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Poster #0913

HIV Risk Increases with Positive Ties in Highly Connected Sociospatial Network of People Who Inject Drugs

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BACKGROUND

- People who inject drugs (PWID) represent a key population with high HIV and HCV burden and account for some of the fastest growing HIV epidemics globally.
- India has a concentrated HIV epidemic, with PWID representing the population of highest burden.
- Individual characteristics associated with HIV and HCV infection have been well-characterized; less is known about network-level predictors and even less about spatial predictors.
- Moreover, most network studies have been limited by focusing on immediate ties (egocentric network) rather than the broader sociometric or spatial network (Figure 1).
- An in-depth understanding these networks and their role in transmission could play a critical role in efficiently targeting resources in program implementation and designing network-based strategies (e.g., treat-a-friend approach for HCV).

OBJECTIVES

- Characterize the egocentric, sociometric and spatial networks of PWID in New Delhi, India.
- Identify individual-, network- and spatial-level correlates of HIV and HCV infection.

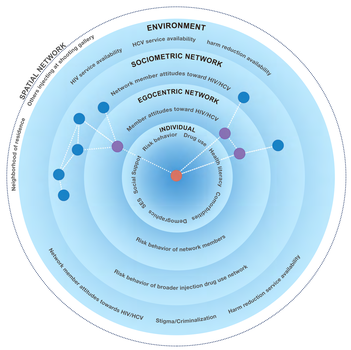


Figure 1. Conceptual framework depicting the egocentric and sociometric networks (purple and blue colored circles) and the dynamic relation of individual-, network-, environmental-, and spatial-factors.

METHODS

STUDY POPULATION

Eligibility Criteria for Indexes

1. 18 years of age or older
2. Provide written informed consent
3. History of injecting drugs for non-medicinal purposes in the prior 24 months
4. Part of evaluation RDS assessment of a cluster-randomized trial

Eligibility Criteria for Recruits

1. 18 years of age or older
2. Provide written informed consent
3. Recruited to participate in the study via network referral card
4. Unique identifier listed by recruiter matches participant

RECRUITMENT

- PWID were recruited using a named injection partner recruitment approach between 2017-19 in New Delhi, India.
- Sampling was initiated using 11 "indexes"; these indexes were selected from participants of an RDS survey that was conducted in New Delhi in 2016-17.
- Each index was asked to recall who they injected with in the past month; for each named member, they were also asked to describe unique identifying characteristics (e.g., cell phone number, appearance, name of spouse, etc.).
- For each named individual, the index was given a referral card (egocentric network of "index").
- Similarly, each recruit named and recruited their recent injection network (egocentric network of recruit and sociometric network of "index").
- Recruitment process was continued until target sample size (~2500) was achieved.

STUDY PROCEDURES

- All participants provided written informed consent.
- Biometric registration was performed to identify duplicates (and establish cross-network linkages).
- An electronic interviewer-administered electronic survey that captured information on demographics, network characteristics, risk behaviors, access to HIV/HCV services, and information on injection/residence locations was administered.
- Rapid on-site HIV (three rapid tests as per National guidelines) and HCV (anti-HCV antibody) testing was performed and results were delivered with appropriate pre- and post-testing counseling and referrals, where applicable.
- All specimens were shipped to the YRGCARE Infectious Disease Laboratory for additional testing and storage.

LABORATORY PROCEDURES

- HIV RNA was quantified using the Abbott RealTime HIV-1 viral load assay.
- HCV RNA was quantified using the Abbott RealTime HCV viral load assay.
- All tests were performed as per manufacturers instructions.

STATISTICAL ANALYSIS

- Sociometric injection networks were constructed and analyzed with bespoke Python scripts and visualized in Gephi.
- A Boruta wrapper of the random forest machine learning feature selection algorithm was used in Python to nominate candidate risk factors.
- Sociometric and egocentric network measures and path lengths were calculated with bespoke Python scripts; path length was defined as the number of steps between an index and a network member with the outcome of interest (HIV or HCV) .
- Correlates including network characteristics were analyzed for an association with baseline HIV and HCV prevalence using multivariate logistic regression in Stata Version 15.
- Spatial hotspots were visualized in GIS.

ETHICAL CLEARANCE

- This study was approved by the Johns Hopkins Medicine and YR Gaitonde Centre for AIDS Research and Education institutional review boards.



Figure 2. Map of India with study location.

