Ministry of Health

National Center for HIV/AIDS, Dermatology and STD

Report of a Consensus Workshop

HIV Estimates and Projections for Cambodia 2006 - 2012

Surveillance Unit
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I. Background

The Cambodian Demographic Health Survey (CDHS), conducted in 2005, included assessment of HIV infection status. The results of the survey, which was based on a household sampling methodology, were formally released by the National Institute of Statistics, Ministry of Planning, in April 2007. The estimated national prevalence of HIV infection among adults aged 15-49 was 0.6%, and was identical in males and females.

The results of this survey contrasted substantially with the findings of the HIV Sentinel Survey (HSS) that had been conducted by the National Centre for HIV/AIDS, Dermatology and Sexually Transmitted Diseases (NCHADS) in 2003. This survey found that the national prevalence of HIV infection among pregnant women was 2.2%. This result provided the basis for the official national estimate of people living with HIV infection of 1.9% in 2003. The most recent HSS round was conducted during late 2006 and early 2007 in 22 out of 24 Cambodian provinces/municipalities, and found that the prevalence of HIV infection among pregnant women had fallen to around 0.9%

In order to review the findings of these two surveys, and their implication for the updated national estimation of the number of people living with HIV infection, NCHADS convened a Consensus Workshop, involving national and international specialists in HIV epidemiology, statistics and epidemic modeling (see Appendix 1 for list of participants). This report describes the process and outcome of the Workshop.

II. Objectives of Consensus Workshop

1. Review data on HIV prevalence from the CDHS, HSS and other relevant sources that may be available
2. Determine methodology and assumptions for estimating HIV prevalence and incidence in Cambodia, with a particular emphasis on the 2006 prevalence
3. Prepare estimates of HIV prevalence, incidence and mortality in Cambodia
4. Project the future incidence of HIV infection, AIDS and numbers of people requiring treatment, under various scenarios.

III. Sources of HIV prevalence data

1. CDHS 2005

A comprehensive report of the CDHS is available online (http://www.measuredhs.com/pubs/pdf/FR185/FR185.pdf). The survey used a well-established sampling strategy to recruit adult males and females from households. Over 95% of those contacted for the study agreed to be interviewed and 93% provided blood specimens. Dried blood spot specimens were tested by the National Institute of Public Health (NIPH) laboratory. A subsample of negative and positive specimens was retested by CDC in Atlanta, Georgia for external quality control of NIPH results.

The CDHS found a substantial difference in prevalence by place of residence. Prevalence among those living in provincial capitals, classified as urban, was 1.3% among females and 1.6% among males, compared with 0.5% and 0.4%, respectively, among those living in remaining districts, classified as rural (urban-rural classification is based on pre-2004 definition).

For the purpose of estimating national HIV prevalence in 2005, the **Consensus Group considered that the only limitation of the CDHS was the lack of information about people who were unlikely to be included in the household sample**. It was considered likely that some populations at higher risk of HIV infection, including women who engaged in sex work, men who were mobile for occupational reasons, such as fishermen and transport drivers, and people with severe HIV-related illness requiring hospitalization were likely to be underrepresented in household sample.

NCHADS compiled estimates of the numbers of people in population groups at increased risk of HIV infection, including men in the military and police, women engaged in sex work, mobile populations, men who have male-to-male sex, and people who inject drugs (see appendix 2). Upper-limit estimates of the numbers in these groups, combined with upper-limit estimates of the corresponding HIV prevalence, led to an approximate 33% increase in the estimated national HIV prevalence, representing some 14,000 additional people aged 15-49 years living with HIV infection in 2005.

2. HSS 1996-2006

HSS was first conducted at the national level in 1996, and then almost annually through 2003. It has recorded a steady decline in the prevalence of HIV infection among a number of population groups since 1999. Of particular importance are the measurements of HIV prevalence in women attending antenatal clinics (ANCs), (Figure 1) which have been used as the basis for estimating the prevalence of HIV infection in the general population.

Although there have been some variations in the methodology (testing algorithm and locations of health centers selected) used by HSS, **the Consensus Group agreed that there had been sufficient consistency over time to allow the survey results to be used to estimate temporal trends**. The HIV testing in the two most recent rounds of the HSS has been conducted using rapid testing in the field. Dried blood spot specimens were collected for laboratory quality control and validation of results.

The HSS prevalence estimates for ANC women were adjusted in two ways. First, a correction was applied to account for false positive and false negative test results, based on the laboratory validation. Second, the estimates were separately calculated for women attending clinics that were classified as urban and rural, and a combined national estimate then derived based on the relative proportions of the population in each category. This adjustment makes the implicit assumption that ANCs located in urban areas serve women who are urban residents, and similarly for ANCs located in rural areas.

A further adjustment was made to the ANC prevalence estimates to translate them into estimates of prevalence for general population women in the 15-49 age group. From CDHS 2005, the ratio of HIV prevalence among women aged 15-49 to the estimated HIV prevalence among women attending public ANCs for the last birth in the past 3 years was 0.75. In 1999, a very similar ratio had been obtained from the comparison of HIV prevalence obtained from a household survey of women in five provinces with the ANC prevalence obtained from HSS 2000 in the same provinces. Based on these two comparisons, over five years apart, **it was agreed that HIV prevalence among ANC women should be calibrated by 0.75 over all HSS years, to estimate the HIV prevalence among general population women aged 15-49.**

3. Male-to-female ratio

While the ANC results provided a reasonably picture of the prevalence of HIV infection among women in Cambodia, HSS does not provide similar data for the general male population. Male populations, primarily military and police, have been included in the HSS but are not considered to be nationally representative of male populations in the same way that ANC data represent the female population. Therefore it was necessary, for the purposes of national estimation of HIV prevalence and incidence, to use other means of estimating HIV prevalence among male population.

