Estimating the Lifetime and Age-Conditional Risk of an HIV Diagnosis in Iran, 2011-2015

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Abstract

Background: According to the importance of infectious diseases, especially HIV, the purpose of this study was to estimate lifetime and age-conditional risks of HIV diagnosis in Iran.

Methods: We used vital statistics, HIV surveillance and census data for 2011-2015 to calculate Age-specific HIV diagnosis and non-HIV death rates. These rates then converted to the probability of an HIV diagnosis considering the competing risk. Finally, the probabilities were applied to a hypothetical cohort of 10 million live births. The lifetime and age-conditional risk of HIV diagnosis in the total and general population of Iran were calculated by Dev Can software (version 6.7.4).

Results: Lifetime risk was 0.084% (95% CI: 0.081-0.088) or one in 1183 for females and 0.21% (95% CI: 0.201-0.211) or one in 483 for males in the total population. In the general population lifetime risk for men was 0.069% (95% CI: 0.066-0.072) or 1 in 1454 men and 0.066% (95%CI: 0.063-0.069) or one in 1523 for women. In the total and general population, the 10-yr age-conditional risk of HIV diagnosis showed that the highest risk of an HIV diagnosis is related to 30-yr -olds.

Conclusion: The estimated risks differed based on gender, age, and type of population. Paying close attention to these differences is critical for infection control planning and policies.

Keywords: Lifetime risk; Age-conditional risk; HIV; Population; Iran

Introduction

AIDS is an emerging disease which has become a major public health problem in the third millennium. According to the WHO reports, at the end of 2019, approximately 38 million people were living with HIV all around the world, 1.7 million of these people were recently infected and 700 thousand deaths were related to HIV/AIDS(1). Based on data from the Iran National HIV/AIDS Case Registry System, a total number of 34949 people living with HIV (PLWH) had been identified and registered until Mar 21st, 2017. Out of all the registered cases, 84% were males and 16% were females (2). Of course, the number of registered cases in Iran is much lower than the true number of infected cases and it is estimated that PLWH will reach 98,000 by 2020(3).

The number of HIV infection has risen dramatically in Iran and the epidemic pattern of HIV/AIDS changed from low to a concentrated level (4, 5). people in some groups, such as Injection Drug Users (IDUs), Female Sex Workers (FSWs) and prisoners with HIV prevalence 13.8%, 4.5% ,and 1.4% respectively are the main key population at risk of HIV/AIDS(6-9), an effective strategy is needed to control this infection since it has the potential to lead to generalized epidemic(10). For HIV prevention messages to be efficient, it is important to communicate clearly the burden of disease and who is at risk (11). In previous studies in Iran, the burden of disease is defined in terms of prevalence (12-15). Using new methods to calculate existing cases, can lead to more accurate estimates and one helpful method to provide a more comprehensive assessment of the burden of disease is to estimate lifetime risk.

Lifetime risk is widely used as a popular measure of how widespread disease is in a special population (16) and mostly expressed in terms of the number of people who would need to be followed over their lives to observe one occurrence of the disease. This method can guide policymakers and be a useful tool for clinicians and researchers when describing the burden of disease; also it can be more easily understood by the non-technical audiences (11). Moreover, the age-conditional risk is the probability of a person of a specific age group being diagnosed with HIV within a specified time period (e.g. 10 yr). This allows the identification of age groups with higher burdens of disease (17).

Lifetime risk estimate is commonly used to describe the risk of cancer but it used in some studies for HIV diagnosis too. Kristen Hess et al estimated the lifetime risk of being diagnosed with HIV/AIDS based on sex, age, and race by using data 2009–2013 in the United States (11). In addition, other studies were conducted such as (17), Disease Control and Prevention centers in 37 States of America and Puerto Rico in 2008 (18), and Bosh et al in Missouri, USA (19).

After reviewing previous studies in Iran, nothing seems to be published on lifetime risk of HIV diagnosis. Given the importance of this infection, the ability to estimate the probability of HIV diagnosis in Iran can be very useful to health policymakers for more appropriate planning. Therefore, the purpose of this analysis was to estimate the lifetime and Age-conditional risks of an HIV diagnosis based on gender in the total and general population of Iran.

