



Ministry of Health
National Center for HIV/AIDS,
Dermatology and STDs



Report on
HIV SENTINEL SURVEILLANCE
in Cambodia 2003



Report on HIV Sentinel Surveillance in Cambodia, 2003



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FOREWORD



HIV was first detected in Cambodia in 1991 during serologic screening of donated blood, followed two years later by the first report of an AIDS diagnosis to the Ministry of Health. For over a decade, NCHADS, together with international partners and with full support from top policy makers, has been committed to fighting the HIV/AIDS epidemic. Cambodia's HIV surveillance system is an essential component of our efforts; the information it provides about the epidemic's magnitude and trends are needed to evaluate interventions, guide strategic planning, and shape national policy. Since 1994, NCHADS has conducted regular HIV seroprevalence surveys in sentinel groups chosen to represent core groups for HIV transmission, as well as the general population. The 2003 round of HIV Sentinel Surveillance (HSS) is the latest of these surveys to be conducted in Cambodia.

Because the duration of HIV infection is very long, changes in HIV prevalence (the number of persons living with HIV) occur gradually. A decrease or stabilization in the number of new HIV infections transmitted may not be translated into a reduction in HIV prevalence for several years, when the number of people dying from AIDS surpasses the number of newly infected individuals. Therefore, trends in HIV prevalence (the number and percent of people living with HIV), the number of newly infected individuals, the number with AIDS, and the number of HIV-related deaths need to be estimated from sentinel surveillance data.

This HSS report presents HSS results, estimates, and trends, and provides interpretation of their meaning. This report confirms that HIV prevalence has continued to decline in groups characterized by high-risk sexual behavior, as suggested by the results of the HSS 2000 and 2002. The data show that HIV prevalence has stabilized in the general population but that it may not yet have peaked among women. From these data, we estimate that 123,100 Cambodians aged 15 to 49 years (1.9% of the adult population) were living with HIV at the end of 2003.

Although these findings reflect the success of interventions to prevent HIV transmission, HIV incidence is still high among persons in high-risk groups and transmission in the general population continues. While continuum-of-care activities and antiretroviral treatment infrastructure are being rapidly developed, reduction of new HIV infections must remain a high priority for Cambodia.

Finally, I would like to express my gratitude to all those who have contributed to this survey and particularly to our Cambodian men and women who have accepted our invitation to participate in the survey and provide their blood for the good of their country.

Phnom Penh, 06 July 2006

NCHADS Director

MEAN CHHI VUN, MD, MPH



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EXECUTIVE SUMMARY



In Cambodia, sentinel surveillance data are used for estimating national HIV prevalence and modeling trends in HIV and AIDS incidence and mortality. In 2003, Cambodia conducted its ninth round of HIV sentinel surveillance (HSS) in 22 of its 24 provinces and municipalities. Sentinel groups surveyed were brothel-based female sex workers (FSW), female beer promoters and women working in karaoke establishments as a proxy for informal female sex workers (IFSW), policemen, and pregnant women attending antenatal care (ANC) clinics. HIV rapid tests were performed in the provinces and dried blood spot specimens were prepared for quality control testing at the National Laboratory of Public Health. This round of surveillance included strict quality control of laboratory results to validate the HSS data. Adjustments of data from this and previous surveys were applied consistently to provide a better picture of epidemic trends. Strict quality control of laboratory results implemented in 2003 and retrospective retesting of a sample of specimens from previous surveys have improved the validity of the HIV seroprevalence data. Estimates have benefited from adjustments applied consistently over time to provide a better picture of epidemic trends.

As in previous years the highest seroprevalence was found among FSW (21.4%) followed by IFSW (11.7%), policemen (2.5%), and ANC women (2.2%). Seroprevalence among ANC women varied by ANC location—seroprevalence was higher among women attending urban ANC clinics (2.5%) compared with those attending rural clinics (1.6%). Seroprevalence among young FSW aged 15-19 years (8.3%) was much lower than FSW aged 20 years and older (25.5%).

Analyses of trends suggest that prevalence is continuing to decline among FSW and policemen. Prevalence among IFSW was lower than in previous years; however, trends could not be analyzed because the composition of this group has not been consistent from one survey to the next. Among ANC women, seroprevalence appears to be relatively stable.

ANC data are used to generate national estimates of prevalence, numbers of persons living with HIV and with AIDS, HIV incidence, and deaths due to AIDS. Pregnant women who attend ANC clinics are not representative of all pregnant women in Cambodia (less than half of all pregnant women in Cambodia seek care from ANC clinics) and pregnant women aged 15-49 years are not representative of all Cambodian women in that age group. With these factors taken into account, HSS and other data were used to estimate that 1.9% of Cambodian adults aged 15-49 were living with HIV in 2003. Among 123,100 persons estimated to be living with HIV in 2003, almost half (46.7%) were women, and 21,500 (17.5%) were living with AIDS.

HIV prevalence in Cambodia has appeared to decline from an estimated peak of 3.0% in 1998 to 1.9% in 2003. Declines in prevalence may be explained by a declining number of new infections (incidence) in high risk groups and the increasing number of deaths that are occurring as the epidemic matures. Declining prevalence is seen mostly among men and the modeled estimates presented in this report show a large number of deaths and few new infections among men. Among women, however, the number of deaths and new infections are almost equal resulting in stable prevalence, i.e., the number of women living with HIV has not changed substantially since 1997.

INTRODUCTION



HIV sentinel surveillance in Cambodia

Cambodia's first documented case of HIV infection was reported to the National Blood Transfusion Center in Phnom Penh in 1991. In 1992, the Cambodian National AIDS Program, with support from the World Health Organization (WHO), conducted an unlinked, anonymous HIV seroprevalence survey of selected sentinel groups in Phnom Penh. An estimated 4.2% of direct (i.e., brothel-based) female sex workers tested positive for HIV antibody. In 1994, the National AIDS Program, with support from WHO, implemented the first national HIV sentinel serosurvey (HSS). The survey was conducted to help determine characteristics and the extent of the epidemic through analysis of cross-sectional HIV epidemiologic data from selected populations (sentinel groups) in selected geographic areas.

Including the 1994 survey, HSS has been conducted nine times, most recently in 2003. As more is understood about the epidemic in Cambodia, HSS sentinel groups and group definitions have changed. Not all groups have been surveyed each round or from every province (see Appendix I, Table 1). Over the years, sentinel groups have included:

1. Female sex workers (brothel-based sex workers)
2. Informal female sex workers, including at various times one or more of the following groups:
 - a. Beer promoters
 - b. Women who work in massage houses
 - c. Women who work in karaoke lounges
 - d. Women who work in entertainment establishments (e.g., discotheques and restaurants)
3. Freelance sex workers (defined by NCHADS as women who work in karaoke lounges, massage parlors, and bars)
4. Military
5. Military police
6. Police
7. Pregnant women attending antenatal care (ANC) clinics
8. Married women of reproductive age
9. Tuberculosis patients
10. Hospital inpatients
11. Men and women living in households
12. Sexually Transmitted Disease (STD) patients

ANC women have been surveyed in each HSS round except for that of 1998 when the group was temporarily replaced by married women of reproductive age. Seroprevalence data from the ANC sentinel group is the main source of data used to construct the national estimate of HIV prevalence, i.e., the number and percent of Cambodians living with HIV at the time of the survey.

HSS results have been an important source of information used in consensus workshops on estimating national HIV prevalence and making HIV/AIDS projections. The workshops have been held in Cambodia for each round of HSS since 1999. The Consensus Working Group comprises NCHADS staff and several international consultants.

