Disease Risk Network Topologies Among People who Inject Drugs in Rural Puerto Rico

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Rural drug use in Puerto Rico

Injection drug use in rural Puerto Rico has increased dramatically since the 1980s:

- Close link to New York and Boston heroin markets
- Evolution of the “trampoline” drug economy
- Gentrification and urban renewal that displace low-income high unemployment communities to rural areas
- Natural and fiscal disasters that hurt law enforcement efforts and exaggerated treatment deficits

2014-present “Vida Accion Salud (VAS)”

Support

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  - NIDA Minority Supplement R01 DA037117-S1 -S2.
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- “REU Site: Social Network Analysis for Solving Minority Health Disparities”. National Science Foundation SMA 1757739
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- “Biomarkers for Dysbiosis-Related HIV-Associated Cognitive Disorders among Persons Who Inject Drugs in Puerto Rico” National Institutes of Health, National Institute on Drug Abuse R01 DA047823

Local Partners:

- **El punto en la Montaña SEP**
- **University of Puerto Rico Medical Sciences** (Juan Carlos Reyes, Professor and Chair of Epidemiology and Biostatistics)
- **Universidad Central del Caribe School of Medicine** (Department of Microbiology and Immunology)
- **CDC National HIV Surveillance Team San Juan** (Sandra Miranda, Puerto Rico Department of Health)

Conflicts of Interest Declaration

This presentation declares no conflicts of interest or sources of support other than the federal funding support and university/organization partnerships listed in the previous slide.


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Benzos
2. Ativan
4. Valium
Riesgos Altos
1. Mezcla de Drogas
2. Usar de más
5. Usar solos
6. condición física
Síntomas Sobredosis
1. ronquido
2. no conciencia
3. viste perdido/ido
4. morado en labios, punta dedos
5. pálida


VAS
VIDA. ACCION.

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Journal of Substance Abuse Treatment

Association between alcohol consumption and injection and sexual risk behaviors among people who inject drugs in rural Puerto Rico

Melissa Welch-Lazoritz [a,*], Dane Hautala [b], Patrick Habecker [c], Kirk Dombrowski [c]
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Social determinants of HIV/HCV co-infection: A case study from people who inject drugs in rural Puerto Rico

Roberto Abadie *, Melissa Welch-Lazoritz, Bilal Khan, Kirk Dombrowski

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Drug and Alcohol Dependence
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Full length article

Rural and urban comparisons of polysubstance use profiles and associated injection behaviors among people who inject drugs in Puerto Rico

Dane Hautala*, Roberto Abadie, Bilal Khan, Kirk Dombrowski

Taylor & Francis
Substance Use & Misuse
ISSN: 1082-6084 (Print) 1532-2491 (Online) Journal homepage: http://www.tandfonline.com/loi/isum20

Injection Partners, HCV, and HIV Status among Rural Persons Who Inject Drugs in Puerto Rico

Patrick Habecker, Roberto Abadie, Melissa Welch-Lazoritz, Juan Carlos Reyes, Bilal Khan & Kirk Dombrowski

THE JOURNAL OF RURAL HEALTH
NRHA

ORIGINAL ARTICLE

Latent Risk Subtypes Based on Injection and Sexual Behavior Among People Who Inject Drugs in Rural Puerto Rico

Dane Hautala, PhD;[1] Roberto
Kirk Dombrowski, PhD[1]

Duncan et al. Harm Reduction Journal (2017) 14:69
DOI 10.1186/s12954-017-0195-5
Harm Reduction Journal

RESEARCH Open Access

Needle acquisition patterns, network risk and social capital among rural PWID in Puerto Rico

Ian Duncan[1*], Patrick Habecker[1], Roberto Abadie[1], Ric Curtis[2], Bilal Khan[1] and Kirk Dombrowski[1]

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Hepatitis C serosorting among people who inject drugs in rural Puerto Rico

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International Journal of Drug Policy
journal homepage: www.elsevier.com/locate/drugpo

Research paper

Differential access to syringe exchange and other prevention activities among people who inject drugs in rural and urban areas of Puerto Rico

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Vida Accion Salud

2015 Wave 1 – Respondent Driven Sampling, with a recruitment criteria of injection drug use in the last 30 days
2017 Wave 2 – Random resampling of the Wave 1 network for peer recruitment and micro ethnographic assays
2017 Post-Maria OAT study
2018 Wave 3 – Post-Maria resampling
2019 Photovoice Project
2019 Dysbiosis Related HIV Cognition Study

Question: To what extent can "homophily" be used to understand patterns of interaction among PWID?

Rationale: Affiliation/recruitment patterns represent a "walk" over a risk network which may be related to the ways that viruses are transmitted.

