



Evaluation of the epidemiological impact of harm reduction programs on HIV in Vietnam

2011

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Executive summary

Vietnam's HIV epidemic is concentrated, both in specific behavioral sub-populations and geographic regions. The key populations at higher risk for HIV infection in Vietnam are female sex workers (FSW) and their clients; injecting drug users (IDU); and men who have sex with men (MSM). Vietnam identified harm reduction interventions for IDU and FSW as a key component of its last 5-year National HIV strategy 2004-2009. Harm reduction interventions aim to reduce the dominant behavioral risk factors that facilitate transmission of HIV in Vietnam, namely, sharing injecting equipment and engaging in unprotected sex. The main service components of harm reduction for these groups include the distribution of free sterile needle-syringes and condoms and providing behavior change communication through peer educator-based outreach. As the next phase of programming is planned and resources allocated, it is important to assess the achievements of previous programs aimed at minimizing risk of infection in terms of coverage and epidemiological impact.

Objectives and approach

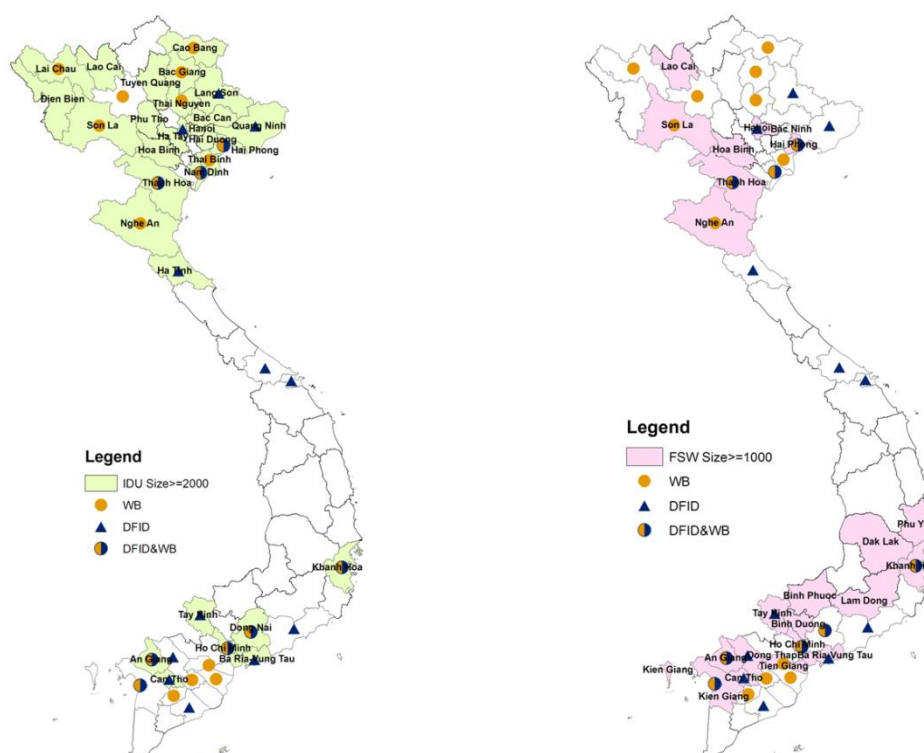
This impact assessment study has the following objectives:

- To examine coverage of harm reduction interventions in Vietnam among IDU and FSW (programs targeted for MSM were not examined) from 2004-2009;
- To understand the HIV transmission dynamics in Vietnam and to estimate the extent to which harm reduction interventions among core groups have contributed towards epidemiological trends and reduced HIV transmission in Vietnam during the 2004-2009 strategy.

The primary geographic unit of analysis for program coverage and likely impact was province level. Through ecological analysis and epidemic modeling, the assessment explored the plausibility of intervention impact on epidemic trajectories. By estimating the likely number of infections averted compared with coverage levels, the effectiveness of programs across the country could also be used to predict the expected impact of introducing new programs or further expanding existing programs.

Assessment of program coverage

Harm reduction interventions for IDU and FSW have been in place at limited scale in some provinces since 2001. Large-scale harm reduction programs in 32 provinces receiving U.K. Department for International Development (DFID) and/or World Bank (WB) support began in 2004/5 and are the primary subject of this assessment (see maps below). Interventions for MSM have been implemented in some areas, but are not at the same scale or formality as for IDU and FSW, and program monitoring data are not available. The impact of MSM interventions is not assessed in this study.



Assessment of program coverage concluded that:

- All but three provinces, of 32 provinces assessed, have nearly or more than 2000 IDU or 1000 FSW.
- Nine provinces without DFID or WB support had more than 2000 IDU and nine had more than 1000 FSW (seven of these provinces have both large numbers of IDU and FSW).
- These numbers provide a strong case for expanding harm reduction interventions to more areas.

Even in provinces which have harm reduction interventions, there is room to expand coverage. The most reliable and consistently available indicators of program coverage across provinces and the assessment time period were free commodity distribution. It was found that:

- Levels of needle-syringe and condom distribution increased substantially over the 5 year period, 2005-2009.
- According to WB project targets of 240 condoms per FSW per year and 200 sterile needle-syringes per IDU per year,
 - 12 of 32 provinces exceeded levels of “good coverage” for FSW interventions;
 - 7 of 32 provinces exceeded levels of “good coverage” for IDU interventions.

The following table shows provinces with the largest numbers of IDU and FSW along with the highest annual level of commodity distribution achieved by the programs during 2005-2009.

	Estimated IDU size (2008)	Estimated HIV prevalence among IDU (2005 HSS)	N/S per IDU (year*)	Estimated FSW size (2008)	Estimated HIV prevalence among FSW (2005 HSS)	Condoms per FSW (year*)
HCMC	34,000	47%	16 (2008)	30,000	12%	28 (2009)
Hanoi	37,900	28%	113 (2008)	4800	13%	210 (2008)
Son La	28,000	NA	5 (2009)	1100	NA	59 (2009)
Bac Giang	8636	11%	58 (2008)	800	1%	218 (2009)
Hai Phong	8300	58%	203 (2008)	3000	25%	750 (2008)
Thanh Hoa	8200	26%	251 (2008)	1500	7%	500 (2007)
Nghe An	6700	34%	65 (2008)	1400	7%	270 (2009)
Lang Son	6000	29%	124 (2008)	300	4%	777 (2007)
Tay Ninh	2800	NA	82 (2008)	3000	NA	29 (2009)
An Giang	2200	26%	106 (2008)	2400	9%	286 (2009)

* the year in which the highest level of per-capita condom distribution was achieved. Numbers in bold indicate that WB project targets of 240 condoms per FSW per year or 200 needle-syringes per IDU per year were achieved.

Ecological results

Ecological analysis assessed whether high levels of commodity distribution was reflected in declining or stabilizing trends in HIV prevalence:

- Sentinel surveillance data suggested that in almost all provinces HIV prevalence trends among IDU began declining prior to 2005.
 - Thus, it was not surprising that in 12 of 19 provinces with sufficient data, relatively high levels of per capita needle-syringe distribution (i.e. >100 needle-syringes per IDU) corresponded with stable or declining prevalence trends among IDU.
- There was a weak relationship between commodity distribution and impact on epidemic trends among FSW.
 - In eight of 15 provinces with sufficient data, high condom distribution and a continued low/stable HIV prevalence trend was observed.
 - In several provinces, declining or stable HIV prevalence trends were observed despite low levels of commodity distribution.

Epidemic trajectories naturally have dynamic profiles. Therefore, purely examining trends in prevalence is insufficient for assessing the success of programs. Due to the complex interactions and background factors associated with epidemic and behavioral trends, epidemic modeling can be valuable to understand the underlying transmission dynamics of HIV in each province and evaluate the true extent to which the harm reduction programs have contributed to mitigating the spread of infection.

Modeling results

A standard population-level mathematical transmission model was developed to describe HIV epidemics in Vietnam. The Vietnam HIV Model (VHM) was developed in a manner to be specifically customized to represent the unique situation in Vietnam and to evaluate harm reduction programs that have been implemented. Provincial models were developed for: HCMC, Hanoi, Hai Phong, Da Nang, An Giang, Can Tho, and Dien Bien. Provinces were selected based on which had sufficient and consistent biological, behavioral, and program data. These seven

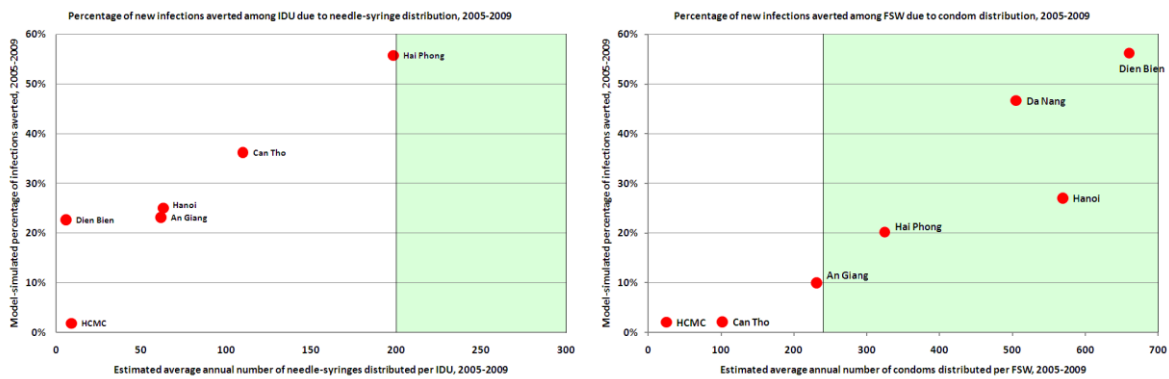
provinces represent a wide variety of epidemic contexts, geographic distribution, and types of intervention support.

The VHM was designed to fit observed behavioral and program coverage data simultaneously to biological data. It assumed that increasing commodity distribution would lead to a decrease in the number of shared injections or unprotected commercial sex acts:

- Despite program data indicating large increases in commodity distribution, behavioral trends measured through two rounds of IBBS (2005/6, 2009/10) have been disappointing.
 - In all but one province included in the modeling analyses, there was an increase in reported sharing of needle-syringes among IDU in 2009 compared to 2005.
 - Assuming reliability and representativeness of data, this trend suggests that there may have been other external factors influencing engagement in risk behaviors.
 - To indirectly account for any underlying behavioral risk patterns, the VHM relied primarily on program coverage data to determine how much additional unprotected sex and sharing of injecting equipment would likely have occurred without the availability of needle-syringes and condoms distributed by the programs. The potential numbers of infections averted were then calculated.

The modeling results from seven provinces suggest that harm reduction programs:

- Averted between 2-56% of infections among both IDU and FSW, depending on the level of program coverage achieved.
- Due to prevention of infections in the population groups directly targeted with the harm reduction programs, chains of transmission to other population groups have been reduced by averting up to 39% of infections (in Hai Phong).



Based on the results of modeling evaluations across seven provinces over the period 2004/5-2009 (figures above), generalizations can be made about future program levels.

- ***If program coverage targets (>200 needle-syringes per IDU and >240 condoms per FSW) are reached, it can be expected that more than 50% of infections among IDU and more than 20% of infections among FSW would likely be averted.***

Limitations of the analysis

All aspects of these analyses are dependent on the use of existing data. Many of the data sources used have some issues of data quality or completeness that influence the confidence with which the results are presented. The main report and technical annexes explore issues of data quality and their implications on the assessment results in more detail. However, it is useful to note that the size estimates of FSW and IDU, program coverage data as well as biological trend data have wide margins of uncertainty, which would be important to address to allow more robust assessment of intervention effects in the next phase of the national strategy.

Recommendations

Although harm reduction programs have been introduced in numerous provinces of Vietnam for the purposes of reducing sharing rates and decreasing unprotected sex, these risk behaviors still occur at levels that facilitate moderately high levels of HIV transmission. Harm reduction programs that distribute free needle-syringes and condoms are immensely valuable and have been shown in this report to be effective in mitigating epidemics. Given that many provinces have not yet reached their targets of 'good' coverage, and the majority of FSW and vast majority of IDU report that they are not being reached by the peer educators with free needle-syringes and condoms, there is still need for expansion of programs coverage. For example, only two of the eight provinces with more than 6000 IDU have distribution levels exceeding 150 needles/syringes per person; and 13 provinces have more than 1000 IDU and/or FSW and no large-scale harm reduction services in place. Concerted scale-up of services is required in HCMC due to the large numbers of people at higher HIV risk.

Summaries of specific recommendations from this report include:

- *Improve data collection and analysis of size estimation of key populations at higher risk for HIV infection (e.g., IDU, FSW, MSM), as well as for the male clients of FSW, program monitoring statistics, and sentinel surveillance.*
- *Introduce harm reduction programs in all provinces with large numbers of IDU and/or FSW and improve levels of coverage within provinces with programs, giving highest priority to regions with greatest numbers of key populations at higher risk of HIV infection.*
- *Establish national guidance on the package of services, quality standards, and coverage targets for harm reduction services.*
- *Conduct operational research to understand technical efficiency and why implementation works in some regions.*
- *Strengthen training and supervision of peer educators to improve coverage and distribute commodities efficiently.*

Introduction and background

Since the mid-1990s, HIV epidemics have occurred among specific sub-populations, leading to a concentrated epidemic in Vietnam. The government of Vietnam and its key development partners recognize HIV as a major health and development threat and have marshaled increased national and international resources to contain the epidemic. One of the country's greatest challenges is to ensure the additional financing available enables Vietnam to mount a cost-effective, evidence-based, well-evaluated and prioritized HIV response.

The key population groups at risk in Vietnam's concentrated HIV epidemic are female sex workers (FSW) and their clients; injecting drug users (IDU); and men who have sex with men (MSM). Sentinel surveillance data for these groups have been collected since the early 1990s and suggest that HIV remains relatively low among most groups of FSW, but has increased relatively rapidly over the past two decades in most provinces with a visible population of IDU. Infections among IDU account for approximately 60% of reported HIV cases but they indirectly contribute to an even larger percentage, through overlapping networks among IDU who pay for sex and FSW who inject, as well as secondary infections to other population groups. More recently, sentinel surveillance data from numerous provinces suggests that some HIV epidemics appear to have declined or stabilized; however, this is not consistent across all regions. Although sentinel surveillance is not conducted among populations of MSM, recent exploration of the rates of HIV in this group through integrated behavioral and biological surveys (IBBS) suggest the existence of high-risk behaviors in this segment of the population. In 2005/2006, HIV prevalence among MSM in Ha Noi and Ho Chi Minh City (HCMC) was 9% and 5% respectively. According to the UNAIDS/WHO estimates and projections program models (2007 EPP report, published in 2009), HIV prevalence in the general population aged 15-49 was estimated to be 0.43% in 2009. By 2007, there were an estimated 293,000 people living with HIV in Vietnam.

HIV prevalence is highest in Vietnam's two economic hubs; specifically, the Haiphong-Hanoi corridor of the Red River delta and the Mekong delta, including HCMC, which alone has approximately one-quarter of Vietnam's reported HIV infections. Thus, Vietnam's epidemic is highly concentrated, both in specific behavioral sub-populations and geographic regions.

Vietnam's HIV response

Vietnam has implemented two medium-term plans, the first from 1993 to 2000; while the first national strategy spanned 2004-2009. The strategy emphasizes policy reform, capacity building, coordination, surveillance, prevention, and treatment and care. The next phase of programming is in preparation and will be launched in 2011.

Given the concentrated nature of the epidemic, the National AIDS Control Strategy prioritizes the speed, scale and coverage of harm reduction interventions. As the current phase of programming is ending, assessing the achievements in coverage is a critical measure of the effectiveness of the response and the ability to effectively utilize available resources. In particular, matching high levels of coverage to areas where there are large populations of IDU, FSW and clients is critical in a diverse epidemic.

Achievements of the program

Notwithstanding these challenges, Vietnam has had notable success in its response to the HIV epidemic, including focused policies and programs to address vulnerability among FSW and clients, MSM, and IDU. As a result of the Law on Prevention and Control of HIV/AIDS, Decree 108, a comprehensive range of HIV services including needle and syringe programs and methadone maintenance therapy can now be implemented and expanded. A single national executing and coordinating body has been established while multisectoral cooperation and coordination is to be further strengthened. A national monitoring and evaluation framework has been developed, including establishment of ambitious coverage targets for harm reduction, and routine HIV reporting systems. Resources have also been mobilized to provide care for people living with HIV/AIDS (PLHIV) and treatment for those with AIDS.

Rationale and objectives of the current study

Until this assessment, there have been no rigorous studies of the extent to which the harm reduction interventions that form the foundation of the national program have directly contributed to these trends. The Vietnam Administration for HIV/AIDS Control (VAAC) and its development partners wish to assess the likely impact of harm reduction interventions in the

country thus far and determine whether resources are being used effectively. Experiences from the past six years of implementation should also inform future implementation, management and evaluation of harm reduction interventions. This study examines program coverage and also conducts analyses based on all available surveillance and programmatic data, in conjunction with a sophisticated mathematical model designed for this evaluation exercise, to estimate the effectiveness of the programs across a number of Vietnamese provinces. The findings and recommendations of this study will be used to inform the prevention strategy for the next 10 years.

The impact assessment study has the following objectives:

- To examine coverage of harm reduction interventions in Vietnam among IDU and FSW¹;
- To elucidate HIV transmission dynamics in Vietnam, including a description of regional differences within Vietnam, and to demonstrate to what extent implementation of harm reduction interventions among core groups in Vietnam have contributed towards epidemiological trends and reduced HIV transmission in Vietnam.

Impact assessment approach

To meet these objectives, the impact assessment has been divided into three main areas:

1. Review the intervention history and intensity of harm reduction programs from 2004/5 to 2009 is conducted, by the key populations at higher risk for HIV infection (e.g., IDU, FSW); geographic area, and intervention partner
2. Explore the plausibility of intervention impact on epidemic trajectories through ecological analysis of the timing of intervention versus changes in epidemic trajectory; and the relationship between intensity of intervention and changes in HIV prevalence trends.
3. Estimate the likely epidemiological impact of the harm reduction programs (e.g. estimating infections averted) on FSW, IDU, and the general population through epidemic modeling in geographic areas of different intervention intensity and epidemic conditions. Averted infections

¹ Although MSM are recognized to be an important group for prevention interventions, during the study period of the assessment, formal programming for MSM was not being implemented in most areas to the same scale as for IDU and FSW. Consequently, reliable program data for capturing these activities were not available for the analysis.

are estimated by comparing the current scenario with expected epidemic trajectories if the program did not distribute prevention commodities (i.e. condoms and needles/syringes).

The results from these analyses are synthesized to form the basis of recommendations for improving the scale-up, scope, and quality of interventions in the future.

Methodology

Scope of the harm reduction program included in the assessment

In Vietnam, there is no national guideline defining the basic package of services that should be included in a harm reduction for either FSW or IDU. Through discussion with program managers and review of implementation plans and progress reports, a list of services was compiled that appears to be common to the harm reduction programs supported by WB and DFID (see **Error! Not a valid bookmark self-reference.**).

Table 1: Package of services for harm reduction programs included in the WB/DFID program in Viet Nam

IDU	FSW
○ Needle/syringe distribution	○ Condom distribution
○ Condom distribution	○ Peer outreach
○ Peer outreach	○ Mapping
○ Mapping	○ Interpersonal behavior change communication
○ Interpersonal behavior change communication	○ Drop-in Centers
○ Drop-in centers	○ Advocacy (provincial and/or local levels)
○ Advocacy (Provincial and/or local levels)	○ STI clinic services (screening and/or syndromic management)
○ Oral substitution therapy (Methadone) and drug detoxification	

The degree of coverage of specific components of the package varies considerably between provinces that provide harm reduction programs. The services listed in Scope of the harm reduction program included in the assessment

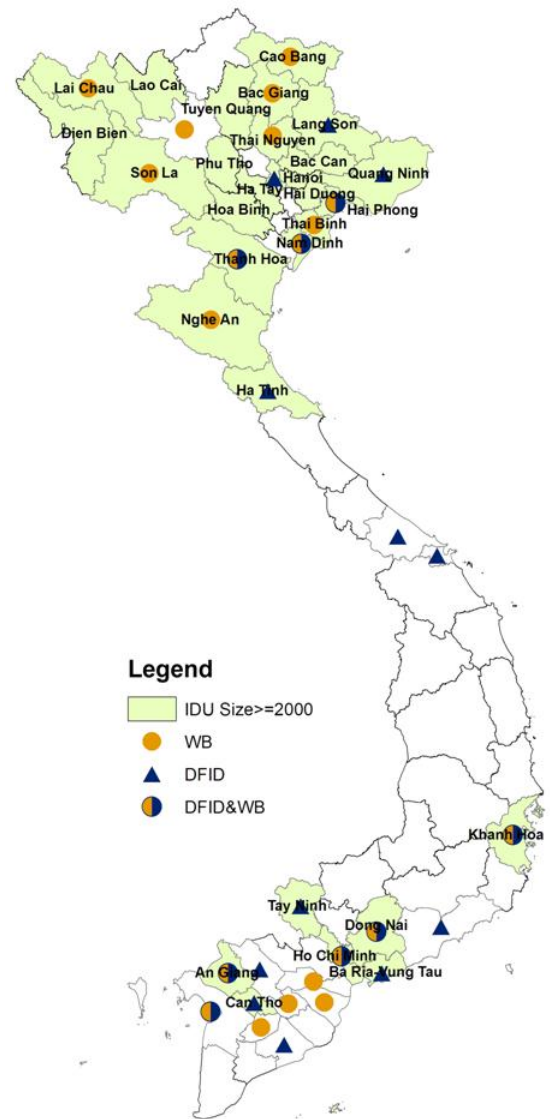
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Table 1 are considered as part of the impact assessment. Services such as VCT, basic care and support or treatment, mass media education, and large scale condom social marketing, are not explicitly included in the assessment of impact.

In addition to harm reduction services provided in community settings, some populations are managed in 05 and 06 Centers.² Individuals may be placed in these centers for durations of between a few weeks to several years. In each province the policy and enforcement of the ordinance authorizing 05/06 Centers varies resulting in different proportions of IDU and FSW who are in the community compared to who are in the centers. Conditions related to risk behavior and HIV epidemiology in the 05/06 Centers are different to those in the community. Consequently, the proportion of key populations at higher risk found in the centers and the duration of stay can greatly influence transmission dynamics in these groups overall. Estimates of the size of the populations of IDU and FSW are also influenced by the proportion of these groups actively managed in the centers, those who are managed in the community, and those who attempt to stay hidden from local authorities.