Changes implemented in 2003

Several changes to HSS were implemented in 2003:

- Assurances of confidentiality were signed by all survey staff
- Individual informed consent was required
- HIV testing was decentralized and was conducted in provincial laboratories rather than in one national lab
- Simple, rapid assays were used for HIV testing
- Quality control testing was performed by the national reference laboratory and results were validated by the US Centers for Disease Control and Prevention (US CDC)
- Quality control test results were used to adjust data

Comparability with previously published HSS results

HSS 2003 results are not directly comparable with results published in previous HSS reports. In 2002, as in previous years, the best data and most up-to-date methods available were used to estimate HIV prevalence. Epidemiologists and surveillance experts are continuously working on improving data collection and analysis methodology to improve accuracy of results. As additional data and improved methods become available, estimates are commonly revised. HSS estimates from previous years have been revised for several reasons:

1. HSS 2003 data were adjusted based on results of quality control testing. Previously published data from earlier HSS rounds had not been similarly adjusted and thus were not directly comparable. Subsequent retesting of a sample of stored specimens from HSS 1999, 2000, and 2002 provided retrospective quality control results which showed that original test results included a substantial proportion of “false positive” and “false negative” results. These quality control results were used to perform adjustments similar to those applied to the 2003 data, thus allowing us to revise estimates in seroprevalence by sentinel group for each year (for more detail, see Appendix III, Technical Notes,).
2. Year-specific population figures were used to estimate trends in HIV seroprevalence. In 2002, the same population denominator had been used to calculate seroprevalence. Because the Cambodian population is rapidly increasing, this may have resulted in biased estimates of seroprevalence trends.

Adjustments and improvements in calculations were applied in a consistent way to data from 1999 through 2003 so that the revised national data are comparable over time.

Results presented in this report are estimates and not actual case counts. We have an increasing understanding of the best practices for making mathematical estimations, and with improved knowledge comes the responsibility of revising estimates. Similarly, the Joint United Nations Programme on HIV/AIDS (UNAIDS) has recently reviewed their estimates worldwide in light of improved methodology. As mentioned above, previously published

numbers from earlier HSS rounds should not be regarded as relevant or comparable with numbers published here.

Flexibility is one of the strongest attributes of any surveillance system. As more data become available and surveillance methods improve, we must be flexible about using the best available data and methods. Estimates presented in this report have been reviewed by a team of national and international experts, many of whom have served on the Consensus Working Group for several years, ensuring continuity in interpretation of results. The HSS 2003 Consensus Working Group believes that this report presents the data as accurately as possible.

The HIV epidemic in Cambodia has recently entered the treatment era with approximately 14,000 HIV-infected persons receiving antiretroviral (ARV) treatment as of April 2006. Fortunately, treatment will improve the quality of life and lengthen survival among persons with HIV and AIDS. Such improvements may make it difficult, however, to interpret trends in HIV prevalence. That is, HIV prevalence alone may become a less useful indicator of the dynamics of Cambodia’s epidemic—without dramatic reductions in the incidence of new HIV infections, prevalence may rise as increasing numbers of persons benefit from ARV therapy. Addition of supplementary surveillance tools to the national surveillance system needs to be explored. Data on the entire spectrum of the epidemic—HIV exposure, incidence, morbidity, antiretroviral resistance, and mortality—are needed to monitor trends in the Cambodian epidemic and the impact of prevention, care, and treatment programs. Using the best surveillance methods available is a public health imperative.

Objectives

Objectives of HSS 2003 were to provide data needed to:

1. Estimate HIV seroprevalence in selected sentinel groups in 2003;
2. Estimate the number of people living with HIV in 2003, and trends in the national prevalence among adults aged 15-49 based on the best available data and methods; and
3. Understand and explain the dynamics of the HIV epidemic to guide future prevention, care, and treatment programming.

METHODS



Overview

A cross-sectional design was used to obtain HIV prevalence data from four sentinel groups. Venous blood specimens were drawn in an anonymous fashion, specifically for the purpose of HIV testing. Participants were informed of the purpose of the survey and their rights to refuse participation without repercussions. Oral consent was obtained from each participant and documented before any information was collected or blood drawn. There were no identifiers on any of the blood specimens that could be traced back to the individual, although survey specimens could be linked to sentinel sites and geographic location. The survey protocol was approved by the Cambodian National Ethics Committee and US CDC.

Sentinel groups

Four sentinel groups were sampled for HSS 2003:

1. Female sex workers (FSW) (brothel-based)
2. Informal female sex workers (IFSW) (women working as beer promoters or in karaoke establishments)
3. Policemen
4. Pregnant women attending antenatal clinics (ANC)

Table 1. Target sample sizes by sentinel group

Sentinel group	Target sample size, per province
FSW (brothel-based)	150
IFSW (beer promoters)	175
Policemen	150 in provinces where prevalence >5% 300 in provinces where 2002 prevalence ≤5%
ANC women	300 in provincial capitals 300 in remaining districts

Sentinel provinces and sentinel sites

HSS 2003 was conducted in 20 of Cambodia's 22 provinces and its 2 municipalities (Phnom Penh and Pailin), heretofore referred to collectively as provinces (Appendix I, Table 1). ANC women were selected from both provincial capitals and remaining districts (covering the whole province); other sentinel groups were selected from urban areas. FSW, IFSW, and police were recruited from randomly selected sites within each sentinel province. ANC women were recruited from purposively selected sentinel sites, with efforts made to sample from the same sites as those included in previous HSS rounds (Appendix II, Table 2).

Sampling

Table 1 lists target sample sizes for each sentinel group and Table 2 summarizes the sampling strategy used in HSS 2003.

Female Sex Workers

The target sample size for FSW was 150 per province. In provinces where the total number of FSW was 150 or fewer, all FSW in the province were sampled.

In provinces where the estimated number of FSW was substantially greater than 150 (e.g., 200 or more), two-stage cluster sampling was done. Although all urban-area establishments (brothels) had been listed before the survey started, the number of women working in each brothel was not required to be documented. An average number of FSW per brothel was calculated for each province by dividing the estimated total number of FSW in the province (obtained from the Provincial AIDS Offices) by the total number of brothels in the province. To determine the number of clusters to select in order for a take-all sample to achieve a total provincial sample size of 150, the desired sample size (150) was divided by the average number of FSW per brothel. For example, if there were an average 10 FSW per brothel, 15 clusters were selected randomly with equal probability to achieve a sample size of 150. In a province with an average of 15 FSW per brothel, 10 clusters were selected. All women at the selected brothels were asked to participate in the survey and each woman had the right to refuse participation without repercussion.

After individual informed consent was obtained from the participant, a venous blood specimen was drawn and a specimen information sheet was completed. The specimen number, collection date, province, participant age, marital status, education level, duration of sex work, and nationality was recorded on the specimen information sheet. Information on each cluster was also completed, including the name and geographic location of the establishment, its cluster number, the total number of women present on the day the provincial surveillance team visited, the number of women who were invited to participate in the survey, and the number of women who chose not to participate.

Informal Female Sex Workers

For HSS 2003, IFSW were defined as women working as beer promoters or in karaoke establishments. The target sample size for IFSW was 177 per province. In provinces where the total number of IFSW was 177 or fewer, all IFSW in the province were sampled.

In provinces where the estimated number of IFSW was substantially more than 177, a two-stage cluster sampling methodology was used. For each province, all establishments employing women as beer promoters were listed and each establishment was considered one cluster. These establishments were mapped and visited by the provincial surveillance team. The number of clusters to be randomly selected in order for a take-all sample to achieve the desired sample size in each province depended on the average number of women employed at each establishment and was determined the same way as described above for FSW. All women at the selected establishments were asked to participate in the survey and each woman had the right to refuse participation without repercussion.

After individual informed consent was obtained from the participant, a venous blood sample was drawn and the specimen information sheet was completed. The specimen number, specimen collection date, province, participant age, marital status, education level, duration of employment as beer promoters or karaoke workers, and nationality was recorded on the specimen information sheet. Information on each cluster also was recorded, including the name and geographic location of the establishment, its cluster number, the total number of women who worked for the company as beer promoters, the number of women who were working at the establishment on the day the provincial surveillance team visited, the number of women who were invited to participate in the survey, and the number of women who chose not to participate.

Policemen

The target sample size for policemen was 300 per province. The sampling frame for policemen consisted of a list of bureau posts or stations within urban districts obtained from provincial surveillance teams, under the supervision of the provincial AIDS manager. The police bureau offices included immigration, anti-drug trafficking, anti-crime, logistics, and justice police. Districts that were inaccessible or accessible only with great difficulty were excluded from the sampling frame. The provincial AIDS managers were responsible for documenting which districts were excluded from the sampling frame.

