International Scholars Journals

African Journal of AIDS and HIV Research ISSN 2326-2691 Vol. 6 (12), pp. 423-431, December, 2018. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Modelling of HIV/AIDS in Iran up to 2014

Haghdoost, Ali Akbar[6], Mostafavi, Ehsan[3], Mirzazadeh, Ali[2], Navadeh, Soodabeh[1], Feizzadeh, Ali[4], Fahimfar, Nooshin[5], Kamali, Kianoosh[5], Namdari, Hengameh[5], Sedaghat, Abbas[5], Gooya, Mohammad Mehdi[5], Sajadi, Leily[1], Farzaneh, zolala[1] and Nasirian, Maryam[1]*

[1]Regional knowledge hub for HIV/AIDS surveillance, Kerman University of Medical Sciences, Kerman, Iran.
[2]World Health Organisation (WHO), HCD Unit, Tehran, Iran.
[3]Department of Epidemiology, Pasteur Institute of Iran, Tehran, Iran.
[4]Joint United Nations Programme on HIV/AIDS (UNAIDS), Papua, New Guinea.
[5]Center for Disease Control (CDC) of Iran, Ministry of Health and medical education, Tehran, Iran.
[6]Research centre for modelling in health, Kerman University of Medical Sciences, Kerman, Iran.

Accepted 03 April, 2018

Using estimation-projection package (EPP) and spectrum, the model was developed based on different data sources. Four scenarios were introduced, including minimum and maximum estimations, plus most realistic scenario. In the fourth scenario (R2), data of studies with adequate quality were applied. The objective of the study is to estimate and project HIV/AIDS in Iran up to 2014. Based on the main scenario R2, the estimated prevalence of HIV infection among adults was 0.16% (0.08-1.03%) in 2009. It will slightly decrease to 0.15% (0.06-1.08%) in 2012. With respect to the number of infected people with HIV, the estimated number was 89,000 and 106,000 for 2009 and 2014 respectively. There were estimated to be approximately 7,000 new cases annually. The highest trend of HIV was estimated to be a shift from IDUs to FSWs, and the estimate is that new infected cases via unsafe sex will increase in the future, while over time, the trend with respect to transmission via unsafe injection will decrease. We expect the HIV epidemic in Iran to remain almost constant at concentrate level. However we believe that the pattern of transmission will change from that of unsafe injection to unsafe sexual contact.

Key words: HIV, AIDS, epidemiology, modeling, projection.

INTRODUCTION

AIDS is an emerging disease which has become known as 'the plague of the century' (Tavoosi et al., 2003,). Although HIV is on the downward trend in a number of countries, the general trend globally is upward (UNAIDS, 2008, 2010; Nejat et al., 2006), and it continues to challenge human communities with its health, social, economic, cultural, and political consequences.

According to a WHO report, the prevalence rate of HIV/AIDS in Iran has risen from low to concentrated (Center for Disease Control, 2008). The prevalence in the overall population is below 1%; this rate, however, has surpassed 5% in some high-risk groups such as IDUs (Mojtahedzadeh et al., 2008; UNAIDS, 2004).

For effective management and planning on the prevention and control of HIV, it is crucial to attend to the number of people living with HIV (PLHIV) and to identify prime high-risk groups. As well as focusing on the HIV/AIDS epidemic in the country and its longitudinal patterns of changes (Khalili, 2008; Husain et al., 2007; Gouws et al., 2006; Montazeri, 2005; Pisani et al., 2003).

Despite raised awareness of the HIV problem, many countries, including Iran, do not have a clear figure for HIV prevalence. This lack of information can be explained by the longevity of the incubation period of HIV infection before emergence of clinical symptoms and the iceberg features of this disease; concealing the disease due to social stigma; lack of public access to counselling, testing, and HIV/AIDS diagnosis services both in high-risk groups and the general public; underreporting, and/or no reporting; culminating in the identification of only a limited percentage of PLHIV. The limited availability of data in Iran is due partly to the fact that most studies on HIV have been carried out fairly recently. For example, the first bio-behavioural survey among

*Corresponding author. E-mail: maryamnasirian27@gmail.com. Tel: +98-913-2298038. Fax: +98-341-3205127.

FSWs was conducted in 2011. Additionally, a few studies have recently been carried out on TB and their results are not publicly available. With respect to the previous comment, prior to 2006, sources of data on HIV, including the prevalence and incidence of HIV, are scarce.

Modelling is a statistical method, which may prove useful in providing us with information that is not easily achievable.

Some programmes have been designed by WHO and UNAIDS for the modelling of HIV/AIDS and are simple and available. Estimation and Projection Package (EPP) has been recommended by the UNAIDS reference group and uses available data to estimate the trend of national adult HIV prevalence and incidence over time.

It is notable that National HIV epidemics are composed of multiple epidemics in different populations and hence epidemic curves can be developed separately for different populations in EPP and then combined to produce a single epidemic curve, which estimates HIV prevalence at a national level (WHO/UNAIDS, 2009).

Another programme, which has been recommended, is Spectrum. The prevalence and incidence estimates produced by EPP can be exported to Spectrum and used to develop further estimates of the impact of the HIV epidemic nationally (WHO/UNAIDS, 2009).

