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Research Article

Size Estimation of Most-at-Risk Groups of HIV/AIDS Using Network Scale-up in Tabriz, Iran

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Abstract

Purpose: To begin to manage a serious health problem like AIDS, it is crucial that we know the size of the subpopulation related to the problem. In this study we used Network scale-up method (NSUM), an indirect method of size estimation of hard-to-reach subpopulation, to estimate most-at-risk population (MARPs) of Tabriz.

Methods: Having adapted a purposive sampling, we interviewed 500 people of target population. To estimate the size of social network (C), we used known population method through collecting data of 29 known sub-groups. To estimate most-at-risk populations, we applied frequency approach of NSUM. Adjustments were done to correct common errors of this method.

Results: Among groups at risk due to sexual contact, the greatest frequency was related to clients of female sex workers (CFSWs) with 831 out of 100000 of men's population (95% CI: 649, 1055), then female sex workers (FSWs) with 709 out of 100000 of women's population (95% CI: 512, 930). Among groups at risk due to drug use, the biggest frequency belonged to alcoholic substance users with 1136 out of 100000 of total population (95% CI: 955, 1332). After that, it included opium users, crystal users and injecting drug users (IDUs), respectively.

Conclusion: Although the estimated number of MARPs in Tabriz is less than other areas, it is necessary to perform preventive programs like harm reduction programs to reduce transmission of AIDS.

Introduction

AIDS is one of the most important health, social, political, economic and mental problems of the human society [1] which is unique in the human history because of its rapid distribution, wide propagation and effect intensity [2], which is referred to as "the plague of the century" [3-4]. Without the shadow of a doubt, AIDS pandemic is the greatest disaster of human society after World War II [5] and has relationship with addiction, unemployment, poverty and prostitution in many countries [6-8].

At the end of 2011, 34.0 million (31.4-35.9 million) people were living with HIV in the world [9]. This disease is the 4th cause of total mortality and the 2nd cause of mortality among infectious diseases worldwide [3,10]. In the 21st century, HIV/AIDS has been one of the primary 10 causes of disease burden globally [3] leading to 84.5 million DALYs [2-3].

Based on the most recent data collected up to June 21st, 2013, a total of 26556 people are living with HIV/AIDS (PLHIV) in Iran, among whom 89.6 percent are men, 10.4 percent are women, and 46.1 percent were in 25-34 age-group at the time of infection [11]. According to modeling of new HIV infections

based on exposure groups using MOT (Modes of Transmission) model in Iran, the new HIV cases in 2010 were estimated to be about 9137 cases [3,12], and according to estimates, the number of PLHIV in Iran was 88000 in 2009 and will increase up to 105000 in 2013 [13]. There is always the concern that the reality of HIV/AIDS in Iran is worse than what is represented in published data [3].

Considering disease prevalence, the most-at-risk groups of HIV can be divided into four main groups: Injecting Drug Users (IDUs), Female Sex Workers (FSWs), Clients of FSWs (CFSWs) and Men who have Sex with other Men (MSM) [1,3,14-16]. Obviously the spouses and other sex partners of mentioned groups, addicts, prisoners, truck drivers and youth are regarded as at risk groups as well [1,3,14].

The devastating impact of the virus on development has caused to feel the need to do more to prevent its spread [15]. In Asia, Latin America and Eastern Europe, where HIV is more heavily concentrated in most-at-risk sub-populations, more governments are now investing in surveillance systems that trace the distribution of the virus and the behaviors that diffuse it in the hard-to-reach populations. However, even the best existing surveillance systems bear one important weakness. While they can gauge the level of risk behaviors, HIV and STI infection in a given sub-population, they cannot give any indication of the exact size of the sub-population itself [15]. Populations at increased risk or most-at-risk for HIV are often referred to as hidden or hard-to-reach. These populations are composed of individuals who engage in behaviors that are sometimes illegal or stigmatizing so these populations tend to avoid disclosure [16]. Countries have to know the relative size of different at-risk populations so that they can plan their overall response and without accurate measures and estimates, it is impossible for countries to carry out HIV program activities [15-16].