In the past, the consensus group in Cambodia has made use of the ratio of male-to-female HIV prevalence among people attending treatment services for tuberculosis, to provide an estimate of the male-to-female ratio in HIV prevalence. This option has a number of potential weaknesses, as it depends on assumptions about tuberculosis incidence in people with and without HIV infection, treatment-seeking behavior and diagnosis of tuberculosis in Cambodia, and the representativeness of the tuberculosis clinics that have been included in the national surveys for HIV infection.

After extensive debate, **it was agreed that the year-specific sex ratio in HIV prevalence among people attending treatment services for tuberculosis should be used as the estimate of the sex ratio of HIV prevalence in the general population two years earlier**. In other words, a lead of two years was applied to reflect the assumption that the HIV sex ratio in a given year would be manifested in the corresponding ratio in people with tuberculosis, two years later. Ratios from years without surveys of tuberculosis clinics were obtained by interpolation from the survey years (Figure 2).

The consensus group considered that other available sources of information on the male-to-female ratio (blood donors, VCT attendees, AIDS and HIV case reporting) had even greater

limitations than the tuberculosis clinic data, but nevertheless provided estimates that were generally consistent with those derived from the tuberculosis clinics.

IV. Model fitting and estimation

1. Estimation Projection Package (EPP)

Publicly available computer programs were used to derive estimates of HIV prevalence.

First, the computer program Estimation and Projection Package (EPP) was used to fit the curve of estimated HIV prevalence among ANC women obtained from HSS, after applying two corrections noted above (adjustment for laboratory quality control and urban-rural proportions). EPP fits a smooth curve to a series of point estimates to produce an estimate of HIV prevalence among ANC women for each year from 1995 to 2006. The correction of 0.75 described above was then applied to translate these figures into estimates of the HIV prevalence among general women aged 15-49. The resulting HIV prevalence estimate for general population women in 2005 was 0.97%, slightly higher than the 0.8% upper confidence limit of the CDHS point estimate of 0.6% in 2005. The Consensus Group was not concerned with this difference, because of the potential for the CDHS to have missed non-household women at higher risk of HIV infection.

Second, the male-to-female ratios of HIV prevalence derived from the tuberculosis clinic data, with two year lead time, were applied to the general population female estimates to derive an estimated HIV prevalence curve among general population men aged 15-49 in Cambodia from 1995 to 2006.

The resulting male prevalence estimates were combined with the female estimates in proportion to population sizes to form the updated national estimates of HIV prevalence in Cambodia (Figure 3). Of note were

- The new 2006 estimate of 0.9% or 65,000 people aged 15 – 49 year living with HIV infection. Alternatively, the estimate HIV prevalence among Cambodian population aged 15 years or older in 2006 was 0.7%, corresponding to 67,200 currently living with HIV.
- The newly revised 2003 estimate of 1.2% or 81,900 people aged 15 – 49 year living with HIV infection.

The reduction in the previous 2003 estimate was due to a more accurate adjustment which considered the urban-rural distribution of the population, use of a slightly lower male-to-female ratio, as well as the lower ANC estimate from HSS 2006 which was included into EPP to fit the epidemic model.

Figure 1: Prevalence of HIV infection in ANC women as estimated by HSS, adjusted for laboratory quality control and urban-rural population proportions, EPP-smoothed