Needless to say, there is a crucial need to obtain information on HIV in the country, showing the increasing number of HIV cases on a daily basis. This type of information is vital for the planning, monitoring, and control of the disease. Hence, in this study, we aim to use EPP and spectrum models in Iran; one of the few countries in the Middle East and North Africa (MENA) to estimate and project HIV infection and its impacts on the community from 2009 to 2014, classified by subgroup.

METHODS

We used EPP 2009 Release 2 and Spectrum software in this study. EPP is a type of HIV modelling software, which estimates and projects HIV infections using information in each of the subgroups of the 15-49 year old population. Subgroups included in EPP are: intravenous drug users (IDUs), men who have sex with other men (MSMs), female sex workers (FSWs), and prisoners, all of whom were considered the MARPs (Most at Risk Populations), as well as low risk populations (all others excluding MARPs). If information exists only at two or three points in time for each group, EPP uses the linear interpolation method followed by the empirical Bayesian method, to fit the best epidemic curve and to estimate HIV infection individually for each different group. It then subsequently combines curves to produce a single epidemic curve, which estimates HIV prevalence at a national level (WHO/UNAIDS, 2009).

Spectrum is a general software package, one of the main components of which is an AIDS Impact Model (AIM). The advantage of Spectrum compared to EPP is the availability of increased and detailed demographical information and therefore the ability to estimate and project demographic, social, and other impacts of HIV epidemics. By exporting EPP outputs directly into Spectrum, the number of AIDS related deaths, the number needing ART (anti retrovirus treatment), and other information can be estimate and projected.

Software and instructions for their application can be found at http://www.unaids.org. The main parameters required by EPP were the prevalence of HIV infection in the general population and among MARPs in recent years, as well as the size of each subgroup.

To obtain accurate information for EPP parameters, as a first step, all published and unpublished literature was reviewed systematically.

Medline, Google Scholar, and local databases (Iranmedex, Irandoc, Magiran, and SID) were systematically searched by main keywords (HIV, AIDS, sexual contact, sex, drug use, drug injection, addiction, injecting drug addiction, prostitute, sex worker, street women, men who have sex with men, gay, and their Persian equivalents), and restricted to Iran. We also contacted Iranian medical universities, HIV related organizations, and key authorities and sought information from them. The CDC, other Governmental official reports between 1991 and 2009, and all national survey were also reviewed. Moreover, the references of all eligible studies were also checked to acquire further evidence.

After assessing the relativity and quality of searched papers by standardized forms, all extracted data were input separately in to an Excel spreadsheet, based on each subgroup.

For the next step, the validity and generalisation of findings and defining scenarios were assessed by an expert panel. This panel consisted of 12 experts from the Ministry of Health (CDC), National AIDS committee, and academic staff from the Regional Knowledge Hub for HIV/AIDS Surveillance in EMRO. To achieve this, abstracted parameters and statistics were made available to the expert panel.

Because of discrepancies within the data and disagreements between experts regarding some of the parameters and subsequently to create a more comprehensive perspective, four scenarios were defined as follows:

1. The minimum scenario (Min): optimistic input parameters and minimum size of MARPs to acquire minimum estimates.
2. The maximum scenario (Max): pessimistic input parameters and maximum size of MARPs to acquire maximum estimates.
3. The first realistic scenario (R1): This generates the most realistic estimations based on all available information regardless of their qualities.
4. The second (most) realistic scenario (R2): This is a modified version of R1 based on the most accurate available information. Consequently, we expect the results of models R1 and R2 to be more or less comparable.

In Min scenario, MARPs were considered to be injecting drug users (IDUs) and prisoners; while in the Max, R1 and R2 scenarios, female sex workers (FSWs) and men who have sex with men (MSMs) were also added to the list.

The best values for the input parameters of each scenario were selected by consensus during expert panel sessions (Appendix 1).

In addition, HIV+ prevalence among the general population (it is preferable to term this 'low risk population') was calculated based on HIV+ prevalence in donated blood, which was obtained from blood transfusion organizations.

The demographic information of Iran was imported into Spectrum based on the 2004 National Census (a census is conducted routinely every 10 years), obtained from the Iran Centre for Statistics.

RESULTS

Using EPP, the prevalence of HIV positive in Iran during 2010 (population approximately 74 million) was between 7.14 and 15.95 (per 10,000 population).

Table 1. The estimated number of HIV positive and new HIV infected cases in Iran, based on different scenarios in 2010, 2012 and 2014.

Scenario	New HIV infected cases annually (*1,000)			Number of HIV positive cases(*1,000)		
	2014	2012	2010	2014	2012	2010
Min	3.9	3.7	3.4	51	51	53
Max	12	12	11	137	126	118
R1	8.7	8.4	7.8	109	97	90
R2	8.2	7.7	7.1	106	96	90

Although there was some variation between estimations of scenarios, the number of HIV positive cases and new HIV infected cases annually, will increase with respect to all scenarios from 2010 to 2014 (Table 1).

The main scenario was R2, which was based on the most valid data. Therefore its results were considered as the most important results of our study. Regarding the order of the presented scenarios, the main results of the scenarios were based on the order explained in the methods, to retain coherency between the methods and result.