To begin to manage a serious social problem such as homelessness, rape, AIDS, HIV infection, homicide and suicide it is vital that we know its true extent, namely, the size of the subpopulation related to the problem [17], because by size estimation of risk groups, a country can design its strategic plans, allocate resources appropriately and improve its epidemic model [15-16,18-20].

Informing policy makers in existence and magnitude of most-at-risk populations for HIV, convincing officials to allot budget for prevention, surveillance and treatment interventions, designing and conducting prevention, surveillance and treatment programs, determination of service coverage for at-risk populations and attainment of HIV prevention service coverage goals, determining the trend of at-risk people's quantity and assessment of public health policy are other applications of size estimation of most-at-risk people for HIV [15-16,18-20].

Knowing the size of specific populations at a local level is also a key to good program planning, implementation and administration [15] and although the size estimation methods of hidden population are complicated, such statistics is fundamental for planning [14].

Methods

This cross-sectional study was conducted to estimate the size of most-at-risk populations (MARPs) for HIV/AIDS in Tabriz (the capital city of East Azerbaijan Province) using Network Scale-up method (NSUM). Based on 2011 census, Tabriz population was 1494998 inhabitants. The target population of this study was all the people above 18 years old who have been living in Tabriz for, at least, the last five years.

Adapting a purposive sampling we interviewed 500 people of target population which were equally divided into both sex. Samples were selected from crowded areas of the city including three main universities (Tabriz University of Medical Sciences, Tabriz University and Tabriz Azad University), 20 crowded areas in the city which were geographically central to the city and people from all areas of the city go to those areas and also from people's work places.

To estimate the size of social network (c) and MARPs, two trained interviewers filled the questionnaires in face to face interviews. Having introduced themselves at first and elaborating the main objectives of the study, interviewers tried to convince the samples to participate in the study. Prior to the interview, verbal consent of participants was obtained. The questionnaires contained demographic questions such as age, job, education and marital status, questions to estimate social network size (c) using known population method (indirect method) and also questions about MARPs like IDUs, FSWs, MSM, etc.

c is the size of active social network which indicates the number of people each person knows. Based on this concept, we defined 'know' as mutually recognizing each other by sight and name, having had contact in the past one year in person, via phone or email and being able to contact each other (in person, phone or email) when needed [14,19-21].

Our definition of at-risk groups was at least one-time use of drug or one sexual contact in the past one year. The MARPs whose sizes were estimated in this study include FSWs, CFSWs, MSM, males who have extra or premarital sex with females (MSFs), females who have extra or premarital sex with males (FSMs), IDUs, opium users, crystal users and alcohol users.

We used "known population methods" to estimate c in our study. This approach of estimating c is explained in detail in Bernard et al, UNAIDS and Shokoohi et al papers [19-21]. In this method using the following formula we can easily estimate c:m/c = e/t

Where, m is the average number of people belonging to a sub-population who were known by our respondents (in the second part of questionnaire), c is the active social network size, e is the size of known sub-populations whose information is obtained from other sources, and t is the total population.

To estimate c using known population method, information of 29 sub-groups as shown in Table 2 were collected. The known populations can be chosen from any sub-group whose data is available from related resources, and it is more convenient to choose them from various sub-groups and first names so that they do not be similar to each other [22-23]. To increase estimate accuracy there should be 20 to 30 sub-groups [19-20]. So with emphasis on the knowing definition, as explained before, samples were asked whether they knew anybody belonging to each of these sub-groups within their active networks and if they knew, the number of people known was requested too. Then responses of samples to each sub-group were combined and the active network size of each respondent was calculated separately. After that, using maximum likelihood method, the total active network size was estimated. The 95% Confidence Interval (CI) of c was estimated using bootstrap technique based on 1000 iteration.

To estimate MARPs in Tabriz using NSUM with frequency approach we used following formula:

m/c = e/t

Where, m is the average size of MARPs whom are recognized by sample population and their data is collected by interview (part three), c is the average active social network size which is calculated in this study, e is the size of sub-population which we aimed to estimate and t is the whole population of area. With knowing m, c, and t, we estimated e using formula mentioned above. The 95% Confidence Interval (CI) of e was calculated using bootstrap technique based on 1000 iteration.

To adjust common errors in NSUM such as Transmission error and Barrier effect, we used correction coefficients of Transmission rate and Popularity ratio, respectively.

