Network Location and Risk of Human Immunodeficiency Virus Transmission among Injecting Drug Users: Results of Multiple Membership Multilevel Modeling of Social Networks

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Original Article

Abstract

Background: Despite the implementation of harm reduction program, some injecting drug users (IDU) continue to engage in high-risk behaviors. It seems that there are some social factors that contribute to risk of human immunodeficiency virus (HIV) transmission in IDUs. The aim of this study was to analysis the social network of IDUs and examines the effect of network location on HIV transmission risk using the multiple membership multilevel models.

Methods: From October 2013 to March 2014 we conducted face-to-face interviews on 147 IDUs. We asked participants to nominate up to 20 people whom they had more than causal contact with them during the last month and specify if each nominee is drug injector or not. We defined four Network locations as Core and Peripheries of main components. The risk of HIV transmission for each individual was measured based on 7 items scale. We applied Multiple Membership Multilevel Linear Regression analysis to examine the relationship between network location and HIV transmission risk. We used Stata and UCINET software's for the analysis of data.

Findings: The mean age of participants was 37 ± 9.32. Most of the individuals were male, single and educated up to guidance school. Being a core member of the main component as like as being a member of other small components in comparison with Isolates/unlinked significantly increased the HIV Transmission risk. Engagement in methadone maintenance therapies (MMT) was associated with a decrease in HIV transmission score.

Conclusion: Network analysis is a useful guide to find the most influential members of IDUs network and may have a complementary role for harm reduction program. The efficacy of interventions programs can be reinforced by addressing them to core individuals within the network. Furthermore, it provides the harm reduction staff to find the broader number of IDUs who are usually hard to reach by routine outreach case-finding tasks.

Keywords: Social network analysis, Injecting drug users, Human immunodeficiency virus transmission risk, Network location, Iran

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Introduction

One of the key populations at higher risk of human immunodeficiency virus (HIV) are injecting drug users (IDUs).[1] Behaviors that expose IDUs to HIV infection are the use of non-sterile needles and other injecting equipment and engagement in unprotected sex practices.[2] Although lack of access to harm reduction services is the main determinant of engagement in high-risk behavior among IDUs, in many countries as well as Iran, despite the large scale coverage of such services and all great success achieved, Injection of drugs is still the main mode of HIV transmission.[1,3,4] Most of the available harm reduction programs such as education, needle exchange, methadone maintenance therapies (MMT) and condom distribution rely on individually oriented models of change. Despite the awareness, individual attributes and access to services, there are other causal factors that contribute to risk of HIV transmission among IDUs.[5,6] In other words, there are some macro-level and social phenomena that make it difficult for people to avoid risk factors.[7-9]

Network analysis is relatively new concept in epidemiology that is based on the assumption that social networks may impose the behavior of their members to some extent. Albeit, the degree of network constraints depends on the structure of the network and the position of individuals within the networks that they belong to.[10-12] One of the most promising usages of this concept in drug abuse and HIV/AIDS (acquired immune deficiency syndrome) research is to answer possible questions on social mechanisms through which individuals are engaged in drug abuse practices and consequently high-risk behaviors that may expose them to HIV infection. The position of individuals within their risk network is one of the most important factors that affect the risk of HIV transmission among IDUs. Some studies indicate that occupying the core position within the drug injection network is associated with needle sharing, unprotected sex and also HIV infection in this population,[8,13,14] Although in other situations, HIV infection has been concentrated in persons who are located in smaller, unconnected component and peripheral positions.[15]

Despite an increasing number of studies examining the association between social network position of IDUs and HIV transmission risk, there are still a number of gaps in the available researches. For example, most of the studies defined HIV transmission risk of individuals based only on two factors: needle sharing and unprotected sex. Whereas, other characteristics of IDUs' personal network such as number of needle sharing partners, number of sex partners, proportion of IDUs in their personal network, extent of using condom in sexual relations and sharing injection instruments such as cookers, cotton or rinsing water has been largely ignored in these studies. Whenever it comes to better ranking of IDUs based on HIV transmission risk, we should consider these important factors with appropriate weighting schemes.

