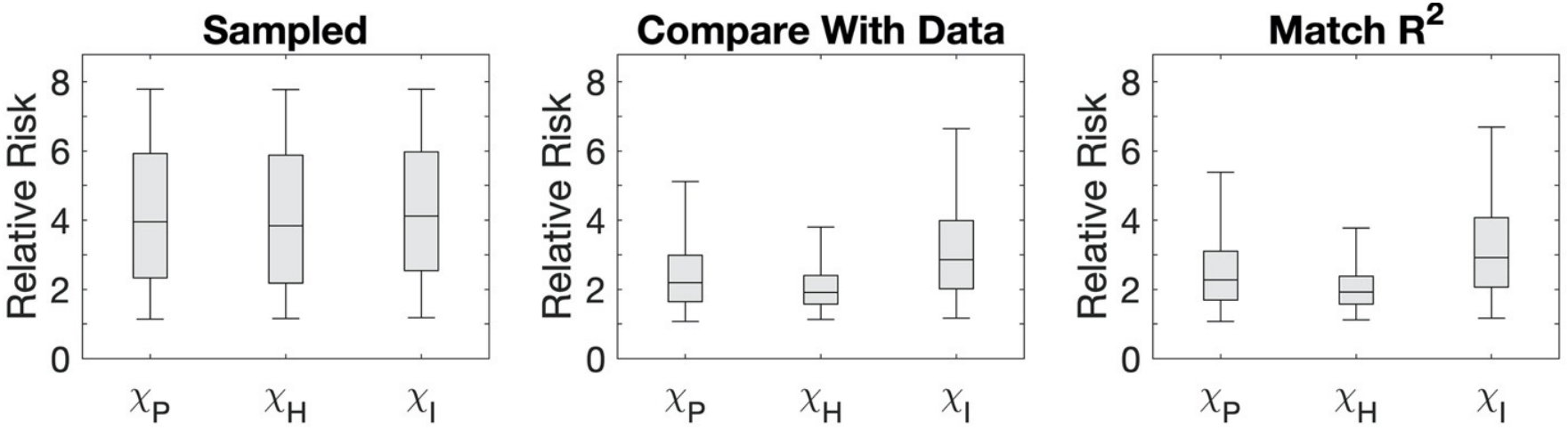

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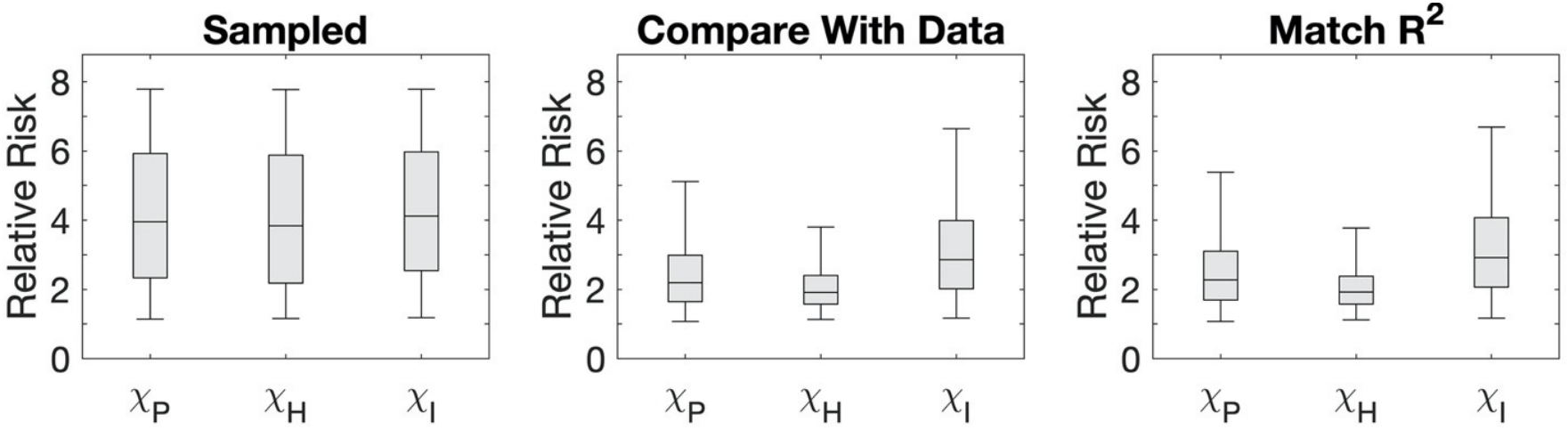