All calculations were conducted using Microsoft excel 2010 and SPSS version 19.

Results

50.9% of respondents were male and 49.1% were female. The average age of respondents was 35.8±13.48; this average

for men and women was 40.9±13.98 and 30.6±10.67 respectively. 45.2% of respondents were in age-group of 18-30 years old, of whom 45.2% had academic education and 61.2% were married (Table 1).

Table 1. Distribution of respondents' frequency (after omitting outliers) based on demographic variables

		Frequency	Percent
Sex	Male	232	50.9
	Female	224	49.1
Age group	18-30	206	45.2
	31-45	148	32.5
	45<	102	22.3
Educations	Illiterate/elementary	28	6.1
	High school	34	7.4
	Diploma	188	41.2
	Graduate	186	40.8
	Post graduate	20	4.4
Marital status	Single	147	32.2
	Married	279	61.2
	Divorced/spouse death	30	6.6

Although we interviewed 500 people, 44 of them were omitted from analysis as outliers because of zero or very small amount of c. We considered c equal to 25 or less as very small amount of c. Also from 29 sub-groups we interviewed, 7 sub-groups excluded from analysis, 6 of them because of not receiving their data from given institutes and one because of its size being more than 5% of the whole population. Therefore we analyzed data of 456 respondents and 22 sub-groups.

Then we calculated c using maximum likelihood method. Using this method, from 22 sub-groups that were in analysis, 10 of them after 10 times of repeating analysis, excluded in order (the greatest first) from final counting of c, since the ratio of estimated size of each sub-group to real size of it was not in the range of 0.5-2 and 12 sub-groups remained in final calculation of c (Table 2). Thus we reached to an average c of 113.85 (95% CI: 109.8, 118.2) with standard deviation (SD) of 45.01. Considering the definition of "know" described above, this number means that every person above 18 years old in Tabriz averagely knows 113.85 people in Tabriz. The biggest estimated c among respondents was 451.93 and the smallest was 38.29.

The estimated size of main MARPs for HIV/AIDS is indicated in Table 3 separately for males and females with age-groups. Also crude estimate and adjusted estimate of each main MARP and correction coefficients is shown in Table 4.

Population size of risky sexual contact group

As indicated in table 4, among sub-groups connected to sexual contacts, the greatest frequency was related to CFSWs with 831 in 100000 of men's population (95% CI: 649, 1055), after that were FSWs with 709 in 100000 of women's population (95% CI: 512, 930) and MSFs with 303 in 100000 of men's population (95% CI: 191, 424), then were MSM with 247 in 100000 of men's population (95% CI: 114, 419) and FSMs with 186 in 100000 of women's population (95% CI: 97, 292).

Population size of drug-related group

In this group, the biggest frequency belonged to alcoholic substance users with 1136 in 100000 of total population (95% CI: 955, 1332), this frequency in men was 1972 in 100000 men and in women was 283 in 100000 women. After that, were opium users with 514 in 100000 of total population (95% CI: 397, 641), crystal users with 377 in 100000 of total population (95% CI: 285, 473), and then IDUs with 280 in 100000 of total population (95% CI: 194, 371).

94.4% of alcohol users used it for pleasure, while 84.1% of opium users, 98.2% of IDUs and 100% of crystal users were reported to be addicted.

Discussion

Social Network

Using various methods, it is possible to estimate the social network size and each method can produce different estimates [21-22], as in a study in the United States six various methods produced six diverse estimates from 97 to 399 (97, 105, 105, 113, 117 and 399) [23] and in other study in Kerman, Iran, four methods made four different estimates from 100 to 350 [21]. In spite of this fact, we applied known population approach using maximum likelihood method. The main reason is the higher accuracy of this method in comparison with other methods which caused researchers in past studies to favor this method, as well [21,23-26]. Because this method consists of active searching of respondents' memories and active memory searching usually leads to more accurate answers [21].

With regard to the social network sizes estimated in other studies, the number 113.8 for the active network size in this study, based on the given definition of "know", seems to be a logical estimate and is near to estimated active network sizes in other studies [21, 23].