In addition, most of the studies used simple regression models to examine the effects of network structure on HIV transmission risk. The main assumption for applying such models is the dependency of observation violated in network data. Indeed, the social relations that exist between individuals may affect their behaviors, whereas there are some degrees of similarities between people who belong to the same groups. On the other hand, the characteristics of individuals who belong to the same group may differ from those of individuals who belong to other groups. When there is grouping structure in the data, the multilevel approach would work the best. One of the assumptions of using hierarchical multilevel models is that each lower level unit should be a member of only one higher level unit, while in some situations, as in the context of social networks, an additional source of dependency may violate this assumption.[16]

There are always some individuals within the network who belong to more than one group and therefore there are some degrees of overlap between personal networks of different individuals that break the hierarchy of multiple levels. Nevertheless, the multilevel nature of data as well as multiple memberships of individuals within different groups has been largely ignored in social network literature. In their two-level analysis, Chung and Beretvas demonstrated that relinquishing the multiple membership nature of observations may underestimate the higher level-predictor coefficient as well as variance component and overestimate the level-one variance.[17]

Hence, the aim of the present study, the first study on social network analysis of IDUs in Iran, is to describe the sociometric risk network of IDUs and examine the adjusted effect of network location on HIV transmission risk score by modeling the multilevel nature of data using the multiple membership method. Identifying key locations in drug injectors' network may help harm reductionists to implement more targeted interventions for prevention of HIV transmission in this population.

Methods

Formative research and recruitment

The study was carried out in Kerman city, Iran, the capital city of Kerman province, which is located in southeast of Iran. We conducted more than 20 interviews with individuals and key informants who had great knowledge about IDUs' communities to identify potential sites that IDUs live, hangout or bargain drugs. In addition, four drop-in centers in Kerman (two for males and two for females) provide services to both IDUs who refer to these centers and outreach areas. Consequently, we used chain referral technique to enroll a representative network of IDUs from all affected sites, including drop-in centers, shelters, voluntary counseling, testing centers and outreach spots. Eligible participants were individuals above 18 years old who had injected drugs at least once during the last year and had not participated in similar studies in 2 months preceding the interview.

From October 2013 to March 2014, three trained interviewers conducted the interviews. We asked participants to nominate up to 20 people whom they had more than causal contact with during the past 30 days. Then, we requested them to specify if each nominee is a drug injector or not. Each participant was given primary incentive (80000 Rails equal to around 2.7 USD) and also recruitment coupons to recruit other IDUs in their personal network. For each recruitment, they also received secondary incentive (30000 Rials equal to 1 USD). To ensure that the nominated person was actually the person who interviewed, we asked respondents to provide additional information (including name, sex, age, location of residency and duration of contact) on each nominee and then matched them with the characteristics of referred persons. Furthermore, in some instances the outreach staffs who knew both respondents and their personal networks made a decision about the validity of referred persons. The interviews were conducted in two drop-in centers in a very confidential setting. In some cases that the individuals were unwilling to complete the interviews at DICs, the interviewers completed the questionnaires in site.

Ultimately, we collected data on personal network of 147 IDUs. Like other network studies on open populations, we did not have access to entire population who had nominated by respondents; therefore, we limited sociometric analysis to the subset of network that the data on interrelationship of nodes were complete.

We conducted face-to-face structured interviews to collect data on social and risk networks of IDUs. The main parts of the questionnaire were as follows:

1. Demographic information and checking the eligibility criteria
2. Name generator (network member) part: in this section, we asked the respondents to nominate up to 20 persons whom they had more than causal contact during the past 30 days. We used the following prompts to help the respondents recall the members of their personal networks:

1. People whom you used drugs together within the last 30 days.
2. People whom you had sex with during the last 30 days.
3. Family members, friends, relatives or other individuals that you feel close to.
4. People you live with.
5. People you hang out with.
6. People you work with.

For each nomination we also asked questions on degree of intimacy, frequency of contact within the last 30 days, duration and types of their relation, gender and age of nominee and if the person is also an IDUs or respondent sex partner. Finally, we collected the self-reported data[18] on high-risk behaviors of respondents by asking some questions on drug injection (needle sharing, sharing injection instruments, the age of first injection), sexual habits (the number of sexual partners, extent of using condoms), the types of drugs that respondents use and engagement in MMT.