The minimum scenario results

Based on the Minimum scenario, the prevalence of HIV infection among adults was estimated to be 0.09% (0.05-0.67%) in 2009 and will be 0.08% (0.03-0.64%) in 2012. The number of HIV infections was estimated at 64 thousand between 2003 and 2004, but then showed a decline to 53 thousand in 2010, and 51 thousand in 2014. The annual incidence of HIV had an upward trend in 1994, then reached a peak in 2000 (10,000 cases). Subsequently, it decreased slowly and reached 3,700 cases in 2012. HIV prevalence among prisoners has decreased more quickly than any other MARPs (As previously explained, in this scenario FSWs and MSMs were omitted).

The maximum scenario results

According to the Maximum scenario, the prevalence of HIV infection among adults was 0.20% (0.11-1.34%) in 2009 and is expected to be 0.20% (0.08-1.45%) in 2012. The Maximum scenario estimation showed that HIV infection in 2009 was approximately 115 thousand, and is expected to reach approximately 138 thousand by 2014. Since 1991 the annual incidence of HIV has increased, reaching its peak at 17 thousand cases in 2000, then decreasing until 2006, but it has started to increase again and will reach 12 thousand by 2012.

In this scenario there was an upward trend for HIV infection in the general population and MARPs, except IDUs and prisoners. In addition, we expect around 10% of HIV infections in 2014 to belong to FSWs, MSMs and prisoners, whereas approximately 60% of them will occur within the general population.

The first intermediate scenario results (R1)

The estimated trend of HIV infection in R1 scenario was very similar to the Max scenario and the main difference between them was in relation to the estimation of the number of HIV infections. In R1 scenario we estimated 86,000 HIV infections in 2009 and that this would probably reach 109 thousand by 2014.The prevalence of HIV infection among adults was 0.15% (0.08-1.04%) in 2009 and expected to be 0.15% (0.06-1.13%) in 2012. In R1 scenario the annual incidence of HIV has increased since 1994, reached its peak in 2000 (about 14 thousand) and has then declined until 2005. Subsequently, it has started to increase again and will reach 8,469 by 2012. This scenario, like others, predicted that both currently and in the future, most positive cases are among low risk population.

The realistic scenario based on the most valid data (R2)

We estimated the prevalence of HIV infection among adults to be 0.16% (0.08-1.03%) in 2009 and 0.15% (0.06-1.08%) in 2012. The estimated number of HIV infections in 2009 was about 89,000 and will reach 106,000 by 2014 (Figure 1). This scenario shows that the prevalence of HIV has had upward trends in MARPs and also within the general population in recent years and will be continuous, except in IDUs. HIV prevalence in IDUs was the highest among MARPs in 2009 (11.04%), but will reduce over subsequent years and for this reason, HIV prevalence among FSWs (9.04%) will be higher than other groups in 2014.

Based on R2 scenario, around 24 percent of HIV Infections occurred in IDUs in 2009, and IDUs as the main High-risk group, had contributed to the increase in the prevalence of HIV infection in the general population via unsafe injection. But it is expected that this proportion will reduce to 9 percent in 2014 and this will be due to the fact that that other High-risk groups will increasingly contribute to the increase of HIV infection via unsafe sex.

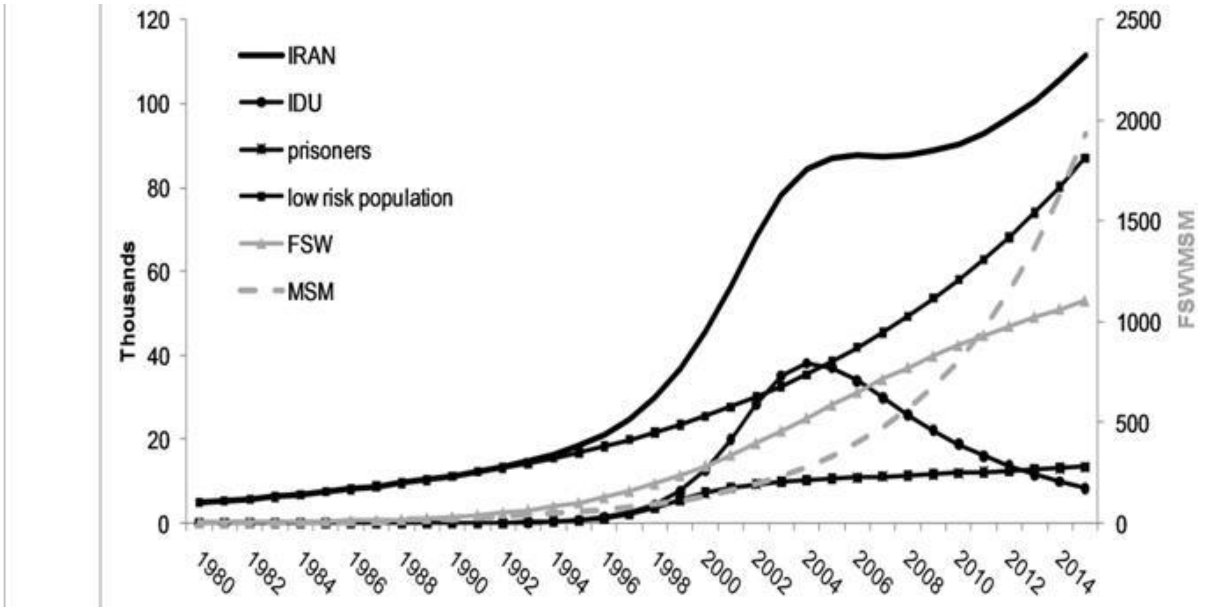


Figure 1. The estimated number of HIV infections (thousands) in MARPs and in the general population, according to the realistic scenario based on the most valid data -R2- from 1980 to 2014.
*The number of HIV infections in all groups appears on the left hand side of the figure, excluding FSWs and MSMs.