Together, DFID and the World Bank fund the largest scale harm reduction program activities in Vietnam. Vietnam. Both programs channel funds through the Vietnam government, which implements the program program at the provincial level, overseen by the Provincial AIDS committee. Harm reduction programs are programs are in place in 12 provinces funded by the World Bank, 13 provinces funded by DFID, and eight

² Under the Ordinance on Administrative Violations 04/2008/PL-UBTVQH12, drug use and sex work are administrative violations and result in detention for up to two years in centers managed by the Ministry of Labor, Invalids and Social Affairs (MOLISA). These centers are referred to as 05 Centers for female sex workers and 06 Centers for drug users.



and eight provinces where both donors fund activities (see

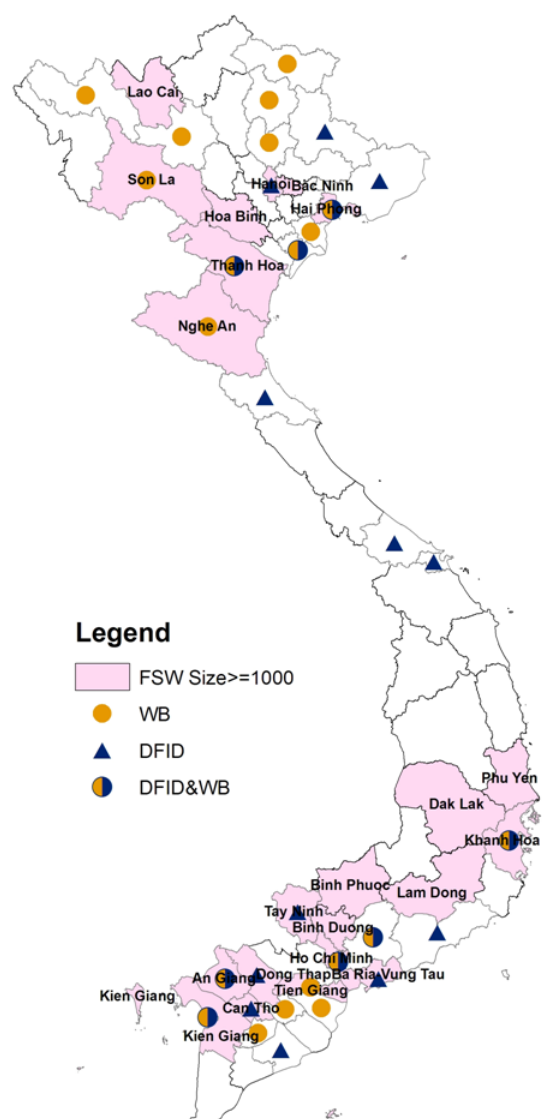


Figure 1 in the following chapter). In jointly-supported provinces, the program avoids overlaps through clear designation about which donor funds activities at the district or commune level.

In addition to the WB and DFID activities, the US government also funds peer outreach activities and condom distribution through a program called Life-GAP. No needles and syringes are distributed as part of this program. The US government programs currently span 29 provinces, scaled up from four provinces in 2001 and reaching a peak of 40 provinces in 2005. Many of the provinces targeted by these programs are the same as those with WB and/or DFID programs.

The impact assessment associated with this report reviews the harm reduction program over the period of 2004 to 2009.³ The WB and DFID projects began in 2004 but did not reach full implementation until late 2005/early 2006. While, the DFID project ended in 2009, most of the DFID-supported commodity distribution and peer education was phased out by mid 2009.

The prevention services for MSM over the period covered in this impact assessment consisted of small scale add-ons to existing harm reduction programs. Due to a lack of specific program data, the mathematical models included MSM as an important aspect of provincial transmission dynamics but the contribution of harm reduction services on the epidemic trajectory of this group could not be assessed.

Use of existing data

The impact assessment relied heavily on collation of existing data from available documents, reports, and data files. Some of the key data sources include results from sentinel surveillance sites, integrated biological and/or behavioral surveys conducted among IDU, FSW, and MSM in selected provinces, population size estimates of IDU and FSW provided by MOLISA, and program monitoring data from the harm reduction programs.

Other efforts were made to collate the epidemiologic and program data relevant to the HIV epidemic in Vietnam recently or during the same time period as the current assessment. This includes a project to produce the estimates and projections program (EPP) indicators, conducted under the leadership of VAAC, with technical support from NIHE, FHI, WHO and UNAIDS, as well as a coordinated effort by VAAC, NIHE, FHI, PEPFAR and UNAIDS to increase data triangulation capacity in-country. These efforts, particularly the production of estimates and projections, have involved substantial efforts to review the quality of various data sources and to develop consensus around appropriate adjustment and correction factors to develop an understanding of the epidemic which is more realistic. Participants in this consensus and data validation process at both central and provincial levels have included individuals involved with the primary data collection and persons with experience implementing harm reduction programs and working with IDU, FSW, and MSM. In addition, international consultants with surveillance and modeling

³ Harm reduction interventions were in place prior to 2004 in a few large municipalities such as HCMC, Hanoi, and Hai Phong.

expertise from the region have facilitated these discussions and helped the group decide and validate on the final inputs used in the EPP models.

To make best use of the extensive discussions about the epidemiologic data, the impact assessment team reviewed the primary published reports and data of specific studies, as well as the notes and final synthesized inputs. Interviews with key individuals in the Vietnam EPP exercise were critical to better understanding of how these data and the resulting figures should be interpreted and used in the present exercise.

Given the importance of understanding and interpreting the existing data sources, the impact assessment team consulted with research institutes and provincial level program managers to verify information, particularly with respect to the population size estimates and program monitoring data available. A detailed description of the primary and secondary data sources available and their strengths and limitations are provided in a technical annex to this report.

Protocol development and implementation process

The terms of reference and study protocol were developed, reviewed and approved by the Viet Nam National Strategic Information and Monitoring and Evaluation Technical Working Group, chaired by the VAAC. VAAC convened a senior advisory group for the study, approved the selection of international consultants and appointed a team of national consultants, representing north, south and central regions. After an initial review of available data, the study team prepared a more detailed approach for the analysis and modeling. This was presented to the advisory group and the larger monitoring and evaluation technical working group for feedback and input. Preliminary results of the ecological analysis and tables of input parameters for the modeling were shared in a third meeting of the senior advisory group and the monitoring and evaluation technical working group, as well as with provincial level representatives for further inputs, corrections, and comments. A fourth meeting of the monitoring and evaluation technical working group was convened to review the final results of the impact assessment, before completion of the final written report.

Team Composition

This impact assessment team was led by the VAAC Monitoring & Evaluation and Harm Reduction Departments and included three components:

- A senior study team, consisting of senior researchers from VAAC, the Hanoi School of Public Health, the National Institute of Health and Epidemics (NIHE), WB and UNAIDS,
- National data collation team to support the gathering and verification of data sources which could be used in the impact assessment. Members were selected to allow broad geographic coverage: a member of the VAAC M&E department covering the Northern provinces, a researcher with the HCMC Pasteur Institute covering the Southern provinces, and a researcher with the Nha Trang Pasteur Institute covering the Central region.
- A team of international consultants with expertise in surveillance, epidemiology and modeling to support the more in-depth analysis and interpretation of findings.

The results of the impact assessment are provided in the following two chapters. The first results chapter reviews the intervention coverage over time at the provincial level, as well as the surveillance trends and their correlation, providing ecologic plausibility for the effect of harm reduction on the epidemic. The second results chapter describes the findings of the Vietnam epidemiological transmission model developed for this study, including the estimated number of infections averted in selected provinces, which may be attributable to the intervention. Each chapter begins with a short description of the specific analytic method used to address the key study objectives. Greater technical detail on each analysis is provided in the Technical Annexes.

Review of intervention coverage and associations with sentinel surveillance data

This chapter presents the analytical method and results of the history of scale-up and intensity of harm reduction programs for IDU and FSW in Vietnam. Correlations in intervention coverage and epidemiological trends among IDU and FSW are also examined ecologically.

Analytical approach

The primary unit of analysis was province, which is consistent with the management structure for implementation of harm reduction programming. At the most basic level, the adequacy of the response is determined by whether the provinces with large numbers of FSW and IDU have harm reduction programs in place. If resources are insufficient to place harm reduction services in all areas where there is need, provinces with greater vulnerability should be prioritized in terms of the resources available for implementing programs. The next level of analysis considers whether coverage is adequate in provinces with harm reduction programs.

Service coverage can be measured in multiple ways, but only a few indicators are the focus of this assessment.⁴ These measures are indicative of the degree and intensity of service provision, but cannot fully describe the implementation experience. The set of indicators used in these analyses was determined by the availability of reliable program monitoring data throughout the time period of the assessment in the provinces with harm reduction activities. These key indicators include:

- The number of free distribution condoms given out each year;
- The number of free needle and syringe units (N/S) given out each year.

⁴ The number of outreach contacts made to FSW and IDU is included as a core indicator of the harm reduction program. However, these data are less complete and are more difficult to collect in a standardized manner, making it difficult to interpret and compare as a measure of scaled-up service. In many provinces, the number of districts and communes with harm reduction programs for FSW or IDU each year and the number of peer educators hired in each year are available. These data are used to look at whether increased distribution of commodities is consistent with geographic expansion of services and staffing for outreach services.

The numbers of commodities distributed at the provincial level are compared to the estimated size of the IDU and FSW in the province. The resulting values, the number of condoms per FSW distributed annually and the numbers of needles/syringes per IDU annually, are compared to the estimated number of risk acts, or need.⁵

The current standard for condom need used by the WB harm reduction programs is 20 condoms per month per FSW or 240 per year. In Vietnam, there is no specific standard for the number of needle-syringes to be distributed per month per IDU. Guidance from UNAIDS/WHO on target setting for IDU prevention interventions suggest that a threshold of 200 needle-syringes per IDU per year is considered very good. The data on average numbers of injections and commercial sex acts per month are available from survey data, such as the IBBS. Table 2 presents the range of results from four rounds of survey data. These numbers fluctuate greatly from year to year, suggesting some uncertainty in the reliability of this measurement. In general, the free condom and needle-syringe distribution targets used in this analysis represent a moderate, achievable level of meeting expected need, as calculated from local behavioral data.

Table 2: Estimated % of acts covered by condom and needle/syringe distribution targets

	An Giang	Can Tho	Da Nang	Dien Bien	Hai Phong	Ha Noi	HCMC	Quanh Ninh
Karaoke-based SW								
Est # commercial acts/year*	824-1002	360-1125	252-1125	244-1002	626-2304	827-1256	629-1840	318-1125
% acts covered by 240 condoms/year	19-29%	21-67%	21-95%	24-98%	10-38%	19-29%	13-38%	21-75%
Street-based SW								
Est # commercial acts/year*	708-1450	837-1572	551-1036	659-1450	297-1858	420-1316	621-3164	435-1450
% acts covered by 240 condoms/year	17-34%	15-29%	23-44%	17-36%	13-81%	18-57%	8-39%	17-55%

⁵ Ideally the adequacy of scale-up is defined according to the distribution and size of the beneficiary population in the province and their need for commodities. For example, harm reduction services in one province may cover only six of 15 districts, but determining whether this constitutes good coverage depends on whether there are IDU and FSW in sizeable numbers in more than six of those districts, and whether the six districts covered by programs are consistent with the six districts with the largest number of IDU or FSW. For the most part this level of detail, e.g. size estimates for IDU and FSW at district or commune level and the listing of specific districts/communes where services are present, was not available for the impact assessment.

People who inject drugs								
Est # injections/year*	326- 637	586- 756	173-456	236- 843	540- 1004	491- 981	860- 926	562- 714
% acts covered by 200 N/S / year	31-61%	26-34%	44-116%	24-85%	20-37%	20-41%	22-23%	28-36%

*Estimated number of sex acts and injections come from behavioral surveys conducted in selected provinces in 2000, 2002, 2005, and 2009. Values presented are the low and high value among the results from the four time points. Note that in these surveys, street-based sex workers and karaoke-based sex workers are sampled separately. However, in the current analysis these groups are treated as a combined group of FSW.

All aspects of this analysis depend heavily on the population size estimates of the FSW and IDU populations. Although there are several sources of population size estimation data, many uncertainties remain about the true size of each key population at higher risk. This analysis used the set of consensus adjusted population size estimates for IDU and FSW, used in the 2007 EPP analyses. This provides some consistency between other efforts of data synthesis and modeling already adopted in country, as well as by the epidemic modeling component of this impact assessment. Technical Annex 1 provides a discussion of the data sources available for the population size estimates and impact assessment.

Peer educators do not focus exclusively on members of their own peer group, and free condoms are distributed to both IDU and FSW. However, due to lack of more detailed information, the following simplifications are made about the program monitoring data used to measure the response:

- FSW peer educators only conduct outreach to other FSW and IDU peer educators only conduct outreach to other IDU;
- All free distribution is given out through peer educators and free condoms are given primarily to FSW.

More detailed examination of the strengths and limitations of the program monitoring data used in these analyses are provided in Technical Annex 1. Given the lack of information to adjust the data, these analyses are suggestive of the levels of coverage but are subject to some inaccuracy.

The pattern of scale-up of services in each province is then compared to the crude trends in the HIV prevalence of the relevant risk group, given by sentinel surveillance data, to assess

plausibility in the impact of the intervention on changing transmission dynamics. The provinces are classified roughly into four groupings, each for IDU and FSW, as shown in Table 3.

Table 3: Classifications for coverage-epidemiology trends

IDU	Declining/ stable prevalence trend	Increasing prevalence trend	FSW	Declining/ stable prevalence trend	Increasing prevalence trend
High/ adequate coverage	I	II	High/adequate coverage	I	II
Low Coverage	III	IV	Low Coverage	III	IV

Provinces which are categorized in the upper left cell (I) for each table must be further assessed in terms of the timing of harm reduction reaching substantial scale compared to inflection points in the HIV prevalence trends. If data indicates provinces are categorized in groups II or III then it suggests either there are other factors impacting the trajectory of the epidemic or that the measures of program coverage and/or HIV prevalence may be unreliable.

Key Results

1. Are harm reduction interventions in the provinces with large numbers of IDU and FSW?

Overall, 32 provinces received either DFID or WB support for harm reduction over the period of 2004-2009.⁶ The median number of IDU in each province was 1800, while the median number of FSW was 700. All of these provinces, receiving WB and/or DFID financial support, have greater than 2000 IDU or 1000 FSW, except for three: Ben Tre, Hau Giang, and Vinh Long. Large numbers of IDU and FSW are also estimated to exist in provinces without the support from harm reduction interventions from WB and DFID. Eighteen provinces have more than 2000 IDU⁷ while nine

⁶ Although the WB and DFID programs are the largest donor supported harm reduction programs, prevention activities have been growing in other provinces. In 2009, eight provinces that do not have programs supported by the WB or DFID reported distributing more than 10,000 N/S to IDU and 38 provinces reported distributing more than 10,000 free condoms. However, because reliable and complete program monitoring data were not available for the entire assessment period from these provinces, they were not included in this assessment.

⁷ Data from two provinces, Bac Lieu and Ha Nam, do not appear to be reliable.

provinces have more than 1000 FSW; of these, seven provinces have both large numbers of IDU and FSW, suggesting a strong case for the need to introduce harm reduction interventions (see

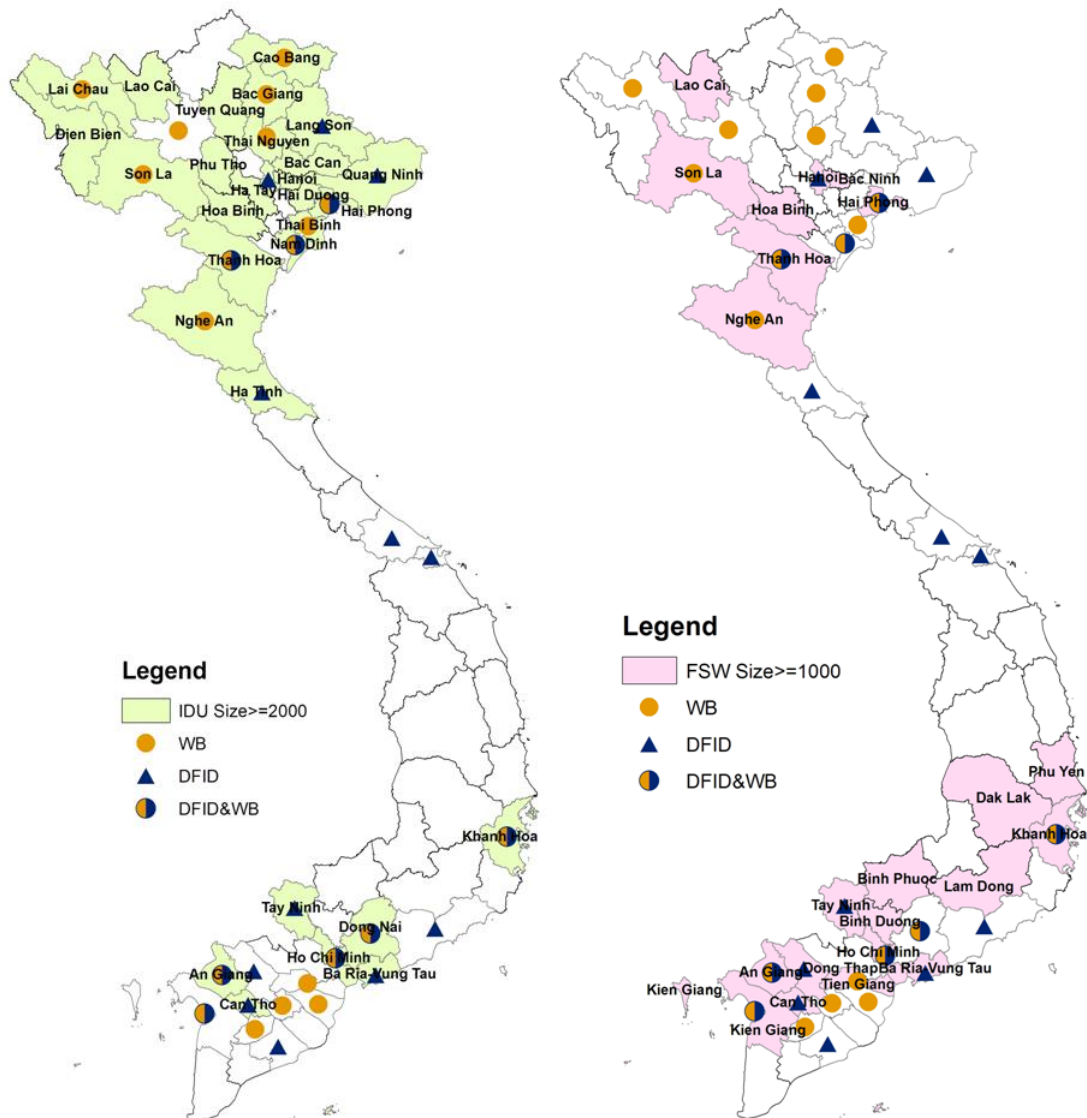


Figure 1). These data suggest the need to further scale up harm reduction services in a number of provinces. However, current harm reduction interventions appear to generally be in appropriate places, i.e. in provinces with large populations of FSW and/or IDU.

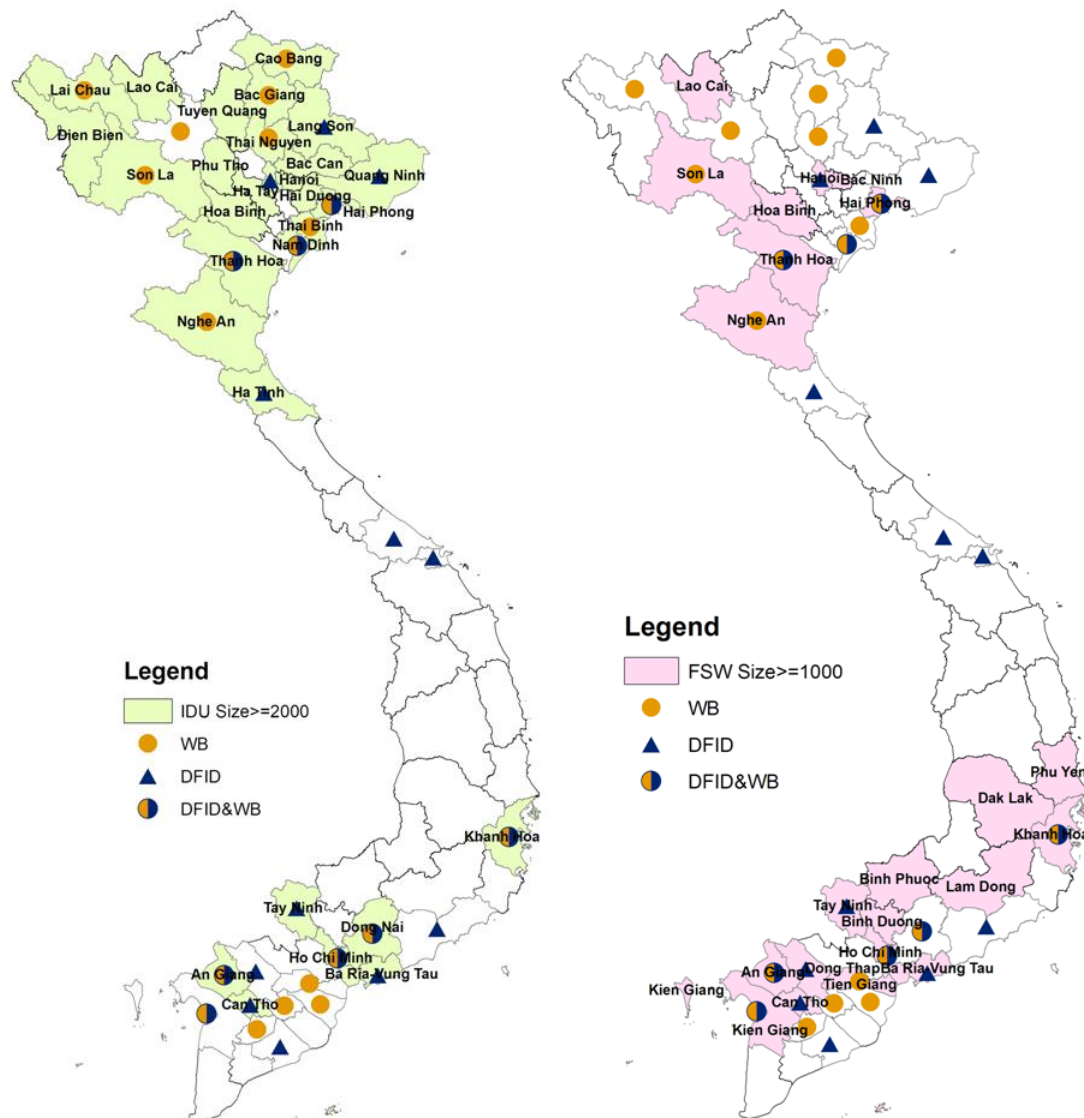


Figure 1: Map of Vietnam indicating provinces with harm reduction programs sponsored by WB/DFID, color-coded according to IDU and FSW population sizes

2. How adequate is coverage of harm reduction programming in provinces with interventions?

Overall, the average number of condoms and needles/syringes distributed rose steadily between 2004/5 and 2008 (Figure 2). Condom distribution increased to a much higher level than needle/syringe distribution. For most provinces the largest increases in per capita commodity distribution occurred between 2007 and 2008. The numbers reported in 2009 dropped

substantially in most provinces, due to the discontinuation of DFID-supported projects in early 2009.⁸

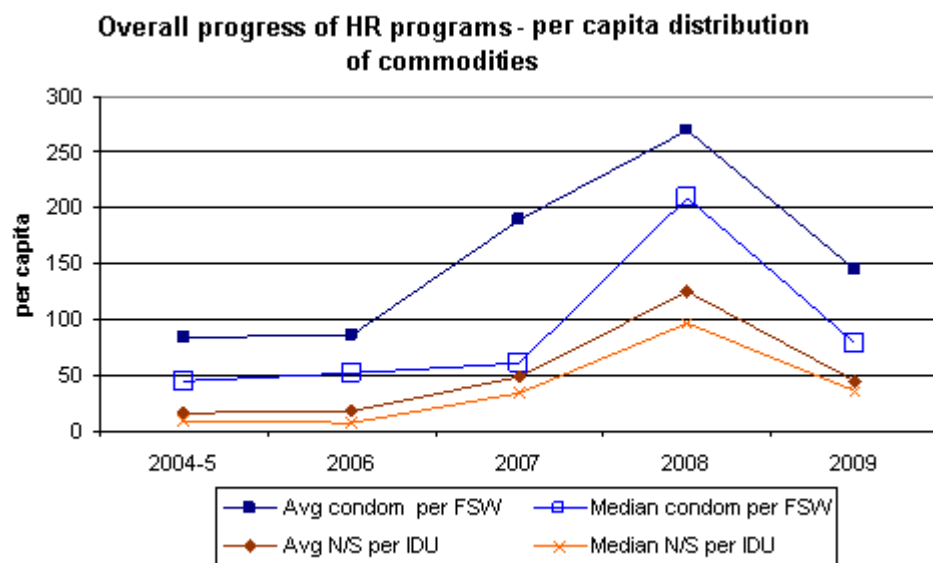


Figure 2: Estimated per-capita distribution of condoms and needle-syringe units over time, 2004-2009, for 32 provinces with WB or DFID supported harm reduction programs

In general, DFID supported provinces scaled-up distribution of condoms sooner than WB supported provinces, which is consistent with the staggered start of the respective projects. By 2008, the level of condom distribution was similar in both DFID- and WB-supported provinces (Figure 3).