Police were sampled using a 2-stage cluster approach designed to produce a non self-weighted systematic sample. In provinces where there were 300 or fewer police, all police were sampled. For provinces with more than 300 police, clusters were selected.

A fixed number of police were selected from each bureau (cluster). The fixed number depended on the minimum number of police to be found at the bureaus in each province. For example, if during the mapping process, it was found that all bureaus had at least 12 police, then the assumption was that 10 (allowing for refusal rate) men could be sampled from each bureau, and 30 clusters of 10 would need to be selected to reach the overall sample size of 300. In each province, the desired number of clusters was selected randomly with equal probability.

A random sample of police was recruited from each cluster. Arrangements were made with the bureau chief to convene all the men on the day of the survey. The predetermined number of men was randomly selected. Each man recruited was given the right to refuse to participate, in which case he was replaced by another randomly selected man.

After selecting participants, the provincial surveillance team obtained individual informed consent, drew a

venous blood sample, and completed the specimen information sheet for each participant. The specimen number, specimen collection date, cluster, province, participant age, marital status, and education level, was recorded on the specimen information sheet.

ANC women

Pregnant women who presented at sentinel ANC sites (Appendix II, Table 2) for their first prenatal visit were eligible for participation.

After obtaining individual informed consent for each woman recruited, ANC clinic staff drew a venous blood sample and completed the specimen information sheet. The specimen number, collection date, cluster, province, participant age, marital status, education level, and nationality were recorded on the specimen information sheet.

The target sample size was 300 for provincial capitals and 300 for remaining districts. Women were recruited consecutively (i.e., in the chronological order that they presented for services) until a sample of 300 was reached. Sampling stopped after a period of three months, regardless of whether the desired sample was achieved.

Table 2. Summary of sampling strategies

Sentinel group	Sampling strategy	Sample
FSW	Two-stage cluster sampling: equal probability sample of brothels at 1 st stage, take-all approach at 2 nd stage	Self-weighted, probability sample
IFSW	Two-stage cluster sampling: equal probability sample of establishments at 1 st stage, take-all approach or fixed number at 2 nd stage	Self-weighted, probability sample
Police	Two-stage cluster sampling: equal probability of urban police bureaus at 1 st stage, fixed number sampled from each selected cluster at 2 nd stage	Non-self-weighted, systematic sample
ANC	Consecutive sampling at purposively selected sentinel ANC sites	Non-probability sample

Training of personnel

Training for HSS 2003 was conducted at several levels:

1. A three-day pre-surveillance training workshop, primarily for provincial AIDS managers, was convened in Phnom Penh just before the start of data collection.
2. In each province, the Provincial AIDS Manager was responsible for establishing and training a provincial surveillance team and ANC clinic staff.
 - a. The provincial surveillance team had primary responsibility for conducting the survey among FSW, IFSW, and policemen. Training covered mapping, sampling, confidentiality, informed consent, universal precautions, specimen collection, processing and transport of specimens, and record keeping, including how to complete the specimen and cluster information sheets.
 - b. ANC clinic staff were responsible for conducting the survey among pregnant women. Their training covered eligibility criteria, the consecutive sampling technique, confidentiality, informed consent, universal precautions, specimen collection and handling, and record keeping, including completion of the specimen information sheet.
3. Three two-day regional laboratory trainings were convened for provincial surveillance team staff responsible for specimen collection, processing, testing, and recording of results. Specific topics covered were: universal precautions, performance of Determine™ HIV-1/2 (Abbott Diagnostics) and HIV 1/2 STAT-PAK (Chembio Diagnostics, Inc.) simple rapid HIV assays; interpretation and recording of test results; and preparation, drying, and storage of dried blood spot (DBS) specimens to be transported to the National Laboratory of Public Health (NLPH) for quality control testing.

4. NLPH Serology Department technicians were trained for two weeks on processing and testing DBS specimens by US CDC laboratorians. The proficiency of all staff performing quality control assays was evaluated by the US CDC instructors.

Specimen collection, handling, and HIV testing

Five milliliters of blood were collected from each participant into vacutainer tubes containing EDTA anti-coagulant. Specimens were stored in a cool box until transport each day to the provincial referral hospitals or laboratories. ANC specimens were stored in a cool box at the ANC clinics until they were picked up by PAO staff twice a week and delivered to the provincial laboratories for testing and preparation of DBS specimens.

WHO/UNAIDS Guidelines for Using HIV Testing Technologies in Surveillance¹ were followed:

- Whole blood specimens from all sentinel groups, regardless of historical prevalence, were tested with Determine.
- For sentinel groups with 2002 HIV prevalence of 10% or greater (FSW and IFSW groups):
 - Determine-non-reactive specimens were considered HIV-negative;
 - Determine-reactive specimens were considered HIV-positive.
- For sentinel groups with 2002 HIV prevalence less than 10% (police and ANC women), a sequential two-test algorithm was used:
 - Determine-non-reactive specimens were considered HIV-negative;
 - Determine-reactive specimens were retested with Stat-Pak (reportedly more specific than Determine) to confirm results.

¹UNAIDS/WHO. Guidelines for Using HIV Testing Technologies in Surveillance: Selection, Evaluation, and Implementation. UNAIDS/01.22E. 2001

This prevalence-specific algorithm has been recommended to rule out false-positive results in groups with low positive predictive value, i.e., groups with low HIV prevalence.

Testing was done at sites other than where specimens were collected or after the participant had left the premises. At the time rapid tests were performed, DBS were prepared following standard operating procedures developed by NLPH. DBS were allowed to dry completely and stored with desiccant until transport to the NLPH in Phnom Penh. DBS were stored in Phnom Penh at -80° until the time of quality control testing.

Quality control testing

For quality control of laboratory testing, approximately 10% of HIV specimens were retested using the following algorithm:

- For FSW and IFSW groups, DBS filter paper cards were prepared on every tenth specimen regardless of initial test result.
- For the ANC and policemen groups, DBS cards were prepared on all the positives and a 10% sample of the negatives.

DBS specimens were tested at NLPH using two enzyme immunoassays (EIAs)—Vironostika HIV Uni-Form II Plus O® (Organon Teknika) and Murex HIV-1.2.O (Abbott Diagnostics). New LAV Blot I (Bio-Rad Laboratories) Western blot assay was performed on specimens with discordant EIA results.

As a validity check, a subsample of 500 DBS, stratified by sentinel group, was drawn and tested at the Centers for Disease Control and Prevention¹ (Atlanta, Georgia, USA), using the same assays. Reactive specimens were oversampled to achieve a subsample with approximately 40% reactive specimens.

Prior to conducting HSS 2003, stored specimens from HSS 1999, 2000, and 2002 which were previously

identified as HIV-positive had been retrieved for a study² of HIV incidence. Specimens were retested using Genetic Systems™ rLAV HIV-1 and Genetic Systems™ HIV-1/HIV-2 Peptide (BioRad Laboratories). After approximately 11% were determined to have been false positive, a 5% random sample of specimens which had initially tested negative was drawn from surveillance group- and survey year-specific batches of stored specimens. Negative specimens were retested with the particle agglutination test, Serodia®-HIV-1/2 (Fujirebio, Inc.) and the enzyme linked immunoassay, GENSCREEN® (BioRad Laboratories). Specimens positive by both tests were confirmed using the Western blot assay, New LAV Blot I and II (Bio-Rad Laboratories) for final determination.

Data entry, adjustments, and analysis

HSS data were entered by NCHADS staff into a computerized database using Epi-Data and analyzed with Stata-8, software programs with which NCHADS staff are familiar.

Quality control adjustments:

Based on results of HSS 2003 quality control testing, province- and group-specific false positive and false negative rates were calculated for each sentinel group (FSW, IFSW, policemen, and ANC women). These rates (Appendix III, Table 3) were used to adjust results for interprovincial variation in test performance (see Appendix III, Technical Notes).

National group-specific false positive and false negative rates were likewise calculated based on results of retrospective QC testing for survey years 1999, 2000, and 2002 and used to adjust group- and year-specific prevalence. Because rates did not vary widely by year within each sentinel group, the Consensus Working Group proposed that the rates for three years be averaged to adjust survey data collected before 1999. Adjusting all the data consistently rendered them comparable and allowed us to observe trends in prevalence.