Table 3. Estimated number of MARPs in each sub-group and its percentage divided by sex and age-group

MARPs	Number of crude estimation	Men percentage			Women percentage		
		total	18-30 years old	30<	total	18-30 years old	30<
FSWs	1754	-	-	-	100	60.7	39.3
FSMs	604	-	-	-	100	33.3	66.7
CFSWs	2761	100	36.5	63.5	-	-	-
MSFs	1007	100	31.4	68.6	-	-	-
MSM	374	100	84.5	15.5	-	-	-
IDUs	1582	100	43.6	56.4	0	0	0
Opium users	2905	98	33.7	64.3	2	2	0
Crystal users	2128	98.6	32.4	66.2	1.4	1.4	0
Alcohol users	9174	87.7	26.6	61.1	12.3	8.2	4.1

Table 4. Crude and adjusted estimation and correction coefficients for each MARP

MARPs	Crude estimation	Popularity ratio	Transmission rate	Adjusted estimation	Frequency in 100000
FSWs	1754	0.76	0.44	5246	709
FSMs	604	1.00	0.44	1373	186
CFSWs	2761	1.00	0.44	6275	831
MSFs	1007	1.00	0.44	2288	303
MSM	374	1.00	0.2	1869	247
IDUs	1582	0.70	0.54	4184	280
Opium users	2905	0.70	0.54	7684	514
Crystal users	2128	0.70	0.54	5630	377
Alcohol users	9174	1.00	0.54	16989	1136

In a study done in the United States by McCarty et al, the mean number for social network was 291 [22]; the difference between this number and the social network number estimated in our study can be due to difference of estimation area,

because in the mentioned study, the social network of people were estimated in a whole country while we estimated this number only in a city. The other reason is the knowing definition; one part of definition in McCarty's study is: "at least one contact in the past two years", whereas this part of definition in our study is at least one contact in the past one year. This discordance in the definition causes differences in the number of people known by respondents and therefor, diversity in the number of social network. Also another important difference is dissimilarity in the sampling methods in two studies; while McCarty used RDD (Random Digit Dialing) sampling method we used Purposive Sampling method that is the limitation of our study since it is not a random sampling method. We had to use purposive sampling method, like similar studies conducted in Iran [14,21], because applying RDD or other random methods in Iran is somewhat difficult due to dominant cultural conditions and sensitive essence of questions which cause some response problems.

Shokoohi et al in Kerman, Iran, estimated several numbers for c using various methods, but having used similar method as we used in our study, they produced the estimated c as 303 [21] which is very different from our estimation. The reason behind it can be dissimilarities of target groups; in Kerman's study the target group was 18-45 year-old Kermanian men who were asked how many 18-45 year-old men they knew, and knowing was not limited to Kerman city, then respondents reported all men of target group they knew in all over Iran. However in our study we asked respondents to report the number of people they knew in Tabriz city. Still this discordance in target group does not justify the interval between 113.8 and 303. One other reason can be the way known population sub-groups are selected in two studies. In Kerman's study selected sub-groups consisted of six first names. This kind of selection can have two disadvantages; used sub-groups are only first names whereas they should consist of various sub-groups [23], on the other hand just 6 sub-groups are used, while it is better to use at least 20 to 30 sub-groups to increase estimation accuracy [19-20]. Mentioned drawbacks might cause an overestimation of c number in Kerman's study.

Some other factors that justify differences among c numbers in various studies are cultural dissimilarities in different areas, variation in respondents' features and vastness of area on which the study is conducted [27].

Table 2. Sub-groups of known populations used to estimate social network and ratio of estimated number to real number in each sub-group.