⁸ Since that time, the WB project has consolidated with the DFID project and initiated the second phase of its work, and in many provinces has filled the temporary gap left by DFID.

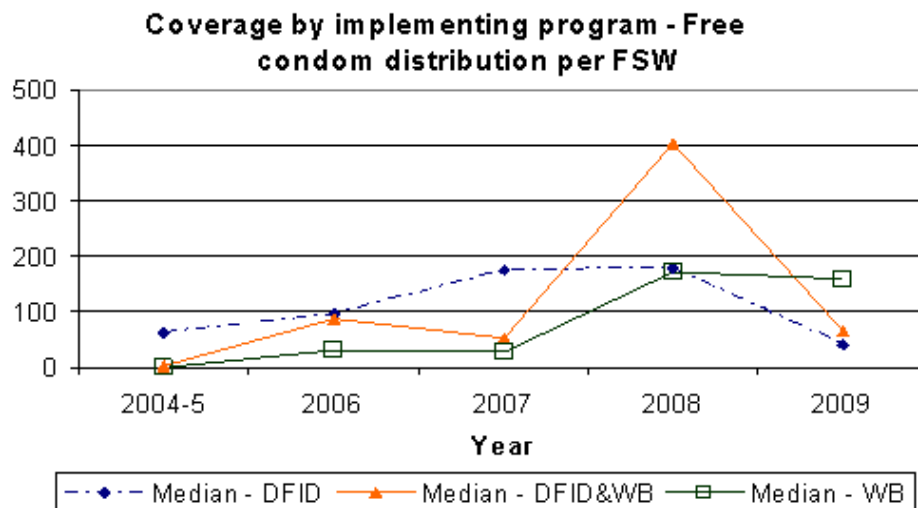


Figure 3: Estimated annual per-capita distribution of condoms to FSW, 2004-2009, grouped by whether provinces had DFID and/or WB harm reduction program

The presence of both projects in the same province did not seem to enhance the level of free commodity distribution. A similar pattern in distribution of needles/syringes per IDU was observed, in which distribution in WB-supported provinces was lower than in those provinces supported by DFID, and did not exceed the levels of coverage achieved by DFID-supported provinces until 2009, when the DFID project ended (Figure 4).

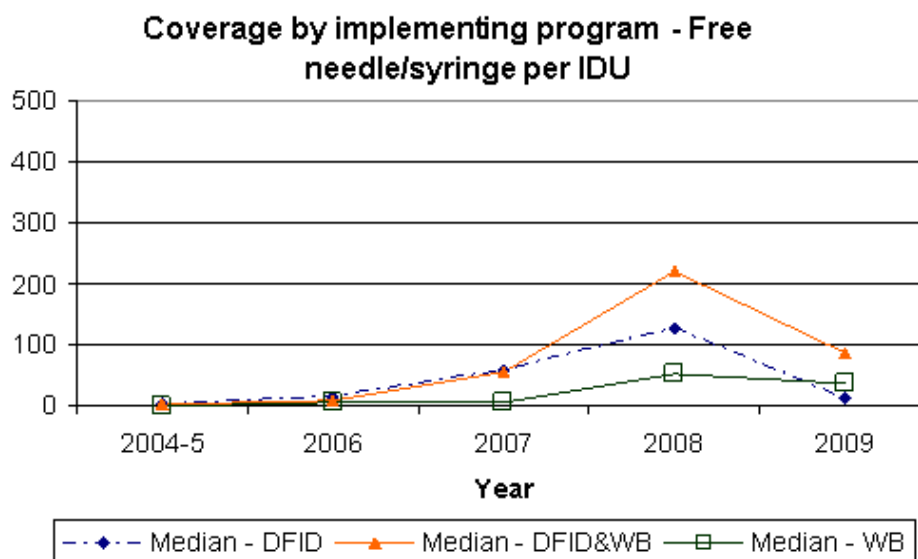


Figure 4: Estimated annual per-capita distribution of needle-syringes to IDU, 2004-2009, grouped by whether provinces had DFID and/or WB harm reduction program

With respect to assessing commodity distribution (Table 2), five of 12 DFID-only supported provinces, four of the eight jointly supported provinces, and three of the 12 WB-supported provinces exceeded condom distribution of 240 per FSW by 2008.⁹ It is worth noting that in some provinces supported by DFID, the numbers of condoms distributed per FSW greatly exceeded the 240 program target. In four DFID-only supported provinces (Binh Thuan, Ha Tinh, Lang Son, Soc Trang) and four jointly supported provinces (Dong Nai, Hai Phong, Nam Dinh, and Thah Hoa) the per capita number of free condoms distributed exceeded 500 per FSW per year.

These large numbers and outliers in condom distribution could suggest inaccuracy in the size estimates of the population, inaccuracy in the program monitoring data, or high levels of wastage of commodities distributed. For example, Hai Phong reported 750 condoms per FSW per year in 2008; however program monitoring data for this province fluctuates greatly, showing 13 condoms per FSW per year in 2007 and 19 condoms per FSW per year in 2009. Furthermore, the number of peer educators dropped from 82 to 60 between 2006 and 2007 and remained at these levels in 2008. This suggests that program coverage measures in Hai Phong may not be reliable. Condom distribution numbers in Ha Tinh were rounded to the nearest 10,000, suggesting that data are not based on specific counts. And in Dong Nai, the condom distribution numbers in 2007 were reported to be 800 per FSW per year, but only nine FSW peer educators were working during this time, suggesting more than 8500 condoms distributed by each peer educator per month. In these provinces conclusions about coverage and the effectiveness of the program should be drawn carefully.

⁹ Judging the level of achievement in per capita distribution of commodities depends heavily on the choice of the estimated size of FSW or IDU populations. Even among the consensus estimates developed through the 2007 EPP process, a high and low estimate were given. If the low population size estimates were used, then a much larger proportion of provinces would seem to exceed the 240 condoms per capita per year and many more provinces would also have distributed more than 200 needle-syringes per IDU. At the same time, using these lower numbers for population size estimates also results in unexpectedly high levels of commodity distribution, which appear unrealistic. For example, more than a third of the provinces would have distributed more than 1000 condoms per FSW estimated per year. It may be more likely that the actual population size estimate lies between these two extremes. Using the high population size estimates provides a more conservative and measured assessment of program achievements. But until more reliable and robust size estimates become available, it is difficult to come to a definitive conclusion.

A smaller number of provinces achieved high levels of needle-syringe distribution per IDU. Seven of the 32 donor supported provinces distributed more than 200 needle-syringes per IDU per year; all seven of these provinces had total or partial DFID support. Only two provinces with WB-only support (Yen Bai and Vinh Long) distributed more than 100 needle-syringes per IDU in a given year.

From a national perspective, it is useful to examine whether program coverage is high in areas with the most severe epidemics, i.e. where the numbers of FSW and IDU are the largest or where HIV prevalence is at high levels among these populations. For example, HCMC has the largest size of FSW and IDU, but relatively low levels of per capita condom (84 per FSW in 2009) and needle-syringe distribution (32 per IDU in 2008). Over time, free commodity distribution in HCMC has increased steadily, but this low level of coverage reflects the challenges of reaching such a large population, and understanding how best to achieve coverage with a large array of service providers. In contrast, Hanoi appears to have achieved much higher levels of condom and needle-syringe distribution despite its large numbers of FSW and IDU. Factors that allow some provinces (e.g. Hai Phong and Thanh Hoa) to distribute high numbers of needle-syringes to large populations of IDU may be helpful for increasing coverage in other critical provinces.

Table 4 provides a summary of the levels of coverage of the provinces (that have harm reduction programs) with more than 6000 IDU or 2000 FSW.

Table 4: Estimated per-capita distribution of needle-syringes and condoms to IDU and FSW.

	Estimated IDU size (2008)	N/S per IDU (year*)	Estimated FSW size (2008)	Condom per FSW (year*)
HCMC	34,000	16(2008)	30,000	28 (2009)
Hanoi	37,900	113 (2008)	4800	210 (2008)
Son La	28,000	5 (2009)	1100	59 (2009)
Bac Giang	8636	58 (2008)	800	218 (2009)
Hai Phong	8300	203 (2008)	3000	750 (2008)
Thanh Hoa	8200	251 (2008)	1500	500 (2007)
Nghe An	6700	65 (2008)	1400	270 (2009)
Lang Son	6000	124 (2008)	300	777 (2007)
Tay Ninh	2800	82 (2008)	3000	29 (2009)
An Giang	2200	106 (2008)	2400	286 (2009)

*the year in which the highest level of per capita condom distribution was achieved.

Provinces are in order of the largest IDU populations. Bold numbers highlight those provinces where distribution exceeded the target. Cells shaded in grey indicate provinces with less than 6000 IDU or 2000 FSW.

Another issue to consider in interpreting per capita calculations of needle-syringe distribution is the stability of the population size. For example, calculations of per capita needle-syringe distribution in HCMC are further complicated due to a change in the policy for detention of IDU in 06Centers, which resulted in large numbers of IDU being released into the community over the time period of the assessment. Size estimates of IDU, forming the denominator of the per capita estimates, were taken from 2008 data and do not reflect a growing IDU population. These large fluctuations in the size of the IDU population that need services in the community may also be present in other provinces.

3. How consistent are levels of program coverage with trends in HIV prevalence among FSW and IDU?

Baseline HIV prevalence: Among FSW, sentinel surveillance results suggest that in a majority of provinces where data are available, HIV prevalence remains low to moderate (i.e. below or near 5%). In Dong Nai, Nghe An and Binh Duong raw sentinel surveillance measures have exceeded 5% more than once. In large cities such as Hanoi, HCMC, An Giang, and Can Tho HIV prevalence among FSW ranges between 10 and 20% and is even higher in Hai Phong.

Among IDU, HIV prevalence levels are generally considerably higher than for FSW, ranging between 20 and 40%. However, in Dong Thap and Thua Thien Hue, HIV prevalence among IDU remains relatively moderate, at around 10% or below. The crude prevalence trends among IDU fluctuate substantially over time, and are more likely to reflect the difficulty in obtaining systematic, comparable samples over time, rather than representing actual fluctuations in prevalence among the IDU group. Nonetheless, in some provinces steep declines in HIV prevalence have been measured from sentinel surveillance among IDU, often starting in 2001 or 2003.

Comparing trends in HIV prevalence to timing of program coverage scale-up: There are 18 provinces for which there are both sentinel surveillance trend data and program coverage estimates (a further 10 provinces have harm reduction programs but insufficient data to assess

whether there is evidence for a relationship between program coverage and impact on the HIV epidemic because of unreliability of biological trends).

In eight provinces, more than 200 condoms per FSW were distributed for free by the end of the 2009 and a declining or low/stable HIV prevalence trend was observed (Table 5). This is consistent with the notion that condom distribution helped to maintain stable HIV prevalence among FSW. However, other provincial patterns suggest only a weak association between high condom distribution and positive effects on the HIV prevalence trend. For example, in five provinces low/stable prevalence trends remained, despite much lower levels of condom distribution. In two provinces, including HCMC, HIV prevalence trends declined despite low condom distribution. Some explanations for this inconsistency in pattern include that size estimates for FSW in these provinces are too high; that FSW who have particularly high risk for HIV transmission/acquisition are well targeted and benefiting from either free condom distribution or socially marketed condoms; or that a larger proportion of condoms used during paid sex are purchased by clients of sex workers. Despite high levels of condom distribution in Binh Thuan and Hai Phong, the sentinel surveillance data showed slight increases in HIV prevalence measured among FSW. As discussed in the previous section, per capita condom distribution is relatively high in these two provinces, suggesting that some data for calculating this indicator may be unreliable and condom coverage may not be as high as program data suggest.

Table 5: Categorization of provinces according to levels of per-capita condom distribution among FSW compared with HIV prevalence trends.

Annual program distribution level	HIV prevalence trend		
	Declining	Low/Stable	Increasing
>500 condoms per FSW		Nam Dinh (1185) Lang Son (777) Ha Tinh (718) Soc Trang (638)	Binh Thuan (1150) Hai Phong (750)
200-500 condoms per FSW	An Giang (286)	Vinh Long (327) Bac Giang (218) Hanoi (208)	
<200 condoms per FSW	Quanh Ninh (165)	Da Nang (187) Kien Giang (154)	Thai Nguyen (50)

	HCMC (28) Thua Thien – Hue (117) Ba-Ria Vung Tau (68) Can Tho (68)	
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Provinces with insufficient information: Dong Nai, Tay Ninh, Dong Thap, Ben Tre, Cao Bang, Lai Chau, Nghe An, Son La, Khah Hoa, Thanh Hoa.

The red text indicates provinces for which the trend in prevalence precedes the increase in program coverage. Values in parenthesis indicate the highest level of condom distribution per FSW per year measured.

The correlation between HIV prevalence trends and commodity distribution is stronger among IDU than for FSW. Twelve of the 19 provinces with sufficient data show relatively high levels of per capita needle-syringe distribution (i.e. >100 needle-syringes per IDU) and corresponding stable or declining prevalence trends. While these patterns are consistent, many of the provinces in this grouping observed declines in prevalence prior to the scale-up of interventions and commodity distribution (highlighted in the table in red). Five provinces show similar declines or stabilization in trends with less than 100 needle-syringes distributed per IDU. Thanh Hoa shows continually increasing HIV prevalence trends despite more than 250 needle-syringes distributed per IDU in 2008.

Table 6: Categorization of provinces according to levels of per-capita needle-syringe distribution among IDU compared with HIV prevalence trends. (

Annual program distribution level	HIV prevalence trend		
	Declining	Stable	Increasing
>200 needle-syringes per IDU	Nam Dinh (315) Kien Giang (292) Soc Trang (234) Hai Phong (203)	Can Tho (246)	Thanh Hoa (251)
100-200 needle-syringes per IDU	Vinh Long (133) Binh Thuan (129) Lang Son (124) Hanoi (113)	Ha Tinh (153) Thua Thien-Hue (107) An Giang (106)	
<100 needle-syringes per IDU	Khanh Hoa (90) Ba-Ria Vung Tau (79)	Nghe An (65) Bac Giang (58) HCMC (16)	Thai Nguyen (81)

Provinces with insufficient information: Quanh Ninh, Dong Nai, Tay Ninh, Dong Thap, Ben Tre, Cao Bang, Hau Giang, Lai Chau, Son La, Yen Bai, An Giang, Da Nang.

The red text indicates provinces for which the trend in prevalence precedes the increase in program coverage. Values in parenthesis indicate the highest level of N/S distribution per IDU per year measured)

The weaker relationship between free condom distribution and prevalence trends among FSW may also be due to the large number of socially marketed condoms available in many provinces. Condom social marketing data for some provinces is available from the VAAC central database and may reflect the portion targeted for use during commercial sex acts. These data suggest that the number of socially marketed condoms sold may have resulted in total condom numbers that were two to five times higher than the number of reported free condoms distributed.¹⁰ High distribution of socially marketed condom took place in several provinces where low free per capita distribution was reported but declines in prevalence were observed among FSW in sentinel surveillance data (i.e. in An Giang, Quanh Ninh, and HCMC).

Conclusion of ecological analysis

Overall, the ecological analysis of the effect of commodity distribution in HIV prevalence trends is mixed. This is partly due to both the general declines/stable HIV prevalence trends observed among FSW and IDU, which often began prior to 2006. It could also be due to instability in both the measures of HIV prevalence trends through sentinel surveillance as well as in the calculation of per capita commodity distribution. The ecological association between commodity distribution and prevalence trends is stronger for IDU populations than for FSW.

A key limitation of this analysis is the reliance on a few measures of program performance, i.e. commodity distribution. These measures were the only types of data available for the entire period of the program assessed and in a majority of provinces. Using per capita commodity distribution as a measure of program coverage is that it is not sensitive to the actual number of IDU or FSW who may be reached by free distribution. The impact on the epidemic may be quite different if a large number of commodities reached a few people, compared to the same number distributed to a large proportion. Data from the 2009 IBBS survey indicates that overall 47% of FSW and 15% of IDU reported being reached by HIV prevention interventions. These relatively low levels of coverage suggest that even if high levels of commodities are distributed, a large number of key populations at higher risk for HIV infection may not benefit from these services.

¹⁰ According to the DFID project final report, more than 170 million condoms were distributed through social marketing in the 21 project provinces between 2005 and 2008, which is 30 times the volume distributed free through peer educators. However, not all of these socially marketed condoms were targeted for HIV or STI prevention, i.e. for high-risk sex acts.

These data suggest that the coverage of key populations at higher risk as measured by per capita commodity distribution could over-estimate the potential impact made on reducing HIV transmission.

The risk behavior and size of the network among key populations are also diverse. This has implications for disproportionate transmission risks for different people. Future analysis may consider further segmenting the population of key populations into higher-risk and lower-risk groups, and considering levels of coverage and per capita commodity distribution among these subgroups to better assess its effect on the epidemic.

Mathematical modeling to evaluate the epidemiological impact of harm reduction programs

Methods

A standard population-level mathematical transmission model [1] was developed to describe HIV epidemics in Vietnam. The Vietnam HIV Model (VHM) was developed in a manner to be specifically customized to represent the unique situation in Vietnam and to evaluate harm reduction programs that have been implemented. The VHM accounts for various population groups at risk of HIV infection (Figure 5) and the different extents of HIV infection in these groups. Change in categorization of people in the model is incorporated through rates in which people from one population group may transition to be represented by another population group (e.g. 'Male IDUs' may stop injecting and become 'General males' or vice-versa); see Technical Annex 3 for details. The VHM describes sexual and injecting related transmission of HIV. Sexual mixing occurs across population groups and the model ensures conservation of partnerships; that is, the total number of partnerships that general males have with general females is equivalent to the total number of partnerships that general females have with general males, when adjusted across dynamic population sizes.

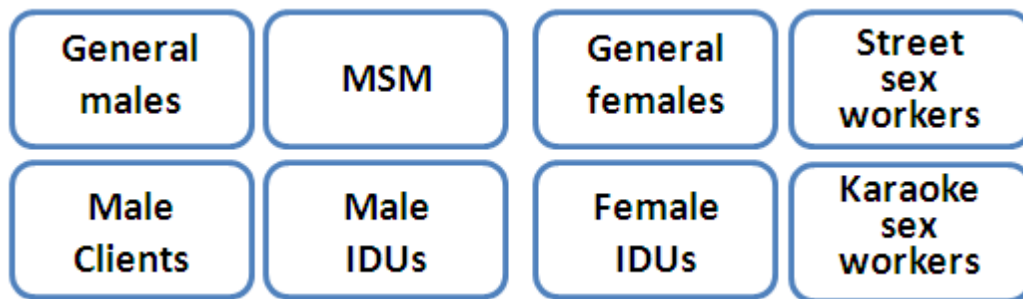


Figure 5: Population groups included in the VHM

The VHM describes the changes over time in the epidemics as a whole and among each population group. For each population group, the VHM:

- tracks the rate at which uninfected people become infected with HIV;
- differentiates between people who have been diagnosed with their infection through HIV testing and those for whom it remains unrecognized;
- tracks the rate of disease progression to late-stage infection and treatment-eligibility and subsequently the number of people who receive antiretroviral therapy.

These stages are illustrated in Figure 6.

Each disease stage is associated with a different viral load and hence a different level of infectiousness [2, 3]. Effective antiretroviral therapy (ART) substantially improves survival rates and decreases the likelihood of transmitting the virus (by 92% on average [4, 5]). Although this is dependent on the level of adherence to therapy [6, 7], adherence levels of individuals and their impact on viral suppression are not explicitly modeled but the average population-level impact of treatment is included [8-10].

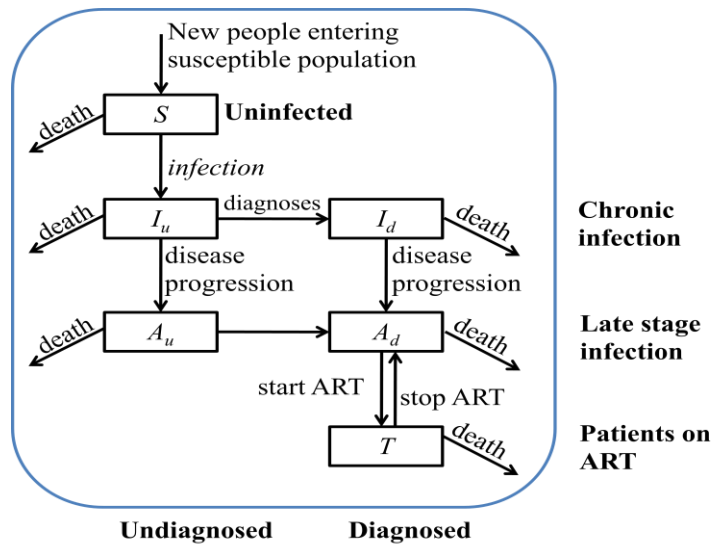


Figure 6: Schematic diagram of the structure of the natural history of infection in the VHM

Mathematical description of VHM

Mathematically, the VHM is described by 48 ordinary differential equations, one for each of the eight population group (Figure 5) multiplied by one for each of the six disease states (Figure 6); the equations are developed according to standard disease modeling [1] and are presented in Technical Annex 2.