HIV transmission risk scale

The outcome variable, HIV transmission risk, was measured based on 7 items linear scale that we constructed by applying principal component analysis. The scale takes into account different dimensions of HIV risk taking behaviors/situations, including injecting and sexual risk behaviors. Briefly four items were related to injection practice (history of sharing needles and injection equipments, number of injection partners and proportion of IDUs in personal network of participants) three items were related to sexual behaviors (number of sexual partners, the extent of using condoms within their sexual intercourses and in the last sex).[19]

Sociometric network definitions

A social network consists of a set of units (individuals or nodes) with the relationship between them. In social network terminology, Egos refer to index person under the study and alters are the people who are connected to the egos. Tie or link is any connection between two nodes. Personal or egocentric network involves the direct relationships between ego and all of its' alters while in sociometric or whole network analysis, all direct or indirect relationships between all members of a network are the focus of study.[12,20] In the first step, we constructed the directed adjacency matrix of relations between IDUs in the network. In the simplest form, the adjacency matrix is a square matrix with rows and columns corresponding to individuals within the network. If a link is present between two individuals the corresponding cell will label by 1 and otherwise 0. We measured all of the network indices based on this directed matrix.

One of the aims of descriptive analysis of network is to identify subgroups of individuals that have strong relationships with each other. There are some definitions to describe such subgroups within the network: Clique is a subset of nodes in which all nodes are directly related to another. A Component included all connected nodes (directly or indirectly) within the network (all none isolates). A K-core refers to a subset of network wherein each node is connected to at least k other node. We measured the Reciprocity or mutuality as the proportion of mutual ties to all ties. A mutual tie refers to any relation between two persons that goes in two ways. For example, if person A knows the person B, the person B also knows the person A. Some behaviors such as needle sharing and unsafe sex are more common in reciprocated relations. We also calculated the proportion of transitive triads within the network.[21,22] A triad is the relationships between three people. Transitivity of a relation means that when there is a tie from A to B, and also from B to C, then there is also a tie from A to C. In another word, it is something like "friends of my friends are my friends." There are possible 16 types of triad in the network. Whatever the proportion of transitive triads within a network increases the network will be more cohesive. In our study, all of these measures were calculated based on the adjacency matrix of directed links between 147 participants.

To examine the hypothesis if the location of individuals within their social network may be related to HIV transmission risk, we defined the location of each participant based on both coreness scores and component analysis.[23] As we stated previously, the coreness scores were calculated based on K-core analysis. For example, if someone in the networks was in contact to at least 2 other members the coreness score of 2 has been assigned to him. We also characterized the groups of any connected (both directly and indirectly) IDUs as a component. In another word, component analysis simply refers to characterizing the subgroups of any size that are connected within but dis-connected between groups. The main component in a network is a component with the highest number of members. Accordingly, we specified four types of locations in the network:

1. Core of the main component that refers to core members (the coreness scores of 2 and 3) of the largest component.
2. Peripheries of main components (with the coreness score of 1)
3. Members of other small components that contain all individuals who are the members of other small components
4. All isolates or unlinked IDUs within the network.

All network measures were calculated by UCINET 6 software.[24]

Multiple membership multilevel modeling of HIV transmission risk

Because there may be some degrees of similarities between IDUs who belongs to the same groups, logically it seems that the multilevel analysis is

the most appropriate way of modeling the effect of social relations and other covariant on high risk behaviors of this group. But regarding the simultaneous membership of IDUS in different groups, the assumption of hierarchy of different levels violated in network data. Hence, we used the MMMM to examine the relationship between location of IDUs within their drug injection network and HIV transmission risk adjusted for other variables. "A multiple membership model is an extension of multilevel models, which considers the case when the lowest level unit is a member of more than one higher classification unit."[25] Hence, in our study, IDUs (level 1) are nested within ego-nets or personal networks of various nodes (level 2) while in contrast to hierarchical multilevel models, each IDUS can be a member of more than one ego-net simultaneously (multiple membership)."One of the important feature of multiple membership data structures is that the degree to which each lower level unit belongs to each higher level unit will often vary across those higher level units. Multiple membership weights are used to quantify this, and this information is used when fitting multiple membership models."[26] Simply, in MMMM, the extent to which the lower level unit belongs to each higher level unit and its associated effect is modeled. We used the weighting scheme that was applied by Tranmer et al.[16] to specify the extent of multiple memberships of individuals to different personal networks. Accordingly, if an ego nominated N others, each of these nominees is given a weight of 1/n in the weight matrix. For instance, if an IDU stated that he/she is in contact with three other IDUs in the sample, the weight of 1/3 was assigned to each of these three nominated IDUs based on adjacency matrix that we explained earlier. Based on the notation that was given by Rasbash and Browne[27] the model can be written as follows:

$$y_{i\{j\}} = X_i'\beta_0 + \sum_{j\varepsilon group1\{j\}} w_{i,i,j}\, u_j + e_i$$

In this model, $y_{i\{j\}}$ is an individual HIV risk score, X′ and β_0 are vectors of fixed covariates and their regression coefficients respectively, group 1 {i} is a set of ego-nets to which i is a member, the term $\sum_{j\varepsilon group1\{j\}} W_{i,i,j}\, u_j$ is a weighted sum of ego-net effects where the multiple membership weight $W_{1,i,j}$ measures the extent to which IDUS i belongs to ego-net j with associated effects, and e_i is the residual error term. We used Stata software (version 12, Stata, College Station, Tex.) to the analysis the data.