Methods

Age-specific HIV diagnosis, mortality, and population data from 2011 to 2015 were used In order to calculate lifetime and age-conditional risks of being diagnosed with HIV. HIV diagnosis data (sex, age at diagnosis and mode of transition after gaining permission) were obtained from Ministry of Health, Tehran, Iran records. This data were registered in the electronic system of the Ministry of Health from all over the country. The population data for 2011 was extracted from the recorded census data available on the statistical center of Iran's website. Based on the fact that population census is performed every five years, the 2012-2015 demographic data were calculated based on the population growth rate using the Spectrum software.

The general mortality data were obtained from the national organization for Civil Registrations website. Gender-specified HIV- mortality data and date of death were obtained from the AIDS office of Iran's Ministry of Health.

In this study, the lifetime and age-conditional risks of HIV diagnosis were determined based on two models. In the first model, lifetime risk was estimated in the entire population of Iran based on gender. Regarding the high prevalence of HIV in high-risk groups, in the second model lifetime risk was estimated in the general population.

In the first model, the number of HIV diagnoses and HIV and non-HIV mortality data from 2011 to 2015 were determined for age groups with 5-yr intervals. Because of the electronic registration of HIV diagnostic information and insignificant delays in reporting, the data were not adjusted for the delay. Age-specific rates included 5-yr HIV

diagnosis and Non-HIV death rates were calculated by dividing the number of HIV diagnoses and non-HIV deaths in each age group by the population denominator for that specific age group. These rates were transformed to probabilities of a diagnosis of HIV at a certain age range. To estimate these probabilities, the competing risk was considered and the probability of a diagnosis of HIV was conditioned on never having acquired HIV before the beginning of the estimated age range. Competing risk was assumed to be independent of HIV diagnosis. Finally, in this model, the probabilities were applied to a hypothetical cohort of 10 million live births and estimates were derived for each age group in the assumptive cohort of the number of newly diagnosed HIV cases, the number alive and HIV-free cases at the beginning of the interval, the number of non-HIV deaths among the HIV-free population, and the cumulative probability of being diagnosed with HIV from birth. DevCan software (version 6.7.4) freely available at the National Cancer Institute was used to estimate lifetime and age-conditional risks. This software used Generalized Gamma to estimate the 95% confidence interval.

In the second model, lifetime risk was estimated for the general population of Iran and the steps were similar to those of the first model. The data included Age-specific HIV diagnosis, mortality, and population data specified by sex and age and the parameters related to FSWs and IDUs were drawn from this data. Estimates regarding high-risk populations required further calculations due to their concealment in society and not being noted in the census or mortality data. We used previous studies for the estimated proportion of patients in each age group and size estimation studies for the estimated number of these two high-risk groups (4, 8). The number of cases of HIV diagnosis and death from HIV in IDUs was specified in the reports of the Ministry of Health, Iran but because there was no accurate infor-

mation about FSWs, for the estimation of new cases and gathering HIV mortality rates, we used previous studies (3, 6, 7). The Spectrum Software was used and the proportions of the age groups were calculated, considering the fact that only 30% of HIV cases are actually diagnosed. Finally, to derive all-cause mortality in FSWs and IDUs, we multiplied the calculated proportion of each high-risk group by age group and sex in the mortality parameter due to all causes.

To test the accuracy of the obtained data, results were compared with Ministry of Health reports and valid modeling results such as the Mode of Transmission (MOT) and Spectrum.

Results

In Iran, 9362 new cases of HIV were diagnosed throughout 2011 to 2015; of these, 6690 cases were related to men and 2672 cases were related to women respectively. A number of 3341 HIV related deaths were reported of which nearly 89.5% occurred in males. The lifetime risk of HIV diagnosis was estimated at 0.15% (95% CI: 0.14-0.15), this means to observe one HIV diagnosis 681 live births would need to be followed over a lifetime, assuming that based on the current information HIV diagnosis and death rates remain constant over their lifetime.

The lifetime risk of HIV diagnosis was also determined by sex. The lifetime risk in males was 0.21% or 1 in 483, and in females, it was 0.084% or 1 in 1183 (Table 1).

Table 1 shows the 10-yr age-conditional risks of HIV diagnosis among HIV-free males and females in specific age groups. In males, 30-yr old were most at risk of an HIV diagnosis in the next ten years (1 in 1205). It was the same case in females and 30-yr-old had the highest risk of an infection in the next 10 yr. So for a case of HIV diagnosis 3423, 30-yr-old HIV-free women need to be followed over the next 10 yr.