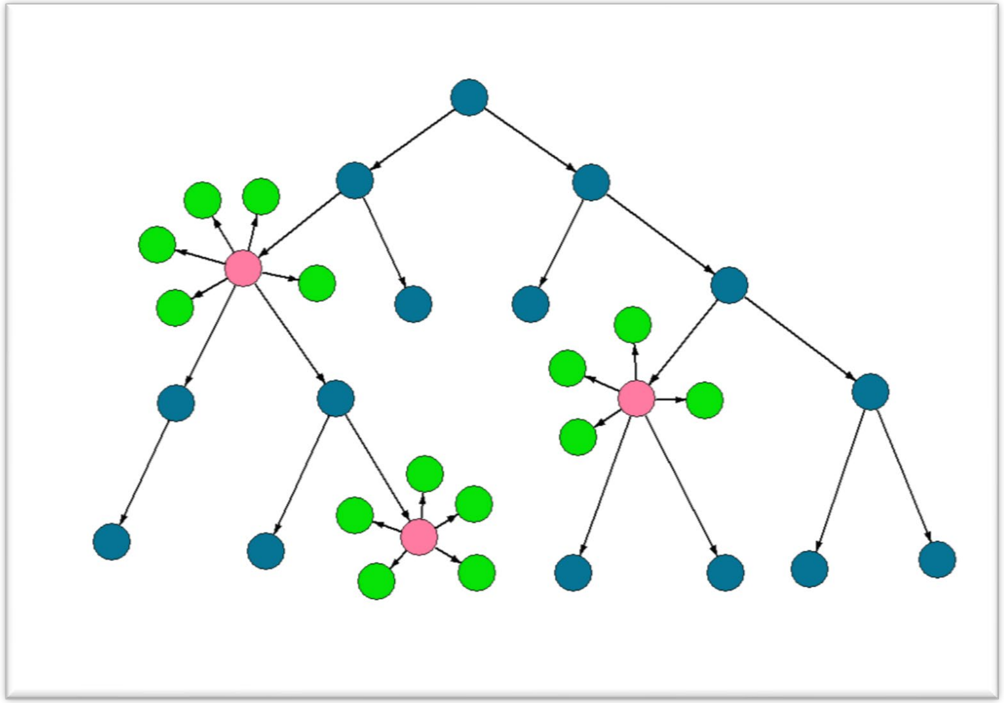


Table 1. Descriptive Statistics.

	Urban sample (512)	Rural sample (315)	Urban NHBS national aggregate
Demographics and health			
Age	41.1	41.8	
Gender (% female)	19%*	10%*	
Mean per capita income	$4,918*	$4,451*	
HIV + Status	13.4%*	6.0%*	11.00%
Been tested for HCV and HCV + Status	48.0%	49.0%	
Have health insurance coverage	52.0%*	82.0%*	61.20%
Have a usual source of health care	71.0%*	90.0%*	
Past year visited a health care provider	55.0%*	68.0%*	78.60%
Unable to access health care due to cost	26.0%*	12.0*%	
No visit to health care in past 5 years	12.0%*	8.0%*	
Ever tested for HIV	87.00%	90.00%	91.30%
Ever tested for HCV	65.0%*	77.0%*	78.00%
Injection drug use behaviors			
Age at first injection	20.6*	21.9*	
# of years spent injecting	20.1	19.9	
# of people used needles after	2.7*	1.2*	
# of people used works after	6.3	4.5	
# of people divided drugs with	4.3*	1.4*	
Past year average frequency of injection	5.8*	5.5*	
Frequency used a sterile needle	3.0*	2.7*	
Frequency used a dirty needle after someone	0.7*	0.4*	
Receptive sharing of syringes	36.90%	32.40%	33.00%
Receptive sharing of injection equipment	45.90%	59.00%	57.00%
Frequency shared a cooker with someone	1.0	1.1	
Frequency shared cotton with someone	0.9	0.7	
Frequency shared water with someone	0.8*	0.7*	

*$p < .05$

The San Juan NHBS sample and the VAS sample are similar in many ways, except:

- **Gender**
- **HIV Status**
- **Health Insurance/Care**
- **Drug and equipment sharing**

Where national NHBS statistics were available, the rural PR cohort seemed more like the national population than the urban San Juan network.

What is homophily/heterophily?

The tendency for individuals to "cluster" in networks with those "like" themselves….*birds of a feather…*

- Complicated by issues like *average degree* and *reciprocity* and *transitivity*
- However, complex statistical means are available to measure homophily in RDS contexts