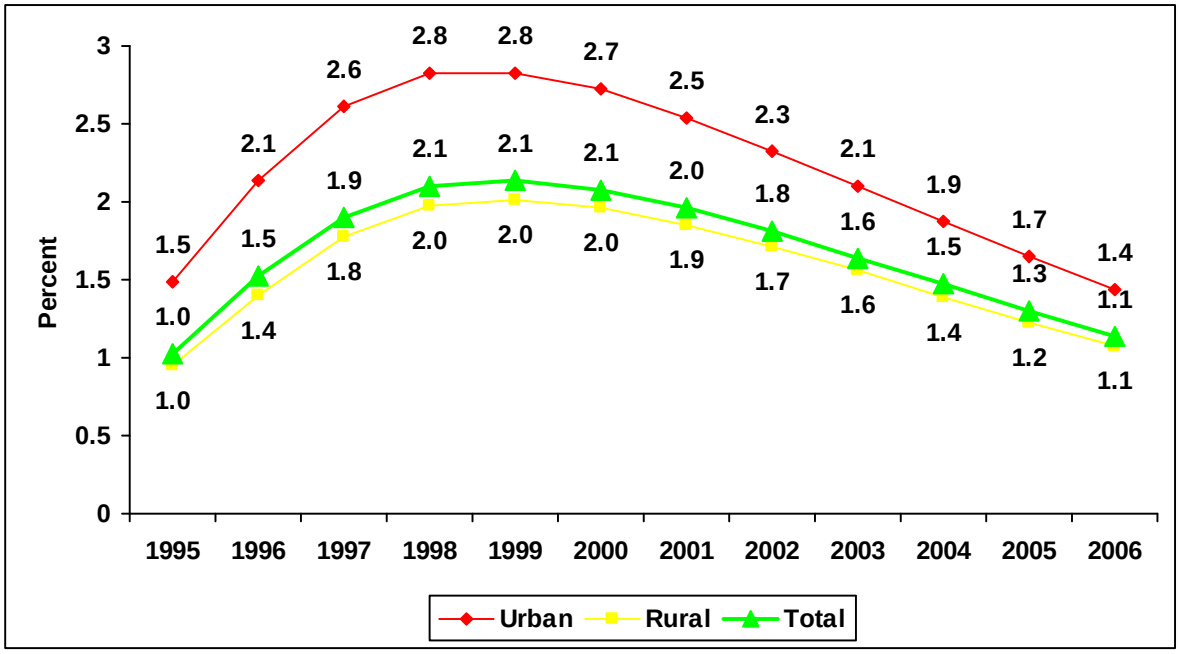


Figure 2: Male-to-female ratio of HIV prevalence among people attending tuberculosis clinics (two year lead time applied), by year

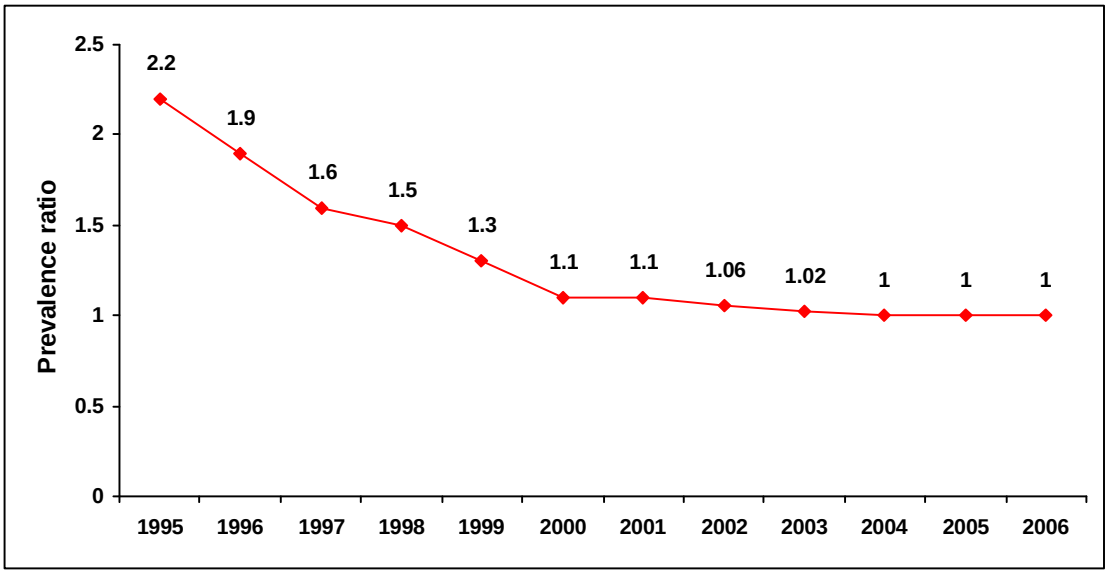
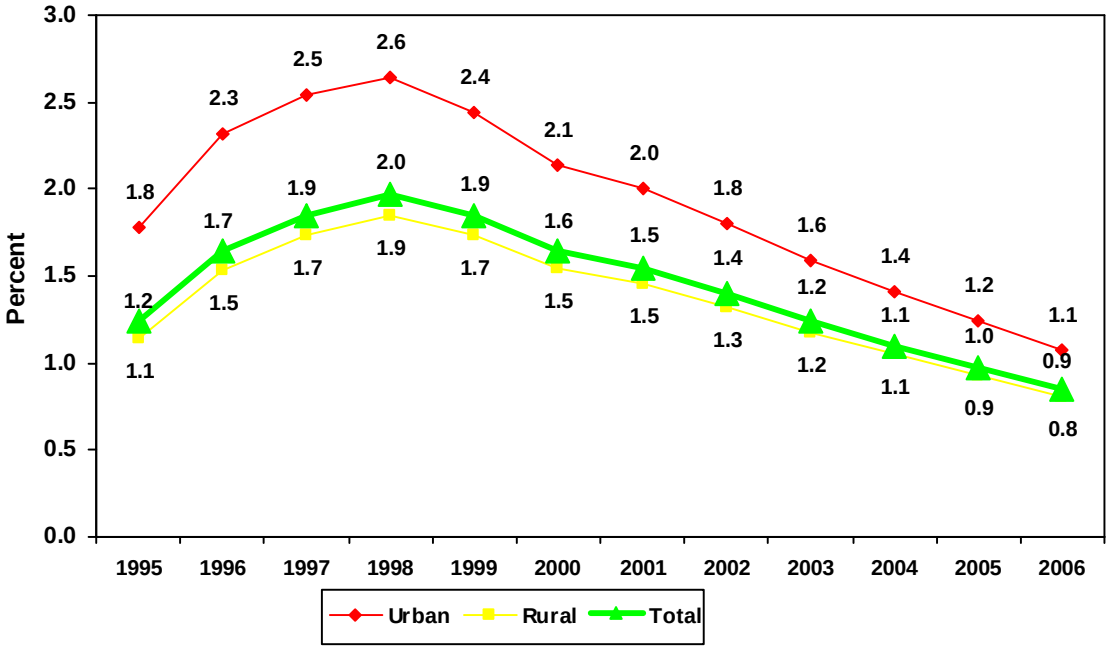