The study protocol was reviewed and approved by Ethics Committee of the Shahid Beheshti University of Medical Sciences, Tehran, Iran. After the interviewers introduced themselves and were explained the study, verbal informed consent was obtained from each participant.

Results

The mean age of participants was 37 ± 9.32. Most of the individuals were male (91.0%), single (50.1%) and educated up to guidance school (73.5%) (Table 1).

Table 1. The demographic characteristics of 147 injecting drug user

Characteristic	Value
Age (year)	
Mean ± SD	37 ± 9.32
Minimum	20
Maximum	36
Education [n (%)]	
Illiterate or primary school	52 (35.3)
Guidance school	56 (38.1)
High school and more	39 (26.5)
Marital status [n (%)]	
Single	76 (51.7)
Married	37 (25.2)
Divorce	30 (20.4)
Death	4 (2.7)
Gender [n (%)]	
Male	134 (91.2)
Female	13 (8.8)
Types of drugs [n (%)]	
Heroine	141 (95.9)
Opium	48 (32.7)
Crystal Methamphetamine	47 (32.0)
Marijuana	33 (22.4)
Crack	16 (10.9)
Neurjezik/Tamjezik	12 (8.2)

SD: Standard deviation

The mean age of participants at first experience of drug injection was 25.74 ± 7.8 with the range of 9-52 years. Most of the participants experienced the first chance of the injection before the age of 30 (66.7%) and declared the "friendship with an IDUS" as the prominent cause of their first injection (46.3%). The majority of them indicated that their first injection occurred at a friend's house. 43% of individuals reported the lifetime history of needle sharing and 27.9% had a positive history of needle sharing within the last 6 months. The average number of daily injection was 2.86 ± 1.97

with the median of 3. More than half of the participants (58.5%) were under the MMT at the time of interview. 24.5% of respondents reported a history of sex with more than one partner within the last 6 months. Amongst those who were sexually active, only 45% reported that they always used condom during sexual intercourse within the last 6 months (Table 2).

Table 2. The drug injecting behaviors of injecting drug users

Characteristic	Value [n (%)]
Age categories of first injection (year)	
< 20	33 (22.4)
20-29	65 (44.2)
30-40	42 (28.6)
> 40	7 (4.8)
The cause of first injection	
Psychological pressures	6 (4.1)
Pry and excitement	19 (12.9)
Hangover	54 (36.7)
Friendship with an IDUS	64 (46.3)
The place of first injection	
Friend house	46 (31.3)
Ruin	41 (27.9)
Their own house	40 (27.2)
Prison	11 (7.5)
Car	3 (2.0)
Hotel	2 (1.4)
Garrison house	2 (1.4)
Body building club	1 (0.7)
Office	1 (0.7)
The average number of daily injections	
One	41 (27.9)
Two	37 (25.2)
Three	47 (32.0)
Four	10 (6.8)
Five or more	12 (8.2)
Life time needle sharing	
Yes	64 (43.5)
No	83 (56.5)
History of needle sharing within the last 6 months	
Yes	41 (27.9)
No	106 (72.1)
History of sharing cooker, rinse water or cotton within the last 6 months	
Yes	90 (61.2)
No	57 (38.8)
Engagement in MMT	
Yes	86 (58.5)
No	61 (41.5)
The number of sexual partners within the last 6 months	
None	67 (45.6)
One	44 (29.9)
Two	15 (10.2)
Three	11 (7.5)
Four	3 (2.0)
Five or more	7 (4.8)
The extent of condom use in sexually active IDUS within the last 6 months	
Never	12 (15)
Sometimes	25 (31.25)
Usually	7 (8.75)
Always	36 (45.0)
Proportion of IDUS in personal networks of participants (%)	
0	19 (12.9)
1-24.9	34 (23.1)
25-49.9	29 (19.7)
50-75	36 (24.5)
> 75	29 (19.7)

IDUs: Injecting drug users; MMT: Methadone maintenance therapy

The mean and median of network members who named by the subject were 7.24 ± 4.01 and 7 respectively. The maximum size of their personal and drug using networks were 18 and 13 respectively. In an average each respondent named 3 other IDUs in his/her personal network who they were in contact with within the prior 30 days with the median of 2. In 44.2% of IDUs, the overlap between personal and risk network was more than 50 % (Table 2).