Table 1: Lifetime and 10-yr age-conditional risks (probability & 1 in N) of HIV diagnosis aged 20-50 yr by sex in the total population

Age(yr)	Male		Female	
	Age conditional Risk Probability*100 (95% CI)	One in N(95% CI)	Age conditional Risk Probability *100 (95% CI)	One in N(95% CI)
15-19	0.012(0.011-0.013)	8103(7509-8763)	0.009(0.009-0.01)	10589(9650-11645)
20-24	0.034(0.033-0.036)	2924(2795-3063)	0.019(0.018-0.02)	5349(5021-5707)
25-29	0.063(0.061-0.066)	1579(1526-1635)	0.026(0.025-0.028)	3824(3624-4039)
30-34	0.083(0.08-0.086)	1205 (1166-1246)	0.029(0.028-0.31)	3423(3237-3622)
35-39	0.078(0.075-0.081)	1285(1238-1334)	0.026(0.024-0.028)	3870(3625-4136)
40-44	0.055(0.053-0.058)	1805 (1723-1891)	0.018(0.017-0.02)	5474(5046-5949)
45-49	0.036(0.034-0.038)	2797 (2630-2977)	0.012(0.011-0.014)	8023(7219-8939)
50-54	0.025(0.023-0.027)	4036(3714-4392)	0.009(0.008-0.011)	10841(9442-12499)
Life time Risk Probability *100 (95% CI)	0.21 (0.201-0.211)		0.084(0.081-0.088)	
One in N(95% CI)	483 (471-496)		1183 (1133-1233)	

The lifetime risk of the HIV diagnosis increased with age in the total population of Iran. In each age group men had a higher risk of being diagnosed with HIV and most of the risk was accumulated before reaching 55 yr in men and 50 in women. Ninety two percent of the lifetime risk of HIV diagnosis was accumulated before the age of 45 in females and in males 93% was accumulated before the age of 55 (Fig. 1).
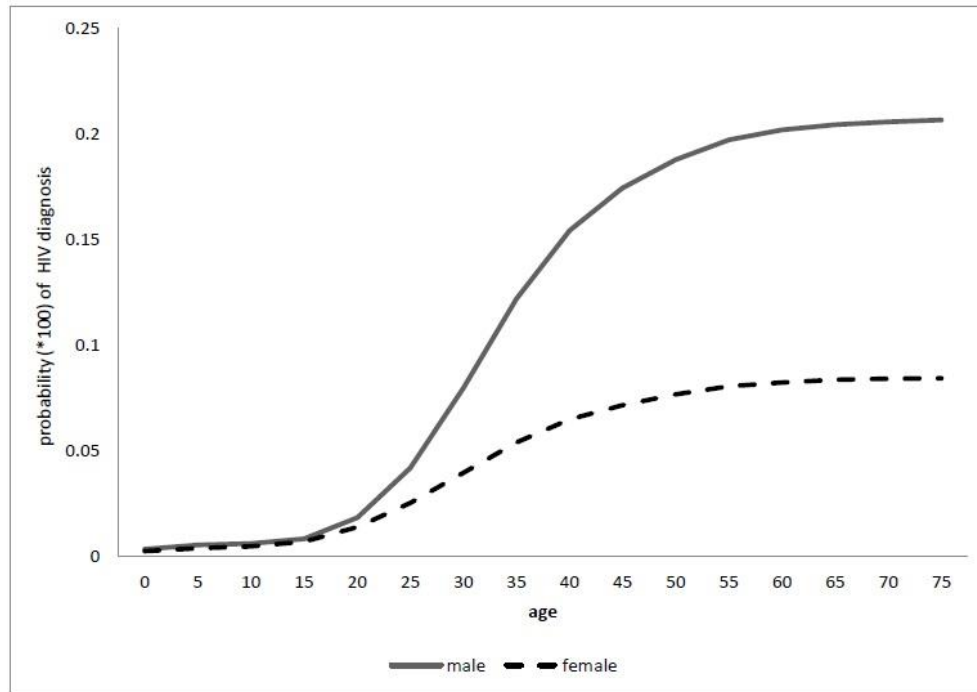

Fig. 1: Lifetime risk of HIV developing, by age and sex in the total poulation

The results of the model in the general population demonstrated that the lifetime risk in an Iranian man was 0.069%; this number indicated that 1454 male would need to be followed over their lifetime to observe one HIV diagnosis. Moreover, the lifetime risk of HIV diagnosis in Iranian females was 0.066% or 1 in every 1523 (Table 2). Estimation of 10-yr age-conditional risks of HIV diagnosis in the general population showed that 30-yr-old men and women are at a higher risk of HIV diagnosis in the next 10 yr (Table 2).