Figure 3 Estimated prevalence of HIV infection among person aged 15-49 by urban or rural locations in Cambodia, 1995-2006,



2. Asian Epidemic Model

The Asian Epidemic Model (AEM) was then used to derive estimates of HIV prevalence (Figure 4 – shows HIV prevalence among persons aged 15-49 years), number of people living with HIV (Figure 5), incidence, and deaths among children aged younger than 14 years, and adults aged15 years and older (Figure 6 – 9). These estimates were based primarily on estimates of HIV prevalence among general population women and female sex workers (FSW) and consideration of other data as described below.

AEM is based on a model of HIV transmission, and requires the input of information about the frequency of sexual intercourse and condom use, both in relation to spouses and sex worker contact. The model accounted for treatment uptake and its effect on survival. Information on time trends in sexual behaviors, based on Cambodian surveys of sex workers and male population groups, was entered into the model, and parameters related to start year of epidemic, HIV prevalence among general female and high- and low-frequency sex workers (brothel-based female sex workers and non-brothel-based female sex workers) were fitted.

The model also incorporated the effect of treatment and its effect on reducing transmission rates, by including the number of people on antiretroviral therapy in Cambodia from 2003 to 2006, and the effect of treatment on transmission rates, assumed to be a reduction of 0.75.

From the model, the fitted start year of the HIV epidemic in Cambodia was around 1985 and the estimated HIV transmission among the adult population aged 15 years or older reached a peak around 1994 in males (18,500 new cases) and 1995 in females (10,100 new cases). Estimated

HIV prevalence, on the other hand, peaked in 1996 (2.6%) and 1999 (1.5%) in males and females, respectively.

The projection from 2006 to 2012 showed that new HIV cases (HIV incidence) in both males and females continue to decline (Figure 6). The number of children aged 0-14 years living with HIV/AIDS in Cambodia and the number of new HIV infections occurring each year among children in this age group were projected from 2006 through 2012 (Figure 7). The model incorporated adult HIV prevalence data, age-specific fertility rates, reduction in fertility for HIV+ women, and the reduction in mother-to-child transmission due to antiretroviral therapy based on the percent of HIV+ pregnant women receiving antiretroviral therapy. The model has not yet been adapted to account for the effect of antiretroviral therapy on reducing mortality among children. Projections will be updated when this feature becomes available.

The model also projected the number of men and women aged 15 years and older in need of antiretroviral therapy (Figure 8). These projections are based on existing data on survival and progression from HIV infection to severe immunodeficiency and death.

Use of AEM allows us to project and compare the number of deaths among adults aged 15 and older who receive ART (based on current program data and expected future coverage) with the number of deaths that could be expected if no ART was available. Figure 9 shows that deaths will decrease from an estimated 9,950 in 2006 to 1,210 in 2009. In contrast, without ART, the number of deaths would decline by fewer than 4,000 in the same time period, from 12,040 in 2006 to 8,310.

As Figure 9 illustrated, widespread availability and use of ART will increase survival and delay progression to death for many years. This will result in a slowing of the decline in the number of persons *living* with HIV infection, that is, a slowing of the rapid decline in HIV prevalence observed before ART became available (Figure 10).

V. Asian Epidemic Model (AEM) Results

Figure 4: AEM-projected prevalence of HIV among the general population aged 15 – 49 years from 2006 – 2012 (with ART available)

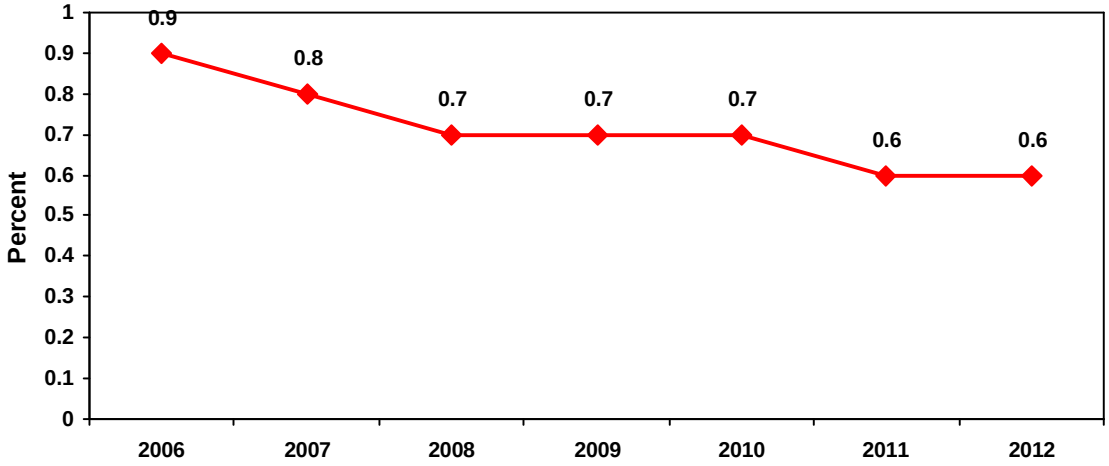


Figure 5: AEM-projected number of people aged 15+ living with HIV/AIDS in Cambodia, 2006-2012