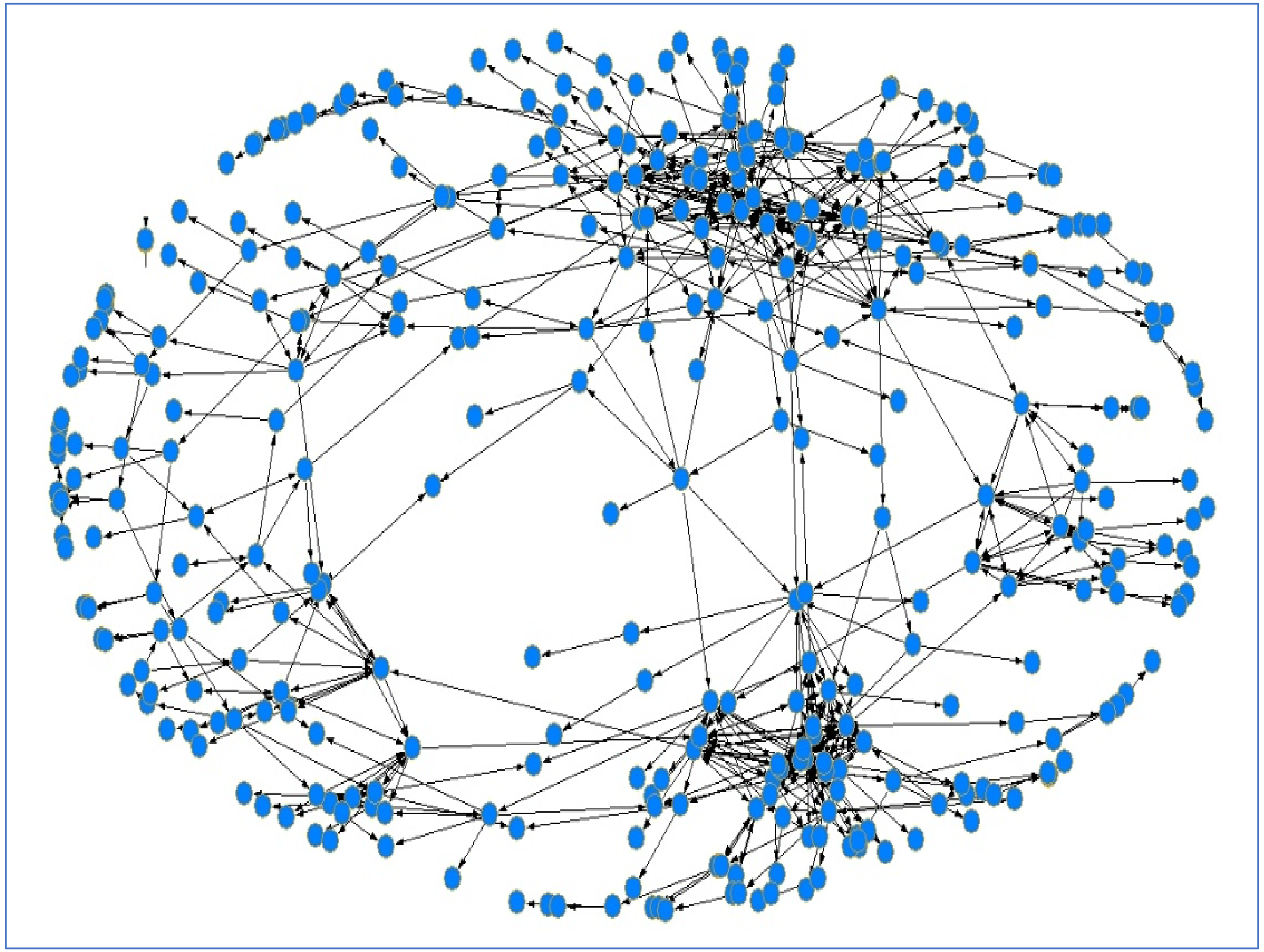


Table 2. Comparisons of homophily between the Puerto Rico urban and rural samples.

	Urban sample			Rural sample		
	Total in-group contact homophily (H)	Affiliation homophily (H_x)	Degree homophily (H_d)	Total in-group contact homophily (H)	Affiliation homophily (H_x)	Degree homophily (H_d)
Gender						
Male	0.000	0.116	−0.024	0.000	−0.006	0.054
Female	0.137	0.116	0.024	−0.601	−0.578	−0.055
Income						
≥ $4,999	0.209	0.000	0.210	0.035	0.073	−0.009
< $5,000	−0.222	−0.015	−0.210	0.081	0.073	0.009
Age						
20–39	0.230	0.169	0.070	−0.020	0.034	−0.060
40–49	−0.091	0.044	−0.157	0.050	0.017	0.033
50–69	0.163	0.138	0.031	0.009	0.002	0.006
Unemployment state						
Unemployed	0.052	0.008	0.044	0.249	0.023	0.231
Not unemployed	0.002	0.008	−0.045	−0.120	0.023	−0.231
Believed HCV status						
Unknown	−0.029	−0.039	0.004	0.041	0.049	−0.026
Negative	0.058	0.045	0.013	−0.038	0.084	−0.217
Positive	−0.002	0.013	−0.027	0.249	0.129	0.140
Drug treatment participation						
No	−0.074	0.015	−0.102	0.018	0.131	−0.336
Yes	0.116	0.015	0.103	0.423	0.131	0.331
Speedball use						
No	0.195	0.195	0.000	0.225	0.251	−0.260
Yes	0.192	0.192	0.000	0.446	0.251	0.270

We tend to look for cases where values are $|h|>0.3$

Several factors stand out:

- Strong heterophily among women in the rural areas
- Rural affiliation around treatment history is pronounced
- Rural speedball use also seems to involve social clustering

	Urban sample			Rural sample		
	Total in-group contact homophily (H)	Affiliation homophily (H_x)	Degree homophily (H_d)	Total in-group contact homophily (H)	Affiliation homophily (H_x)	Degree homophily (H_d)
Alcohol use in the past 12 months						
No	0.218	0.101	0.131	0.115	0.094	0.023
Yes	−0.050	0.101	−0.131	0.038	0.094	−0.024
Binge drinking in the past 12 months						
No	0.269	0.095	0.191	0.102	0.089	0.015
Yes	−0.064	0.095	−0.193	0.069	0.089	−0.015
Injection frequency						
≥ 1x/day	0.481	0.074	0.438	0.247	0.056	0.208
< 1x/day	0.012	0.074	−0.440	0.008	0.056	−0.202
Number of sex partners in the past 12 months						
None	0.033	0.038	−0.022	0.018	0.045	−0.102
Any	0.059	0.038	0.022	0.142	0.045	0.102
Noninjection drug use in the past 12 months						
No	0.189	0.072	0.125	−0.035	−0.014	−0.021
Yes	−0.053	0.072	−0.126	0.013	−0.005	0.021

(Continued)

We tend to look for cases where values are |h|>0.3

Several factors stand out:

- High frequency users in San Juan show high clustering
- In rural areas, clustering on use frequency is less pronounced

Table 2. Continued.

	Urban sample			Rural sample		
	Total in-group contact homophily (H)	Affiliation homophily (H_x)	Degree homophily (H_d)	Total in-group contact homophily (H)	Affiliation homophily (H_x)	Degree homophily (H_d)
Shared needles in the past 12 months						
No	0.006	0.108	−0.061	0.298	0.246	0.070
Yes	0.162	0.108	0.059	0.215	0.246	−0.069
Shared works in the past 12 months						
No	0.038	0.046	−0.012	0.084	0.093	−0.013
Yes	0.058	0.046	0.012	0.105	0.093	0.014
Back-/frontloading in the past 12 months						
No	0.008	0.028	−0.020	−0.031	−0.004	−0.027
Yes	0.048	0.028	0.020	0.020	−0.014	0.027

We tend to look for cases where values are $|h|>0.3$

Finally:

- Though less pronounced, clustering among those who share syringes is more significant in rural than in urban areas

Two sorts of conclusions

Network Implications:

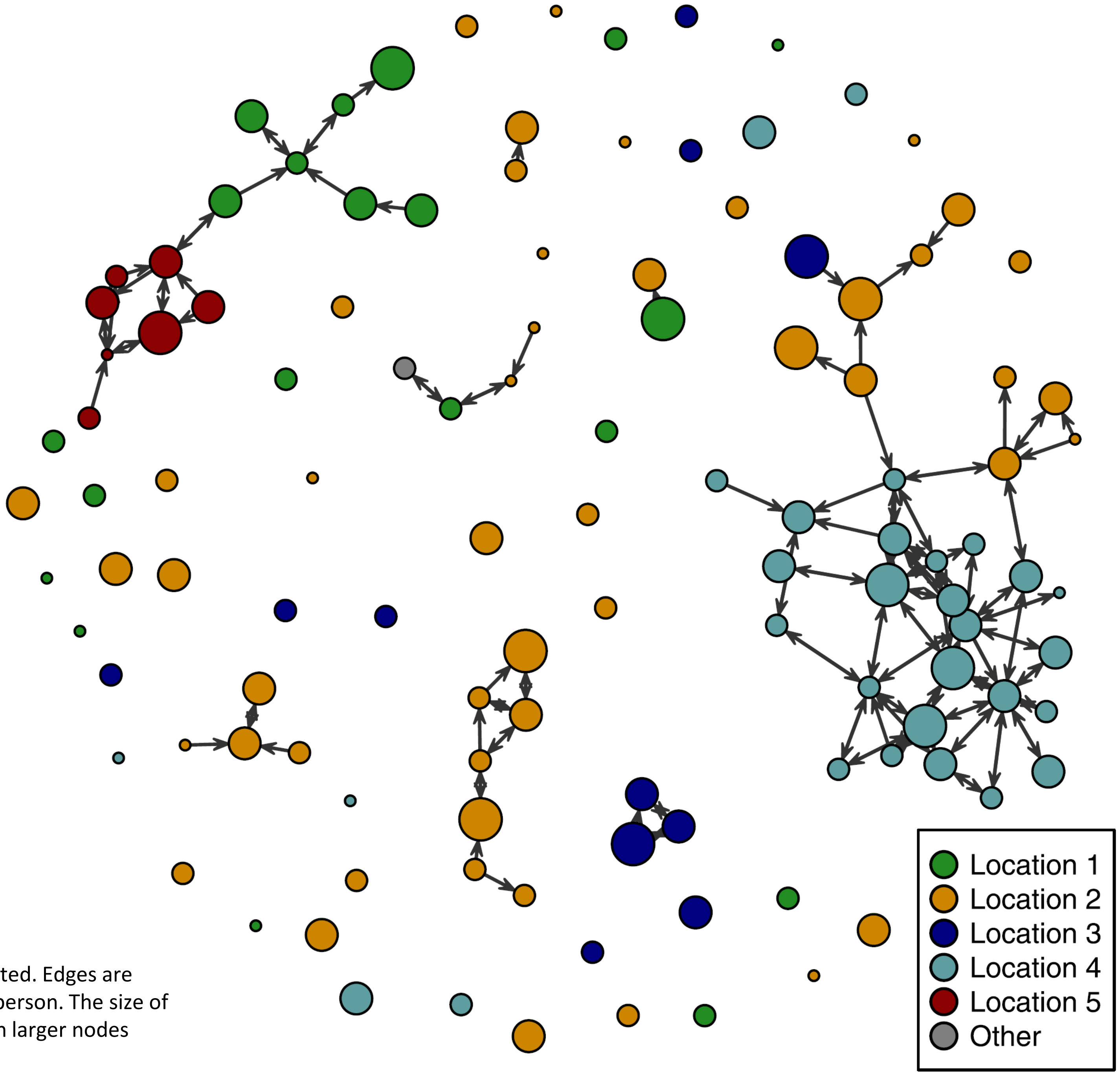
- Much of the effort around respondent driven sampling has sought ways to correct for topological factors that affect sampling—in the process we have overlooked the possible importance of the topological data and what we might learn from it.