¹ National Center for HIV, STD, and TB Prevention/Division of AIDS, STD, and TB Laboratory Research
² Saphonn V, Parekh BS, Dobbs T, et al. Trends of HIV-1 seroincidence among HIV-1 sentinel surveillance groups in Cambodia, 1999-2002. *J Acquir Immune Defic Syndr* 2005; 39:587-92

Population adjustments:

National ANC prevalence for 2003 was estimated by adjusting (weighting) the data using the 2003 province-specific female population aged 15-49 years (see Appendix III, Technical Notes, Table 4). National police prevalence was estimated using 1998 census data because no reliable population data were available for 1993—the year the police force stopped actively recruiting. Results for FSW were adjusted using province-specific population estimates of FSW; these estimates were not available for IFSW and thus, IFSW data were not adjusted.

Smoothing:

For trend analysis, the Estimations and Projections Package (EPP) was used to smooth the data. Smoothing attenuates fluctuation due to sampling variation and generates a trend line consistent with current knowledge about the dynamics of Cambodia's HIV epidemic.

Provincial data:

Appendix IV presents provincial data. In 2003 it was possible to adjust provincial data using quality control (QC) results to improve the accuracy of prevalence estimates. Because the sampling method used to select specimens for QC retesting were stratified by sentinel group and year but not by province, province-specific adjustments could not be made for survey years 1996-2002. Furthermore, because provincial level age-specific population data for the IFSW group is not available, data from this group could not be weight-adjusted; and, because this group's composition has changed with each survey, the data could not be smoothed. Owing to the large fraction of the total FSW population sampled, sampling variation was minimal and data smoothing was not necessary for calculating provincial-level estimates. Adjustments made to the data are summarized in Table 3.

Table 3. Treatment of provincial data by sentinel group and survey year

Sentinel group	For national prevalence estimates ¹		For province-specific prevalence estimates	
	1996 - 2002	2003	1996 - 2002	2003
Female sex workers	QC-adjusted Weighted Smoothed	QC-adjusted Weighted Smoothed	Not QC-adjusted Not weighted Not smoothed	QC-adjusted Not weighted Not smoothed
Informal female sex workers	QC-adjusted Not weighted Not smoothed	QC-adjusted Not weighted Not smoothed	Not QC-adjusted Not weighted Not smoothed	QC-adjusted Not weighted Not smoothed
Policemen	QC-adjusted Weighted Smoothed	QC-adjusted Weighted Smoothed	Not QC-adjusted Not weighted Smoothed	QC-adjusted Not weighted Smoothed
ANC women	QC-adjusted Weighted Smoothed	QC-adjusted Weighted Smoothed	Not QC-adjusted Not weighted Smoothed	QC-adjusted Not weighted Smoothed

¹ Provincial data aggregated

Provincial-level data should not be used to calculate province-specific prevalence in the general population because the sampling methods were not designed with this objective in mind. Furthermore, provincial data should not be compared with previously published data—previous results included a substantial proportion of false positives (21.0-25.5% of ANC results from 1999-2002) and false negatives. Although retrospective retesting of specimens from 1999-2002 have allowed us to adjust national results for trend analysis, provincial quality control adjustments could only be made for 2003.

Timeframe

The timing of HSS data collection has shifted slightly each year (Table 4). HSS 2003 began in August 2003 and data collection was concluded within four months. Quality control testing was delayed until May 2004 and results, including validity testing in the United States, were finalized in September 2004. A dissemination meeting was convened in December 2004 to present preliminary results.

Table 4. Timeframe for HSS data collection

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996												
1997												
1998												
1999											1999	1999
2000	1999	1999									2000	2000
2001	2000											
2002												
2003												



RESULTS

Sample size

A total of 20,706 specimens were collected from the four sentinel groups in 2003 from 22 provinces compared with 16,889 collected in 2002 from the same groups from 20 provinces. Sample

sizes for the four most recent HSS rounds are shown in Table 5 (changes in HSS sentinel sites and groups from 1992 through 2003 are summarized in Appendix I, Table 1).

Table 5. Comparison of sample sizes from 1999 through 2003

Sentinel Group	Year (number of provinces)			
	1999 (20)	2000 (21)	2002 (20)	2003 (22)
Female sex workers	2,259	2,180	2,110	2,411
Informal female sex workers*	1,488	1,799	1,232	1,633
Policemen	4,141	4,711	4,379	5,796
Antenatal clinic attendees	5,397	6,562	9,168	10,866
Total	13,285	15,252	16,889	20,706

* Informal female sex workers included: beer promoters and freelance sex workers (defined as women working in bars, karaoke lounges, and massage parlors) in 1999; beer promoters and women working in bars, karaoke lounges, and massage parlors in 2000; beer promoters and women working in beer gardens and karaoke lounges in 2002; and beer promoters and karaoke workers in 2003.

Percent refusal

The proportion of refusals for each sentinel group by province is shown in Table 6. The percent refusal among ANC (1.9%) in 2003 was identical to that in 2002, but refusal rates among all other groups were lower than those observed in HSS 2002.

Quality control testing results

Quality control (QC) testing demonstrated that test performance of the rapid testing algorithm was excellent in most provinces. Overall sensitivity (ability to identify HIV-positive specimens), however, was lower than the 99% expected. Because QC results indicated lower than expected sensitivity, and because the NLPH quality QC testing results had been validated (98% agreement with US CDC laboratory results), QC results were used to adjust the raw survey data (see Appendix III, Technical Notes for detail).



Table 6. Percent refusal by province and sentinel group, 2003

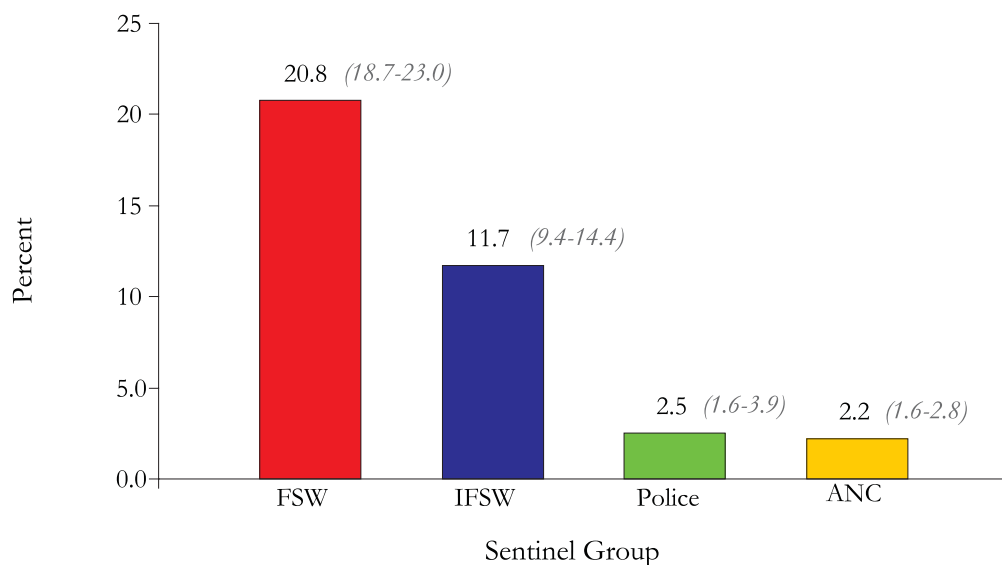
No.	Province	FSW	IFSW	Police	ANC
1	Banteay Meanchey	3.8	2.6	0.0	0.0
2	Battambang	18.1	17.1	13.0	17.3
3	Kampong Cham	0.0	0.0	0.0	0.0
4	Kampong Chhnang	2.0	0.0	0.0	0.0
5	Kampong Speu	1.8	0.0	0.0	0.6
6	Kampong Thom	2.2	16.7	6.6	1.8
7	Kampot	1.3	9.2	7.6	0.0
8	Kandal	8.5	4.9	18.8	0.3
9	Koh Kong	1.0	8.2	1.8	1.5
10	Kratie	0.0	0.0	0.0	0.0
11	Oddar Meanchey	0.0	0.0	0.0	1.3
12	Pailin	0.0	0.0	0.0	0.0
13	Phnom Penh	2.0	8.7	13.7	4.7
14	Preah Vihear	22.0	21.6	3.5	1.9
15	Prey Veng	0.0	0.0	0.0	0.0
16	Pursat	1.5	30.8	0.0	0.0
17	Ratanak Kiri	0.0	0.0	0.7	0.0
18	Siem Reap	3.2	12.7	0.0	1.0
19	Sihanoukville	0.0	3.2	5.0	0.9
20	Stung Treng	3.3	40.0	27.1	0.6
21	Svay Rieng	0.0	0.0	0.0	0.0
22	Takeo	1.6	4.3	0.4	1.2
	Total	3.4	7.6	4.5	1.9