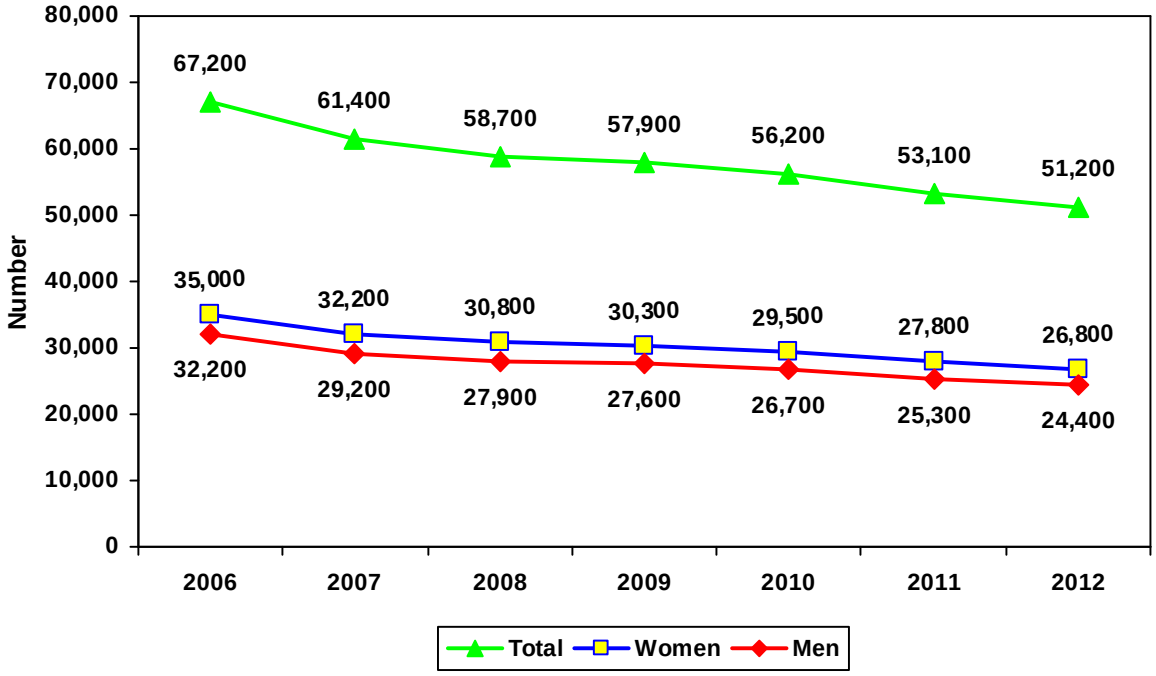


Figure 6: AEM-projected number of new HIV cases annually, among population aged 15+, from 2006 – 2012

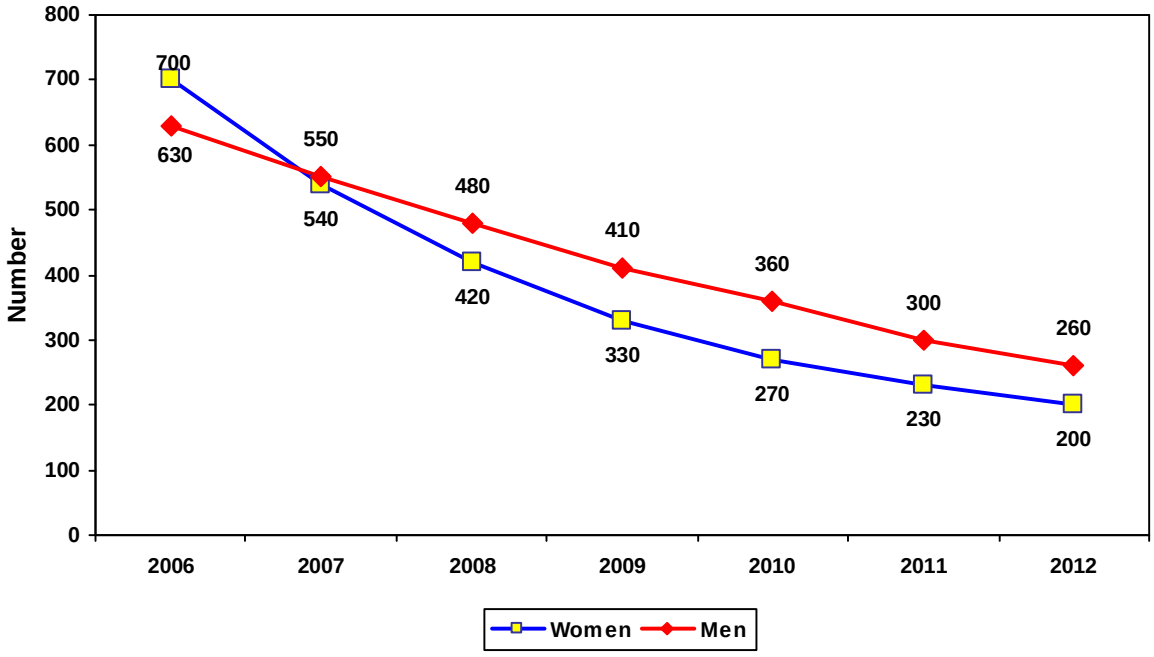


Figure 7: AEM projected number of children aged 0-14 years, currently living with HIV & newly infected (assuming no ART available for children)