The annual per-capita risk of acquiring HIV infection per uninfected person in each population group, known as the 'force of infection', estimates the average rate of infection through both sexual and intravenous transmissions. Sexual transmission risk depends on:

- the number of people in each HIV-infected stage (that is, the prevalence of infection in the population of partners)
- the average number of casual and regular homosexual and heterosexual partnerships per person
- the average frequency of sexual acts per partnership
- the proportion of these acts in which condoms are used, and
- the efficacy of condoms.

The stage of infection (chronic, AIDS/late stage, or on treatment) for the HIV-positive partner in a serodiscordant couple also influences transmission risk due to different levels of infectiousness in each infection stage.

Intravenous transmission risk depends on:

- the number of injecting partners per person per year
- frequency of injecting per year
- frequency of sharing injecting equipment
- percentage of shared syringes that are cleaned before re-use, and
- the efficacy of cleaning injecting equipment.

Mathematically, the force of infection is expressed by standard mathematical risk equations that combine the specific risk behaviors and their frequencies with biological risk probabilities per exposure event and the epidemiology of chance of contact with infected partners to quantify the average per-capita risk of acquiring infection for a given person in each of the defined population groups. These calculations are carried out dynamically to track the evolution of epidemic trajectories. The mathematical equations for the force of infection have been described in detail elsewhere [11] and we also present them in Technical Annex 2.

Provinces evaluated with the VHM

In consultation with partners at the Vietnam Administration of HIV/AIDS Control (VAAC), the Vietnam Strategic Information and Monitoring and Evaluation Technical Working Group, UNAIDS Vietnam, the World Bank, and other stakeholders, available epidemiological, behavioral and program-specific data were reviewed in order to determine which Vietnamese provinces would be applied to the VHM. The selection criterion was that provinces would be included if data were availability on program distribution and key risk-related behavior before and after the implementation of the programs (with minimal requirement of condom usage and syringe sharing rates), as well as population size estimates. Based on this, it was decided that the VHM would be applied to evaluate the harm reduction programs carried out in An Giang, Can Tho, Dien Bien, Hai Phong, Ha Noi, Da nang and HCMC (Figure 7).

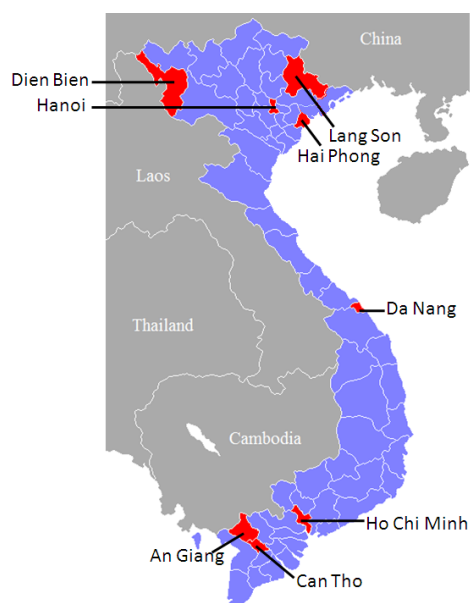


Figure 7: Map of the Vietnamese provinces evaluated by the VHM

The provinces selected include the five largest metropolitan areas in Vietnam (HCMC, Hanoi, Hai Phong, Can Tho and Da Nang) and represent a diverse set of epidemic contexts and geographic regions. For example, mega-cities such as HCMC and Hanoi, as well as Hai Phong, comprise large portions of the IDU and FSW population. An Giang and Can Tho have moderate sized key populations at higher risk for HIV infection of about equal size. However, in Can Tho the IDU epidemic appears to have flattened at a high saturation point, and in An Giang declines in HIV prevalence are seen among IDU sentinel surveillance. Dien Bien is believed to have very high numbers of IDU at high levels of prevalence, but fairly small FSW populations at moderate to low prevalence. Da Nang appears to have a relatively low level epidemic with small to moderate sized key populations at higher risk. Six of the seven provinces are supported by US government prevention funds. Can Tho, Da Nang and Ha Noi had DFID but no WB program support for harm reduction. An Giang, Hai Phong, and HCMC have both DFID- and WB-supported programs. Dien Bien relies primarily on national program support for harm reduction but received international donor support for needle/syringe distribution beginning in 2008 from the Australian government. A complete list of all model inputs and parameters used in the VHM for each province is provided in Technical Annex 3; this also contains a list of province-independent biological and clinical parameters that were used by the model. The main sources of province-specific data were:

- 2000 HIV/AIDS Behavioral Surveillance Survey (2000 BSS) [1];
- 2002 Baseline Survey Report [2];
- 2005 HIV/STI Integrated Biological and Behavioral Surveillance (2005-2006 IBBS) [3];
- 2005 Vietnam Population and AIDS Indicator Survey (VPAIS) [4];
- 2007 MOLISA Data for population size estimates [5], consistent with the ecological analyses;
- Sentinel Surveillance Data from across all provinces.

All provinces included in the modeling analysis had unique epidemiology of prevalence trends, population size distributions, and some behavioral factors. Data were generally available for the most important risk-related factors for each specific province; where data were not available for a particular parameter for a specific region, parameter values are assumed based on averages

across other provinces or other comparable settings (see Technical Annex 4 for detailed information on all data, assumptions and inputs used in all provinces). Biological parameters (e.g. the probability of HIV transmission per discordant sexual act and the rate of disease progression) were assumed to be the same across all provinces. Strengths and weaknesses of the data available for use in the VHM are discussed in Technical Annex 3.

Harm reduction intervention data

The calibrated VHM for each province was used to evaluate the impact of harm reduction programs in the period 2005-2009. Most harm reduction programs in Vietnam were implemented by multiple organizations in different provinces. Intervention data for the total number of free condoms distributed and total number of free needle-syringes distributed in each province were collated across implementation partners (Figure 8, Figure 9).

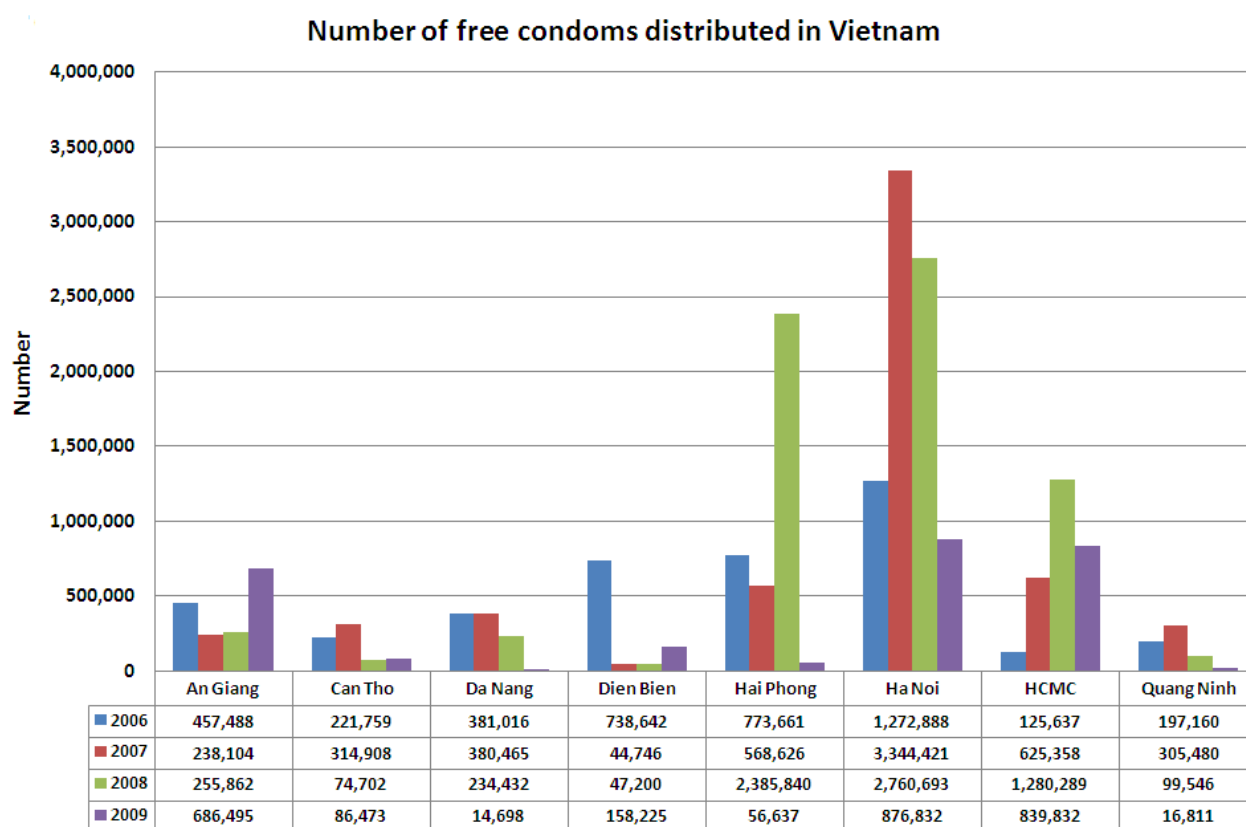


Figure 8: Number of free condoms distributed through harm reduction programs among Vietnamese provinces

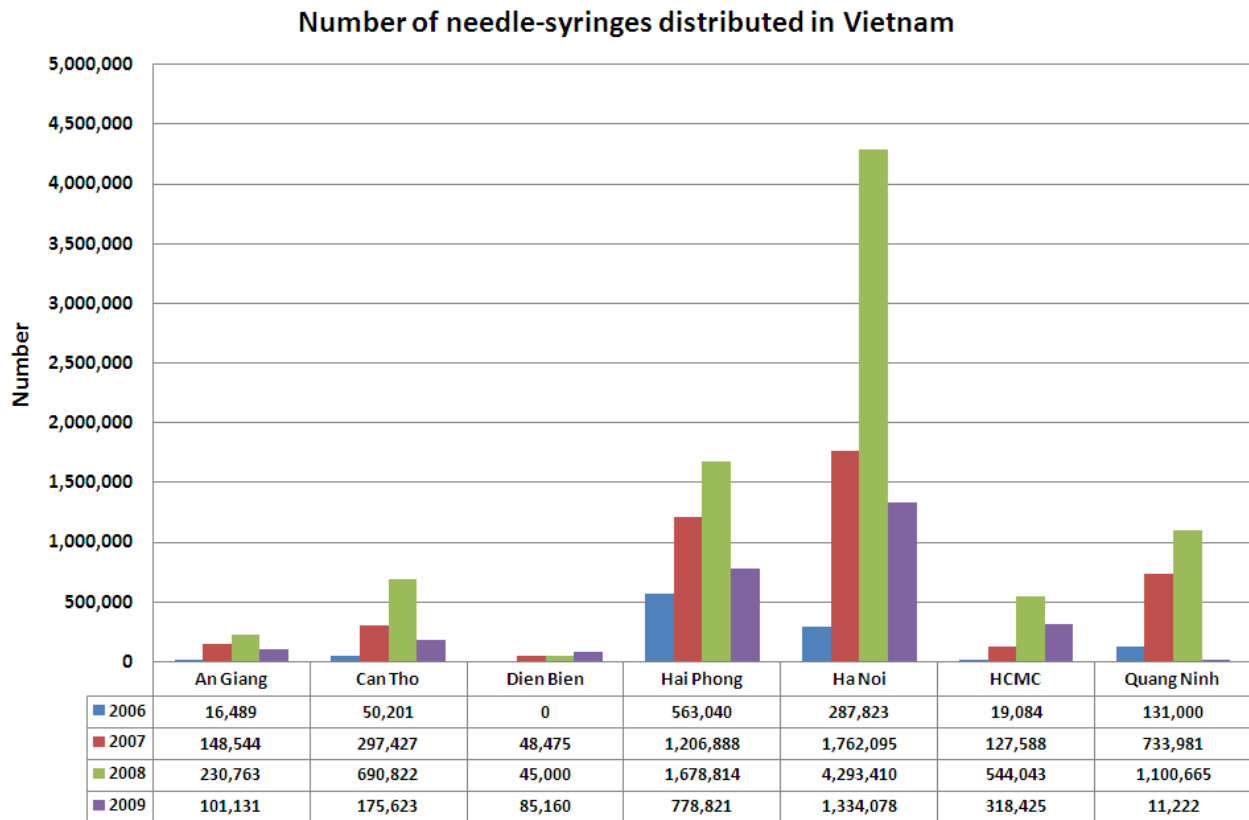


Figure 9: Number of syringes distributed through harm reduction programs among Vietnamese provinces

Evaluating the impact of harm reduction programs

Approach to evaluate impact of programs: Calculate how risk behavior (frequency of syringe sharing and unprotected sex) would likely have been different in the absence of the distribution of condoms and needle-syringes, assuming the total number of injecting/sexual events is unchanged. Here, a mathematical relationship informs how sharing rates/condom usage change with the total number of needle-syringes/condoms distributed to the population (see Technical Annex 2). The VHM is simulated under observed behavior-epidemiological trends and according to levels of risk behavior that would have been expected had the harm reduction programs not distributed condoms and needle-syringes. The difference in the outcomes of these simulations determines the overall impact of the programs. A schematic diagram of this approach is in Figure 10.

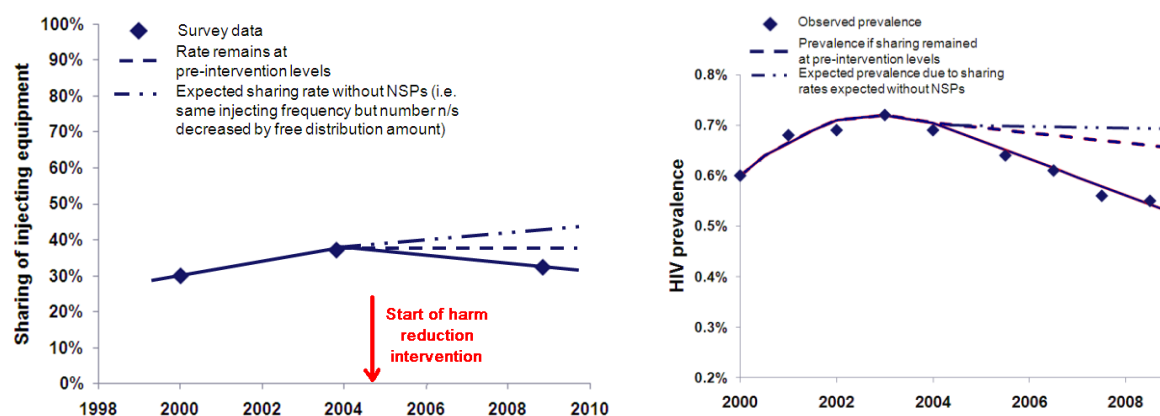


Figure 10: Schematic diagram of behavioral trends and corresponding change in prevalence trajectories

HIV is transmitted due to risky behavior such as unprotected sex or sharing of injecting equipment. Effective public health programs should result in a decrease in indicators associated with these risk-related behaviors and such change should demonstrate the primary impact of the interventions. However, indicators for levels of risk behavior can be influenced by many circumstances beyond the specific public health interventions. Furthermore, trends in risk-behavior indicators can be biased by many (identifiable and unidentifiable) external factors. Consequently, if observed risk behavior indicators increase then it cannot be concluded that the programs have or have not been effective in influencing some positive change. Indeed, the distribution of needle-syringes and condoms that are effectively used in place of sharing of injecting equipment or engaging in unprotected sex, that would have taken place without the availability of this equipment, can only result in some reductions in HIV transmission. In the current study we apply both approaches of investigating (i) observed behavior change and (ii) the expected influence on behavior of distribution of needle-syringes/condoms, on HIV trajectories. The analysis measures the estimated number of infections averted in the primary target population group as well as the number of secondary infections averted in other population groups due to reductions in transmission in the primary group. The model describes mixing between eight population groups (Figure 5). The secondary impact of harm reduction programs for each population group is shown in the results. For example, primary infections averted among FSW should have a flow-on effect to male clients of FSW and then to general females who have sexual partnerships with male clients of FSW, ultimately also to other general males who partner

with general females and to MSM. Evaluation of secondary infections averted incorporates the ‘transmission chain’ among all eight population groups.

Results

The VHM was applied to the province-specific data of each of the seven modeled provinces and fit to the epidemic trajectories overall and by specific population groups at risk (see Technical Annex 2 for specific values of parameters used in each province). For each province, the number and percentage of averted infections among IDU/FSW (i.e. primary infections) and the total population (i.e. secondary infections) were estimated based on the program coverage levels. The number of infections in the total population is based on the sum of all infections occurring from 2005-2009 among the eight population groups included in the model. Although, no harm reduction program was evaluated for the MSM population, estimates of the number of infections occurring among this group are also presented to indicate the relative urgency of implementing prevention interventions for MSM in different provinces.

The following sections review the results from each province, providing some insights from the modeling about the explanations for the level of effects observed. When reviewing these figures it is important to note that changes in incidence trends, for any epidemic, due to prevention programs may not be clearly reflected in prevalence trends; this is especially true in established epidemics with low mortality rates where the bulk of infections comprising prevalence are long standing infections.

An Giang

Smoothed epidemic curves show that the inflection point of the HIV prevalence trends in An Giang occurred prior to the assessment period. Trends in IBBS behavioral data suggest that needles sharing increased from 29 to 44% over this period. Evaluation of the harm reduction programs in An Giang by the VHM indicated that if the interventions had not been implemented, little difference would have been observed in the trajectories of prevalence in most population groups (Figure 11). This is due, in part because intervention scale-up in terms of condom distribution was very low (~40 condoms per FSW per year), except in 2009. Distribution of needle-syringes has likely reduced the prevalence among injecting drug users to a greater, but still only moderate, degree. This level of effect also reflects the moderate distribution of needle-syringes which was almost 0 in the first two years of the program, and increased to 100 needle-syringes per IDU per year in 2008, before dropping back down to less than 50. Projected epidemic curves among the MSM population appear to be increasing since 2006. The expected numbers of primary and secondary infections averted due to harm reduction programs calculated by VHM are presented in Figure 12.

Model trajectories of HIV prevalence among population groups in An Giang

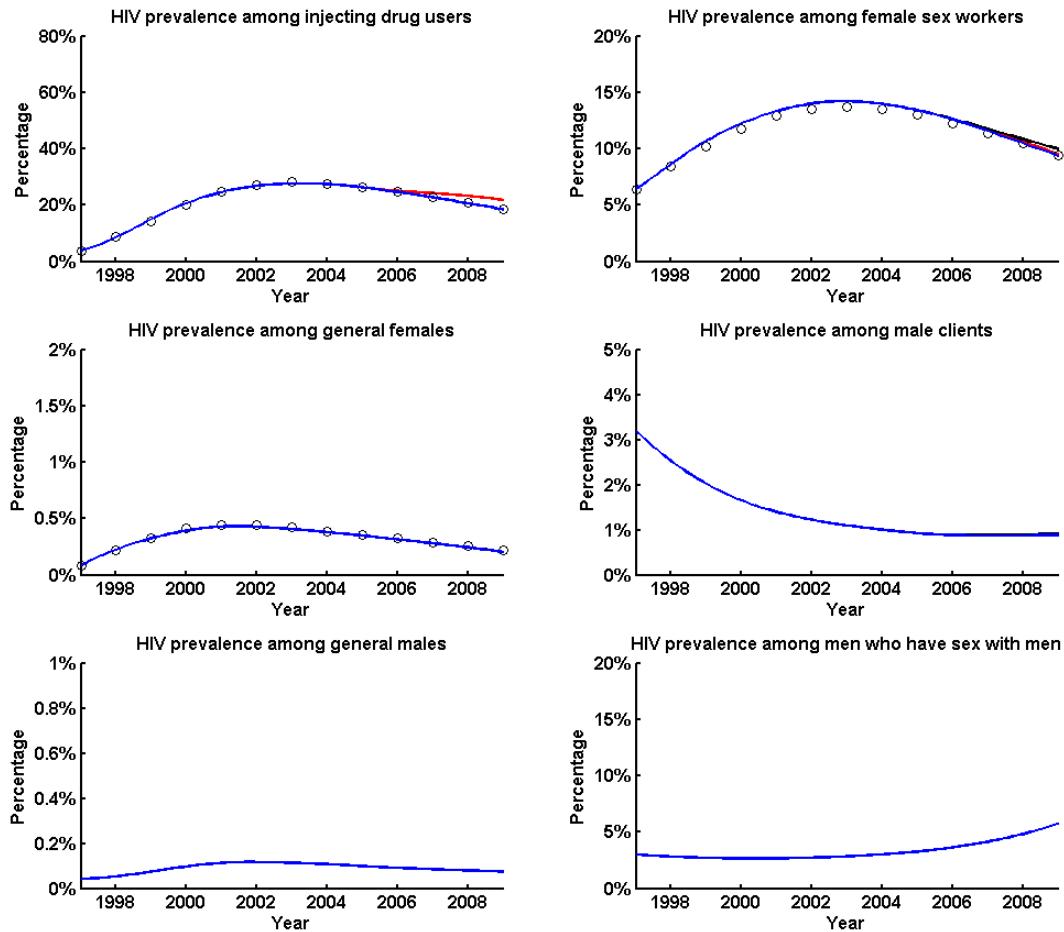


Figure 11: Trajectories of HIV prevalence among IDU, FSW, general females, male clients of FSW, general males, and men who have sex with men in An Giang. Circles represent EPP-fitted curves to available data, the dark blue curves represent the best-fitting VHM simulation, the red and black curves represent VHM-simulated trajectories under the scenarios that needle-syringes and condoms were not distributed, respectively.