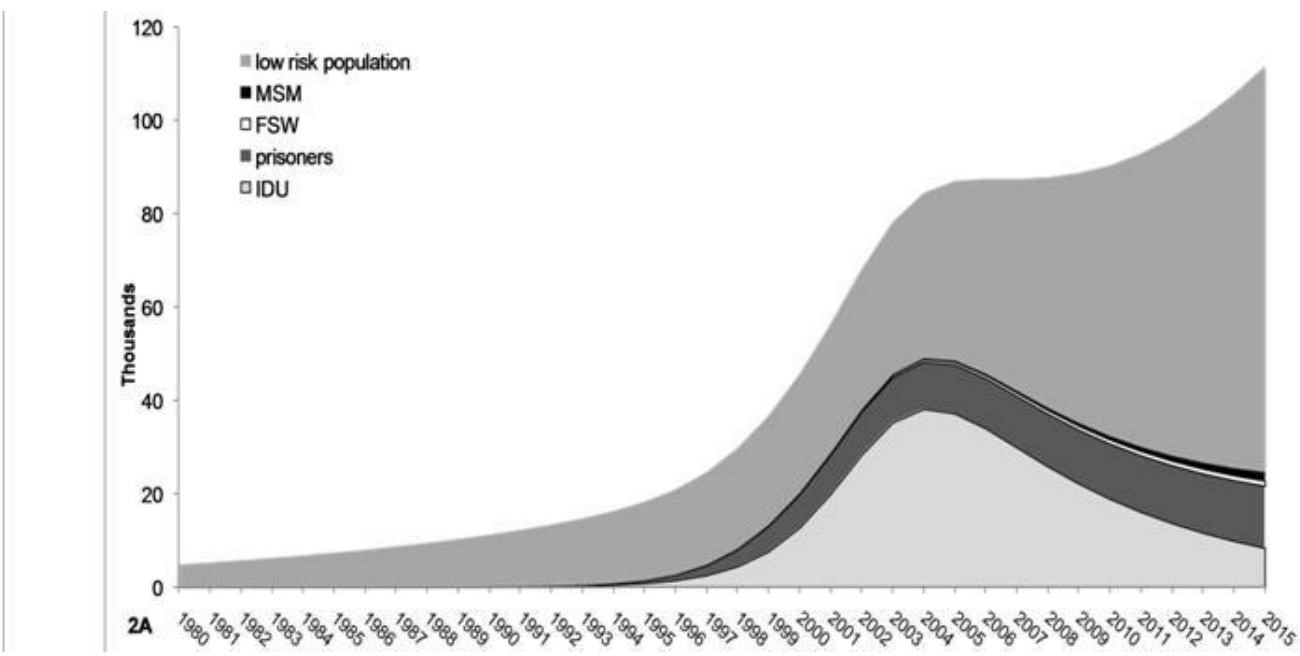
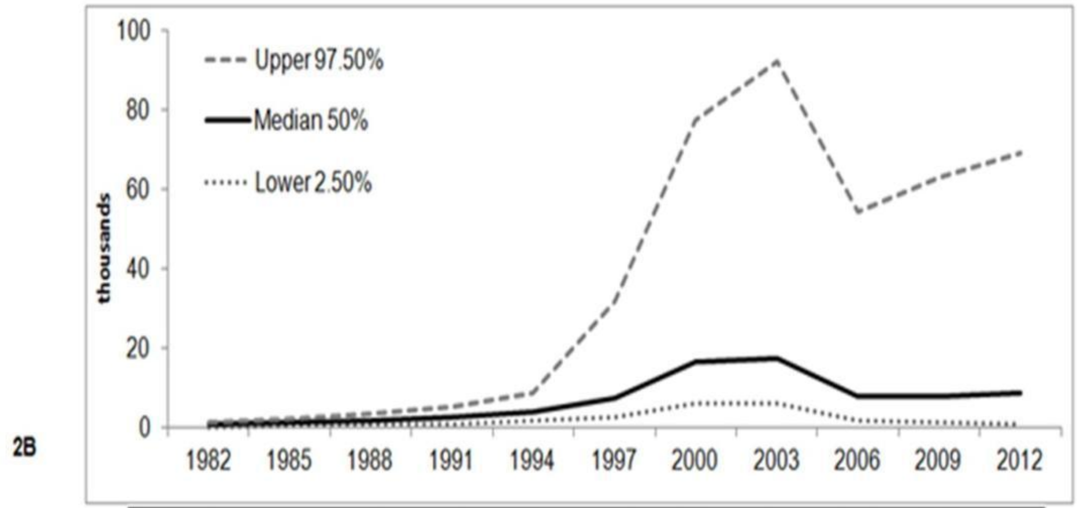


Figure 2A. Proportion of contribution of subgroup in number of HIV infections through R2 scenario between 1980 and 2014.

It is interesting to note that the majority of cases of HIV infection in 2009 occurred among the low risk population (presumably via unsafe sex) and it remained so in the following years, mainly because of the inclusion of a higher proportion of the general population in this group (Figure 2A).