HIV seroprevalence by sentinel group, 2003

Figure 1 shows the HIV seroprevalence in each of the four sentinel populations included in HSS 2003. Results shown include HIV seroprevalence point estimates and 95% confidence intervals. Data are adjusted for results of quality control testing and appropriate population weights. As in previous HSS

rounds, the FSW group had the highest HIV seroprevalence followed by IFSW and policemen; the ANC group had the lowest seroprevalence. In each sentinel group, HIV seroprevalence was lower than that estimated in HSS 2002. Although HIV seroprevalence results should not be compared with previously published results, retesting HSS samples from previous years has allowed us to revise and improve the accuracy of estimates for each sentinel group.

Figure 1. HIV seroprevalence* among sentinel groups in Cambodia, 2003



* HIV seroprevalence estimates (and 95% confidence intervals) are based on HSS data adjusted for results of quality control; police and ANC data are weighted for provincial population size; FSW and IFSW data are not weighted.

Trends by sentinel group

HIV seroprevalence among antenatal care attendees

Figure 2 shows: (1) the trend in HIV prevalence among ANC attendees adjusted for quality control results and weighted for provincial population size; and (2) the EPP-smoothed trend line. The proportion of ANC women living with HIV appears to have declined slightly

from 1999 through 2003. This decline should not be interpreted to mean that the number of women living with HIV has decreased—the decline is partially due to the fact that the Cambodian population is growing rapidly and each year a larger number of uninfected young women enter the 15-49 year age group, i.e., each year the population denominator is increasing more rapidly than the numerator is decreasing.

Figure 2. Estimated HIV prevalence among pregnant women attending ANC clinics in Cambodia, 1996-2003

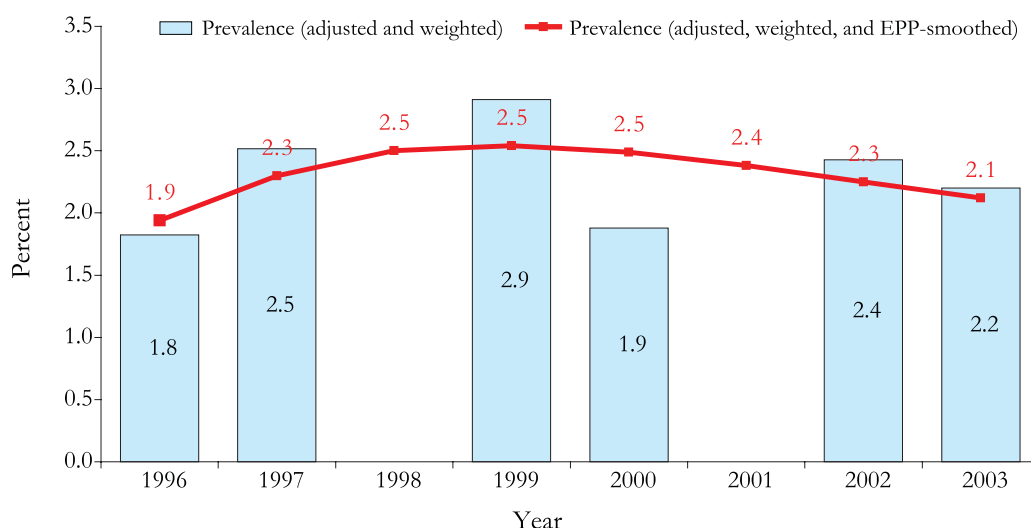
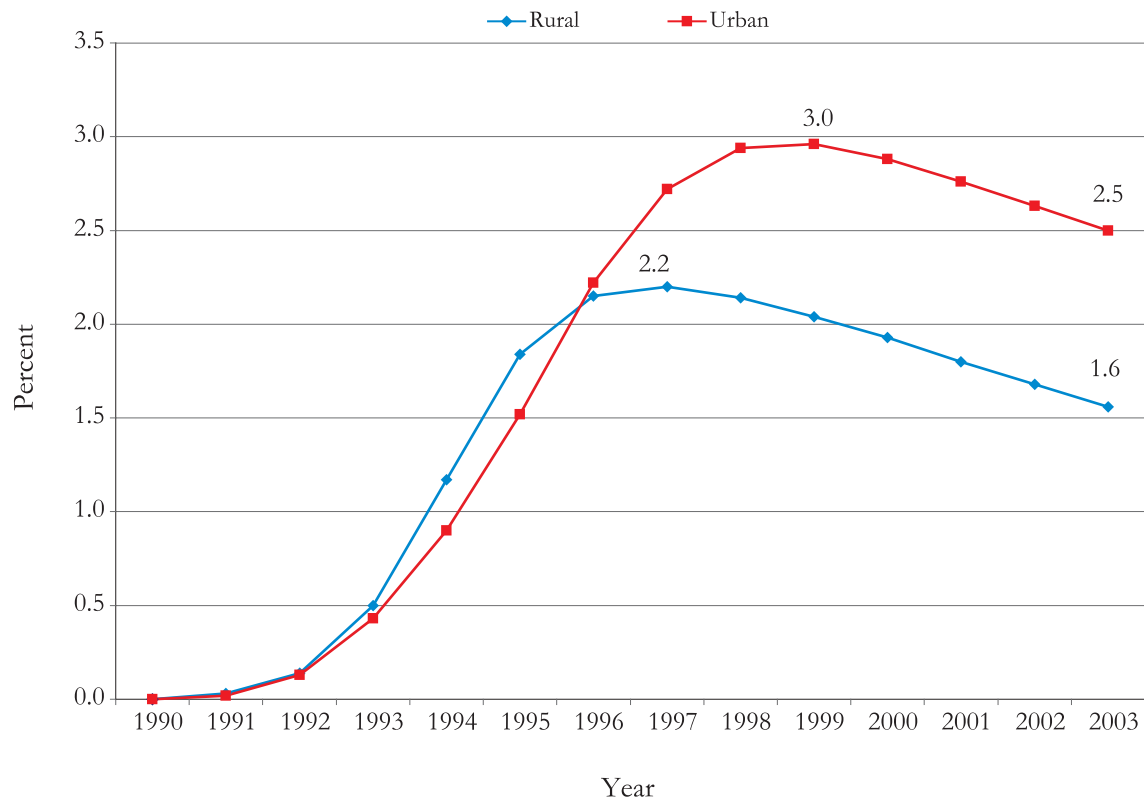


Figure 3. Estimated HIV prevalence among pregnant women attending ANC clinics in Cambodia, by urban or rural location, 1990-2003



HIV infections are usually not evenly distributed between urban and rural areas. *Figure 3* shows the trends in HIV prevalence among ANC women in provincial capitals (urban) and in remaining districts (rural). HIV prevalence appears to be increasing at a faster rate in rural areas than in cities. In rural areas, HIV prevalence among ANC women peaked two years earlier and at a lower level than in the cities. In 1996, HIV prevalence among urban ANC women surpassed that among rural women; in each year since 1999, prevalence has been about one percentage point higher than that among rural women.

HIV seroprevalence among brothel-based female sex workers

Figure 4 shows: (1) the trend in HIV prevalence among FSW adjusted for quality control results and weighted for provincial population size; and (2) the EPP-smoothed trend line. In 2003, the proportion of FSW living with

HIV (21.4%) is less than half the 1998 prevalence (45.8%). In 2003, one of every five to six FSW was living with HIV.