Estimated impacts of N/S and condom distribution in An Giang during 2005-2009

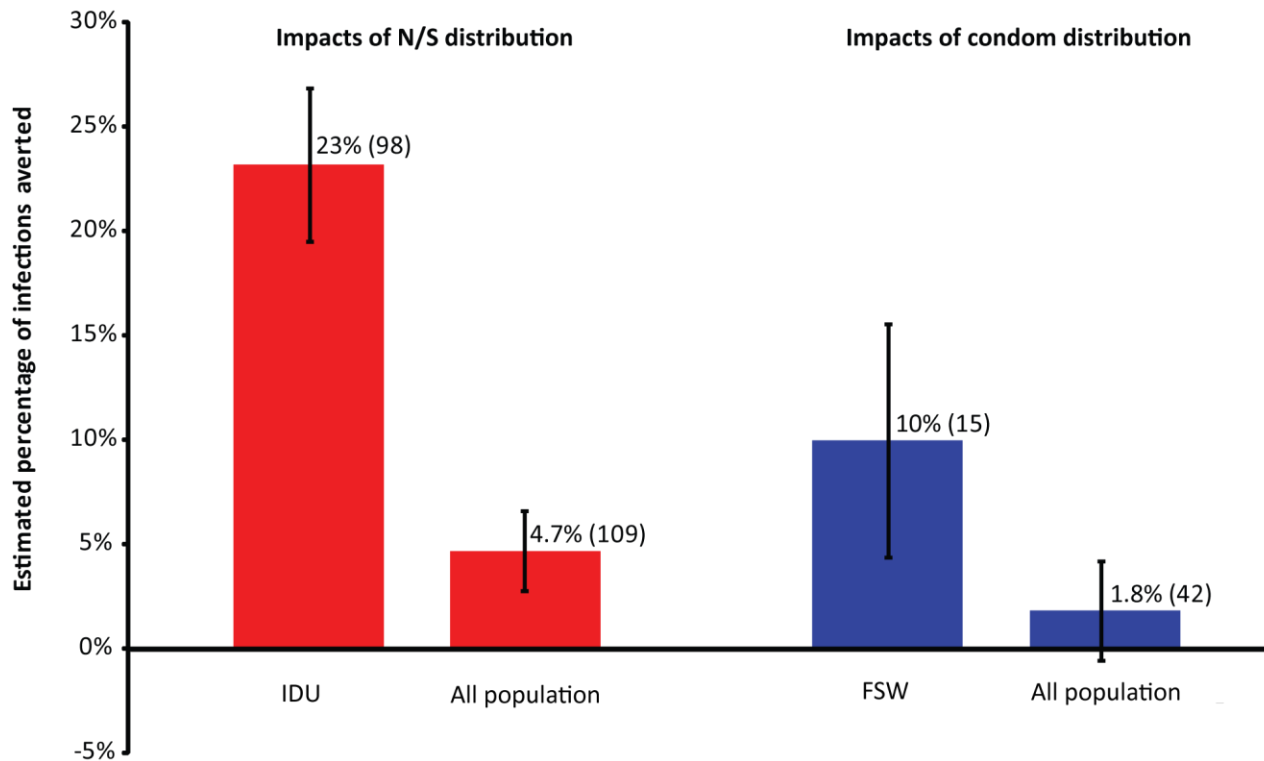


Figure 12: Estimated percentage of infections averted (number of cases averted) over the five-year period, 2005-2009, among IDU, FSW and the entire population based on simulations of the VHM for An Giang. Estimates are based on comparison of the observed HIV epidemic trajectory with the simulated trajectory according to expected risk behavior without distribution of needle-syringes/condoms over the period 2005-2009. Error bars refer to standard deviation of model outputs.

- Distribution of needles-syringes among IDU in An Giang were estimated to avert 98 infections (23% of infections) among IDU, and another 11 infections from other population groups (4.7% of all infections in the total population) between 2005-2009.
- Distribution of condoms among sex workers in An Giang were estimated to avert 15 infections (10%) among sex workers and a further 27 'onward' infections, primarily among clients and regular partners of clients.
- Moderate levels of averted infections are predominantly the result of low-to-medium program coverage; the average number of needle-syringes distributed per IDU was much lower than the target threshold and while the average number of condoms per sex worker approached the target, it was not achieved over the full term of the intervention.

Can Tho

Epidemic trends in Can Tho suggest a mature epidemic among both IDU and FSW, which reached its peak just prior to the assessment period. Trends in behavioral data in this province showed increasing sharing of injecting equipment and reduction in condom use between IBBS rounds. Needle-syringe distribution in this province has been moderately high, reaching greater than 100 needle-syringes per IDU in 2007 and almost 250 per IDU in 2008. Evaluation of the harm reduction programs in Can Tho by the VHM indicated that if the needle-syringe interventions had not been implemented there could well have been a further significant rise in prevalence, and a large absolute number of new infections among injecting drug users and this would have had a flow-on effect to female sex workers and to a small degree among other females (Figure 13). Condom distribution has had little effect on prevalence, in part because levels of distribution were fairly low (average of ~50 condoms per FSW per year). Rapidly escalating prevalence projected among MSM in this province also underscores a missed opportunity for averting infections among this group through prevention interventions. The VHM was used to calculate the expected number of primary and secondary infections averted due to harm reduction programs (see Figure 14).

Model trajectories of HIV prevalence among population groups in Can Tho

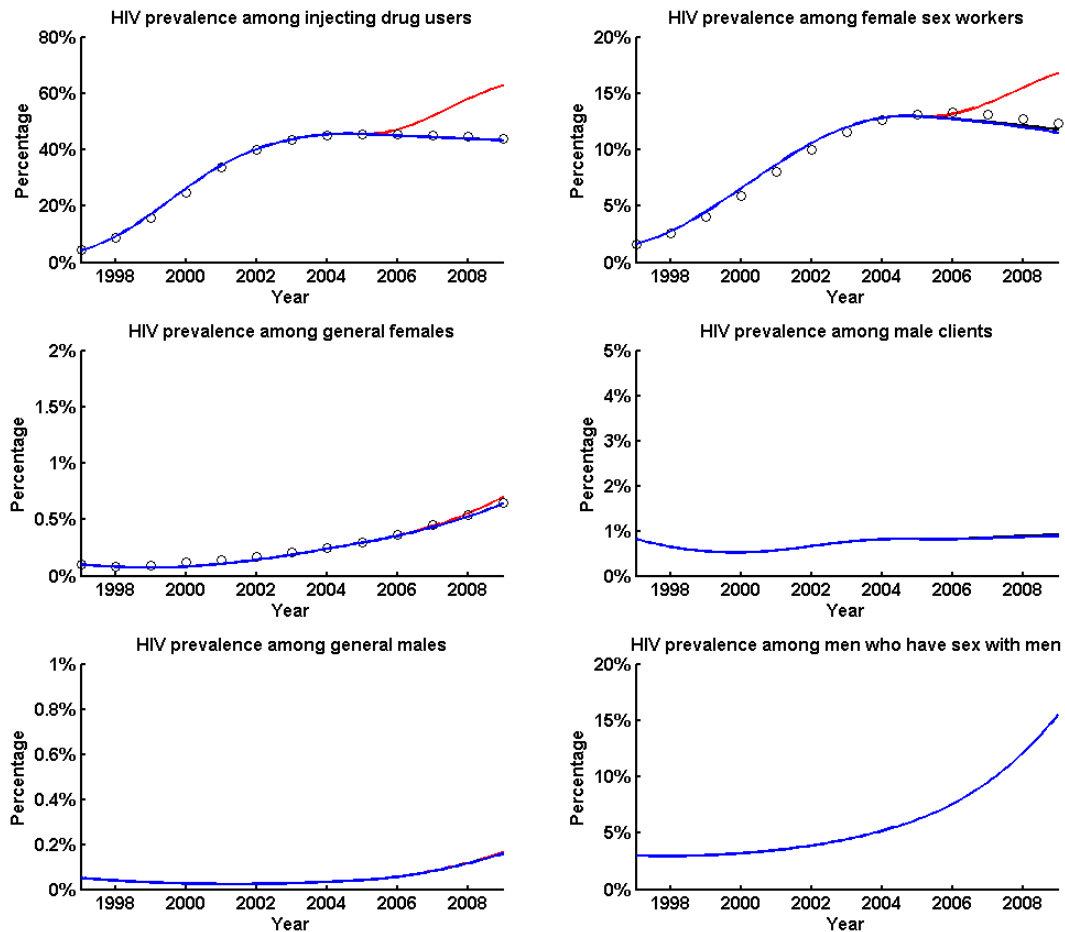


Figure 13: Trajectories of HIV prevalence among IDU, FSW, general females, male clients of FSW, general males, and men who have sex with men in Can Tho. Circles represent EPP-fitted curves to available data, the dark blue curves represent the best-fitting VHM simulation, the red and black curves represent VHM-simulated trajectories under the scenarios that needle-syringes and condoms were not distributed, respectively.

Estimated impacts of N/S and condom distribution in Can Tho during 2005-2009

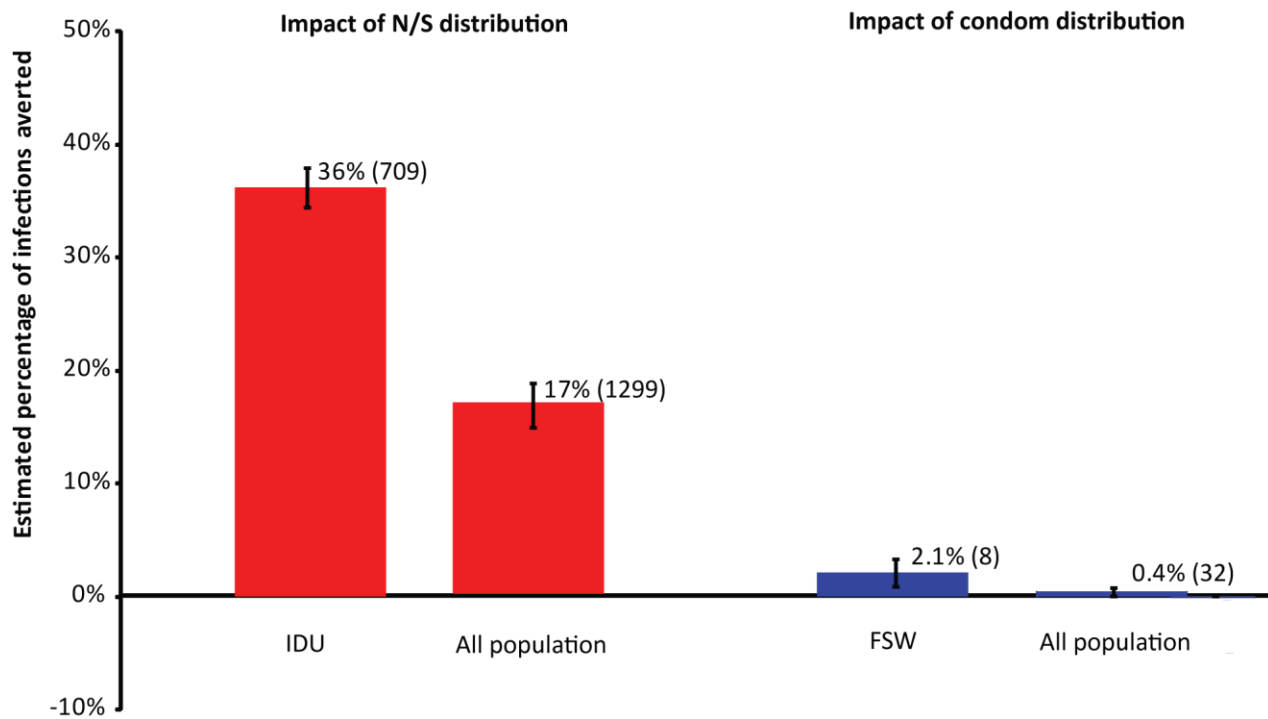


Figure 14: Estimated percentage of infections averted (number of cases averted) over the five-year period, 2005-2009, among IDU, FSW and the entire population based on simulations of the VHM for Can Tho. Estimates are based on comparison of the observed HIV epidemic trajectory with the simulated trajectory according to expected risk behavior without distribution of needle-syringes/condoms over the period 2005-2009. Error bars refer to standard deviation of model outputs.

- Distribution of needles-syringes among IDU in Can Tho were estimated to avert 709 infections (36% of infections) among IDU; and another 590 infections from other population groups (17% of all infections in the total population) between 2005-2009.
- Distribution of condoms among sex workers in Can Tho were estimated to avert 8 infections (2%) among sex workers and a further 24 'onward' infections, primarily among clients and regular partners of clients.
- Moderate levels of averted infections are predominantly the result of low-to-medium program coverage; the average number of needle-syringes distributed per IDU was approximately half the target threshold and the average number of condoms per sex worker was less than half the target level.

Da Nang

Compared to other provinces in the modeling exercise, Da Nang's epidemic trajectory appeared to have greatly declined among IDU and remained very low among FSW. As expected, evaluation of the harm reduction programs in Da Nang by the VHM indicated that the interventions had negligible impact on prevalence trends (Figure 15). The lack of IDU harm reduction programs in Da Nang and small-scale FSW interventions suggests other factors in place which have prevented the spread of HIV in this province. Mild increases in prevalence are projected for the MSM population and it may be useful for programs to explore whether there is a need of intervention among this group. The expected numbers of primary and secondary infections averted due to harm reduction programs calculated by VHM are presented in Figure 16.

Model trajectories of HIV prevalence among population groups in Da Nang

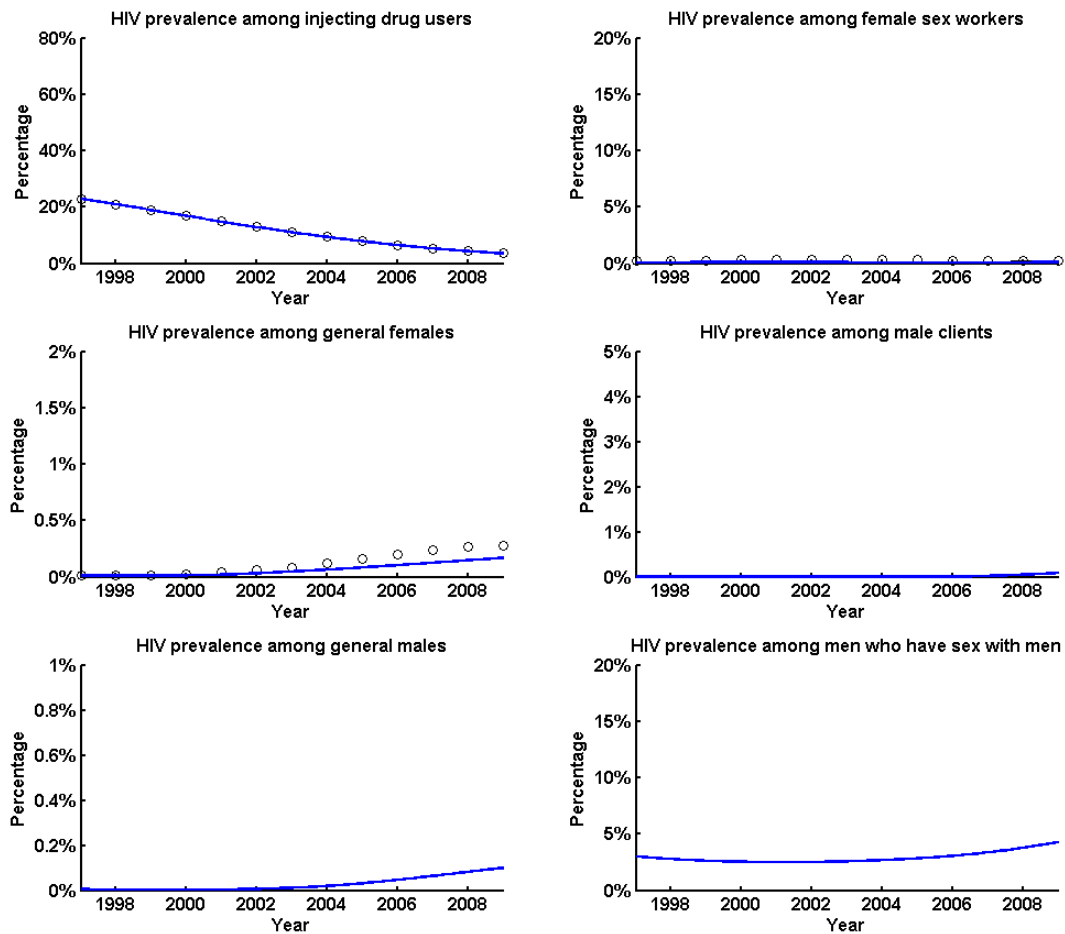


Figure 15: Trajectories of HIV prevalence among IDU, FSW, general females, male clients of FSW, general males, and men who have sex with men in Da Nang. Circles represent EPP-fitted curves to available data, the dark blue curves represent the best-fitting VHM simulation, the red and black curves represent VHM-simulated trajectories under the scenarios that needle-syringes and condoms were not distributed, respectively.

Estimated impact of N/S and condom distribution in Da Nang during 2005-2009

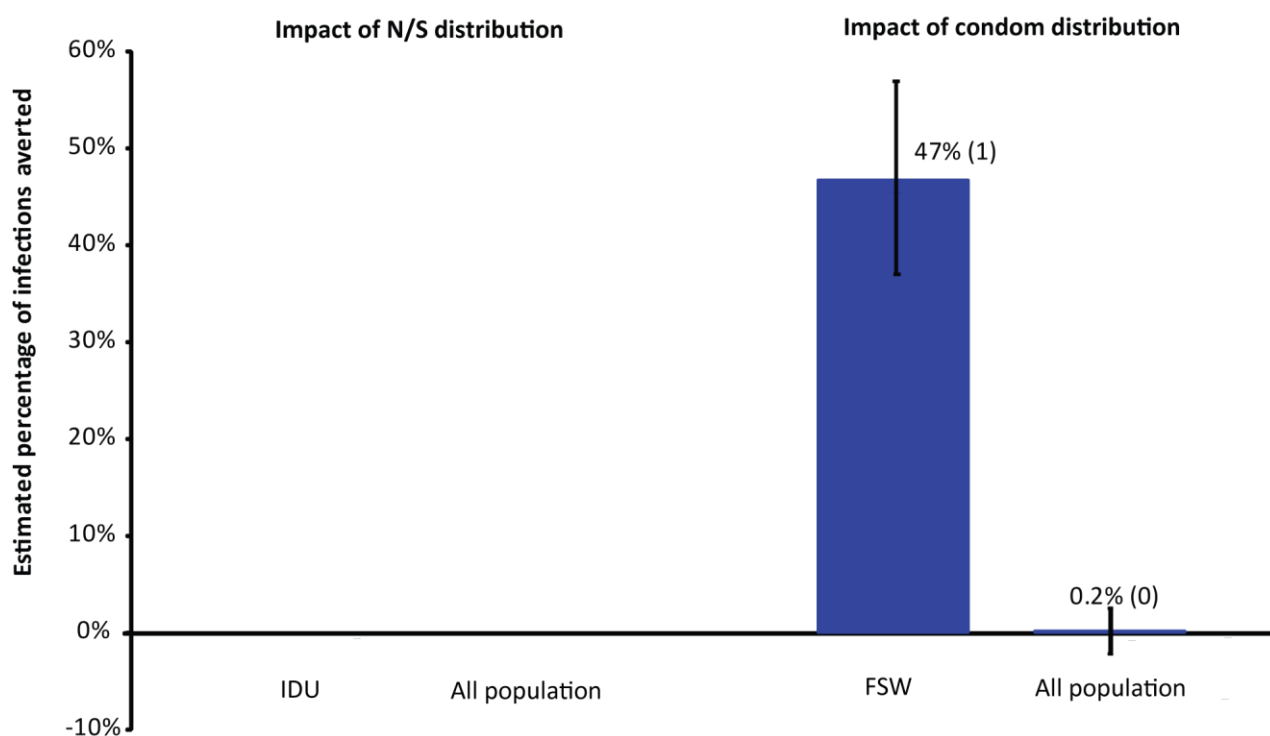


Figure 16: Estimated percentage of infections averted (number of cases averted) over the five-year period, 2005-2009, among IDU, FSW and the entire population based on simulations of the VHM for Da Nang. Estimates are based on comparison of the observed HIV epidemic trajectory with the simulated trajectory according to expected risk behavior without distribution of needle-syringes/condoms over the period 2005-2009. Error bars refer to standard deviation of model outputs.

- Needle-syringe programs were not implemented in Da Nang over 2005-2009, so the effect of program was not measurable.
- Distribution of condoms among sex workers in Da Nang was estimated to avert 1 infection (~47%) among sex workers and no noticeable 'onward' effect to other population groups.
- There are relatively small numbers of IDUs and FSWs at moderately low risk of HIV infection. Nil-to-little program coverage in Da Nang for IDUs could be increased; the coverage of condoms over the small number of FSWs appears to be adequate.

Dien Bien

Despite its relatively small size, very large numbers of IDU are reported to be in Dien Bien. Epidemic curves suggest that the IDU epidemic lagged behind most of the other provinces. The small population of FSW in Dien Bien appears to have experienced low but increasing prevalence of HIV over the period of the assessment. Interventions in Dien Bien have been supported primarily by the government, with a late influx of international donor support for needle-syringe programs in 2008. Evaluation of the harm reduction programs in Dien Bien by the VHM indicated that if the needle-syringe interventions had not been implemented there could have been a moderate increase in prevalence among injecting drug users, rather than stabilization, and this would have had a flow-on effect of higher prevalence among the general female population (Figure 17). Similarly, appropriate levels of condom distribution to the relatively small population of FSW has likely reduced the extent of rise in prevalence in this group and had a secondary impact on their male clients. The curve for MSM remains low and stable for Dien Bien compared to other provinces; this is due to less risk behavior and mixing compared to other regions (based on available behavioral data on mixing within and between population groups and the optimization-reconciliation routine). The expected numbers of primary and secondary infections averted due to harm reduction programs as calculated by VHM are in Figure 18.