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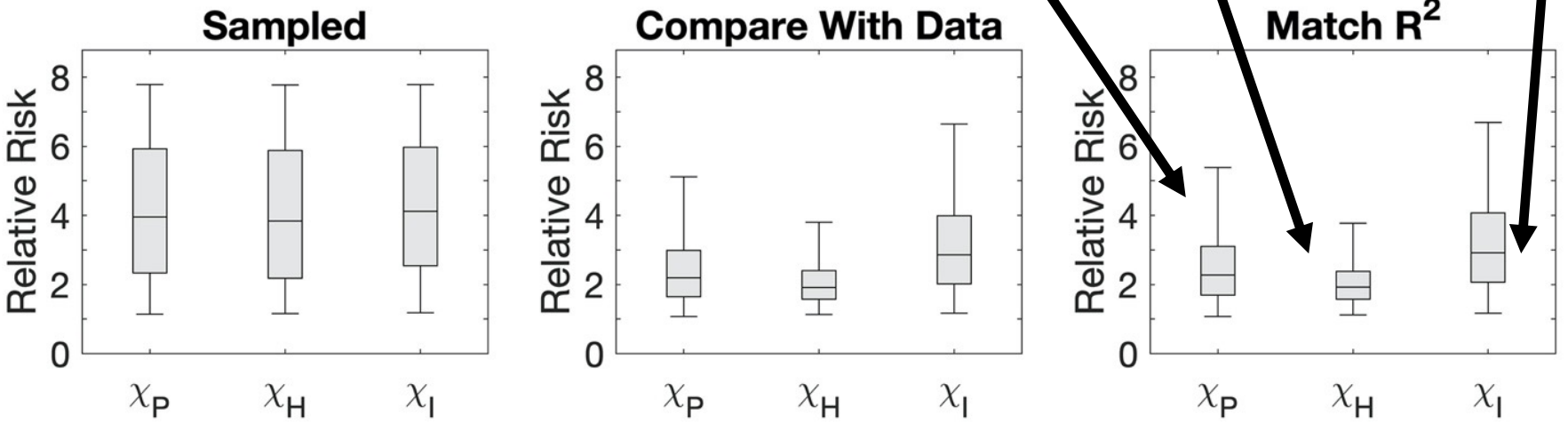
Relative risk Inj4xpd (χ_I): 2.9 [1.2-6.7]

Relative risk ProfInjUse (χ_P): 2.3 (1.1-5.4)

Relative risk HeroinUse (χ_H): 1.9 [1.1-3.8]



Methods – City-Level Modelling Analyses

- For each specific city **(25 unique cities)**, **estimate contribution** of each high-risk factor to HIV transmission
  - Estimate the **population-attributable fraction (PAF)** of new HIV infections over a 10-year period due to each risk factor and overall