Of 147 participants who completed the interview, 131 participants nominated altogether 433 IDUs in their risk networks. 213 of these directed relations were among 119 linked participants who were interviewed. Sixteen participants nominated no IDUs (Isolates). From 131 non-isolates, there were 28 participants who nominated other IDUs in their risk networks, but they did not link other IDUs in the study (Unlinked).

Figure 1 shows the overall network structure of participants who were included in the study. 51% of ties were reciprocated, and 33% of triads were transitive. We found 13 components with two or more members. There were 70 members in the main component. The average distance among reachable pairs in the main component was 5.33. By conducting the clique analysis, we found 86 cliques with a minimum size of two (Table 3). For better understanding of substructures in the network and to define the location of individuals within the network, the K-core analysis was performed (Figure 1). Based on component and K-core analysis, 47 participants were classified as core members of main component, 23 individuals as periphery of main component, 33 individuals as members of other small components and the remaining 44 participants as isolates or unlinked members.

In the null model with only a constant term in the fixed part, we examined the effect of level 2 (ego-nets) variable on HIV transmission risk score (level 1). The calculation of intraclass correlation (ICC) shows that 33% of HIV transmission risk score variance is explained by the ego-net variation. The significant result of Likelihood ratio test (P = 0.030), which compares the current model with the single-level model with no ego-net effect indicating that multiple membership model offers a significantly better fit to the data than single-level mode (Table 4). In the final model, we entered network location, age, level of education, marital status, engagement in MMT, duration of injection and multiple drug abuse as level 1 predictors. Adjustments for these variables lead to a reduction of 26% in ego-net level variance, but a considerably larger drop in individual level variance of 61% that suggest the adjusted variable have an important influence on HIV transmission risk.

The calculation of ICC in the adjusted model suggests that around 40% of HIV transmission

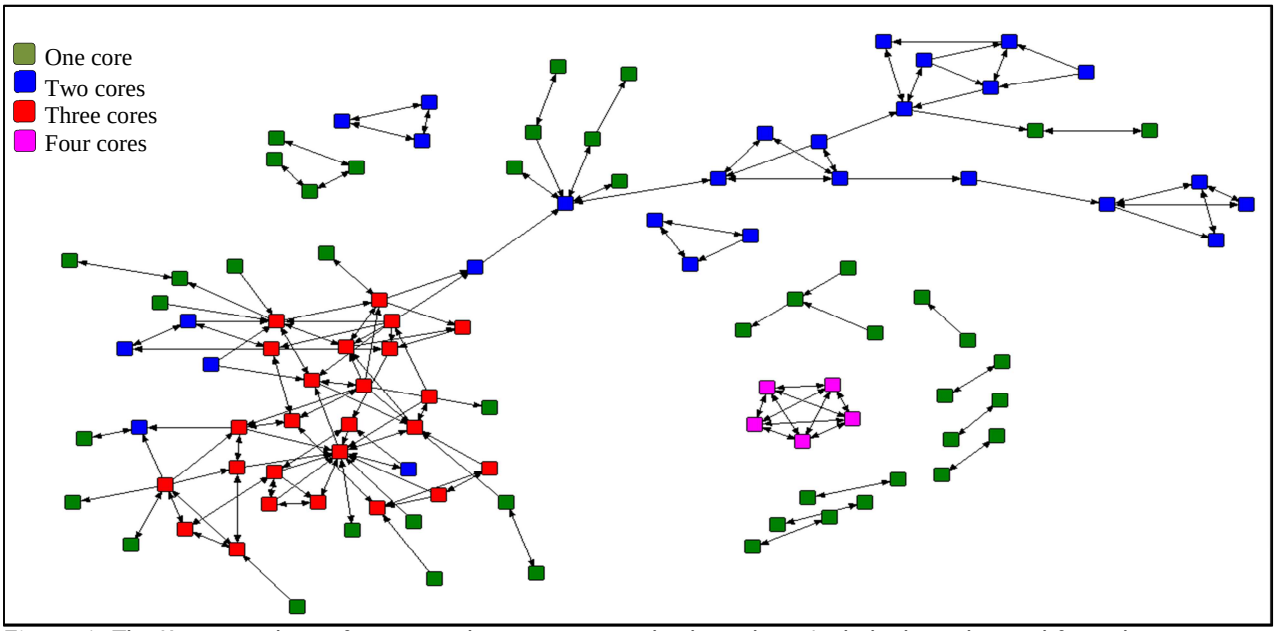

Figure 1. The K-core analysis of injecting drug users network, the isolates/unlinked are dropped from the sociogram