Model trajectories of HIV prevalence among population groups in Dien Bien

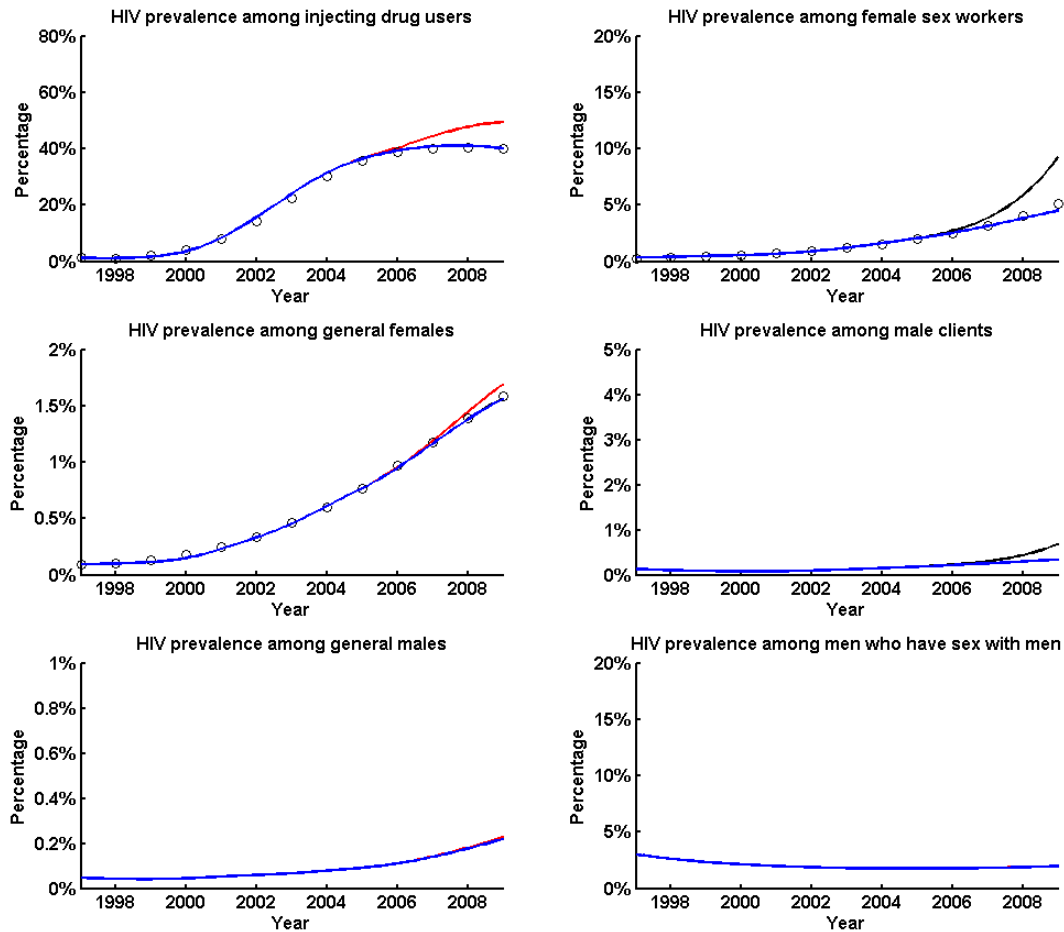


Figure 17: Trajectories of HIV prevalence among IDU, FSW, general females, male clients of FSW, general males, and men who have sex with men in Dien Bien. Circles represent EPP-fitted curves to available data, the dark blue curves represent the best-fitting VHM simulation, the red and black curves represent VHM-simulated trajectories under the scenarios that needle-syringes and condoms were not distributed, respectively.

Estimated impact of N/S and condom distribution in Dien Bien during 2005-2009

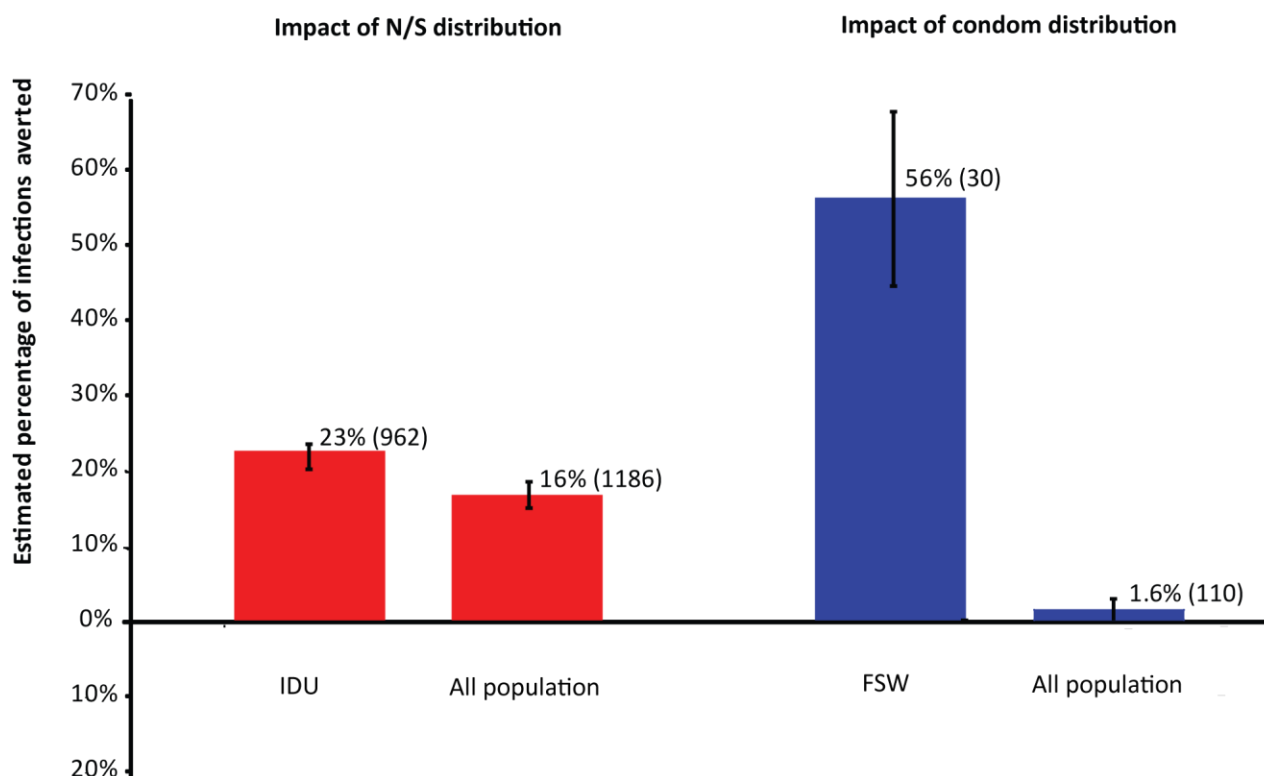


Figure 18: Estimated percentage of infections averted (number of cases averted) over the five-year period, 2005-2009, among IDU, FSW and the entire population based on simulations of the VHM for Dien Bien. Estimates are based on comparison of the observed HIV epidemic trajectory with the simulated trajectory according to expected risk behavior without distribution of needle-syringes/condoms over the period 2005-2009. Error bars refer to standard deviation of model outputs.

- Distribution of needle-syringes among IDU in Dien Bien were estimated to avert 962 infections (23% of infections) among IDU; and another 224 infections from other population groups (16% of all infections in the total population) between 2005-2009.
- Distribution of condoms among sex workers in Dien Bien were estimated to avert 30 infections (56%) among sex workers and a further 80 'onward' infections, primarily among clients and regular partners of clients.
- Coverage among IDU was very low over the period 2005-2009. The moderate reduction in infections is mainly due to the IDU population size. It is important for coverage of needle-syringes among IDU to increase in Dien Bien. Coverage of condoms among FSWs is relatively

high. This has facilitated large success in preventing infections among sex workers. Despite this, behavioral trends need to be addressed.

Hai Phong

Epidemic curves in Hai Phong suggest that it has one of the older and most severe epidemics among IDU, and a steadily increasing epidemic among FSW. Long recognized as an important center of HIV epidemics in Vietnam, interventions in Hai Phong have also been in place prior to the establishment of the WB/DFID interventions. In Hai Phong, levels of sharing among IDU rose slightly despite steady increases in levels of needle-syringe distribution. Evaluation of the harm reduction programs in Hai Phong by the VHM indicated that if the needle-syringe interventions had not been implemented there could well have been a further significant rise in prevalence among injecting drug users and there could also have been a rise in prevalence among female sex workers if condom interventions were not implemented (Figure 19). The extent of potential increase among injecting drug users was produced with the same routine as for other provinces but is perceived as relatively high. This could be due to the IDU population size in Hai Phong or interactions of various factors that changed over time. However, the data sources for Hai Phong were found to be more inconsistent than for most other provinces in the model reconciliation, suggesting that caution should be taken in interpreting results. Only a subset of model simulations could be used to reconcile sampled parameters from distributions of data and these simulations were used to produce the Hai Phong results. For this reason, the model results for Hai Phong are not as robust as for other provinces. The simulations of programs in Hai Phong had little observable impact on secondary infections. This is due to little mixing between population groups, as informed by available data and the reconciliation routine. The VHM was used to calculate the expected number of primary and secondary infections averted due to harm reduction programs (see Figure 20).

Model trajectories of HIV prevalence among population groups in Hai Phong

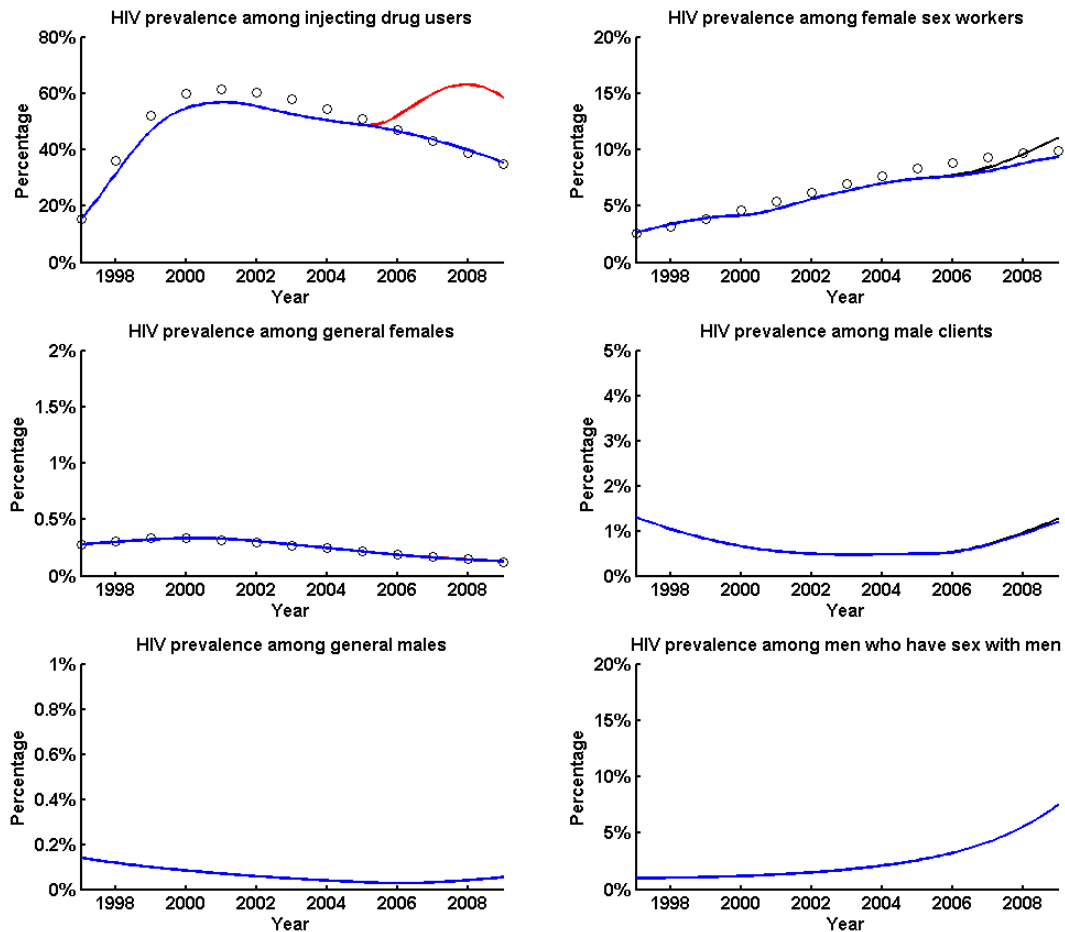


Figure 19: Trajectories of HIV prevalence among IDU, FSW, general females, male clients of FSW, general males, and men who have sex with men in Hai Phong. Circles represent EPP-fitted curves to available data, the dark blue curves represent the best-fitting VHM simulation, the red and black curves represent VHM-simulated trajectories under the scenarios that needle-syringes and condoms were not distributed, respectively.

Estimated impact of N/S and condom distribution in Hai Phong during 2005-2009

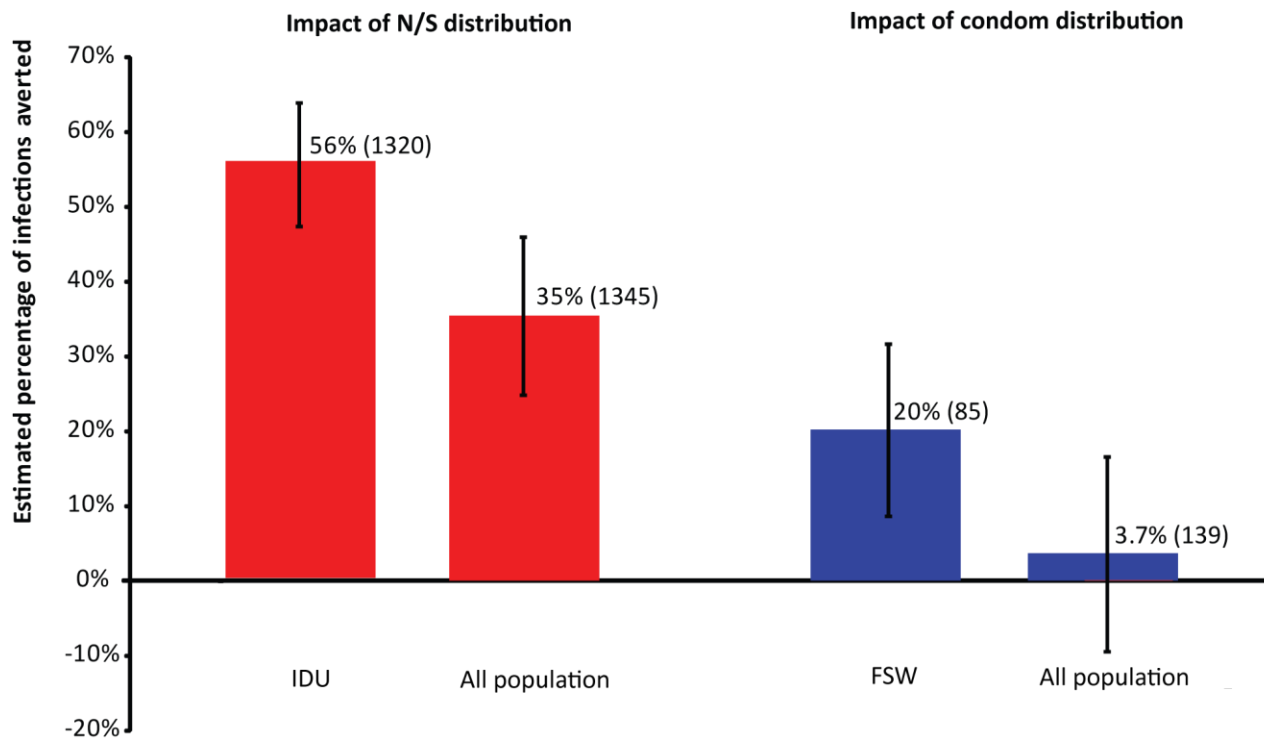


Figure 20: Estimated percentage of infections averted (number of cases averted) over the five-year period, 2005-2009, among IDU, FSW and the entire population based on simulations of the VHM for Hai Phong. Estimates are based on comparison of the observed HIV epidemic trajectory with the simulated trajectory according to expected risk behavior without distribution of needle-syringes/condoms over the period 2005-2009. Error bars refer to standard deviation of model outputs.

- Distribution of needles-syringes among IDU in Hai Phong were estimated to avert 1320 infections (56% of infections) among IDU; and another 25 infections from other population groups (25% of all infections in the total population) between 2005-2009.
- Distribution of condoms among sex workers in Hai Phong were estimated to avert 85 infections (20%) among sex workers and a further 54 'onward' infections, primarily among clients and regular partners of clients.
- Coverage among IDUs reached the WB target over the period 2005-2009 and is the main reason for the relatively large success. However, sharing rates among IDU have still not declined adequately. Coverage of condoms among FSW was erratic over the assessment period, but may have led to increased condom use and reductions in new infections.

Ha Noi

Ha Noi, like HCMC, represents a disproportionately large number of IDU for the country overall. Yet it has historically had a much more moderate IDU epidemic compared to many other large urban regions. The FSW epidemic in Hanoi has been relatively severe but appeared to have peaked several years before the start of WB/DFID interventions. Ha Noi has also benefited from interventions prior to 2004/5.

Over the assessment period higher rates of needle sharing and lower levels of condom use were reported in the IBBS, despite moderate levels of commodity distribution. Evaluation of the harm reduction programs in Ha Noi by the VHM indicated that if the needle-syringe interventions had not been implemented there could have been a moderate increase in prevalence among injecting drug users, rather than a small decline, and this would have also resulted in slightly higher prevalence among the population of female sex workers (Figure 21). Similarly, condom distribution has likely reduced the prevalence among female sex workers, from stable levels to a decreasing trend. The VHM was used to calculate the expected number of primary and secondary infections averted due to harm reduction programs (see Figure 22).

Model trajectories of HIV prevalence among population groups in Ha Noi

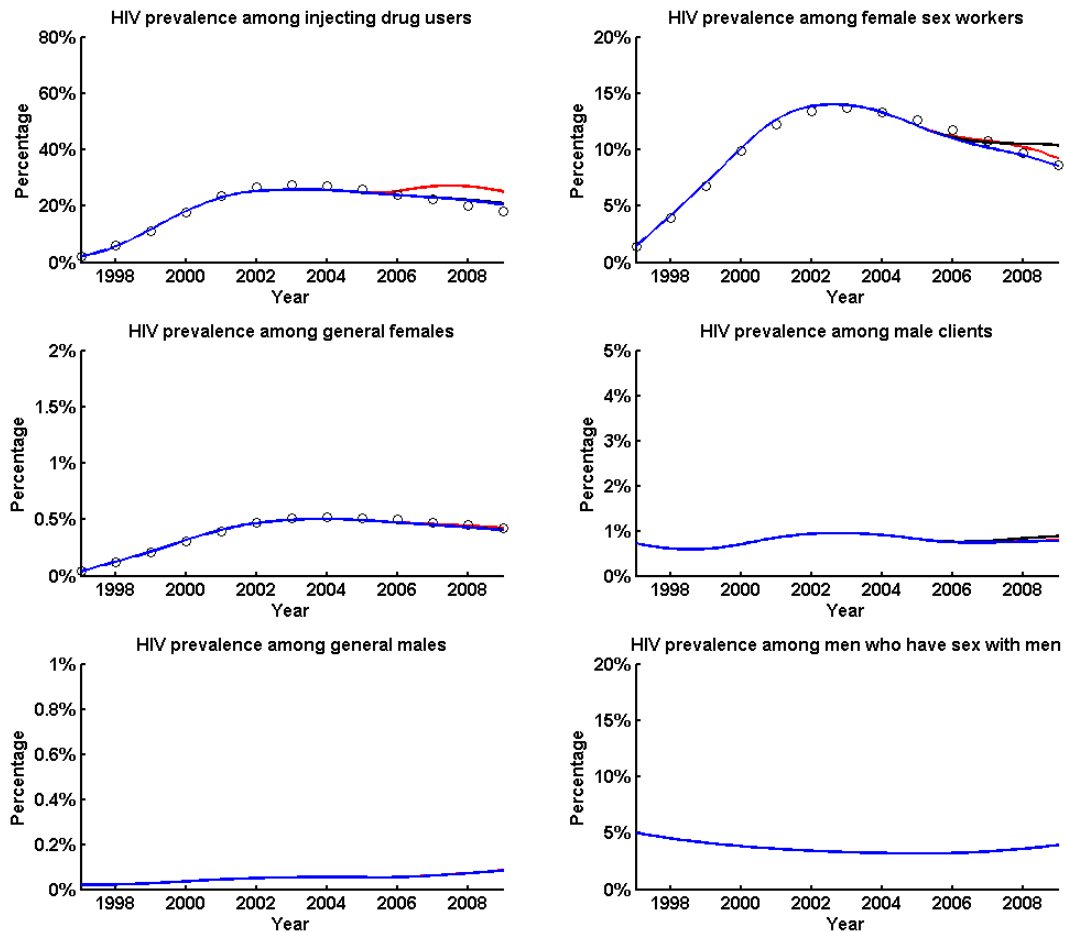


Figure 21: Trajectories of HIV prevalence among IDU, FSW, general females, male clients of FSW, general males, and men who have sex with men in Ha Noi. Circles represent EPP-fitted curves to available data, the dark blue curves represent the best-fitting VHM simulation, the red and black curves represent VHM-simulated trajectories under the scenarios that needle-syringes and condoms were not distributed, respectively.

Estimated impacts of N/S and condom distribution in Ha Noi during 2005-2009

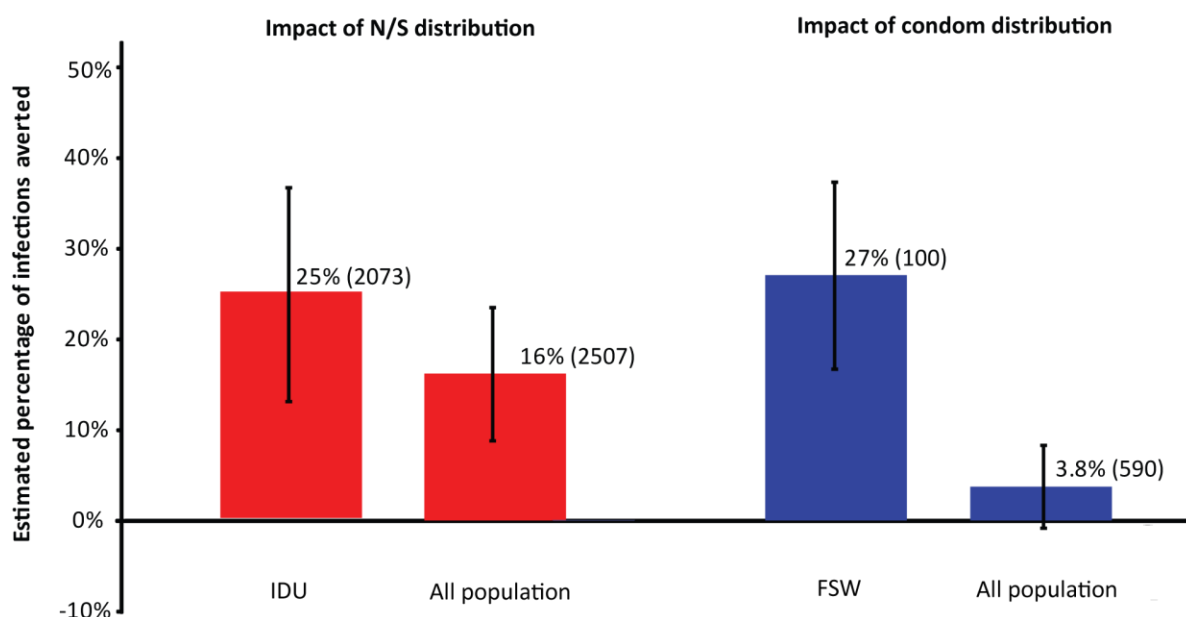


Figure 22: Estimated percentage of infections averted (number of cases averted) over the five-year period, 2005-2009, among IDU, FSW and the entire population based on simulations of the VHM for Ha Noi. Estimates are based on comparison of the observed HIV epidemic trajectory with the simulated trajectory according to expected risk behavior without distribution of needle-syringes/condoms over the period 2005-2009. Error bars refer to standard deviation of model outputs.