The number of new HIV infections has had an upward trend since 1990 and peaked between 2002 and



Lower 2.50%	0.22	0.44	0.79	1.06	1.70	2.25	6.16	6.10	1.86	1.25	0.92
Median 50%	0.56	0.77	1.13	1.60	2.40	4.96	10.51	11.31	6.09	6.88	7.79
Upper 97.50%	0.79	1.05	1.61	2.44	4.50	24.32	61.00	74.97	46.61	55.22	60.75

Figure 2B. Trend of new HIV infections through R2 scenario between 1980 and 2014

Table 2. Summary of some estimated parameters through EPP and Spectrum in 2006, 2009, 2012 in Iran.

Year	Females>15	Males>15	Children<15	AIDS related orphans	Adults needing ART	Annual AIDS deaths
2006	22700	54870	1370	21560	14740	4360
2009	23480	56080	1590	27890	19680	5800
2012	24000	57180	1740	33530	22110	6650

2004, before declining to 6,880 in 2009. It is subsequently expected to increase again (7,790 cases in 2012). However, it should be added, that unfortunately, the confidence limit of the numbers of new HIV infections was quite broad (Figure 2B).

Estimations have shown that 69.3% of HIV infection occurred among male adults during consecutive years. In addition, 29.1 and 1.6% of HIV infections related to female adults and children under 15 years old, respectively. Furthermore, we have estimated that around 5,800 AIDS-related deaths occurred in 2009 and approximately 27,800 children orphaned in 2009 due to AIDS.

Moreover, we have projected that approximately 33,500 children will be orphaned as a result of AIDS in 2012. The number of adults requiring ART in 2012 has been projected at around 22,000 (Table 2).

DISCUSSION

Although some data is obtainable, such as that of HIV prevalence among pregnant women and blood donors, the prevalence of HIV in the general population is estimated indirectly; direct calculation of the intensity of HIV/AIDS infection in the general population and especially in MARPs is not feasible. Therefore, modelling in all settings, particularly at the concentrated level of epidemics, is one of the best approaches. In our models we estimated that in the best and in the worse scenarios, the prevalence of HIV was between 7.14 and 15.95 (per 10,000 population) in 2010. Although all of our models showed an increasing trend, we do not expect this substantial prevalence increase in future years. However, our models have shown that the distribution of HIV positive cases is moving from IDUs towards the general population, who might contract HIV via casual sexual contact, mainly with FSWs. If health providers are in possession of estimated numbers of HIV positive (old and new) cases, they will be in a position to make evidence-based decisions on services, which could respond to well-defined demands.

Although we did not find a large or sharp surge in the number of HIV positive cases in future years, we cannot completely dismiss the possibility of the risk of an unexpected outbreak. There are real examples from other countries with the same level of epidemic and concentrate level that experienced a rapid increase in the rate of HIV infection, due to the lack of preparation of the health system in providing effective preventive strategies and care (Sawires et al., 2009).

Based on our results in the R2 scenario IDUs was the most important group in 2009 and therefore prevention programmes should focus on this group. Although, as a result of recent harm reduction programmes in Iran, the incidence of HIV has had a decreasing trend, IDUs are still an important high risk group. The results indicate that in forthcoming years, Iran will still have new cases of HIV infection among IDUs. However, there is an increased optimism that with a well organized plan, high coverage and supportive harm reduction activities, transmission may be halted in this group (Hasnain, 2005). Iran started harm reduction programmes among MARPs in 2001, which included IDUs, prisoners, and more recently, FSWs. Because of close cooperation between the Ministry of Health, prison department health authorities, judicial authorities, and other interested parties, with regards to drug treatment and HIV/AIDS, the governmental support for the implementation of evidence-based harm-reduction policies has increased (Razzaghi et al., 2006). Currently, harm reduction programmes; especially safe syringe distribution and Methadone Maintenance Treatment are developing rapidly (Zamani et al., 2008). There is increasing evi-dence of the effectiveness of such preventive strategies on transmission via risky injection (Zamani et al., 2010; Rafiey et al., 2009; Farnia et al., 2010). However, the promotion of condom use and other strategies to decrease unsafe sex have not been as effective as they were among IDUs (Eshrati et al., 2008).

The second group with high HIV prevalence was FSWs. Although HIV prevalence in this group is lower than IDUs, the increasing trend of HIV prevalence for this group is predicted for forthcoming years. Therefore, this will be one of the core groups in the transmission of the virus to the general population. Although there are no precise estimates of the percentage of men, especially married men, who are clients of FSWs, some studies have indicated that premarital and extramarital sex among Iranian youth has increased (Mohammad et al., 2007). Some studies estimate that the probability of transmission from an infected woman to a man in one sexual encounter is approximately 0.0007% (taking the 100% male circumcision figure into account, this becomes about 0.0003); from an infected man to a woman it is around 0.0011%. When juxtaposed with STIs, the probability of HIV infection is quadrupled (Ghys et al., 2004; Fleming and Wasserheit, 1999; Gray et al., 2001). Since a large number of FSWs are mobile and remain hidden, implementing serious harm reduction programmes and expanding drop-in centres (DIC) is extremely important.

Based on our results, it is apparent that IDUs as the main high-risk group have contributed to an increase in the prevalence of HIV infection in the general population via unsafe injection. But, this proportion will reduce in coming years and it needs to be considered that other high-risk group such as FSWs and MSMs will contribute increasingly to the increase in HIV infections via unsafe sex.