Table 3. Sociometric network measures of IDUs

Measure	Value
Proportion of reciprocated ties (%)	
Overall	51.06
Main component	42.86
Proportion of transitive triads (%)	
Overall	33.18
Main component	21.45
Average path length	
Main component	5.33
Cliques	
Cliques with minimum size two	86
Cliques with only two members	54
Cliques with only three members	30
Cliques with only four members	1
Cliques with only five members	1
Components	
Components with two members and more	13
The size of main component	70
Components with two members	7
Components with three members	2
Components with four members	2
Components with five members	1
Isolates	16
Unlinked	28

IDUs: Injecting drug users

risk score variance is explained by ego-net variation adjusting for individual-level variables. The reduction in Bayesian information criterion (from 676.56 to 665.98) indicates better status of fitness for the adjusted model compared with the null model. The final model suggests that location of IDUs within their social networks and engagement in MMT are the main predictors of HIV transmission risk score. Compared with Unlinked/Isolates, being a core member of the main component as well as being a member of other small components increases the HIV Transmission risk score by 2.12 and 1.08 respectively. In addition, IDUs, who are not under the MMT compared to IDUs who are engaged in MMT program, have 2.15 times increase in HIV Transmission risk score.

Discussion

Drug injection is the main mode of HIV transmission in many regions. The high prevalence of HIV infection in this subpopulation mainly mediated by high level of risky injection

Table 4. The multiple membership multilevel linear regression analysis of predictors of HIV (human immunodeficiency virus) transmission risk in injecting drug users

	Model 1 (null)	P	Model 2	P
Constant	2.794 (2.39-3.19)	< 0.001	1.40 (-0.12-2.93)	0.072
Network location		-	-	-
Unlinked/isolates		-	-	-
Members of small component			1.08 (0.20-1.97)	0.016
Peripheries of main component			0.39 (-0.62-1.40)	0.450
Cores of main component			2.12 (1.29-2.95)	< 0.001
Age			-0.021 (-0.065-0.022)	0.330
Education				
Primary school			-	-
Guidance school			-0.19 (-0.89-0.51)	0.590
High school and more			0.43 (-0.36-1.22)	0.280
Marital status				
Single			-	-
Married			0.70 (-0.05-1.45)	0.067
Divorce			-0.042 (-0.85-0.76)	0.910
MMT treatment			2.15 (1.49-2.81)	< 0.001
Using multiple drugs			0.39 (-0.24-1.03)	0.200
The duration of injection			0.003 (-0.04-0.05)	0.890
Ego-net level variance (SE)	2.20 (1.52)		1.74 (1.04)	
Residual (individual level variance)	4.48 (0.69)		2.77 (0.43)	
ICC	0.33		0.39	
BIC	676.5673		665.98	
LR test	0.030		0.023	

ICC: Intraclass correlation coefficient; BIC: Bayesian information criterion; MMT: Methadone maintenance therapy; HIV: Human immunodeficiency virus; LR: Likelihood ratio; SE: Standard error

and sexual behavior in this group.[3] Other factors such as a large amount of overlap between social and risk networks of IDUs, as we obtained in our study, may facilitate the HIV transmission among them. In this situation, the risk network can act as the source of social support and relations for its members and the continuity of such supports may be at the expense of acquiesce of members to engagement in high-risk behaviors.[28]

Our results revealed that near one thirds of IDUs had the history of needle sharing within the last 6 months and more than one-fifth of them were engaged in sexual intercourses with more than one partner while less than half of sexually active IDUs reported the persistent use of condoms during their sexual activities in the same period. The results of 2010 National Surveillance Survey in Iran also showed high prevalence of High risk behavior (37.0, 12.6 and 60.0 percent for using non-sterile needles, needle sharing within the last month and not using condoms in the last sex among IDUs, respectively).[3] Indeed, Although Iran is the pioneer of harm reduction program in Middle East and North Africa region and besides all great achievements that are gained; some IDUs continue to engage in high-risk behaviors. HIV infection is a behavioral disease subject to environmental and social influences. HIV associated with IDUs does not pass within IDUs' networks in a random way, depending on social, cultural and environmental differences; it disproportionally affects this population.[8,29,30] Hence, incorporating the social structure of IDUs in related researches and decision making may provide better insight into understanding of HIV transmission in these key groups.