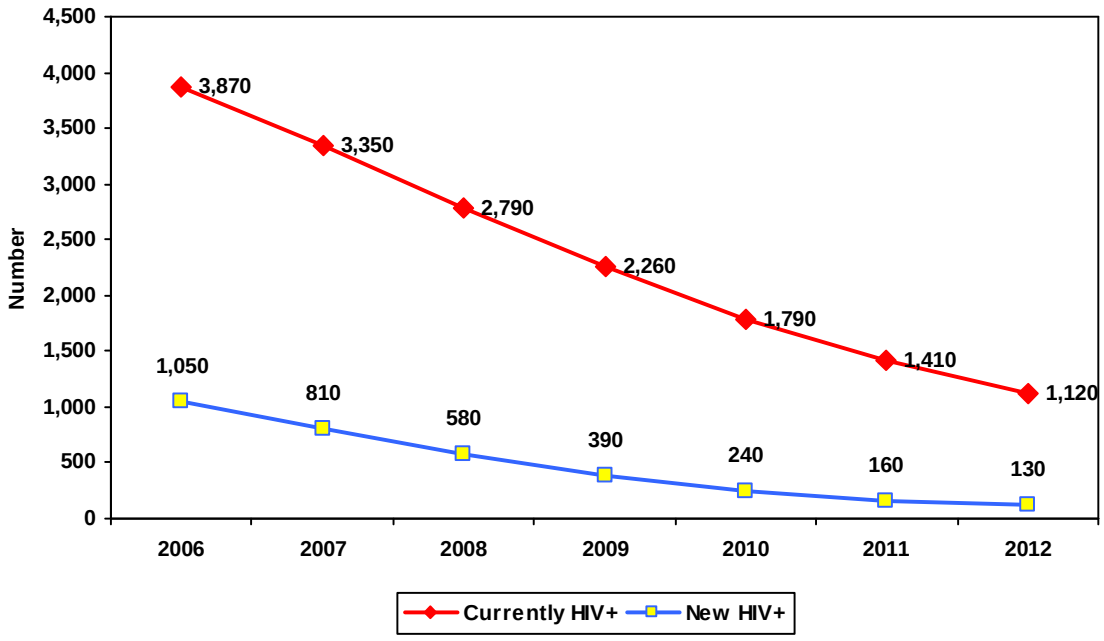


Figure 8: AEM projected number of adults aged 15+ in need of ART from 2006 - 2012

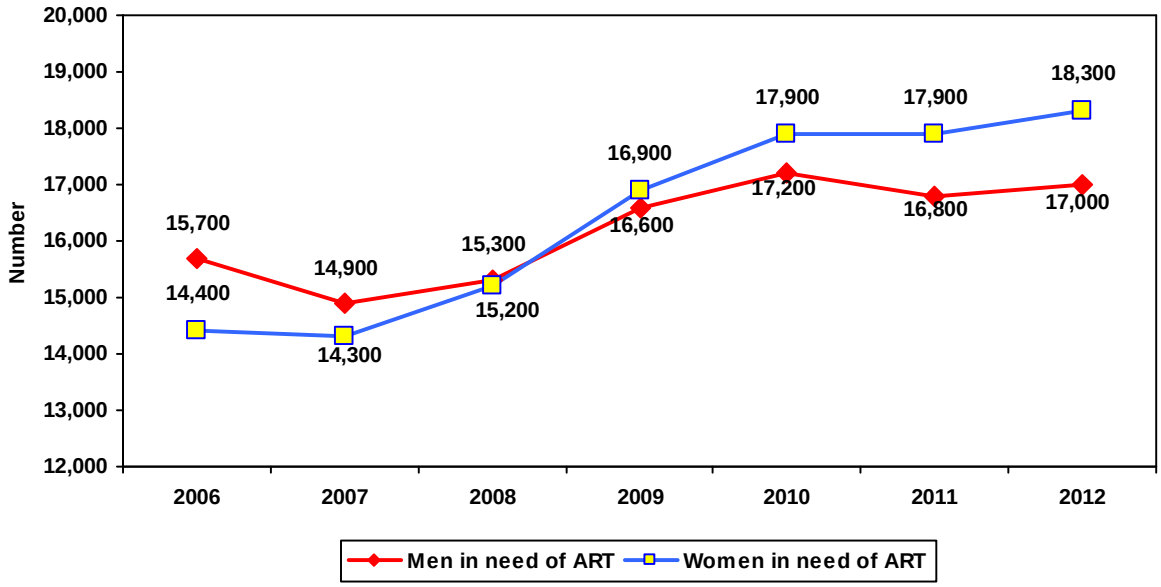


Figure 9: AEM projected number of annual death among adults aged 15 + (with and without ART available)