Based on data from the routine reporting system in Iran, up to the middle of 2009, 20,130 HIV positive cases were detected. Compared to the output of our models (R2 89,000 estimated cases), we believe that less than a quarter of HIV infections were detected in the routing system. This proportion is much higher in developed countries. For example in the United States, an estimated 1 million to 1.18 million persons are living with HIV/AIDS. It seems that the lower detection case rate is one of the problems in some MENA countries (Pierre-Louis et al., 2004). Of these, 24 to 27% have undiagnosed disease and are unaware of their HIV infection (Glynn, 2005). In addition, data from the Health Ministry of Iran has indicated that on average, HIV affected people developed AIDS within five years. It could be concluded that HIV positive cases are detected after a long delay.

Therefore, the lack of reporting of HIV positive detection rates and long delays are two main threats for the spreading of HIV among the population.

Most EMRO countries, including Iran, have young populations and an increase in the age of marriage. Those between the age of 15 and 24 represent appro-ximately one third of the total population of Iran. This young population is prone to contract infection mainly via unsafe sex. In addition, many young people have migrated to other countries for work or study, and because they are far from their family, may engage in risky sexual behaviours. Furthermore, some groups of young people are actively searching for a certain type of freedom, which has subjected them to risky sexual behaviour. Consequently, just as in other countries, the third wave of the HIV/AIDS epidemic has arrived in Iran. However, we believe that a vast improvement can be made, if the current Harm Reduction Programmes for certain high-risk groups such as FSWs and IDUs are purposefully implemented (DeJong et al., 2005).

Studies in MENA have shown that HIV epidemics appear to be emerging among MSMs in at least a few MENA countries and could already be in a concentrated state among several MSM groups (Ghina Mumtaz et al., 2011). It is not implausible that Iran is one of them, but due to the lack of valid information regarding this group, and as they are one of the most hidden populations, we are unable to speak with certainty with respect to the epidemic of HIV in this group. Based on specific evidence, HIV epidemic transmission among MSMs in most MENA countries has become apparent only in the last few years (Ghina Mumtaz et al., 2011). Available evidence indicates that many MSMs in the Middle East and North Africa also have sex with women (Ayodeji et al., 2008). FSWs and MSMs and their clients may play the role of a bridge across populations in transferring a HIV epidemic from MARPs to the general population. As is obvious from the estimations, this fact should be acknowledged by the main health policy makers in Iran. Efficient advocacy and sensitizing main parties in the Ministry of Health and the other organizations, to prevent the majority of HIV transmission among MSMs is highly recommended.

Our study is prone to certain errors, due to lack of valid data to sufficiently parameterize the model. Also some of the available studies have certain methodological limitations. We have attempted to overcome this limitation by presenting different scenarios. Moreover, in some MARPs (MSM) we had little validated data. As the country is now running several national surveys to fill in the information gaps on HIV prevalence and related risky behaviours among MARPs, there is a good opportunity to check outputs periodically to validate the results of the models for upcoming years. Implementation of several integrated bio-behavioural surveillance surveys and sampling methodologies for hidden and hard-to-reach populations, such as respondent-driven sampling are recommended.

As a conclusion, our models have shown that Iran could find itself at a concentrated level of epidemic in future years, but the main transmission routes are changing, mainly as a result of a change in risky behaviours from unsafe injection to unsafe sexual contact. Therefore, national HIV preventative policy needs to be changed accordingly.

REFERENCES

Ayodeji AF, Abu-Raddad L,Semini I,Riedner G, Wilson D, Tawil O (2008). Characterizing the HIV/AIDS epidemic in the Middle East and North Africa: evidence on levels, distribution and trends—time for strategic action, in Middle East and North Africa HIV/AIDS Epidemiology Synthesis Project.

Center for Disease Contorol (2008). Report of activities and their results on HIV/AIDS in Iran, Ministry of Health and Medical Education: Tehran.

Center for Disease Control- Ministry of Health (CDC) (2008). Study of the prevalence of Neisseria Gonorrhoeae, Clamidia Trachomatis, Syphilis and HIV in Kerman prisoners(unpublished report). Kerman.

Center for Disease Control-Ministry of Health (CDC) (2008). boibehavioural survey on HIV/AIDS among Kermanshah prisoners (unpublished report).

DeJong J, Jawad R, Mortagy I, Shepard B (2005). The sexual and reproductive health of young people in the Arab countries and Iran. Reprod. Health Matters, 15(13): 49-59.

Eftekhar M, Gouya MM, Feizzadeh A, Moshtagh N, Setayesh HR, Azadmanesh K, Vassigh AR (2006). Bio-Behavioural Survey on HIV and its Risk Factors among Men Who Have Sex with Men in Tehran (unpublished).

Eshrati B, Asl RT, Dell CA, Afshar P, Millson PM, Kamali M, Weekes J (2008). Preventing HIV transmission among Iranian prisoners: Initial support for providing education on the benefits of harm reduction practices. Harm Reduct. J., 5:21.

Farnia M, Ebrahimi B, Shams A, Zamani S (2010). Scaling up methadone maintenance treatment for opioid-dependent prisoners in Iran. Int. J. Drug Policy, 21(5):422-424.