The analysis of social networks of IDUs in Kerman is the first study in Iran that is concerned with the effect of social structure of this population on HIV risk transmission. Based on our knowledge, it is also the first study in which HIV transmission risk scale constructed by incorporating the network characteristics. Surely, the simple categorization of IDUs based on their high-risk behaviors does not capture the complex behaviors of this population and also increases the type one error by introducing the problem of multiplicity into the analysis. So, for better understanding of behaviors related to HIV transmission, looking simultaneously to multiple factors and conditions may provide better insight into mixed nature of HIV transmission and more proper ranking of this population based on their behaviors. While previous studies suggest that the risk of HIV transmission decreases by increase in age,[31,32] in the present study, we also found a negative association, but it was not statistically significant.

There was a moderate reciprocity in relations (more than half of ties) and approximately one-third of triads were transitive. Because we limited the analysis to IDUs, who were interviewed and because we could not be able to identify all the links correctly, the corresponding measures may be higher than we obtained in our results. As the reciprocity and the transitivity of relations within the network increases, the transmission of infections as well as interventions will be facilitated more.

The results of multiple membership multilevel modeling indicate that location of IDUs within their drug injection network and engagement in MMT program are the main predictors of HIV transmission in this group; therefore, the core members of main interconnected component and in the next, the members of other small components are more pertinent to HIV transmission within this population. On the other hand, positioning in the largest interconnected component of the drug injecting network affects the HIV transmission risk of IDUs. Lovell indicated that locating in the densest part of a large, interconnected network of IDUs increases the likelihood of risky injection practices.[8] These results are supported by Friedman et al. which found that core members of an IDUS network had a higher likelihood of needle sharing as well as acquisition and transmission of HIV than peripheral network members.[13]

The sociometric network location has also been related to HIV infection status. Friedman et al. reported that core location compared with other positions is associated with a considerably higher probability of HIV infection.[14] While Rothenberg et al. demonstrated that most HIV-positive persons appear in smaller, unconnected component and peripheral positions.[15] Although we did not examine the serostatus of IDUs, it seems that some factors such as knowing the HIV status of index persons by other members and duration of infection as well as variation in social and neighborhood settings are reasons of such controversies.

In our study, the network location of each individual was defined based on a combination of two network indices: component and K-core analysis. The K-core refers to "a very cohesive subcomponent of networks in which every member is connected to at least K other people of that component"[8] and a component is defined as a group of all connected individuals. Hence, not only infections but also social pressures, behaviors and information can spread through these bounded confraternities of network and this phenomenon may have implication for design and implementation of comprehensive intervention programs. Unfortunately, most of the HIV prevention programs rely on individually oriented models of change. These programs attempt to improve the health status of individuals by increasing the awareness, improving self-efficacy and modeling alternative, or resistance behaviors.[33] However, an important lost ring in these models as well as harm reduction interventions are ignoring the social relations and interactions that exist among individuals. As our results showed, engagement in MMT program and network location of individuals are the main factors that influence the HIV transmission risk in this population: two different dimensions of harm reduction interventions, one in individual level and another one in macro-social level that may have complementary role for each other. Effective HIV prevention not only encompasses interventions to bring up changes in individual behavior, but also interventions concerning with socio-community level behavior change.[29]

Regarding these, besides the extensive implementation of MMT program in Iran, network analysis can act as a useful guide to find the core or most influential members of IDUs' network. This subpopulation may act as key individuals in the transmission of HIV to other IDUs as well as bridging populations. There are evidences that using network analysis to identify core, and more influential individuals can lead to a more targeted intervention program to reduce the HIV transmission in this key group.[5,34-36] Moreover, by network approach large numbers of IDUs can be reached by social links that exist among them.[5] Some of them may never be captured by routine outreach tracking of IDUs.