Known population sub-group	Source of real data of known population	Ratio of estimated number to real number	Considerations
In the last educational year (2011-2012) started first grade of elementary school	Ministry of Education	0.76	
In the last educational year (2011-2012) got diploma	Ministry of Education	0.72	
Participated in previous (2011) university entrance exam (Concours)	Ministry of Education	0.83	
In the last educational year (2011-2012) was student of medicine	Tabriz University of Medical Sciences and Tabriz Azad University	3.39	Excluded from final calculation
In the last educational year (2011-2012) was student of dentistry	Tabriz University of Medical Sciences	9.12	Excluded from final calculation
In the last educational year (2011-2012) was student of pharmacy	Tabriz University of Medical Sciences	7.76	Excluded from final calculation
Has done military service during the last year (2011)	Via internet	1.57	
Officially married the last year (2011)	Tabriz vital registry office	1.33	
Is divorced the last year (2011)	Tabriz vital registry office	1.25	
Did natural childbirth in hospital the last year (2011)	East Azerbaijan health center	0.39	Excluded from final calculation
Did cesarean in hospital the last year (2011)	East Azerbaijan health center	0.41	Excluded from final calculation
Has been in Hadj (Mecca) during the last year (2011)	Tabriz Hadj and pilgrimage office	1.11	
Has been in Karbala for pilgrimage during the last year (2011)	Tabriz Hadj and pilgrimage office	0.92	
Is completely sightless	Welfare organization of Tabriz	0.56	
Died due to a car accident in the last year (2011)	Tabriz health center	44.59	Excluded from final calculation
Has twin children	Tabriz vital registry office	1.38	
Suffers from epilepsy	East Azerbaijan health center	5.52	Excluded from final calculation
Suffers from diabetes	Tabriz health center	0.92	
His name is Abolfazl	Tabriz vital registry office	1.56	
His name is Hamed	Tabriz vital registry office	9.06	Excluded from final calculation
Her name is Sara	Tabriz vital registry office	3.52	Excluded from final calculation
Her name is Mina	Tabriz vital registry office	5.96	Excluded from final calculation
Has been abroad during the last year (2011)	Omitted in the beginning of analysis		
One leg handicapped	Omitted in the beginning of analysis		
One hand handicapped	Omitted in the beginning of analysis		
His name is Vahid	Omitted in the beginning of analysis		
His name is Samad	Omitted in the beginning of analysis		
Her name is Rana	Omitted in the beginning of analysis		
Her name is Nazila	Omitted in the beginning of analysis		

At-risk populations

Based on the results of our study, the size of at-risk-populations for AIDS in Tabriz is less than other areas [14,26,28]. Salganik et al estimated the number of heavy drug users in Curitiba, Brazil, using various methods [26]. Although by applying direct methods and multiplier method it was near to our estimates, using NSUM the size of MARPs was more than our estimates. The estimated size of main MARPs in Shokoohi

et al study in Kerman, Iran, using NSUM with both frequency and probability approaches was more than our estimates [14].

Regarding the fact that there is no provincial level information about MARPs size in the country, the comparison of results is not possible. But according to Ministry of Health and Medical Education of Iran (MOHME), estimated size of IDUs in Iran is around 200000 people [29-30] and according to State Welfare Organization of Iran (SWOI) in 2001 this number was 136000 people [1]. Assuming an even distribution across the country, estimation of MOHME is close to our adjusted estimate of IDUs, whereas SWOI estimation is near to our crude estimate. Also SWOI reported that in 2001 FSWs size in age-group of 15-49 was 1-2 women out of 1000 [1]. This number in our study was 7.09 out of 1000 women. According to SWOI, the number of MSM in age-group of 15-49 was 1-10 men out of 1000 [1] while in our study this number is 2.47 out of 1000 men, which is consistent with SWOI statistics.

Various studies have been conducted to estimate the size of hidden populations in Iran using different methods. In a study in Tabriz high schools, the prevalence of alcohol usage in second grade of high school boys was 12.7 percent [31], which is higher than our estimate. The difference is due to dissimilarities in methods and definitions of alcohol usage; the method of mentioned study was not NSUM and they estimated one time experience of alcohol use in students, whereas the definition in our study was at least one time of alcohol use in the past one year, and these discordances in definition rationalize our fewer estimated number. The prevalence of alcohol use in Shiraz high school boys was 32 percent [32], in Kerman high school students 11.4 percent [33], in students of Yasouj University of Medical Sciences was 13.95 percent [34] and 22 percent in Tehran 15-35 year-old men [35].

Conclusion

In this paper, we have estimated the number of MARPs in Tabriz using NSUM. Although the estimated number of MARPs in Tabriz is less in comparison with other areas, it seems necessary to perform harm reduction programs in those groups regarding the importance of AIDS. Considering the fact that our study is conducted just by using one of the size estimation methods, estimating the size of MARPs in Tabriz using other methods like Multiplier method is recommended so that results of different methods could be compared.

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