HIV prevalence among young persons who have only recently engaged in high risk behavior is thought to serve as a proxy for HIV incidence (new infections). Indeed, data from Cambodia's 2003 Behavioral Surveillance Survey (BSS) indicate that brothel-based FSW younger than 20 years of age have been working in the profession for an average of 14 months. *Figure 5* shows trends in HIV prevalence among brothel-based FSW aged 15-19 years and those aged at least 20 years. Since 2000 the two trend lines have diverged—prevalence among young FSW is decreasing faster than HIV prevalence among FSW aged 20 or older. This difference suggests declining HIV incidence among young brothel-based FSW.

Figure 4. Estimated HIV prevalence among brothel-based female sex workers in Cambodia, 1996-2003

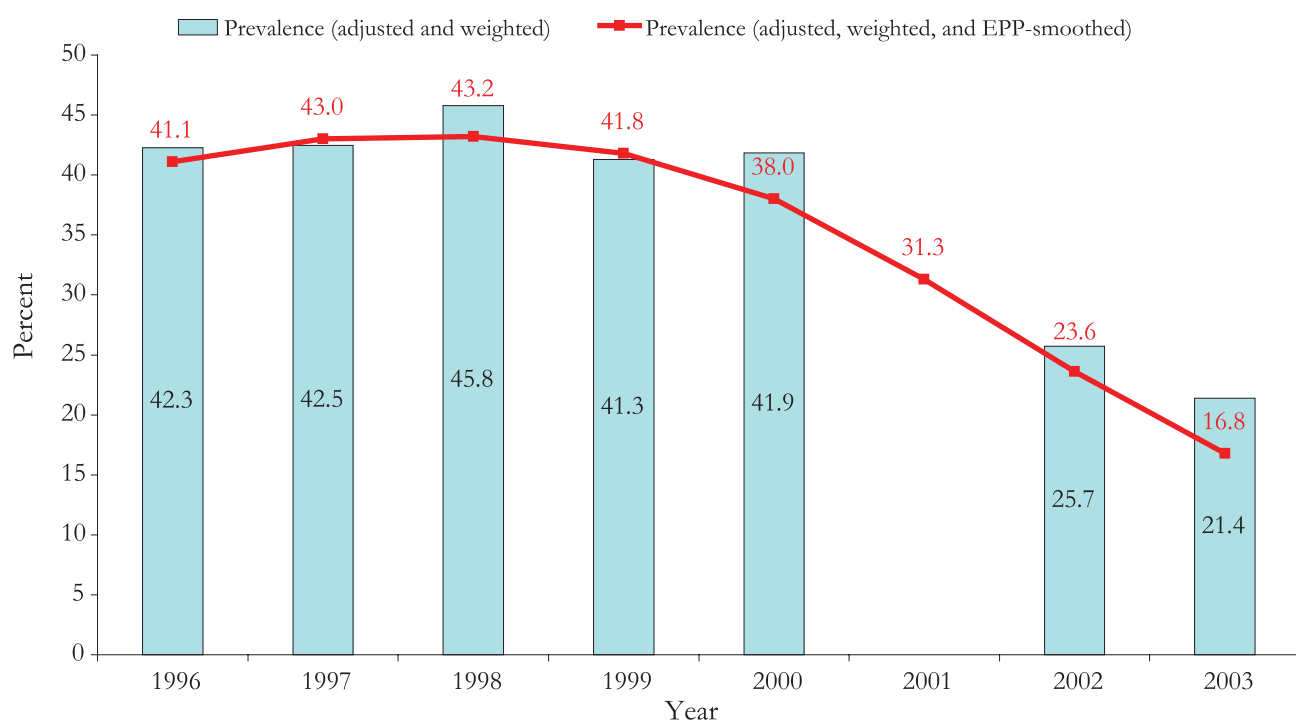
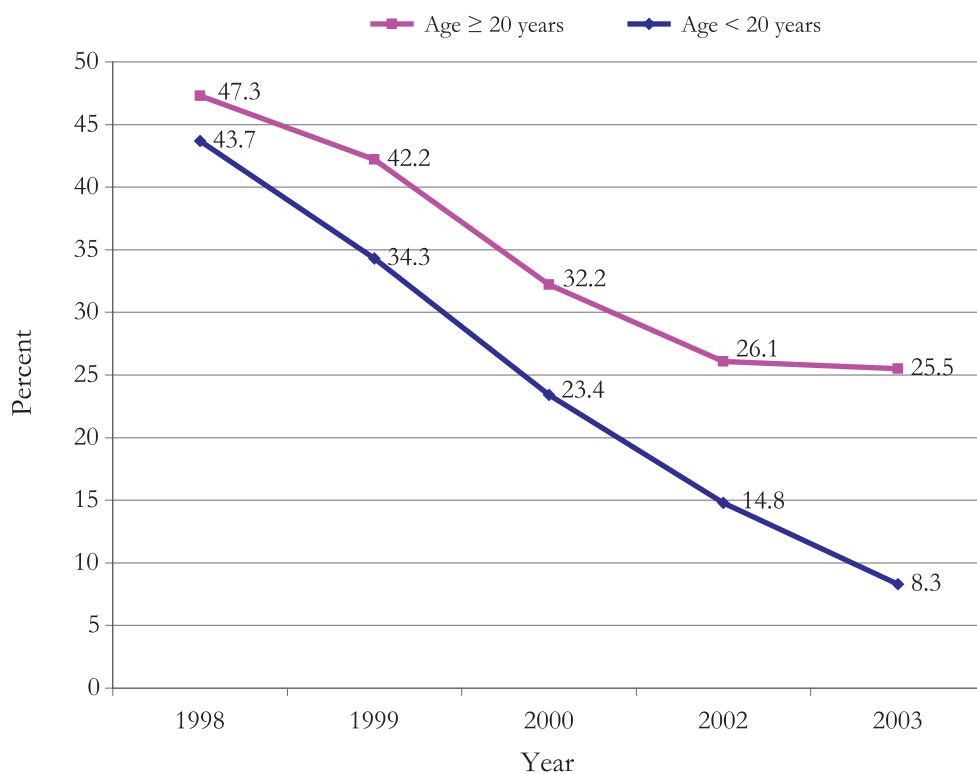


Figure 5. Estimated HIV prevalence among brothel based sex-workers in Cambodia, by age group, 1998-2003



HIV seroprevalence among informal female sex workers

From one HSS round survey to another, the IFSW group has been defined differently and has comprised women working in one or more occupational groups including beer promoters, karaoke lounge workers, massage parlor workers, women working in bars or beer gardens, or freelance sex workers (the latter group comprising several of the former groups). Some women working in these occupations earn additional income by selling sex. Behavioral surveillance has shown that both the proportion of women selling sex and the monthly average number of clients varies greatly between these occupational groups. BSS 2003, for example, found:

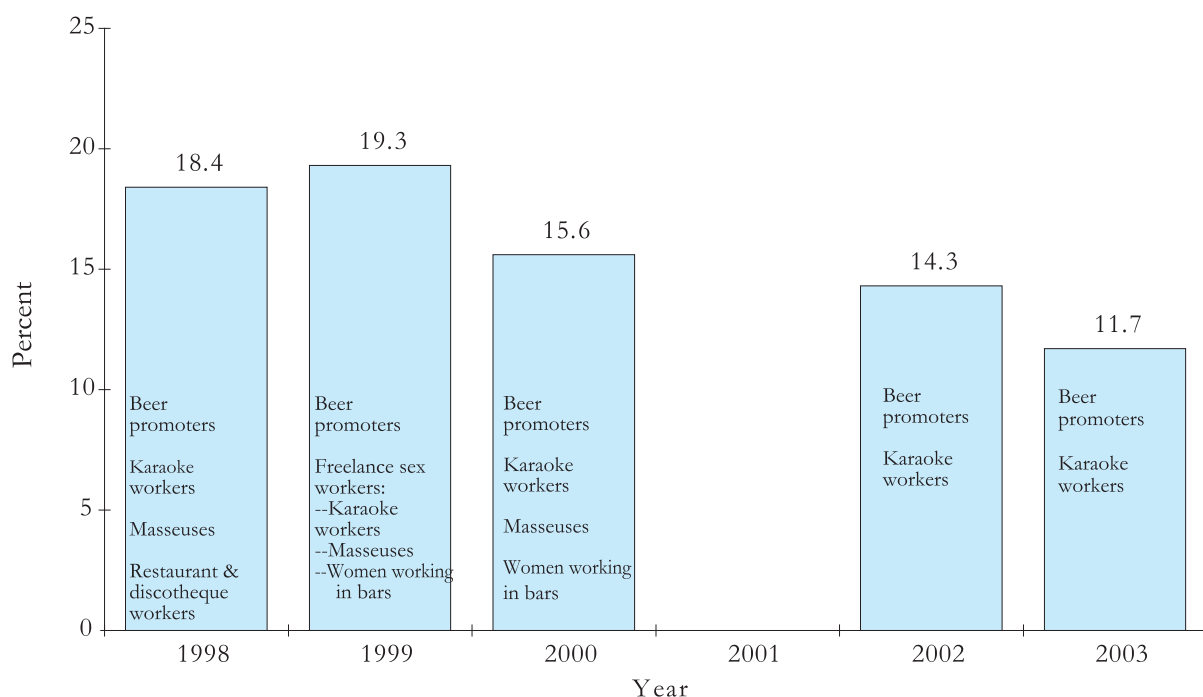
- 6% of beer promoters versus 21% of karaoke workers reported never having had sex;
- 40% of beer promoters versus 56% of karaoke workers acknowledged having sold sex in the past year;

- Beer-promoters who acknowledged selling sex reported an average of one client in the past month compared with karaoke workers who reported two; and
- Beer-promoters had been on the job an average of 14 months compared with karaoke workers who had been on the job only 7 months.

Figure 6 shows HIV prevalence among IFSW from 1998 through 2003. These data should not be interpreted as trend data because they have been obtained from a group that has changed from one survey to the next and that has included women whose prevalence of risk behavior is widely variable, even within the same survey.

In 2003, HIV seroprevalence among beer promoters younger than 20 years old was 3.6% compared with 13.6% among those aged 20 or older. Although prevalence in the younger age group may be used as proxy for incidence, the approximation is not as robust as for brothel-based FSW, among whom all are sexually active and sell sex. As mentioned above, 6% of beer promoters reported never having had sex and only 40% reported having sold sex in the previous year.

Figure 6. Estimated HIV prevalence among informal female sex workers in Cambodia, 1998-2003*

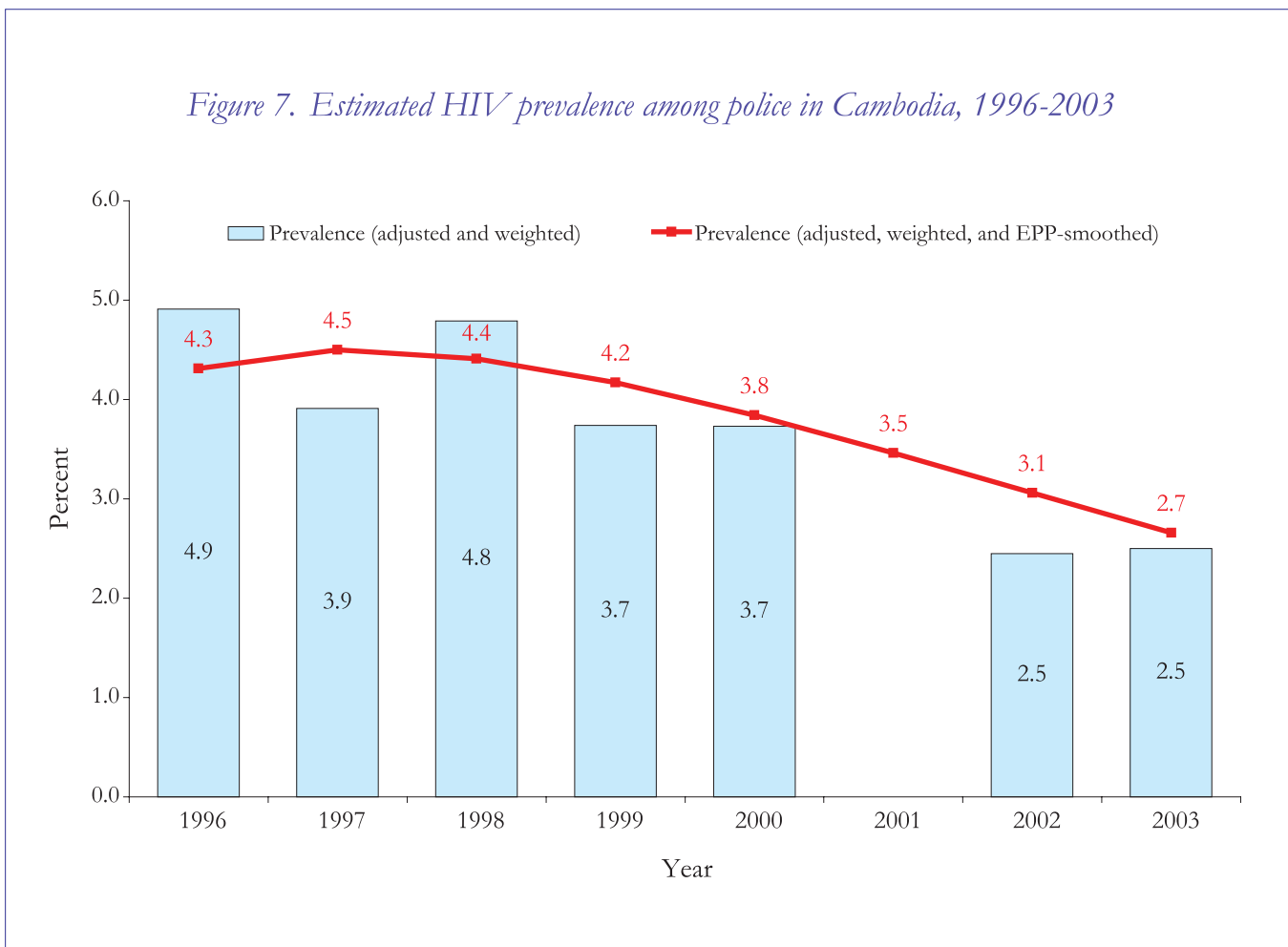


*Data were adjusted for results of quality control, but not weighted or EPP-smoothed

HIV seroprevalence among police

Policemen, as a sentinel group, do not represent the general male population or help us to understand the dynamic of HIV among Cambodian men. The Cambodian male population is young—among Cambodian men aged 15-49 years, 59% are younger than 25 years. In contrast, less than 1% of police in the same age group are younger than 25 years. The police group represents an aging cohort of men because active recruitment of police was more or less suspended in 1993. Policemen, however, serve as a proxy for FSW clients. Indeed, in 2003, 33% of police reported having had sex with a FSW in the past year (BSS 2003), compared with only 8% of Cambodian men who reported this behavior in a household survey conducted the same year (PSI 2003).

Figure 7 shows: (1) the trend in HIV prevalence among policemen, adjusted for quality control results and weighted for provincial population size; and (2) the EPP-smoothed trend line. The proportion of police living with HIV has been declining since it peaked at 4.5% in 1997. The decline is largely attributable to mortality in this group. Incidence has likely decreased as well, because a large proportion of men who practice high risk sexual behaviors have already been infected and others have adopted protective measures to prevent sexual exposure. From 1998 through 2003, the proportion¹ of police who reported having sex with non-marital partners in the past year dropped from 48% to 36%, and consistent condom use with FSW in the past 3 months rose from 59% to 94%.



¹ National Center for HIV/AIDS, Dermatology and STDs. *Cambodia 2003 Behavioral Surveillance Survey Report*. Phnom Penh, Cambodia. 2005.