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- **Incorporating changing risk factors**
  - **Q.** How does reducing prevalence of risks **reflect changes in HIV?**
    - **Scenario 1.** If **professional injecting use** reduced to **lowest (2.8%)**
    - **Scenario 2.** If **heroin use** reduced to **lowest (0.9%)**
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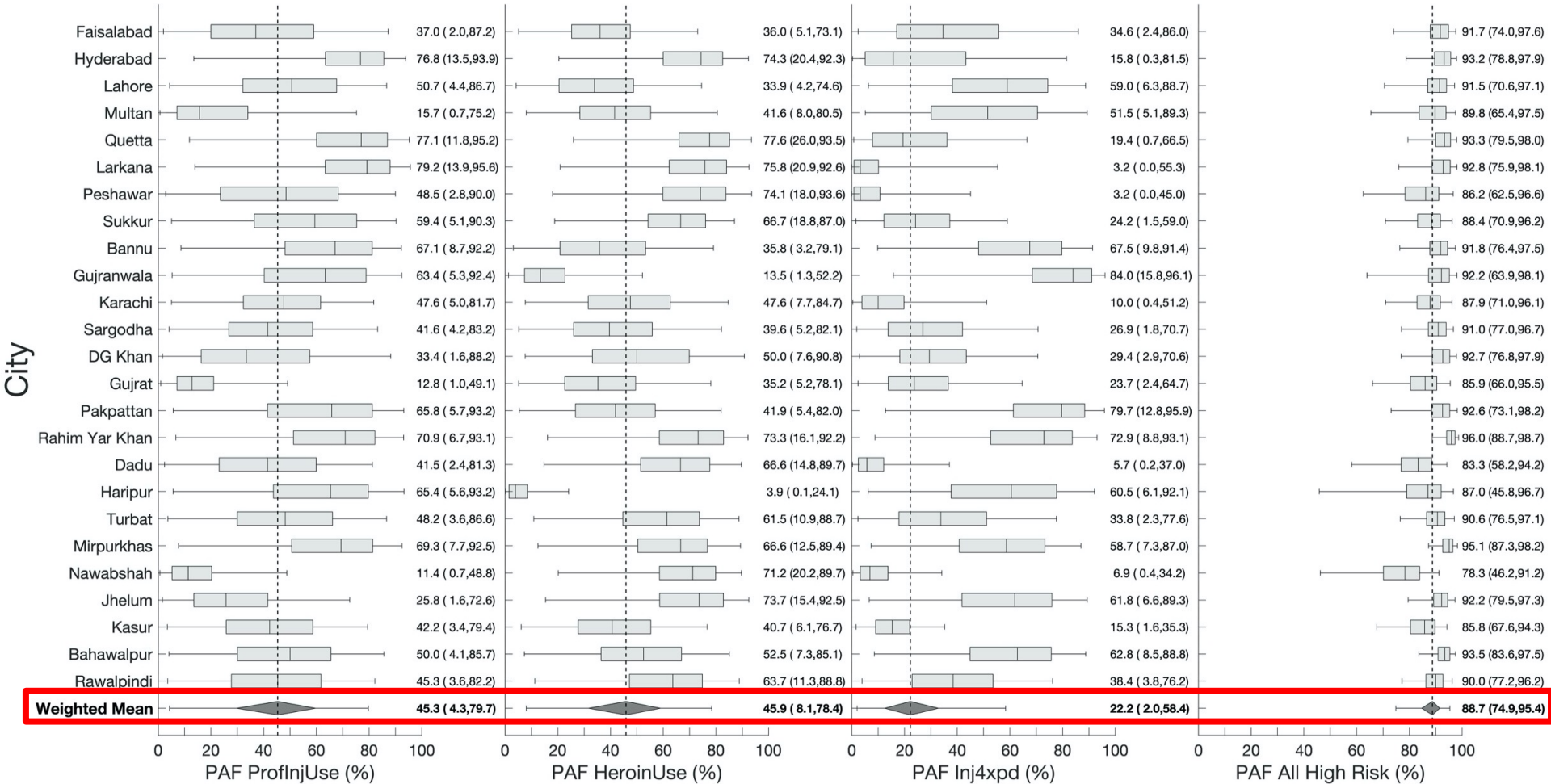
- **Overall estimates** by weighting by city-level HIV infections