Fleming DT, Wasserheit JN (1999). From epidemiological synergy to public health policy and practice: the contribution of other sexually transmitted diseases to sexual transmission of HIV infection. Sex Transm. Infect., 75: 3-17.

Ghina M, Hilmi N, McFarland W, Kaplan RL, Akala FA (2011). Are HIV Epidemics among Men Who Have Sex with Men Emerging in the Middle East and North Africa?: A Systematic Review and Data Synthesis. PLoS Med., 8(8): e1000444.

Ghys PD, Brown T, Grassly N, Granett G, Stanecki KA, Stover J, Walker N (2004). The UNAIDS Estimation and Projection Package: a softwere package to estimate and project national HIV epidemics. Sex Transm. Infect., 80(1): p. 5-9.

Glynn M (2005). Estimated HIV prevalence in the United States at the end of 2003. National HIV Prevention Conference, in Atlanta, Georgia.

Gouws E, White PJ, Stover J, Brown T (2006). Short term estimates of adult HIV incidence by mode of transmission: Kenya and Thailand as examples. Sex Transm Infect., 82(3): p. 51-55.

Gray RH, Wawer MJ, Brookmeyer R (2001). Probability of HIV-1 transmission per coital act in monogamous, heterosexual, HIV-1-discordant couples in Rakai, Uganda. Lancet, 357:1149–1153.

Hasnain M (2005). Cultural approach to HIV/AIDS harm reduction in Muslim countries. Harm Reduct. J., 2:23.

Husain S, Kadir M, Fatmi Z (2007). Resource allocation within the National AIDS Control Program of Pakistan: a qualitative assessment of decision maker's opinions. BMC Health Services Res., 7(11):1-8.

Khalili D (2008). Bio-Behavioral Surveillance of HIV/AIDS in prisoners of Kermanshah province. Centre for Disease Control Ministry of Health and Medical Education.

Madani S, Talebizadeh SH, Raeis dana F, Kamkar M (2007). Rapid assessment of sex workers in Tehran with an emphasise on HIV related risky behaviours. Center for disease control, Ministry of Health and Medical Education; United Nation Development Programme; National Center for Addiction Studies: Tehran.

Mohammad K, Khalaj AFF, Mohammadi MA, Alikhani S, Zare M, Ramezani TF, Ramezankhani A, Hasanzadeh AR, Ghanbari H (2007). Sexual Risk-Taking Behaviors among Boys Aged 15–18 Years in Tehran. J. Adolesc. Health, 41:407-414.

Mojtahedzadeh V, Razani N, Malekinejad M, Vazirian M, Shoaee SSZMB (2008). Injection drug use in Rural Iran: integrating HIV prevention into iran's rural primary health care system. AIDS Behav,. 12(4): p. 7-12.

Montazeri A (2005). AIDS knowledge and attitudes in Iran: results from a population-based survey in Tehran. Patient Educ. Couns., 57: 195-293.

Naranjiha H (2005). A rapid assessment of drug use and addiction in Iran, University of Social Welfare and Rehabilitation,Tehran.

Nejat S, Feizzadeh A, Asghari Sh, Keshtkar AA, Heshmat R, Majdzadeh SR (2006). HIV risk factors in Iran;systematic review,meta analysis and generalized impact fraction aproaches. Payesh,. 6(1): 54-45.

Pierre-Louis AM, Ayodeji AF, Samaha KH (2004). Public health in the Middle East and North Africa: meeting the challenges of the twenty-first century. Vol. 1. 2004, Washigton, D.C.: World Bank Institute.

Pisani E, Garnett GP, Brown T, Stover J, Grassl NC, Hankins C, Walker N, Ghys PD (2003), Back to basics in HIV prevention: focus on exposure. BMJ, 326:1384-1387.

Rafiey H, Narenjiha H, Shirinbayan P, Noori R, Javadipour M, Roshanpajouh M, Samiei M, Assari S (2009). Needle and syringe sharing among Iranian drug injectors. Harm Reduct J., 6: 21.

Razzaghi E, Nassirimanesh B, Afshar P, Ohiri K, Claeson M, Power R (2006). HIV/AIDS harm reduction in Iran. Lancet, 368(9534): 434-435.

Razzaghi E, Rahimi A, Hoseini M, Madani S (1999). Rapid assessment of drug abuse in Iran. Prevention department, State Welfare Organization, Ministry of Health of Iran and United Nations International drug control program.

Sawires S, Birnbaum N, Abu-Raddad L, Szekeres G, Gayle J (2009). Twenty-five years of HIV: lessons for low prevalence scenarios. J. Acquir. Immune Defic. Syndr., 51 (3): S75-82.

Shoghli A, Mousavi N, Fallahnejad M, Momtazi S, Karim H (2007). Behavoiural study of injecting drug users in Zanjan, Iran (unpublished observations).

Tavoosi A, Zaferani A, Enzevaei A, Tajik P, Ahmadinezhad Z(2003). Knowledge and attitude towards HIV/AIDS among Iranian students. BMC Public Health, 2003-2004. 4(17): p. 1-6

UNAIDS (2004). Epidemiological fact sheets on HIV/AIDS and sexually transmitted diseases of Islamic Republic of Iran. UNAIDS/ UNICEF/WHO.

UNAIDS (2008). The World Bank Global HIV/Aids Program (GHAP), and global AIDS M&E Team (GAMET), Modes of Transmission Study, Guidelines for Country Teams.