Clustering patterns differ…

- Along several axes, there were marked differences in network topology between rural and urban PWID networks
- Some of these factors (injection frequency, treatment history, gender) are also known to affect risk tendencies.
- Knowing that “like” persons are likely to cluster can possibly provide insight into behavior reinforcement factors influence injection related risk.

Next steps:

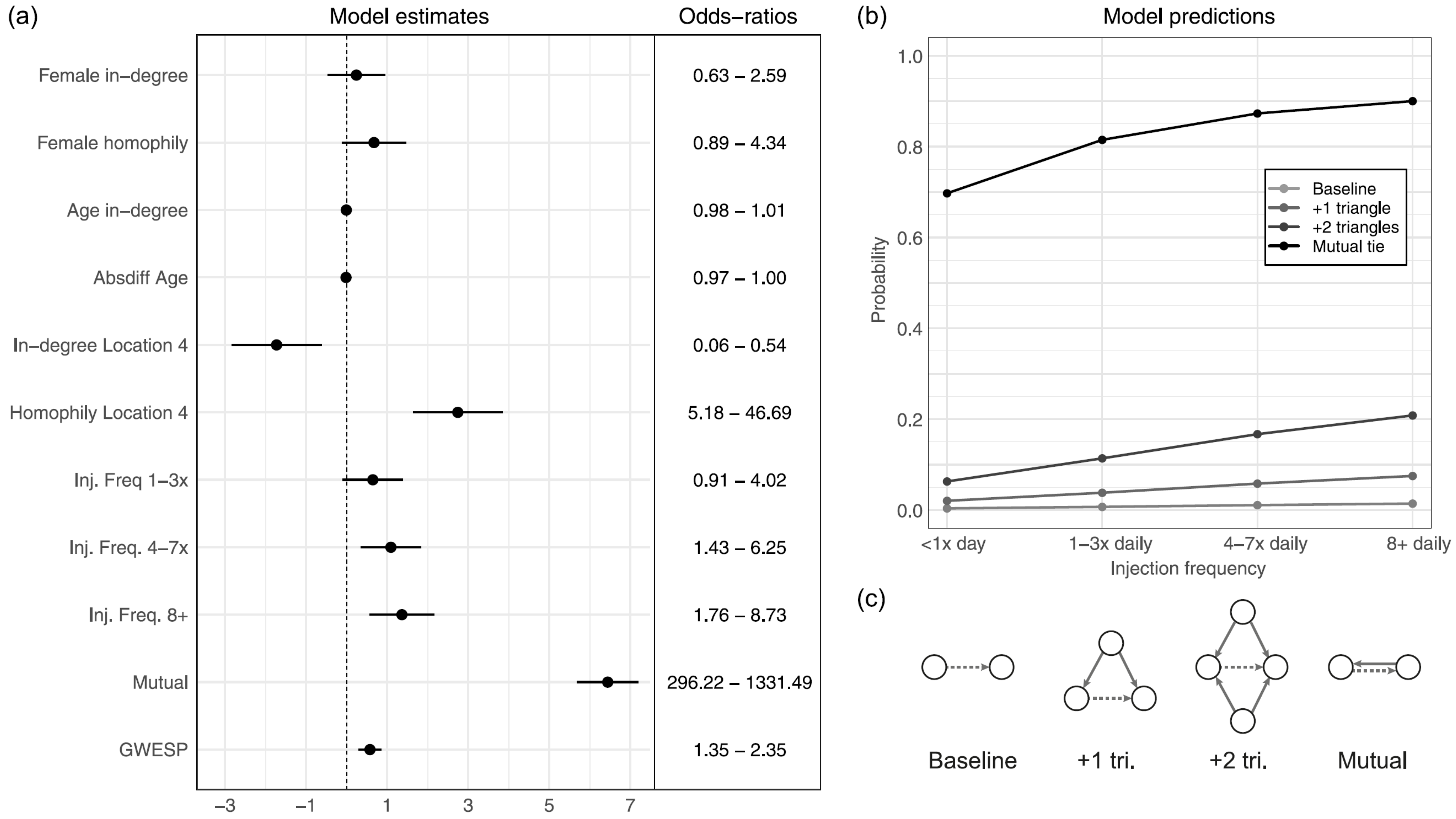
To what extent do rural PWID in Puerto Rico select injection partner on the basis of their perceived risk of contracting or spreading HIV or hepatitis C (HCV)?