Table 2: Lifetime and 10-yr age-conditional risks (probability & 1 in N) of HIV diagnosis aged 20-50 yr by sex in the general population

Variable	Male		Female	
Age(yr)	Age conditional Risk Probability *100 (95% CI)	One in N(95% CI)	Age conditional Risk Probability *100 (95% CI)	One in N(95% CI)
15-19	0.005(0.005-0.006)	18959(16797-21478)	0.007(0.007-0.008)	13422(12083-14950)
20-24	0.012(0.011-0.013)	8418(7776-9130)	0.015(0.014-0.016)	6861(6382-7387)
25-29	0.017(0.016-0.018)	5817(5443-6226)	0.02 (0.019-0.022)	4939(4643-5260)
30-34	0.018 (0.019-0.021)	5190 (4849-5563)	0.022(0.021-0.024)	4468(4188-4772)
35-39	0.018(0.019-0.021)	5233(4851-5652)	0.019(0.018-0.021)	5218(4832-5643)
40-44	0.016(0.015-0.018)	6127 (5617-6696)	0.013(0.012-0.014)	7714(6998-8523)
45-49	0.013(0.011-0.014)	7865 (7084-8756)	0.009(0.008-0.01)	11436(10076-13028)
50-54	0.01(0.009-0.012)	9623(8448-11004)	0.007(0.006-0.008)	14304(12182-16893)
Life time Risk Probability *100 (95% CI)	0.069(0.066-0.072)		0.066(0.063-0.069)	
One in N(95% CI)	1454 (1383- 1526)		1523 (1449-1599)	

In the general population the lifetime risk of HIV diagnosis increases with age but in the total population the lifetime risk in men and women were close to each other and even in some age groups, women had a greater lifetime risk than men. Most of the risk was accumulated before age 55 in males and 45 in females (Fig. 2).
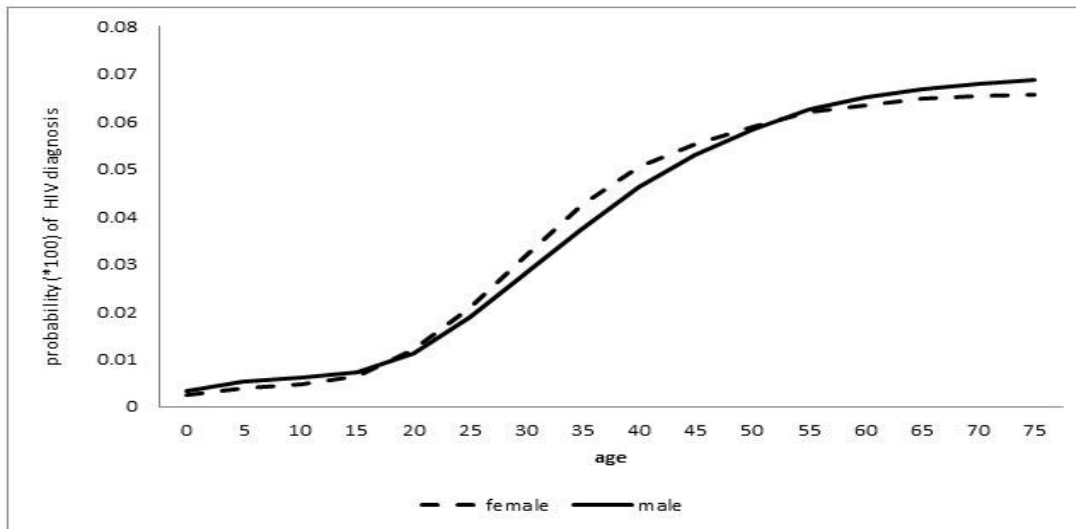

Fig. 2: Lifetime risk of HIV developing, by age and sex in the general population

Discussion

In this study, the lifetime risk of HIV diagnosis was 0.15% in the population of Iran or in other words the number of new HIV cases that will be detected over the next 5 yr (2016-2020) in Iran will be approximately 9500 cases, two thirds of which will be men and one thirds will be women. Considering the 30% sensitivity of registering HIV cases in the AIDs and sexually transmitted infection surveillance system in Iran, it can be said that it is probably necessary to follow 145 males and 355 females to observe one HIV diagnosis. This estimate is similar to HIV reports in the Ministry of Health.