- Distribution of needle-syringes among IDU in Ha Noi were estimated to avert 2073 infections (25% of infections) among IDU; and another 434 infections from other population groups (16% of all infections in the total population) between 2005-2009.
- Distribution of condoms among sex workers in Ha Noi were estimated to avert 100 infections (27%) among sex workers and a further 490 'onward' infections, primarily among clients and regular partners of clients.
- The relatively large numbers of 'onward' infections to other population groups is highly suggestive of large mixing between FSWs and the rest of the population; specifically, a relatively large male client population that has increased sexual activity with other groups. Coverage of needle-syringes among IDUs is moderately low and should be increased substantially. However, coverage of condoms among FSW is moderately high, contributing to reductions in new infections.

Ho Chi Minh City

In terms of the size of key populations at higher risk for HIV and levels of HIV prevalence among these groups, HCMC has the largest potential for harm reduction to contribute to averted infections. During the assessment period sharing rates did not increase, although levels of condom use reported in the IBBS decreased. Very low levels of per capita commodity distribution were reported in HCMC. Based on these low coverage levels, evaluation of the harm reduction programs in Ho Chi Minh City by the VHM indicated that if the interventions had not been implemented, little difference would have been observed in the trajectories of prevalence in any population group (Figure 23). The optimization routine resulted in suggestions that the HIV trajectory among MSM has increased steeply in recent years. This was found to be the consequence of transmission chains and mixing patterns among all population groups and is consistent with increases in other male population groups. Surveillance activities are required to confirm or invalidate the magnitude and trend of prevalence among MSM in HCMC. The VHM was used to calculate the expected number of primary and secondary infections averted due to harm reduction programs (see Figure 24).

Model trajectories of HIV prevalence among population groups in Ho Chi Minh City

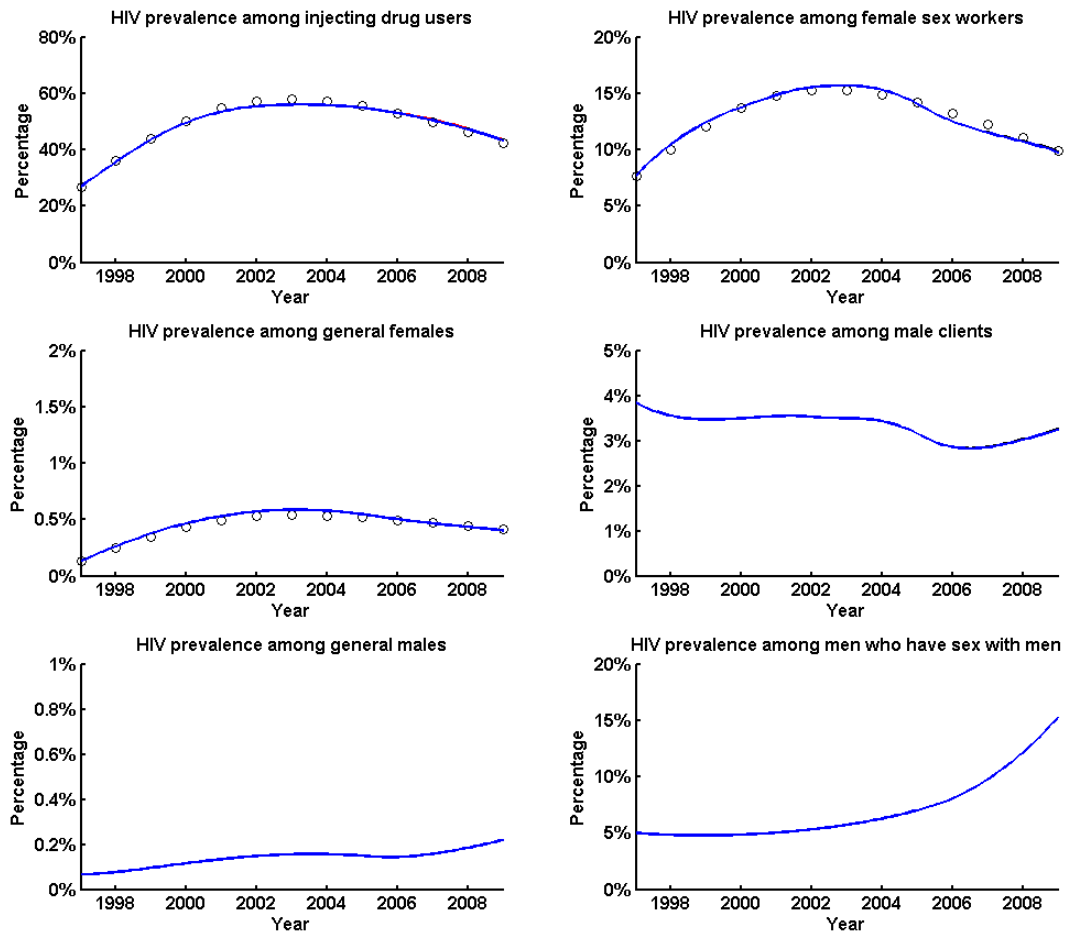


Figure 23: Trajectories of HIV prevalence among IDU, FSW, general females, male clients of FSW, general males, and men who have sex with men in HCMC. Circles represent EPP-fitted curves to available data, the dark blue curves represent the best-fitting VHM simulation, the red and black curves represent VHM-simulated trajectories under the scenarios that needles/syringes and condoms were not distributed, respectively.

Estimated impact of N/S and condom distribution in HCMC during 2005-2009

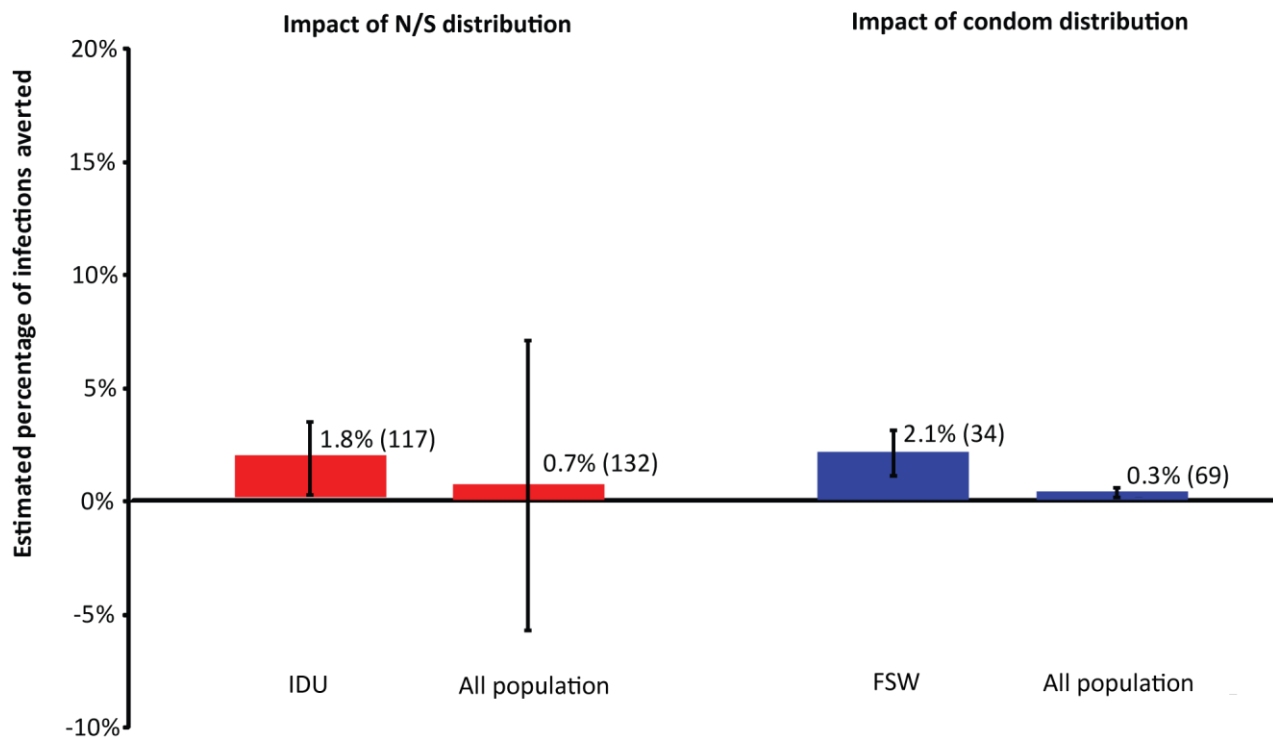


Figure 24: Estimated percentage of infections averted (number of cases averted) over the five-year period, 2005-2009, among IDU, FSW and the entire population based on simulations of the VHM for Ho Chi Minh City. Estimates are based on comparison of the observed HIV epidemic trajectory with the simulated trajectory according to expected risk behavior without distribution of needle-syringes/condoms over the period 2005-2009. Error bars refer to standard deviation of model outputs.

- Given the size of the IDU population in HCMC, even low levels of distribution of needles-syringes among IDUs in HCMC were estimated to avert 117 infections (2% of infections) among IDU; and another 15 infections from other population groups (0.7% of all infections in the total population) between 2005-2009.
- Distribution of condoms among sex workers in HCMC were estimated to avert 34 infections (2%) among sex workers and a further 35 'onward' infections, primarily among clients and regular partners of clients.
- The coverage of harm reduction programs in HCMC has been extremely low. They must increase for both IDUs and FSWs if there is to be a substantial decrease in new infections.

Sensitivity analyses

All parameters of the VHM were designated a distribution of values to account for confidence intervals associated with data-based estimates and other uncertainty in values. One hundred sets of values from the multi-dimensional parameter space were sampled, across all parameters, and used in the VHM to produce 100 different model outcomes trajectories. Sensitivity analyses, conducted in the calibration process and using the SaSAT software [12], identified the most sensitive parameters giving rise to the variation in model outcomes. The following is a list of the parameters which were consistently the most important for influencing epidemic trajectories (roughly in order of relative importance):

- Population size of all population groups, especially IDU, FSW and MSM;
- Biological transmission probability for male-to-female and female-to-male sexual exposure;
- Annual number of injections per IDU;
- Frequency of sharing injecting equipment by IDU;
- Frequency of commercial sexual acts by FSW;
- Number of regular non-commercial sexual partners for FSW;
- Condom usage in commercial sexual partnerships.

Factors that are not included in this list still have influence on the transmission dynamics of HIV epidemics, but to a smaller degree. The factors included in this list should be prioritized in accuracy of data collection for assessing their values and trends over time and they should also be prioritized in public health interventions. The sensitivity analysis identified frequency of sharing injecting equipment and condom use with FSW, which are the key factors targeted by the harm reduction programs in Vietnam. These factors are clearly the ones that have greatest potential for change. This indicates that existing public health programs are focused on appropriate targets. Underlying biological transmission probabilities cannot be affected, however, the presence of other sexually transmissible infections (STIs) may act to increase transmission rates and thus targeting other STIs may be a potential intervention. But the most feasible way to decrease STI incidence is to promote condom use, which is already a direct

priority target. Any epidemiological analysis requires accurate estimation of appropriate denominators, specifically, the size of the populations most-at-risk of infection. It is important that such estimates are made more accurate for future evaluation exercises.

Overview of modeled impact of programs versus coverage

To assess the impact of the harm reduction programs across Vietnam we investigated the model-simulated impact of the programs (with respect to the percentage of infections averted among target population groups) versus the average coverage of the programs (with respect to the number of units distributed per target person). In Figure 25 the estimated percentage of infections averted among injecting drug users in each province over the five year period, 2005-2009, is shown versus the estimated average annual number of needle-syringes distributed per IDU per year over this period.

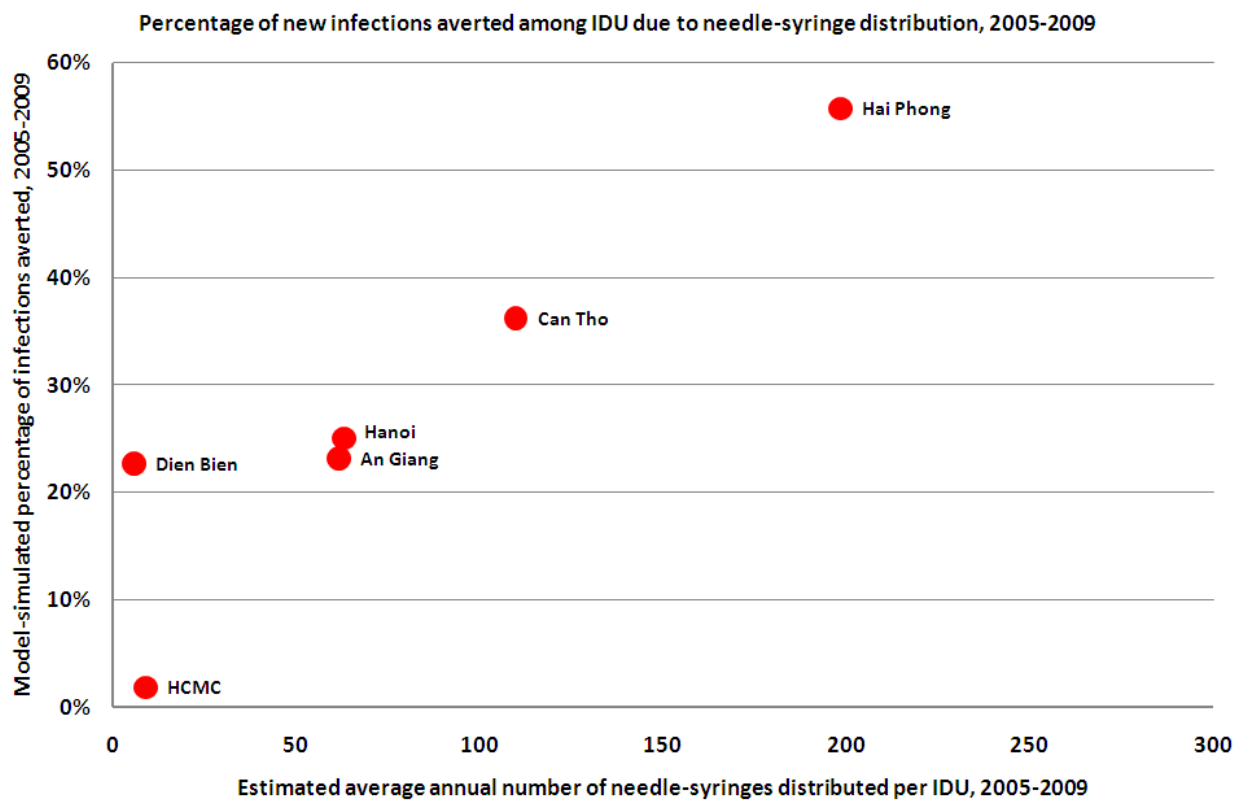


Figure 25: Scatterplot of the results from analyses across all provinces of model-simulated percentage of infections averted among IDU versus average number of needle-syringes distributed per IDU according to expected risk behavior without distribution of needle-syringes over the period 2005-2009.

In Figure 26, the estimated percentage of infections averted among female sex workers in each province over the five-year period, 2005-2009, is shown versus the estimated average number of condoms distributed per FSW per year over this period.

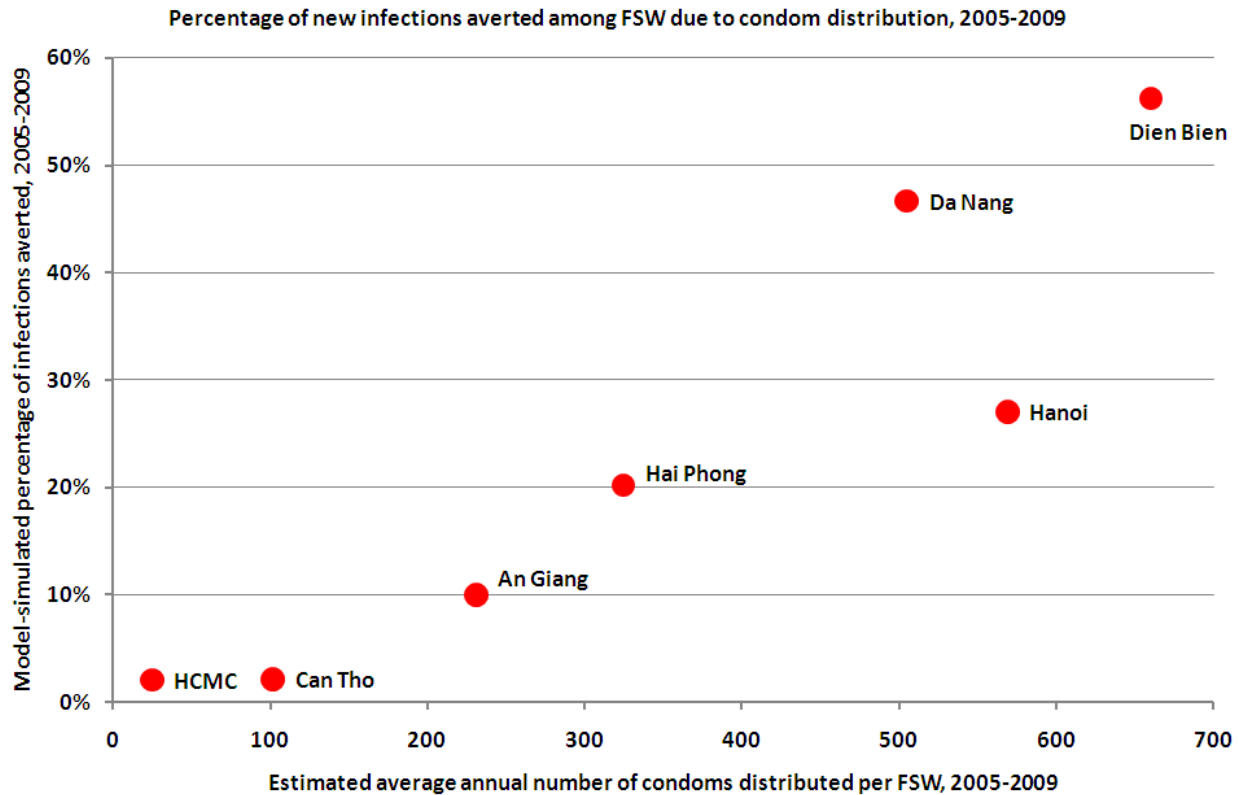
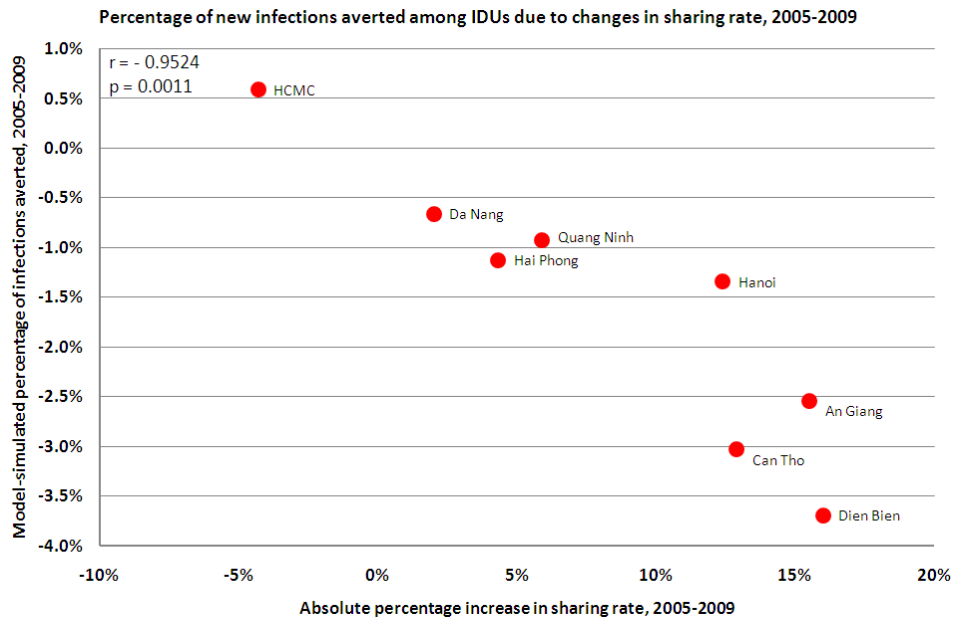


Figure 26: Scatterplot of the results from analyses across all provinces of model-simulated percentage of infections averted among FSW versus average number of condoms distributed per FSW according to expected risk behavior without distribution of condoms over the period 2005-2009.

In Figure 27, the estimated percentage of infections averted among injecting drug users and female sex workers in each province over the five-year period, 2005-2009, is shown versus the percentage change in sharing injecting equipment and condom use, respectively. Condom use among sex workers is measured in surveys for regular and casual clients and regular and casual non-clients. The average percentage change from 2005 to 2009 for each province is included in Figure 27(b).

(a)



(b)

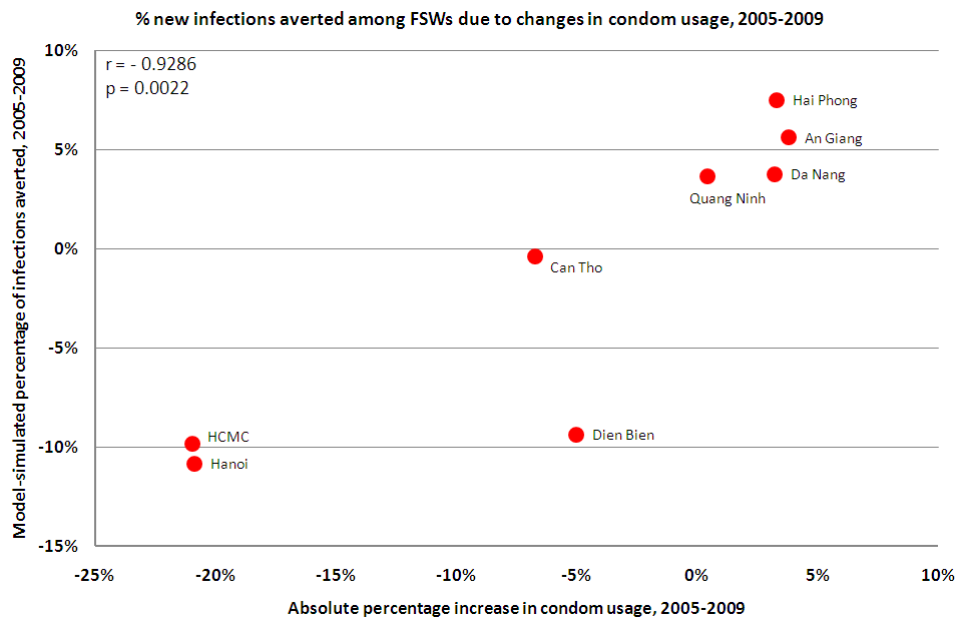


Figure 27: Scatterplot of the results from analyses across all provinces of model-simulated percentage of infections averted among (a) FSW and (b) IDU, versus absolute percentage change from 2005-2009 in needle-syringe sharing rates and condom usage respectively

Summary of results

Table 7 compares the estimated impact of harm reduction programs of IDU and FSW in each province where the VHM was applied. Provinces are ordered according to the estimated size of the IDU population to indicate the relative importance of each province to the overall national epidemic. These results suggest that moderate-to-high levels of commodity distribution by IDU harm reduction programs can result in one-quarter to one-third of infections averted among IDU. This can translate to sizeable absolute numbers of infections averted, particularly when considering downstream infections in the overall population, such as to regular partners and other key populations at higher risk. The factors most associated with greater numbers of secondary infections are behavioral risk variables (specifically, the number of potential exposure events; that is, shared injections). Similar proportions of infections averted due to good coverage of FSW harm reduction programs are also observed, however, the relatively low numbers of FSW and lower levels of HIV prevalence in these groups, suggest smaller numbers of absolute infections averted. The factors most associated with greater numbers of secondary infections are behavioral risk variables (specifically, the number of potential exposure events; that is, acts of unprotected sex and number of different sexual partners).