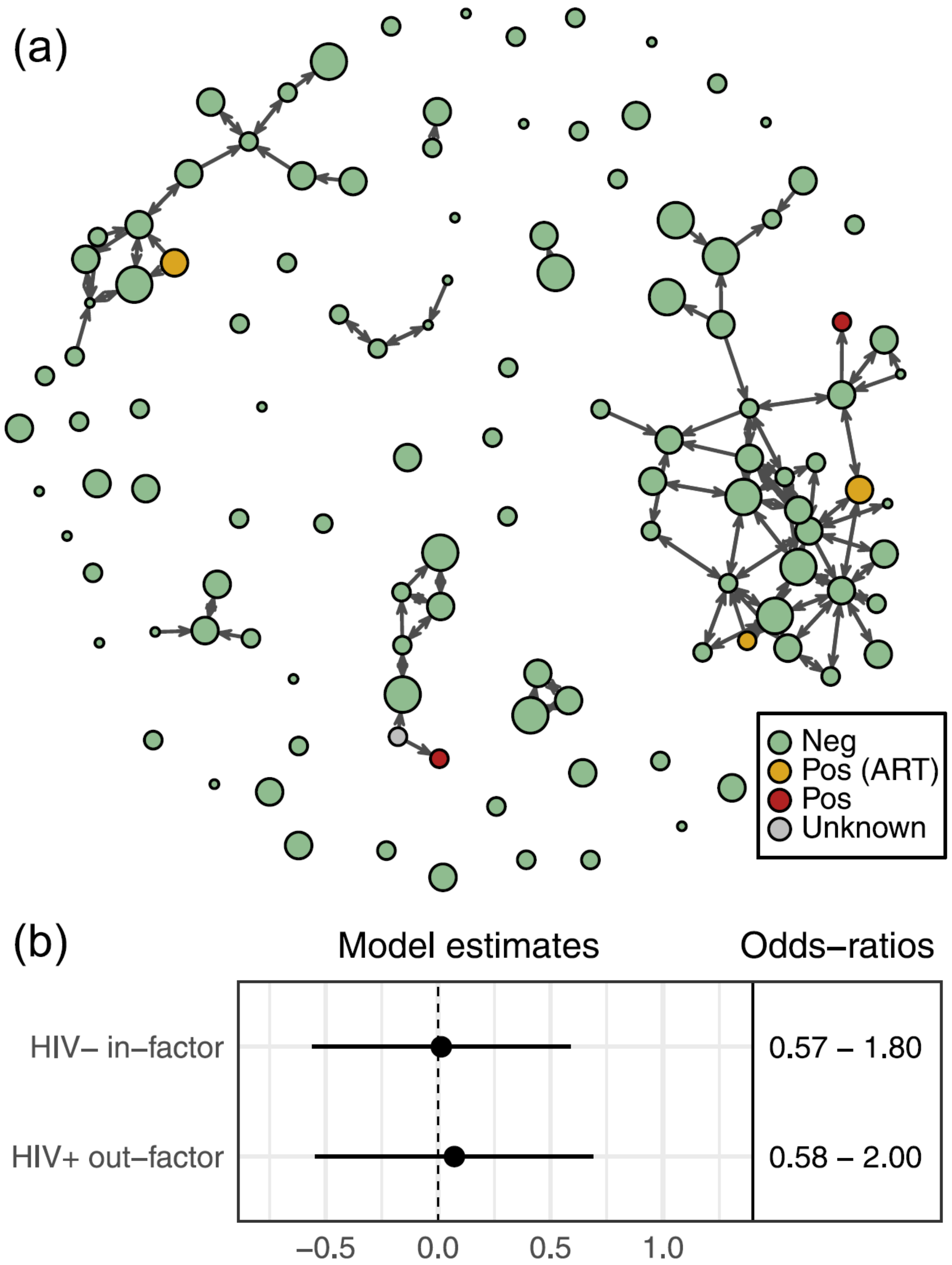


Nodes (individuals) are colored by the residence location of the individual represented. Edges are directed, with arrows pointing to the individual who used a needle after the other person. The size of nodes reflects the frequency with which individuals were using injection drugs, with larger nodes representing network members with a higher injection frequency.