The results showed substantial disparities in lifetime risk between the sexes, this difference was more obvious in the total population where lifetime risk or disparities in men was 2.5 times higher than in women. In both sexes, the number of cases increased Up to 30-35 age groups and then decreased in the next age groups. Thirty to thirty four yr HIV-free men and women had the highest risk of an HIV diagnosis in the next 10 yr. According to a report by the Ministry of Health of Iran and modeling study of Joulaei et al the most cases of infected person were in the age group of 25-34 yr old which confirmed the results of our study(4). In the United States, 20 yr old males in all races and white or black females in the age group of 30 yr old had the highest risk of a HIV infection in the next 10 yr (11). The result of the age-conditional risk of HIV in male was in concordance with our estimation that this difference can be related to the demographic and cultural characteristics or type of epidemiological pattern of HIV infection in two countries. Since HIV/AIDS control is the most important goal of the health care system and the higher prevalence of HIV occurs among the younger population (20) hence, an essential step is a special attention to youth and adolescents in national planning.

Overall, people in the general population are at a lower risk of being diagnosed with HIV throughout their life, and the risk is even less in the female population. Interestingly, in a population-based sero-epidemiological study on HIV infection in the general population of Mashhad in 2009 there was no evidence of HIV infection (15). These results showed that in Iran the key populations most affected by HIV but it seems that continue in preventive strategies such as increasing public awareness and free HIV counseling services and testing in public health centers are necessary.

After withdrawing the population of IDUs and FSWs from the total female population, no significant decrease (22%) was observed in the lifetime risk of the total and general female population. Furthermore, the difference in the lifetime risk of men and women in the general population was not significant which could be due to the fact that the IDU spouse's population was not withdrawn from the total female population. According to previous study, most new HIV infections occur in injecting drug users and their sex partners; the MOT estimates the prevalence of HIV in sex partners of injecting drug users to be about 4%-6%. Moreover, about 12% of new cases of HIV infection are occurring in injecting drug users' spouses (21). Despite the importance of this group, Studies about them are very rare and access to these people is limited.

The lifetime risk of men in the general population after the withdrawal of injecting drug users decreased significantly (about 66%) compared to the total men population. The results of the MOT have shown that about 56% of HIV cases in men occur in injecting drug users and if safe injection levels increase from 80% to 100%, the number of these cases will drop about 56% which is confirmed with the results of this study.

This study had some limitations, the first one was that due to ethical issues and social stigma in Iran many cases of infection are hidden in the community, meaning that over 70% of the cases are not diagnosed and therefore these results do not represent the risk of infection over the lifetime of all individuals. The results were also dependent on HIV diagnosis based on the current sensitivity of surveillance data in Iran. Moreover matching

the results of the study with the recorded data and mismatching with the latest modeling data confirmed the gap between existing and diagnosed cases of HIV infection.

Another limitation of this research was that there are few studies conducted about FSWs, street children, and spouses of IDUs. In addition one of the high-risk groups for HIV transmission is men who have sex with men (MSM) and; there is no accurate estimate of their population.

Considering the importance of HIV in high-risk groups such as IDUs, their spouses and, FSWs it is recommended to conduct such studies to estimate the lifetime risk in these groups.

Due to lack of recorded data based on province and ethnicity, it was not possible to report HIV related results based on geographical area and provinces.

Conclusion

Age, sex, and type of population caused a difference in the probability of an HIV diagnosis. These estimates can be helpful for HIV experts and policymakers to make effective planning to provide targeted action based on age and sex groups at high risk. In addition, the information obtained can be used for notification and sensitization in the general public.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors. The study procedures were approved by the ethics committee of Isfahan University of Medical Sciences (grant number 395889).

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Conflict of interest

The Authors declare that there is no conflict of interest.

References

1. World Health Organization (2020). Fact sheet HIV/AIDS 2019. https://www.who.int/news-room/fact-sheets/detail/hiv-aids

2. Ministry of Health and Medical Education (2017). Islamic Republic of Iran AIDS Progress Report. Tehran, Iran.

3. Nasirian M, Fahimfar N, Hgahdoost AK, et al (2014). Report of HIV estimation and projection in IRAN. Centre for Disease Control Ministry of Health and Medical Education, Tehran, Iran.