RESULTS

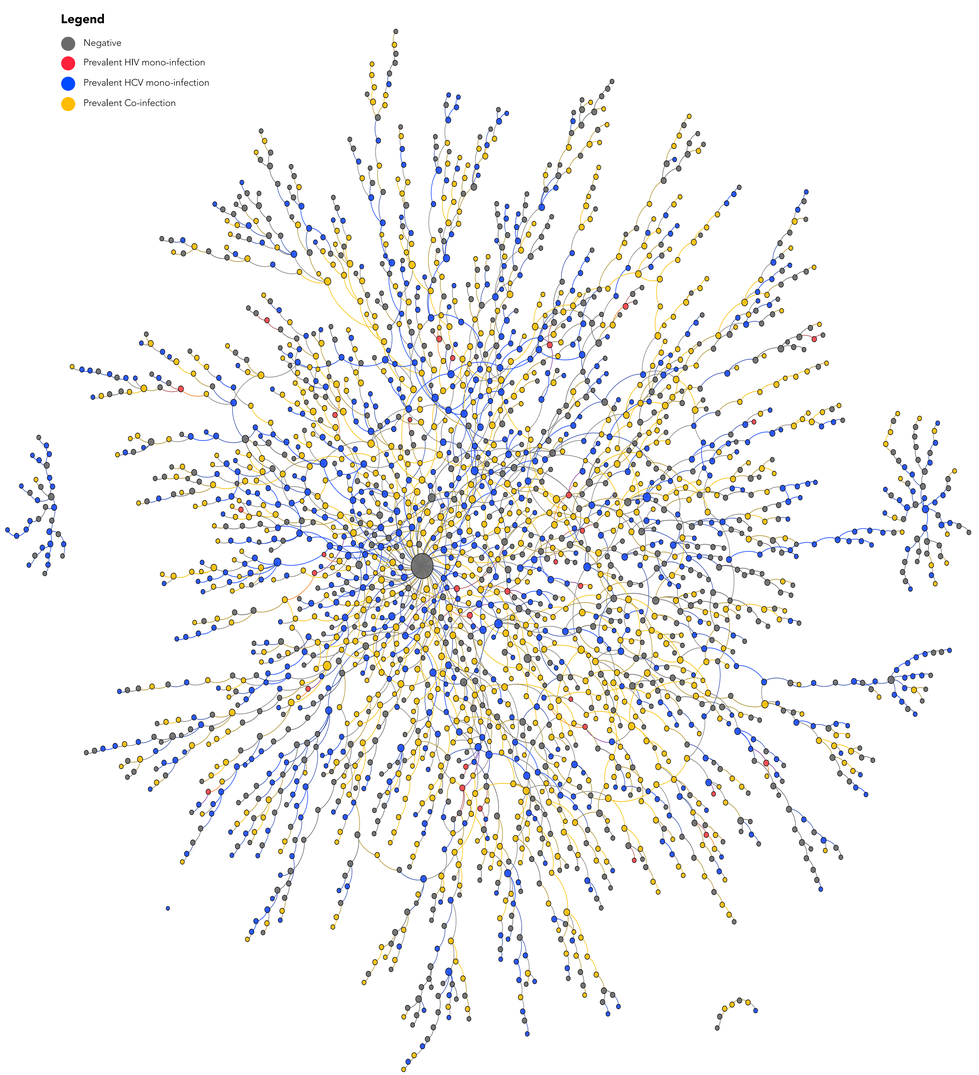


Figure 3. Complete sociometric injection network of 2,512 people who inject drugs in New Delhi, India. Nodes are colored by HIV and HCV status at baseline.

	Total (n=2512)	HIV mono-infected (n=31)	HCV mono-infected (n=737)	HIV/HCV co-infected (n=897)	Negative (n=847)
Median Age (mean)	26 (29)	24 (27.5)	27 (30)	26 (28)	26 (30)
Proportion Male	99.1%	97.0%	99.1%	99.2%	99.1%
Shared Injection Equipment	60.4%	74.2%	62.8%	72.6%	45.0%
High School Education or Above	8.7%	0%	8.3%	4.4%	13.9%
Ever Tested for HIV	47.9%	29.0%	53.5%	49.1%	42.5%
Ever Tested for HCV	4.1%	0%	6.2%	4.8%	1.8%
Mean No. of Injection Partners in Prior Month	3.2	2.9	3.3	3.5	2.8
Inject Heroin in Past 6 Months	26.5%	25.8%	28.6%	29.5%	21.5%
Inject Opioids in Past 6 Months	94.7%	93.5%	95.3%	97.0%	91.9%
Inject Other Drugs in Past 6 Months	1.5%	0%	1.5%	1.3%	1.8%

Table 1. Baseline characteristics of study population (2512 PWID in New Delhi, India).