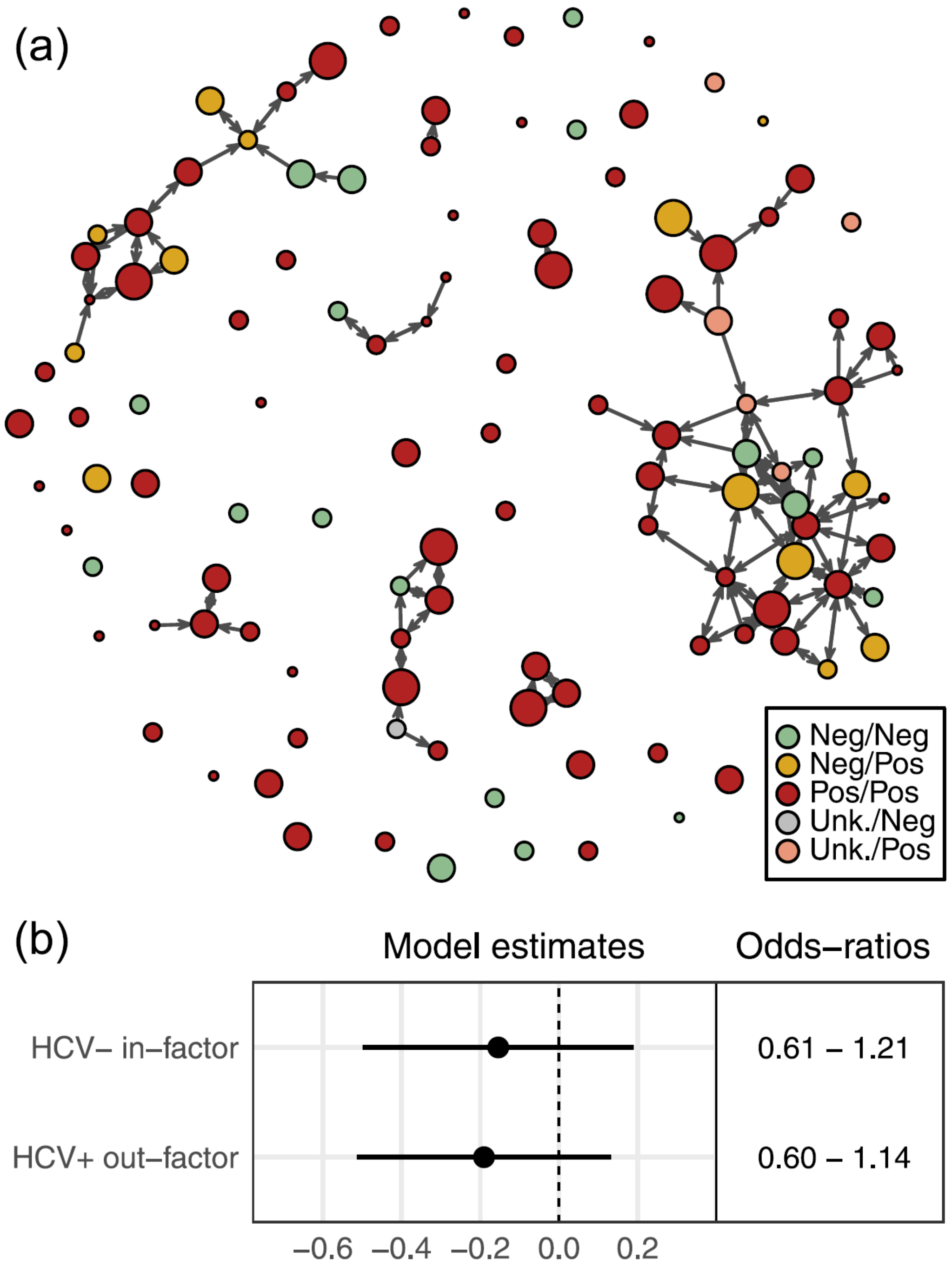
Method: Using ERGM to model tie likelihood