UNAIDS (2010). UNAIDS report on the global AIDS epidemic 2010. Available from: http://www.unaids.org/globalreport/documents/20101123_GlobalReport_full_en.pdf.

WHO (2009). EMRO, HIV/AIDS surveillance among most-at-risk populations; Translated by Ali Mirzazadeh, Ali-Akbar Haghdoost, et al; Introduction to HIV/AIDS and sexually transmitted infection surveillance for Eastern Mediterranean and North Africa Region. Kerman: Kerman University of Medical Sciences.

WHO/UNAIDS (2009). Estimation national adult prevalence of HIV−1 IN concentrated epidemics.

Zamani S, Farnia M, Tavakoli S, Gholizadeh M, Nazari M, Seddighi AA, Setayesh H, Afshar P, Kihara M (2010). A qualitative inquiry into methadone maintenance treatment for opioid-dependent prisoners in Tehran, Iran. Int. J. Drug Policy, 21(3): 167-172.

Zamani S (2008). Methadone Maintenance Treatment (MMT) for Drug-using Prisoners in Ghezel Hesar Prison, Karaj, Iran. Iran Ministry of Health and Medical Education.

Zamani S, Vazirian M, Nassirimanesh B, Razzaghi E, Ono-Kihara M, Ravari SM. (2008). Needle and Syringe Sharing Practices Among Injecting Drug Users in Tehran:A Comparison of Two Neighborhoods, One with and One Without a Needle and Syringe Program. AIDS Behav., 14(4):885-890.

Appendix 1. Different scenarios, population of MARPs and the prevalence (IDUs (Naranjiha, 2005; Razzaghi et al., 1999; Shoghli et al., 2007; Zamani, 2008), FSWs (Madani et al., 2007), MSMs (Eftekhar et al., 2006), prisoners (Center for Disease Control, 2008), general population).

Scenario	The MARP entered	The population of MARP	The prevalence entered	Other characteristics
Min	IDUs	166000	2001(1.8%, 28.1%), 2002(29.8%), 2003(15.2%, 31.5%), 2004(23.2%, 27.1%), 2005(24.5%), 2006(10.7%, 22%)	The population in urban areas
	Prisoners	400000	2000(1.4%), 2001(2.67%), 2003(2.39%), 2004(2.6%), 2005(2.95%), 2006(2.33%), 2007(1.28%)	The population in urban and rural areas
	General population	55780136	2001(0.02%), 2002(0.02%), 2003(0.07%), 2004(0.05%), 2005(0.05%), 2006(0.04%), 2007(0.04%)	remaining population
Max	IDUs	260000	2001(1.8%, 28.1%), 2002(29.8%), 2003(15.2%, 31.5%), 2004(23.2%, 27.1%), 2005(24.5%), 2006(10.7%, 22%), 2007(14.5%, 16.2%)	The population in urban areas
	Prisoners	550000	2000(1.4%), 2001(2.67%), 2003(2.39%), 2004(2.6%), 2005(2.95%), 2006(2.23%), 2007(1.28%)	The population in urban and rural areas
	FSWs	64000	2002(1.8%), 2003(2.4%), 2004(2.3%), 2005(3%), 2006(3.3%), 2008(2.3%)	The population in urban areas
	MSMs	100000	2000(0.7%), 2001(1.3%), 2003(1.2%), 2004(1.4%), 2005(1.6%)	The population in urban areas
	General population	55372136	2002(0.05%), 2003(0.1%), 2004(0.1%), 2006(0.1%), 2008(0.11%)	remaining population
R1	IDUs	200000	2001(1.8%, 28.1%), 2002(29.8%), 2003(15.2%, 31.5%), 2004(23.2%, 27.1%), 2005(24.5%), 2006(10.7%, 22%), 2007(14.5%, 16.2%)	The population in urban areas
	Prisoners	480000	2000(1.4%), 2001(2.67%), 2003(2.39%), 2004(2.6%), 2005(2.95%), 2006(2.23%), 2007(1.28%)	The population in urban and rural areas
	FSWs	50000	2002(1.18%), 2003(1.54%), 2004(1.51%), 2005(1.98%), 2006(1.98%), 2008(1.51%)	The population in urban areas
	MSMs	90000	2002(0.39%), 2003(0.51%), 2004(0.5%), 2005(0.66%), 2008(0.5%)	The population in urban areas
	General population	55526136	2002(0.04%), 2003(0.09%), 2004(0.08%), 2005(0.07%), 2006(0.07%), 2008(0.09%)	remaining population
R2	IDUs	200000	2003(15.2%), 2004(23.2%), 2007(15.3%)	The population in urban areas
	Prisoners	480000	2000(1.4%), 2001(2.67%), 2003(2.39%), 2004(2.6%), 2005(2.95%), 2006(2.33%), 2007(1.28%)	The population in urban and rural areas
	FSWs	50000	2002(1.18%), 2003(1.54%), 2004(1.51%), 2005(1.98%), 2006(1.98%), 2008(1.51%)	The population in urban areas
	MSMs	90000	2002(0.39%), 2003(0.51%), 2004(0.5%), 2005(0.66%), 2008(0.5%)	The population in urban areas
	General population	55526136	2002(0.04%), 2003(0.09%), 2004(0.08%), 2005(0.07%), 2006(0.07%), 2008(0.09%)	remaining population