BASELINE DISEASE PREVALENCE

- Baseline HIV Prevalence: 36.9%
  - Virally Suppressed: 7.4%
- Baseline HCV Antibody Prevalence: 65.1%
  - Chronic HCV (RNA-positive): 79.6%

NETWORK CHARACTERISTICS

- 8 of 11 indexes merged into one network
- Network Diameter: 39
- Average Path Length: 14
- Average Degree: 2.1

NETWORK-LEVEL RISK FACTORS FOR HIV

- Of 928 HIV-positive participants at baseline, 64.6% were directly connected with at least one other HIV-positive PWID.

Predictor	Adjusted Odds Ratio	95% CI	P-value
Path length to HIV infected node	0.60	0.54 – 0.67	< 0.001
Number of HIV infected egos (per unit increase)	1.21	1.1 – 1.34	< 0.001
Injecting at spatial hotspot #40	1.86	1.56 – 2.21	< 0.001

Table 2. Network-level correlates associated with prevalent HIV infection at baseline identified by machine learning and logistic regression. Model was adjusted for individual-level factors[1] including age, sex, needle sharing, number of injection partners, and injection frequency.

1. The following individual-level risk factors were significant in the multivariate regression: age ($p < 0.001$; OR = 0.98), needle sharing ($p < 0.001$; OR = 1.91), and injection frequency ($p < 0.001$; OR = 1.33)

NETWORK-LEVEL RISK FACTORS FOR HCV

- Of 1634 HCV-positive participants at baseline, 86.8% were directly connected with at least one other HCV-positive PWID.

Predictor	Adjusted Odds Ratio	95% CI	P-value
Path length to HCV infected node	0.52	0.43 – 0.63	< 0.001
Number of HCV infected egos (per unit increase)	1.31	1.2 – 1.5	< 0.001
Injecting at spatial hotspot #40	2.4	2.0 – 2.9	< 0.001

Table 3. Network-level correlates associated with prevalent HCV infection at baseline identified by machine learning and logistic regression. Model was adjusted for individual-level factors[1] including age, sex, needle sharing, number of injection partners, and injection frequency.

1. The following individual-level risk factors were significant in the multivariate regression: age ($p = 0.02$; OR = 0.98), needle sharing ($p < 0.001$; OR = 2.1), number of injection partners ($p = 0.002$; OR = 1.1), and injection frequency ($p < 0.001$; OR = 1.44)

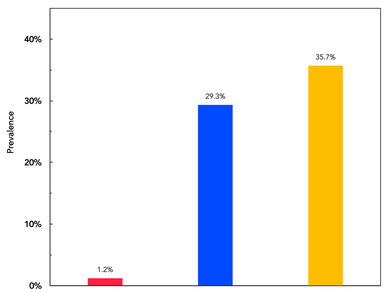


Figure 4. Baseline HIV/HCV infection status of cohort (2512 PWID in New Delhi, India).

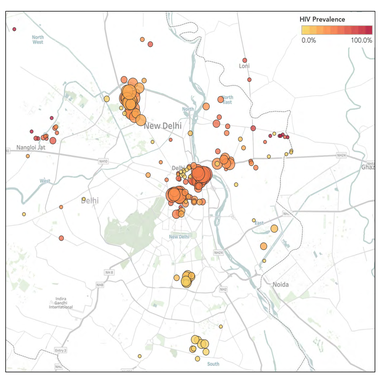


Figure 5. Spatial distribution of injection hotspots. Hotspots are colored by HIV prevalence and sized by number of PWID who report injecting at the site.

CONCLUSIONS

- PWID in this sample from Delhi exhibited a highly interconnected network structure.
- Network and spatial factors play a role in transmission beyond individual-level factors.
- Increasing number of HIV or HCV infected egos was associated with a higher likelihood of being positive for HIV or HCV.
- Increasing path length between an individual and another with HIV or HCV resulted in lower likelihood of prevalent HIV or HCV infection.
- One spatial location was strongly associated with HIV and HCV prevalence.
- Incorporating the underlying network structure into programs is critical to efficient utilization of resources.

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