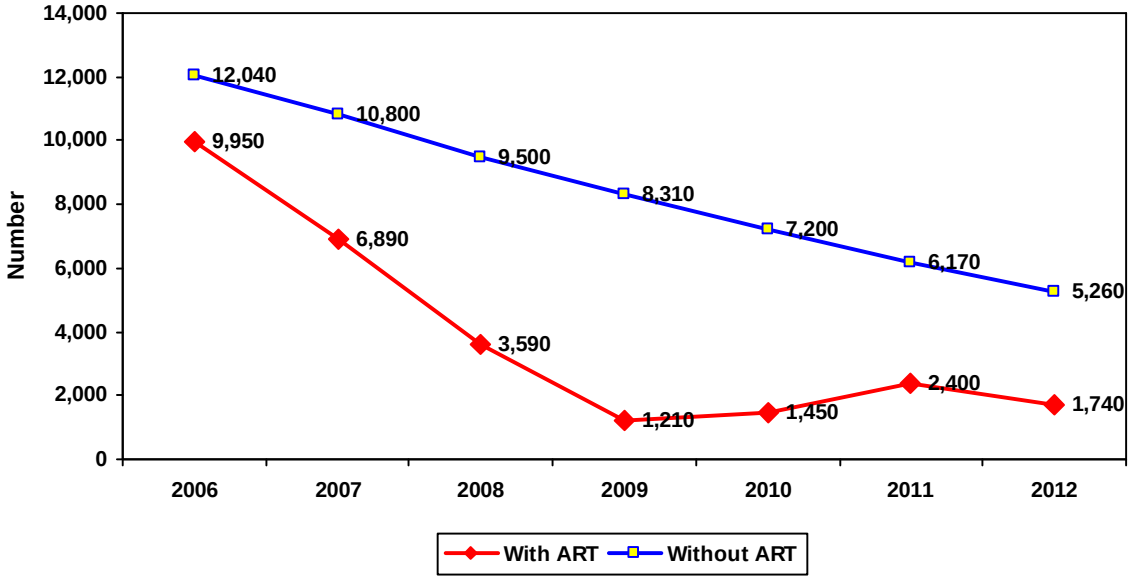
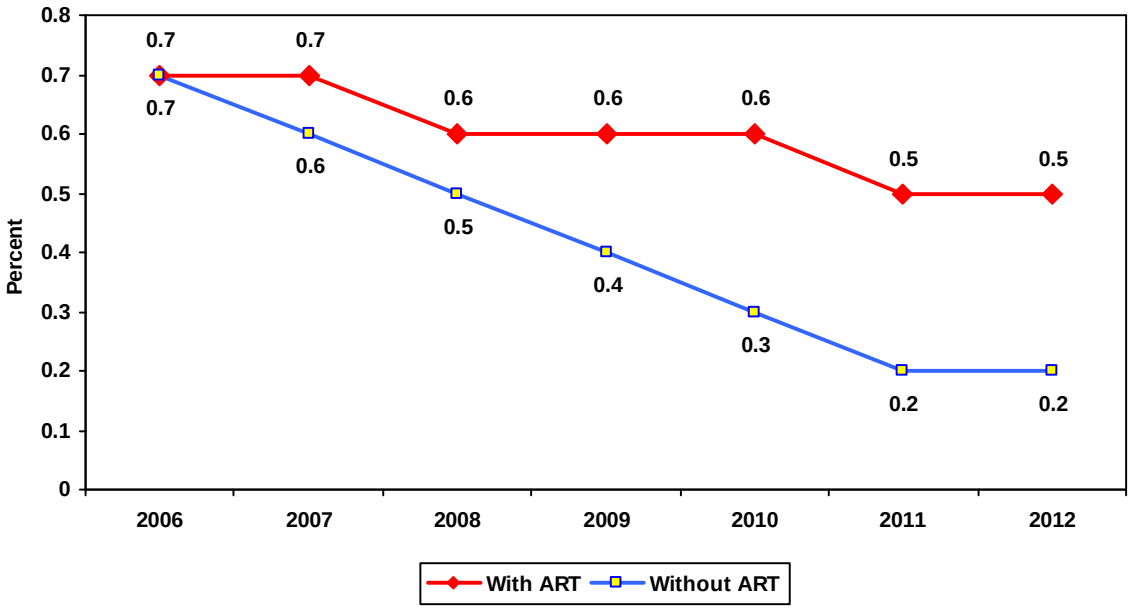


Figure 10: EM projected HIV prevalence among adults aged 15+ (with and without ART)



References

Table 1: Assumptions, inputs, and sources of data used for application of the AEM program to estimate and project HIV incidence, prevalence, and AIDS-related deaths in Cambodia