Limitations

The multiple membership multilevel modeling allowed us take into account group dependency of network data to estimate the variation in individual-level HIV transmission scores at levels of ego-nets that have many implications for decision making and HIV prevention purposes. These two features (dependency of observations and multilevel nature of data) have been largely neglected in previous studies. In addition, to define the outcome variable, HIV transmission risk, we used a seven-item scale, which contains multiple dimensions of IDUs' risky behaviors and provide better insight to understanding the complex behaviors of them. In addition to these advantages, there are some limitations to our study: first, because the population of IDUs is an open population, we could not be able to recruit all of its members. Furthermore, it is likely that some participants do not nominate the members of their personal networks appropriately (e.g. to protect their identities) or may use the conventional naming of alters which in turn lead us to miss some links among this population. Both of these limitations restrict our ability to illustrate the full macro-structure of IDUs network. Although these limitations are not problematic in modeling procedures, they also suggest an even greater number of linkage or density than we indicated in our results.

Conclusion

In order to risk management for HIV transmission, we showed network approach to IDUs may be an efficient way, particularly via key individuals. The efficacy of interventions and education programs to bring about behavioral changes among IDUs can be reinforced by addressing them to more influential individuals within networks. Furthermore, network analysis may lead harm reduction staff to find a broader number of IDUs who are usually hard to reach by routine outreach case-finding tasks.

Conflict of Interests

The Authors have no conflict of interest.

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بررسی ارتباط موقعیت در درون شبکه با خطر انتقال HIV در بین معتادان تزریقی: نتایج حاصل از مدل‌سازی چند سطحی شبکه اجتماعی به روش عضویت متعدد

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مقاله پژوهشی

چکیده

مقدمه: با وجود اجرای گسترده برنامه‌های کاهش آسیب در سراسر دنیا، بعضی از معتادان تزریقی همچنان به رفتارهای پرخطر خود ادامه می‌دهند. به نظر می‌رسد عوامل اجتماعی متعددی با خطر انتقال HIV (Human immunodeficiency virus) در بین معتادان تزریقی ارتباط داشته باشد. هدف از مطالعه حاضر، تحلیل شبکه اجتماعی معتادان تزریقی و بررسی رابطه موقعیت فرد در شبکه اجتماعی با خطر انتقال HIV با استفاده از روش مدل‌سازی رگرسیون خطی چند سطحی با عضویت متعدد بود.

روش‌ها: طی مهر تا اردیبهشت سال ۱۳۹۳، با ۱۴۷ معتاد تزریقی در شهر کرمان مصاحبه صورت گرفت. از افراد شرکت کننده درخواست شد تا ۲۰ نفر از افرادی را که طی یک ماه گذشته با آن‌ها در تماس بوده‌اند را نام ببرند و مشخص نمایند که آیا هر یک از نام‌بردگان معتاد تزریقی هستند یا خیر. سپس بر اساس تحلیل Components (مؤلفه‌ها) و K-core چهار موقعیت در شبکه اجتماعی معتادان تزریقی تعریف و خطر انتقال HIV نیز بر اساس مقیاسی متشکل از هفت موضوع اندازه‌گیری گردید. به منظور تعیین ارتباط بین موقعیت افراد در شبکه و خطر انتقال HIV، از مدل‌سازی چند سطحی با عضویت متعدد و جهت تحلیل داده‌ها از نرم‌افزارهای Stata و UCINET استفاده شد.

یافته‌ها: میانگین سنی افراد مورد مطالعه ۹/۳۲ ± ۳۷سال بود. بیشتر نمونه‌ها مرد و مجرد و دارای تحصیلات راهنمایی و یا کمتر بودند. خطر انتقال HIV در افراد دارای موقعیت مرکزی در مؤلفه اصلی و همچنین افرادی که عضو سایر مؤلفه‌های کوچک بودند، در مقایسه با افراد ایزوله به طور معنی‌داری بیشتر بود. همچنین افرادی که تحت درمان نگهدارنده با متادون بودند، خطر کمتری برای انتقال HIV داشتند.

نتیجه‌گیری: رویکرد تحلیل شبکه اجتماعی روش مفیدی در شناسایی افراد تأثیرگذار شبکه معتادان تزریقی و مکمل برنامه‌های کاهش آسیب می‌باشد. میزان سودمندی مداخلات را می‌توان با متمرکز نمودن آن‌ها بر افراد کلیدی شبکه افزایش داد. علاوه بر این، رویکرد شبکه‌ای به مجریان برنامه کاهش آسیب کمک می‌کند تا تعداد بیشتری از معتادان تزریقی را که بسیاری از آن‌ها در برنامه‌های معمول تیم سیار قابل دستیابی نیستند، شناسایی کنند.

واژگان کلیدی: تحلیل شبکه اجتماعی، مصرف کنندگان تزریقی مواد، خطر انتقال HIV، موقعیت شبکه، ایران

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