4. Joulaei H, Lankarani KB, Kazerooni PA, et al (2017). Number of HIV-infected cases in Iran: True or just an iceberg. *Indian J Sex Transm Dis AIDS,* 38(2):157-162.

5. Zarei E, Khabiri R, Tajvar M, et al (2018). Knowledge of and attitudes toward HIV/AIDS among Iranian women. *Epidemiol Health,* 40:e2018037.

6. Akbari M, Akbari M, Naghibzadeh-Tahami A, et al (2016). Prevalence of HIV/AIDS among Iranian Prisoners: A Review Article. *Addict Health,* 8(3):195-206.

7. Khajehkazemi R, Osooli M, Sajadi L, et al (2013). HIV prevalence and risk behaviours among people who inject drugs in Iran: the 2010 National Surveillance Survey. *Sex Transm Infect,* 89 Suppl 3(Suppl 3):iii29-32.

8. Sharifi H, Mirzazadeh A, Shokoohi M, et al (2018). Estimation of HIV incidence and its trend in three key populations in Iran. *PloS one,* 13(11):e0207681.

9. Rahimi-Movaghar A, Amin-Esmaeili M, Haghdoost AA, et al (2012). HIV prevalence amongst injecting drug users in Iran: a systematic review of studies conducted during

the decade 1998-2007. *Int J Drug Policy,* 23(4):271-8.

10. Wolfe D, Malinowska-Sempruch K (2004). Illicit Drug Policies and the Global HIV Epidemic Effects of UN and National Government Approaches. *Working paper commissioned by the HIV/AIDS Task Force of the Millennium Project.*

11. Hess KL, Hu X, Lansky A, et al (2017). Lifetime risk of a diagnosis of HIV infection in the United States. *Ann Epidemiol,* 27(4):238-243.

12. Seyed Ahmad S, Behnam F, Minoo M, et al (2017). Prevalence of HIV in a Prison of Tehran by Active Case Finding. *Iran J Public Health,* 46(3): 431–432.

13. Foroughi M, Moayedi-Nia S, Shoghli A, et al (2017). Prevalence of HIV, HBV and HCV among street and labour children in Tehran, Iran. *Sex Transm Infect,* 93(6):421-423.

14. Bagheri Amiri F, Mostafavi E, Mirzazadeh A (2016). HIV, HBV and HCV Coinfection Prevalence in Iran--A Systematic Review and Meta-Analysis. *PloS One,* 11(3):e0151946.

15. Miri R, Ahmadi Ghezeldasht S, Mosavat A, et al (2017). No Evidence of HIV Infection Among the General Population of Mashhad, Northeast of Iran. *Jundishapur Journal of Microbiology,* 10 (3); e43655.

16. Ahmad AS, Ormiston-Smith N, Sasieni PD (2015). Trends in the lifetime risk of developing cancer in Great Britain: comparison of risk for those born from 1930 to 1960. *Br J Cancer,* 112(5):943-7.

17. Hall HI, An Q, Hutchinson AB, Sansom S (2008). Estimating the lifetime risk of a diagnosis of the HIV infection in 33 states, 2004-2005. *J Acquir Immune Defic Syndr,* 49(3):294-7.

18. Adih W, Hu X, Campsmith M, et al (2010). Estimated lifetime risk for diagnosis of HIV infection among Hispanic/Latinos—37 States and Puerto Rico, 2007. *MMWR Morb Mortal Wkly Rep,* 59(40):1297-301.

19. Bosh KA, Laffoon BT (2010). Lifetime and Age-Conditional Risk of Human Immunodeficiency Virus Diagnosis, Missouri, 1998–2007. *Sex Transm Dis,* 37(12):764-6.

20. Sharifi H, Shokoohi M, Ahmad RafieiRad A, et al (2017). Methamphetamine use among Iranian youth: a population-based knowledge, attitude, and practice study. *Subst Use Misuse,* 52(9):1232-1239.

21. Haghdoost AA, Mostafavi E, Mirzazadeh A, et al (2011). Modelling of HIV/AIDS in Iran up to 2014. *Journal of AIDS and HIV Research,* 3(12):231-239.