AEM INPUTS	DATA SOURCE
POPULATION	
Population by year (1980-2020) • Males aged 15+ years • Females aged 15+ years • Males aged 15 • Females aged 15	National Institute of Statistics
Percent of population aged 15+ years who are aged 15-49 in 2006	National Institute of Statistics
HETEROSEXUAL BEHAVIORS AND STI	
Sex workers—General	
• Pct of females aged 15-49 who are FSW	NCHADS document in 2000 (Direct around 5,000 and Indirect around 7,500). This two numbers then combined and divided by pop female age 15+. The number in the other years were adjust according to the size of the clients
• Pct of FSW who are higher frequency	NCHADS document in 2000 reported around 5000 high frequency and 7500 low frequency, so the proportion was set at 5000/12500 (around 40%) in 2000 and assume the direct portion of sex worker are higher before the year 2000
• Low frequency to high frequency movement each year	BSS (moving from indirect female sex workers to direct female sex workers)
Sex workers—Higher frequency group	
• No. of clients per day	BSS
• Days worked per week	BSS & field work experience
• Pct condom use with clients	BSS
• Avg duration working (years)	BSS
• Pct with STI	STI Surveys (1996, 2001, 2005)
Sex workers—Lower frequency group)	
• No. of clients per day	BSS
• Days worked per week	BSS & field work experience
• Pct condom use with clients	BSS
• Avg duration working (years)	BSS
• Pct with STI	From BSS, the pct of beer promoters who sell sex and report abnormal

	discharge is slightly lower than the pct of brothel-based sex workers. However only about 30-40% of beer girl sell sex. So the STI level among this population was set to 1/3 of brothel-based sex workers
Clients of FSW	
• Pct of males aged 15-49 visiting FSW in last year	The BSS among household men in 2000 showed the level of about 13%. After adjusting by occupation, the level was set at 11% and assumed that the level has been constant since. CDHS may have underestimated due to exclusion of some high risk and mobile populations
• Avg duration of being a client (years)	BSS IV
• Pct of adult males circumcised	1996 STD survey among military, by clinical exam
Male and female casual sex (non-commercial, non-regular partner)	
• Pct of males having casual sex in last year	BSS (The level was adjusted up slightly to account for underreporting)
• Pct of females having casual sex in last year	BSS (The level was adjusted up slightly to account for underreporting)
• Pct condom use in casual sex	BSS (Many values close to the default value [36%]) from Thailand so the default value was used [Ce])
• Avg number of casual contacts in last year (male)	Used default value from Thailand
Sex with spouses or regular partners (RP)	
• Number of sexual contacts with spouse or RP (per week)	BSS IV
• Pct condom use with spouses or RP	Used default value from Thailand DHS study
• Pct adult population with STI	CDHS 2005
HIV PREVALENCE	
• FSW (11 point estimates from 1992-2006)	HSS
• IFSW (5 point estimates from 1998-2003)	HSS
• General population females (17 point estimates from 1990-2006)	HSS estimated prevalence (QC-corrected and EPP smoothed) among ANC X 0.75 (ANC-to-general population multiplier)
OTHER PARAMETERS (EPIDEMIC DETAILS)	
• Epidemic start year	1985, based on year of first blood bank detection and modeled HSS data

Age distributions for fertility and STIs	
• Age-specific fertility rate	National Institute of Statistics
• Number of STIs in men by age group	
• Number of STIs in women by age group	
Epidemic parameters	
• Transmission probability, female to male (vaginal intercourse) (per act probability)	This is a fitting paramenter
• Transmission probability, male to female (vaginal intercourse) (per act probability)	This is a fitting paramenter
• Ratio of male-to-female transmission probability to the female-to-male transmission probability	This is a fitting paramenter
• Multipliers on the per contact transmission probability for sex where one partner has another STI	This is a fitting paramenter
• Circumcision cofactor	Many studies showed the median cofactor of 3)
• Probability of mother-to-child transmission (MTCT)	Medical literature
• Pct MTCT reduction due to ARV	Medical literature
• Reduction in fertility for HIV+ women	Medical literature
Percent HIV+ pregnant women receiving ARVs for PMTCT	
• Percent by year	Program data

Appendix 1: Workshop Participants

NCHADS
- Dr Mean Chhi Vun
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- Dr Saphonn Vonthanak
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East West Centre
- Dr Wiwat Peerapatanapokin (FHI consultant)

UNSW
- Prof. John Kaldor (WHO consultant)

Appendix 2: Estimation of HIV prevalence among general population aged 15-49 (if taking into consideration all high risk groups)

	Pop in 2006	% Pop age 15-49	Total Pop aged 15-49	% Pop outside CDHS frame	Pop not in CHDS	Pop aged 15-49 (would be in CDHS sample)	HIV prevalence		#HIV+ in Pop aged 15-49
Total population living in households	13,635,653	52.0%	7090540	0.0%	0	7,090,540	DHS estimate	0.6%	42,543
Migrant population (in & out country)	280,000	90.0%	252000	75.0%	189000		Assumption*	6.0%	11,340
Female sex worker	6,000	95.0%	5700	90.0%	5130		HSS 2006	13.3%	682
Indirect female sex worker	26,000	100.0%	26000	90.0%	23400		HSS 2003	9.4%	2,200
MSM in Phnom Penh	4,000	100.0%	4000	50.0%	2000		STI 2005	8.7%	174
MSM in other provinces	4,000	100.0%	4000	50.0%	2000		STI 2005	0.7%	14
Injecting drug users	5,000	100.0%	5000	90.0%	4500		Small survey	15.0%	675
Mitilatry and police	120,000	100.0%	120000	70.0%	84000		HSS 2003	2.0%	1,680
Total of non-household population	445,000								
Total	**14,080,653**					**7,400,570**			**59,308**
Resulting prevalence based on the assumption									**0.8%**

*We assumed that, among migrants, HIV prevalence is 6%,

For indirect female sex worker and police, it is assumed that the prevalence in 2006 is equal to the lower bound of CI in 2003.