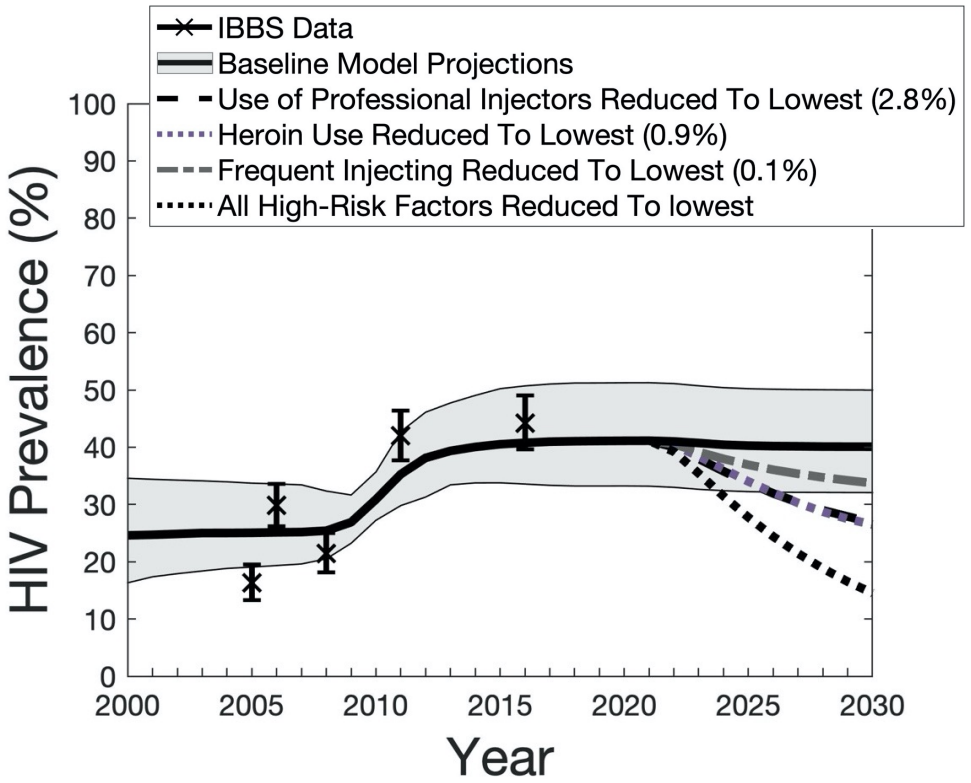
Results – Contribution of High-Risk

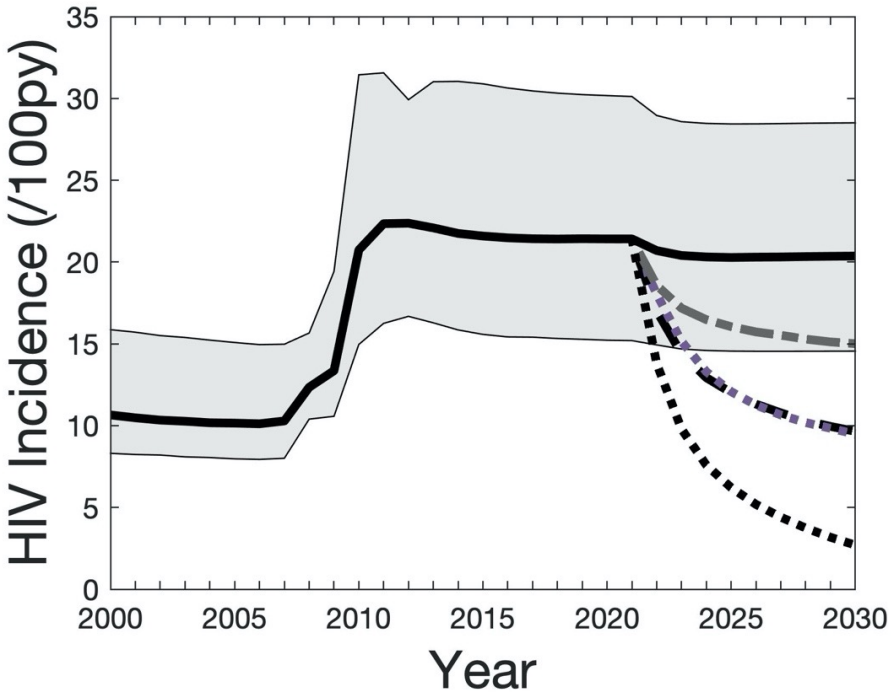
- Overall, high-risk factors combined contribute **PAF_{All}=88.7%** of new HIV infections over the next 10 years
  - Professional injecting use **(PAF_P=45.3%)** & heroin use **(PAF_H=45.9%)** each contribute half, while frequent injecting a quarter **(PAF_I=22.2%)**



Results – Changing Risk Factor Prevalence

- **Reducing the prevalence** of all high-risk factors to lowest observed values reduces HIV prevalence by **68.8% (54.2-85.6%)** and incidence by **87.4% (77.0-94.9%)** after 10 years
  - Reducing professional injecting use and heroin use to lowest values halves HIV incidence (**52.7%** & **53.0%** respective incidence reduction)
  - Reducing frequent injecting to lowest reduces HIV incidence by **28.1%**





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  - Explains **60% of variation** in HIV epidemics across cities
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  - Professional injecting use and heroin use **double the risk** of HIV transmission, while frequent injecting **triples the risk**
- These three risk factors combined is estimated to **contribute 88.7% of new HIV infections over the next 10 years**
- **Changes in prevalence of risk factors** coincide with changes in HIV prevalence and HIV incidence:
  - Focussed interventions could **reduce** HIV prevalence by 68.8% and HIV incidence by 87.4% over 10 years.

Thank you!

University of Bristol:

- Adam Trickey
- Peter Vickerman

Canada-Pakistan HIV/AIDS Surveillance Project

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- Tahira E. Reza

University of Manitoba

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