Harm reduction programs targeted for preventing infections among IDU and FSW can lead to secondary infections averted among other population groups. This is due to migration and mixing between groups. It is common for MSM in Vietnam to also have sex with females (see Technical Annex 3, 2005-2006 IBBS report (Table 37, page 69 [3])). As such, infections prevented in females results in reductions in prevalence among the pool of partners of many MSM. Further, infections prevented among males who inject or are clients of sex workers and are also bisexual can lead to further secondary infections among MSM.

Extrapolating the results of this study to other provinces where harm reduction interventions were implemented will provide a broader view of the likely level of impact the national harm reduction program has made on the overall epidemic in Vietnam.

Table 7: Summary of results

Province	IDU size #	HIV prevalence ##	Program coverage	% infections averted (N) due to n/s distribution		FSW size #	HIV prevalence ##	Program coverage	% infections averted (N) due to condom distribution	
				In IDU	In Total				In FSW	In Total
HCMC	34,000	47%	Low	1.8% (117)	0.7% (132)	30,000	12%	Low	2.1% (34)	0.3% (69)
Ha Noi	37,900	28%	Med	25% (2073)	16% (2507)	4800	13%	Med	27% (100)	3.8% (590)
Dien Bien	9300	42%	None-Low	23% (962)	16% (1186)	400	2%	-	56% (30)	1.6% (110)
Hai Phong	8300	58%	High	56% (1320)	35% (1345)	3000	25%	Med	20% (85)	3.7% (139)
Can Tho	2800	38%	High	36% (709)	17% (1299)	2100	9%	Low	2.1% (8)	0.4% (32)
An Giang	2200	26%	Med	23% (98)	4.7% (109)	2400	9%	Low	10% (15)	1.8% (42)
Da Nang	2000	6%	None	0	0	800	0%	Med	47% (1)	0.2% (0)
#: EPP inputs- high ##: 2005 HSS										

Model limitations

The Vietnam HIV Model was newly developed for this study to evaluate the impact of harm reduction programs in Vietnam. The mathematical constructs that underpin the model are similar to standard disease transmission models, such as the Asian Epidemic Model, and models developed by other leading international modeling groups. Strengths of the VHM include its construction for the purpose of utilizing all available data source in Vietnam, representing the unique population groups and epidemic profiles in Vietnam, extensive data collation and review of model inputs for each province, the model-fitting optimization routine incorporated around a dynamic transmission epidemic model and application to numerous provinces covering different geographical regions, epidemics, and program coverage levels. However, limitations of the model include the following points:

- The VHM assumes that new people enter the population and others leave the population (e.g. due to death or mobility) but the total number of people in each population group is constant. Changes in population sizes influences estimates of program coverage and can magnify or dilute the magnitude of results.
- The structure of the model assumes the mutual exclusivity of risk behavior among individuals over a given time period. For example, men who inject are assumed not to be paying for sex or having sex with men during the period in which they are injecting. This limits the overlap in transmission networks between groups which may contribute greatly to the trajectory of the epidemic and number of 'secondary infections' occurring. However, the model incorporates the major routes of transmission and is more detailed than comparable models. This structure is unlikely to have largely influenced the results of this study.
- The model also considers the impact of harm reduction programs for IDU separately from the impact of programs for FSW. However, in epidemics where the two groups share sexual or injecting networks, the effect of interventions occurring simultaneously may have a synergistic effect which is not accounted for. This was done in order to provide clear assessment of the value of each program. However, the potential synergistic effect can be explored by the model in future analyses.

- The use of average values of parameters for each model simulation. The model could not account for the large heterogeneity that exists within risk groups, for example, wide distributions in behaviors such as number of sexual partners or injecting frequency. Uncertainty bounds around best average values were used to account for some of the differences that exist in the population but outlying attributes of core groups of individuals and other important features of sexual or injecting networks (like concurrency of partnerships) cannot be accommodated by population-level models such as the VHM.
- Mixing patterns between risk groups in the VHM may not be representative of real mixing networks. The model includes a group of men who have sex with men but it assumes that they also have sex with women at a given average sexual activity. The model does not separate men who only have sex with men from those who have sex with both men and women.
- The VHM did not represent trends over time in precise values of estimated behavioral or biological parameters; it was found that data could not be directly reconciled together. To overcome this, an optimization routine was developed to ensure all model input values remained within confidence/uncertainty bounds and directly fit to past biological trends. While the trends in uncertainty bounds represent trends in indicators over time, sampled parameter values for a single run of the model may deviate considerably within the bounds.
- The VHM was applied to a number of provinces in Vietnam. Where province-specific data were available, they were used as model inputs. However, other data may exist that were not known or accessible. Data were also not available for all variables for all provinces. Data from other provinces, or even other countries, were used to fill in gaps for provinces without similar data.
- The program monitoring data available to characterize the implementation of harm reduction over the study period were limited to a few basic measures of program coverage. These limited measures may not adequately distinguish the level of quality or intensity of the intervention across different provinces.
- It is important to note the current model only evaluates impacts of needle-syringe and condom distribution on risk behaviors of the targeted at-risk populations and consequently

HIV prevalence. Other interventions such as peer-education, HIV testing and, prevention of other sexually transmitted diseases may also be highly important for reducing HIV incidence and prevalence. Analysis of the impacts of these extra interventions will be suitable for further investigation as an extension of the current model.

- Differences in survey methods, demographics of recruited participants, and quality of data that informed the VHM were not adjusted in any formal manner other than including confidence limits or uncertainty bounds around best estimates.
- Some model limitations can be addressed through improved quantity and quality of future data collection. Priority data requirements are listed in the Recommendations chapter.

Synthesis of findings and recommendations

Female sex workers and their clients and injecting drug users have been the focus of harm reduction programs in Vietnam implemented over the period of the last National HIV Strategy, 2004-2009. This study assessed the effectiveness of efforts to distribute needle-syringes and condoms and changing risk behavior to reduce sharing of injecting equipment and engaging in unprotected sex so that HIV transmission rates would decline. Analysis of program placement and coverage determined that harm reduction programs are generally established in appropriate places; that is, provinces with large populations of FSW and/or IDU. However, there are some provinces in which there also exist relatively large numbers of IDU and FSW but without the support of harm reduction interventions. This suggests the need to introduce harm reduction interventions in new regions. Data from the 2009 IBBS indicates that 47% of FSW and 15% of IDU reported being reached by HIV prevention interventions. Therefore, more effective targeting of programs is also required to reach a greater proportion of the population most at risk.

While levels of commodity distribution scaled up significantly during the assessment period, an ecological analysis investigating the correlation between commodity distribution and HIV prevalence trends is mixed. This is mainly due to natural epidemic dynamics such that general declines and/or stable HIV prevalence trends were observed among FSW and IDU prior to the introduction of harm reduction programs. Overall, behavioral trends have been disappointing over the past few years. In all but one province included in the modeling analyses, there was an increase in sharing of needle-syringes among IDUs in the 2009 IBBS compared to levels reported in the 2005 IBBS (Figure 27). Where no programs were implemented, increased needle-syringe sharing and some decrease in condom use was observed; for example, there was no formal needle-syringe program established in the province of Da Nang and rates of sharing of injecting equipment increased over the period 2005-2009. This is strongly supportive of the position that external socio-cultural factors may have influenced background trends towards more risky behavior independent of the programs and therefore the harm reduction programs have the challenge of attempting to reverse trends that are tending in directions of increased HIV transmission. Where there has been moderate or large program coverage, relatively modest

change in risk behavior occurred, suggesting that the programs have possibly combated a systematic background increase in risk. Furthermore, model-assumed increases in sharing rates that would have occurred without needle-syringe programs led to estimated percentage of infections averted that are very strongly correlated with program coverage (Figure 25). These results are highly supportive of the large benefit of the harm reduction programs and indicate that higher program coverage will lead to larger relative benefit in reducing infections. Even where there was small program coverage, of approximately 5-10 needle-syringes per IDU in HCMC for example, there were reductions in potential IDU infections (an estimated 2-5% reduction in HCMC). The modeling analyses provide evidence that the harm reduction programs have assisted to mitigate what could well have been greater incidence. At a population level, the effect of the harm reduction programs may not yet be largely noticeable but they have reduced the number of incident infections by a moderate level that is in support of the epidemiological value of the programs. Incidence would have been substantially greater without the number of needle-syringes being available to IDU to reduce the need to share injecting equipment. The modeling results suggest that the programs have potentially averted between two and 55% of infections depending on coverage levels (Figure 25).

There was also a strong correlation between the estimated percentage of infections averted among FSW and program coverage when adjusting for the expected condom use without the condom distribution programs (Figure 26). Overall, it is estimated that the distribution of condoms have reduced the potential number of infections among FSWs by between two and 57% (Figure 26).

Results from modeling vary in quality between different provinces. Hanoi is a good example of the impact of the harm reduction programs for which data are of relatively good quality and there is high confidence in model-based results. Medium-level coverage of both condoms and needle-syringes resulted in an aversion of an estimated 25% of IDU infections (or just over 2000 primary cases) and 27% of FSW infections (~100 cases). Furthermore, due to prevention of these infections in the population groups directly targeted with the harm reduction programs, chains of transmission to other population groups have been reduced. It was estimated that infections averted among IDU and FSW led to an additional ~800 secondary infections averted from other

population groups. However, some of the behavior change has negated some of the effect (sharing of injecting equipment to a small degree but more from decreased condom use among certain partner types).

The routes of HIV transmission and their relative efficiency are well-known. Simple biomedical interventions are available and are inexpensive for preventing transmission of HIV. In Vietnam, sharing of injecting equipment and unprotected sex between discordant sexual partners are the major routes of HIV transmission. Access to sterile injecting equipment, such that all new injections are with a new needle-syringe, and universal effective use of condoms should stop new transmissions. Harm reduction programs have been introduced in numerous provinces of Vietnam for the purposes of reducing sharing rates and decreasing unprotected sex. However, these risk behaviors still occur at levels that facilitate moderately high levels of HIV transmission. It is important to reduce rates of sharing of injecting equipment and unprotected sex. To this end, harm reduction programs that freely distribute needle-syringes and condoms are immensely valuable.

The results of this study support the need for a range of evidence-based public health responses to prevent both primary and secondary HIV transmissions. These include biomedical and behavioral prevention interventions which target injecting and sexual risk behaviors. Needle-syringe distribution and methadone maintenance treatment (MMT) are known interventions for targeting injecting behavior. Interventions designed to encourage frequent testing, early uptake of antiretroviral treatment, and educational campaigns may also be effective. Currently, HIV prevalence trends are generally decreasing across Vietnam, mainly due to the natural epidemic dynamics and assisted by harm reduction programs. Thus, deaths rates of HIV-infected people exceed rates at which people become newly infected with HIV. Increases in antiretroviral treatment in Vietnam should reverse AIDS-defining conditions and prevent HIV/AIDS-related mortality, eventually leading to the number of deaths among HIV-infected people reducing below the number of new infections. Prevalence trends are then expected to rise even if prevention efforts substantially reduce the number of new infections. Thus, it is important to implement systems for monitoring new infections and not purely prevalence in the evaluation of prevention strategies.

Harm reduction programs which distribute needle-syringes and condoms are important for HIV prevention. Current gaps in coverage continue to sustain the epidemic. The results of this study offer strong supportive evidence of the epidemiological benefits associated with expanding these harm reduction services. This should also include the establishment of programs in settings where there is demand and where they currently do not exist, and considering alternative ways of supplying clean injecting equipment and condoms, such as extending hours of distribution, removing legal and political impediments, and making needle-syringe and condom dispensing machines available. Scaling up the distribution of sterile needle-syringes and condoms could result in significant reductions in HIV transmission, averting considerable morbidity and mortality.

Recommendations of priority data requirements for future analyses

Below is a list of variables for which the VHM is most sensitive. These factors are likely to be the most important indicators for any epidemiological evaluation study and for assessing program coverage. It is recommended that these variables be prioritized in future data collected to ensure accuracy and representativeness of population groups. It is also recommended that data collection be carried out in a systematic manner, on a regular basis, with consistent methods in order for trends and comparisons to be appropriately made.

Population size estimates. Almost all epidemiological measures and planning public health responses are reliant on accurate knowledge of the denominator of the total number of people at risk in the population. However, population size estimates in any setting are often inaccurate or not known. Size estimates of at-risk populations, particularly IDU and FSW, were the most important factor in the analysis of this study. The set of population size estimates used in this analysis are derived from the consensus of technical experts adjusting the size of MOLISA-based estimates. Upper estimates of population size were used. To facilitate planning of appropriate coverage of harm reduction programs and conducting evaluation and epidemiological studies, it is important to obtain empirically-based estimates of sizes of at-risk populations in as much detail and as accurately as possible. It is recommended that a systematic approach be taken to calculate population size estimates of at-risk populations, with priority in provinces with greatest HIV prevalence and differentiating between different urban-rural geographical locations.

Incidence and prevalence of an infection are the most important epidemiological measures for understanding the transmission and extent of disease in a population. While incidence estimates are ideal for understanding trends in new infections and the direct impact of prevention strategies, it is difficult and costly to perform routinely. Prevalence provides an understanding of the extent of existing infection in a population. Determining the cross-sectional positivity rate among a sampled group of people representative of the population of interest is a common method for estimating prevalence. Such study-based measurements are often fraught with

participation biases and not representative of the population group of interest, and also do not allow generalization of the results for other regions. Prevalence data used in this study are based on estimates from sentinel surveillance sites; however, they are consistently lower than the prevalence estimates from IBBS reports. It is important for these estimates to be reconciled by adjusting for the different population groups sampled from each study to achieve a consistent estimate that is representative of the broader population. This study uses EPP-smoothed prevalence data from the sentinel surveillance sites to calculate levels and trends in incidence across all population groups, with assumed mortality, disease progression and mixing rates.

With the recent scale-up of antiretroviral treatment in Vietnam, HIV/AIDS-related mortality rates should have declined. With sufficient scale-up of treatment and effective management of HIV-infected patients, the prevalence of HIV should not decline but may increase. Consequently, surrogate indicators of incident infections would become a more important epidemiological marker than prevalence and methods for incidence estimates should be explored.

The number of needle-syringes and condoms distributed are the most obvious indicators of the magnitude of harm reduction programs. The number of units distributed from year to year can vary considerably and the reliability of such data is questionable. It is important to identify all sources of needle-syringes and condom distribution, collect data in an efficient but reliable manner for provincial and national reporting. The number of units obtained from commercial means – outside the harm reduction programs – is believed to be greater than those distributed through the programs. There are not data to support this or provide estimates of the magnitude of units in circulation. Understanding the frequency of use of new needle-syringes and condoms accessed by individuals in the population, and mapping it against frequency of sharing injecting equipment and unprotected sex, is the most important exercise for understanding harm reduction programs in terms of their coverage and effect on modifying risk behavior.

Examine differential coverage. Due to police detention, forced detoxification and re-education in Treatment, Education & Social Labor Centers (TESLCs), some IDU are reluctant to access harm

reduction programs. There is large diversity in coverage of programs across the population. It is important to determine the percentage of IDU and FSW who have access to the harm reduction programs and commercial sites where needle-syringes and condoms can be obtained easily. The analyses in this study assumed accessibility is proportional to average coverage levels (commodities distributed divided by number of people in the population) but stratifying population groups further by extent of program coverage and/or accessibility to commodities may yield significantly different results and provide further information to assist in targeting programs.

The frequency of unprotected sex with casual, regular or commercial partners is the most important variable for quantifying the likelihood of HIV acquisition from sexual exposure. While survey questions around 'consistent condom use' and 'condom use at last act' are useful indicators for the extent of condom use, the total number of unprotected sex acts is the most useful measure of one's risk. Multiplying the estimated number of total (protected and unprotected) acts by the proportion of people who reported use of a condom during their last act, as a surrogate marker for the proportion of all acts in which condoms are used, is currently one of the best methods available for quantifying unprotected sex. However, this can be improved upon. Further differentiation of number of unprotected sex acts by knowledge about the partner's HIV status (HIV-negative, HIV-positive, and unknown) as well as more information about the type of sexual acts (penile-vaginal/penile-anal, with or without ejaculation) would also increase accuracy of modeling estimates and provide more precise indicators of specific risk factors associated with the spread of HIV.

The frequency of receptive sharing of needle-syringes is the most important variable for quantifying the likelihood of HIV acquisition from injecting exposure. While survey questions such as 'have you shared injecting equipment in the last three months?' are useful indicators for the extent of sharing needle-syringes, the total absolute number of receptively shared needle-syringes is the most useful measure of one's risk. Obtaining more precise estimates of the number of times an average injector uses a needle-syringe after another IDU has used it would

be a valuable indicator. Differentiating between rates of sharing needle-syringes, spoons, and tourniquets is important as well as understanding sharing rates not only in terms of the proportion of IDUs who share but the proportion of their injections in which they receptive share injecting equipment. Estimates of the number of people with whom IDUs share and knowledge of the HIV status of these partners would also be useful indicators.

Key recommendations

Improve data collection and analysis of size estimation of key populations at higher risk for HIV infection (e.g., IDU, FSW, MSM), as well as for the male clients of FSW, program monitoring statistics, and sentinel surveillance

Indicators that accurately measure the extent of the HIV epidemic (population size denominators, prevalence and incidence) and are representative of the underlying population are essential. This needs to be combined with accurate data on the extent of program implementation (number of units distributed, number of peer educators, information about the network accessing the programs and subgroups that do not access the programs). Trends in behavioral risk factors are the links between epidemiology and program interventions. Measuring specific variables that are direct indicators of exposure to HIV (frequency of unprotected sex and frequency of receptive sharing of needle-syringes) is important for future evaluation of the success of public health programs. It is also recommended that data collection be carried out in a systematic manner, on a regular basis, with consistent methods in order for trends and comparisons to be appropriately made. Data that should be prioritized are listed above in the *Priority data requirements for future analyses* section.

Introduce harm reduction programs in all provinces with large numbers of IDU and/or FSW and improve levels of coverage within provinces with programs, giving highest priority to regions with greatest numbers of key populations at higher risk of HIV infection

Although harm reduction programs have been introduced in numerous provinces of Vietnam, key risk behaviors still occur at levels that facilitate moderately high levels of HIV transmission. Harm reduction programs that distribute free needle-syringes and condoms are immensely valuable and have been shown in this report to be effective in mitigating epidemics. This analysis identified provinces with large numbers of IDU and/or FSW experiencing HIV epidemics, but as yet, no large-scale harm reduction programs. For example, 13 provinces have more than 1000 IDU and/or FSW and no large-scale harm reduction services are in place. There is a strong case for the need to introduce harm reduction interventions in these regions, informed by experiences of success in other provinces but tailored to the environment of each location. Even in the absence of an established HIV epidemic, it is important to introduce these programs in order to prevent epidemics emerging. Some important provinces, with large numbers of IDU, continue to have relatively moderate levels of coverage. Only two of the eight provinces with more than 6000 IDU have distribution levels exceeding 150 needle-syringes per person. Importantly, given the large contribution HCMC makes to the overall population of key populations at higher risk for HIV in the country, low levels of program coverage in HCMC suggests that national-level epidemic impact requires concerted scale-up of services in this province.

Establish national guidance on the package of services, quality standards, and coverage targets for harm reduction services

There are currently no national standards as to the minimum package of harm reduction services, no specific quality standards or targets for distribution of needle-syringes and condoms. Without this national guidance it is challenging to conduct an impact assessment across provinces which use standardized measures to compare or summarize program achievements at the end of a 5-year implementation period, much less to conduct ongoing program monitoring and management during the implementation period. Recent survey data suggest that even in provinces with harm reduction programs, the majority of intended beneficiaries do not have access to these programs. Thus, it is important to ensure greater coverage among all IDU and FSW networks. It is also important to increase the volume of commodities distributed. If program coverage exceeds target thresholds of 200 needle-syringes per IDU and 240 condoms per FSW,

then it can be expected that more than 50% of infections among IDU and more than 20% of infections among FSW would likely be averted; substantial changes in epidemiological trends would be observed. The target of 200 needle-syringes per IDU per year is consistent with UNAIDS/WHO guidance for achieving high coverage for IDU interventions [13]. The target of 240 condoms per FSW per year is likely to be lower than the 60% of risk acts proposed to be necessary to maintain low or declining trends in HIV prevalence. However, socially marketed condoms play an important role in meeting the need for condoms and it is important to clarify the proportion of need which free distribution of condoms is intended to comprise.

Conduct operational research to understand technical efficiency and why implementation works in some regions

This analysis demonstrated variability in impact across different provinces despite similar harm reduction programs being implemented in all areas. It was shown that coverage levels were very strongly associated with the epidemiological success of the interventions. It is recommended that factors giving rise to the success or failure in each setting be determined. Coverage, in terms of the number of units of needle-syringes/condoms per IDU/FSW, is an appropriate outcome indicator for the programs but understanding how implementation can be improved to reach high coverage levels is essential. Therefore, it is recommended that *implementation science studies* be conducted (i.e., studies to understand technical efficiency of different models of service implementation) and studies to understand the 'why' of impact (i.e. *management science studies*).

Strengthen training and supervision of peer educators to improve coverage of individuals and distribute commodities efficiently

Achieving high levels of program coverage is dependent on sufficient training for program implementers (peer educators). This includes techniques for contacting individuals on a regular basis, distributing sufficient numbers of commodities to each individual and accompanying commodity distribution with effective behavior change communication. Good training will also

depend on establishing and reinforcing national norms and quality standards for peer educator outreach activities.

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