	Model 1			Model 2			Model 3		
	(Base model)			(+ Mutual)			(+ Transitivity)		
	Coef.	S.E.	*p*-value	Coef.	S.E.	*p*-value	Coef.	S.E.	*p*-value
Edges	−5.47	0.62	<0.01	−6.54	0.60	<0.01	−6.44	0.55	<0.01
Node in-factor Female	0.20	0.36	0.58	0.24	0.37	0.51	0.24	0.36	0.50
Node match Female	1.89	0.53	<0.01	0.79	0.45	0.08	0.68	0.40	0.09
Node in-factor Age	−0.01	0.01	0.29	−0.01	0.01	0.34	−0.01	0.01	0.43
Absdiff Age	−0.03	0.01	0.03	−0.02	0.01	0.07	−0.01	0.01	0.08
Node in-factor Location 4	−1.69	0.60	<0.01	−1.83	0.55	<0.01	−1.73	0.57	<0.01
Nodematch Location 4	4.54	0.59	<0.01	3.34	0.53	<0.01	2.74	0.56	<0.01
Node in-factor Injection 1–3×	0.75	0.41	0.07	0.75	0.40	0.06	0.65	0.38	0.09
Node in-factor Injection 4–7×	1.34	0.40	<0.01	1.37	0.39	<0.01	1.09	0.38	<0.01
Node in-factor Injection 8+ ×	1.67	0.44	<0.01	1.71	0.43	<0.01	1.37	0.41	<0.01
Mutual				6.61	0.37	<0.01	6.44	0.38	<0.01
GWESP							0.58	0.14	<0.01
GWESP decay (α)							0.04	0.26	0.89
AIC	1347.08			968.22			950.78		
BIC	1422.24			1050.90			1048.48		
Log Likelihood	−663.54			−473.11			−462.39		


(a)
Model estimates
Odds–ratios
Female in–degree
Female homophily
Age in–degree
Absdiff Age
In–degree Location 4
Homophily Location 4
Inj. Freq 1–3x
Inj. Freq. 4–7x
Inj. Freq. 8+
Mutual
GWESP
0.63 – 2.59
0.89 – 4.34
0.98 – 1.01
0.97 – 1.00
0.06 – 0.54
5.18 – 46.69
0.91 – 4.02
1.43 – 6.25
1.76 – 8.73
296.22 – 1331.49
1.35 – 2.35
–3
–1
1
3
5
7
(b)
Model predictions
Probability
1.0
0.8
0.6
0.4
0.2
0.0
Baseline
+1 triangle
+2 triangles
Mutual tie
<1x day
1–3x daily
4–7x daily
8+ daily
Injection frequency
(c)
Baseline
+1 tri.
+2 tri.
Mutual



HIV infection and needle-sharing. (a) Needle-sharing network colored by self-reported HIV status. “Pos (ART)” denotes individuals on antiretroviral treatment. The person represented by the grey node did not know their HIV status. (b) Estimates and odds-ratios of model coefficients (with 95% confidence intervals) for the partner restriction and informed altruism terms from the ERGMs considering HIV status.



HCV infection and needle-sharing. (a) Needle-sharing network colored by HCV status, shown as the combination of self-report (first term) and antibody test results (second term). (b) Estimates and odds-ratios of model coefficients (with 95% confidence intervals) for the partner restriction and informed altruism terms from the ERGMs considering self-reported HCV status.

Discussion

The analyses suggest that greater injection frequency increases the risk of receptive needlesharing ties in our sample, and that reciprocity and transitivity are important network features.

- At the same time, our models provide no evidence for partner restriction or informed altruism as factors which govern needle sharing in PWID networks
- This conclusion holds despite clear awareness in the population about the risks of disease transmission via syringe sharing.

Social Factors may underlie this:

- Our results suggest that greater injection frequency increases the risk of receptive needle-sharing ties in our sample. As a PWID’s injection frequency increases, so does their need for drugs and equipment and for money to purchase them. Faced with limited monetary resources, PWID may prioritize purchasing drugs over purchasing clean equipment.
- In ethnographic interviews, PWID reported that the biggest need was securing the resources to “cure” themselves of withdrawal symptoms, and so “completing” the money needed to afford their dose becomes their main concern. Even $1—the price of a new syringe in a shooting gallery or on the street—can set them back in achieving this goal (at the time of our study, a small bag of heroin sold for $6, and cocaine for $5).
- In this context, borrowing a syringe after someone else has used it is the cheapest and speediest option for a PWID to obtain their “cure.”

Social Factors *caballo*:

Moreover, the need to acquire drugs while having limited money to pay for them also draws PWID into social interactions with others in a way that considerably increases their risk of using shared equipment.

In Puerto Rico, drug users often pool their resources with others in a practice called *caballo* (or "horse") in order to purchase supplies jointly. *Caballo* is practiced in a variety of substance use contexts, for instance for purchasing a joint or even a pitcher of beer.

Within our study sample, the ethnographers observed that *caballo* for the purpose of acquiring injection drugs was most often practiced by PWID with a high injection frequency. Such sharing is further encouraged by the fact that most PWID in the area prefer to inject speedball, a combination of heroin and cocaine, which increases the funds required to secure a dose.

Meta-Conclusions

- Network analysis continues to provide new insights into risk behaviors in context. Relational approaches switch the focus from individual behaviors to dyadic interactions…behaviors “between” individuals rather than “by” individuals.
- HIV and HCV risk behaviors are seldom guided by “understanding” of risks alone—they are driven by a range of biological and contextual factors, both of which invoke relationships.
- Rural urban differences are not necessarily driven by differences in the availability of drugs or the demographics of the using population, but often exhibit significant “social” differences that likely require different forms of intervention.

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