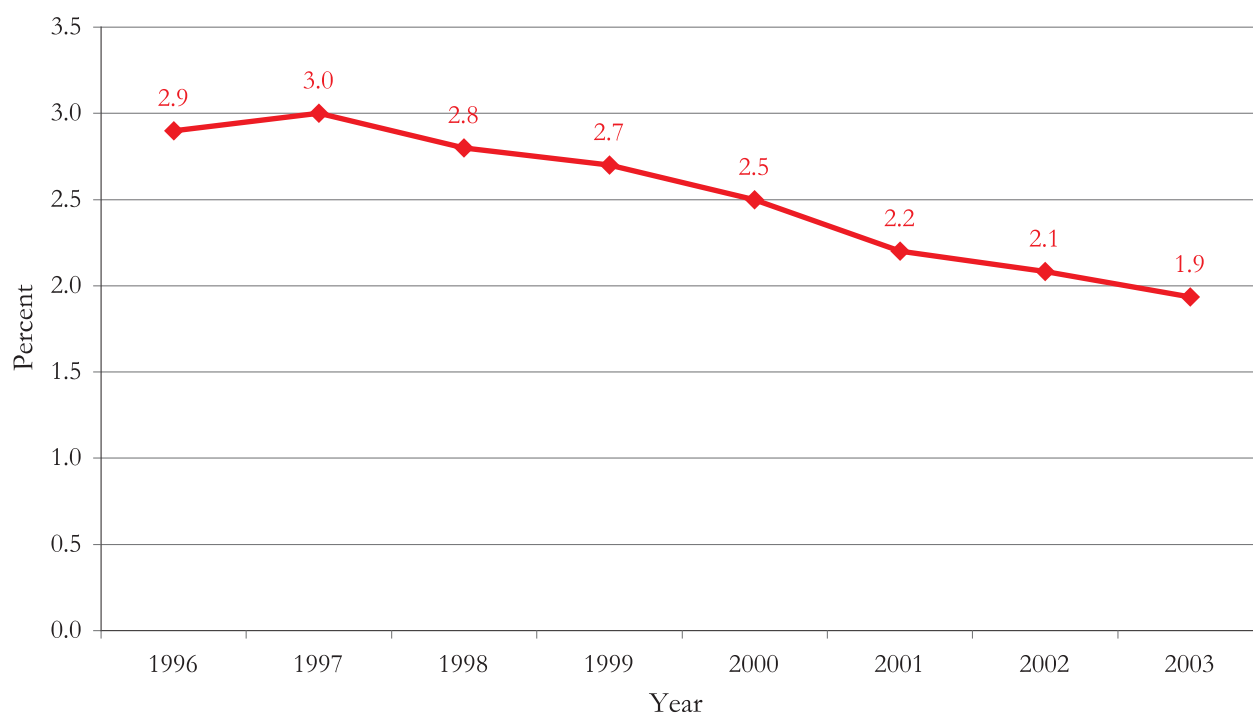
Modeled national trends

HIV prevalence among Cambodian adults

Figure 8 illustrates the modeled trend in HIV prevalence among Cambodian adults aged 15-49 years. The overall proportion of Cambodian adults living with HIV peaked at 3.0% in 1997 and decreased consistently to 1.9% by 2003. As mentioned above, this decline is the result of a reduced number of new infections and increased mortality. In addition, the Cambodian population is growing rapidly with large cohorts of youth diluting percent prevalence. Percent prevalence is calculated by dividing the number of persons living with

HIV (numerator) by the population (denominator) at a specified period in time. Prevalence declines may result from a decrease in new HIV infections, an increase in deaths among persons with HIV, or both. However, the absolute number of persons living with HIV may stay the same (i.e., if the number of new infections and deaths neither increase nor decrease) but if the denominator increases due to a rapidly growing population, the percent living with HIV will decline. Therefore, without data on incidence and deaths, we must also examine trends in the number of persons living with HIV/AIDS for a better understanding of the dynamics of the epidemic. This is done by modeling with the available data (see Appendix III, Technical Notes).

Figure 8. Estimated HIV prevalence among adults aged 15-49 years in Cambodia, 1996-2003*

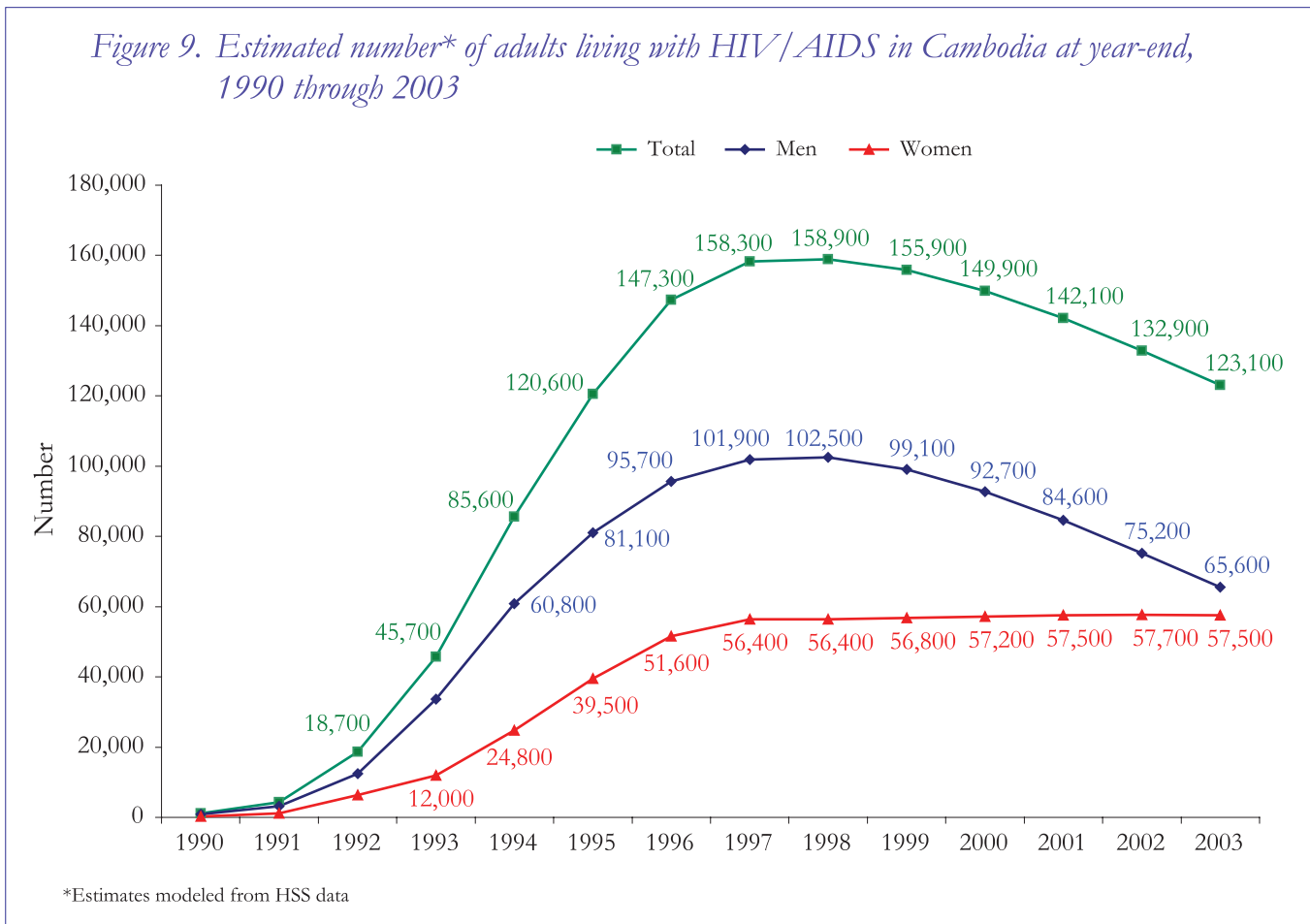


*EPP-smoothed data

Number of Cambodian adults living with HIV

Figure 9 shows the estimated number of Cambodians aged 15 to 49 who were living with HIV, by year. The number peaked at 158,900 in 1998 and decreased

to 123,100 by the end of 2003. The overall trend, however, masks gender disparities. The pattern among men is similar to that overall; however, the number of women living with HIV reached a plateau in 1997 and has not declined since then. Explanation for the variation in epidemic dynamics is provided below.



HIV/AIDS incidence and mortality

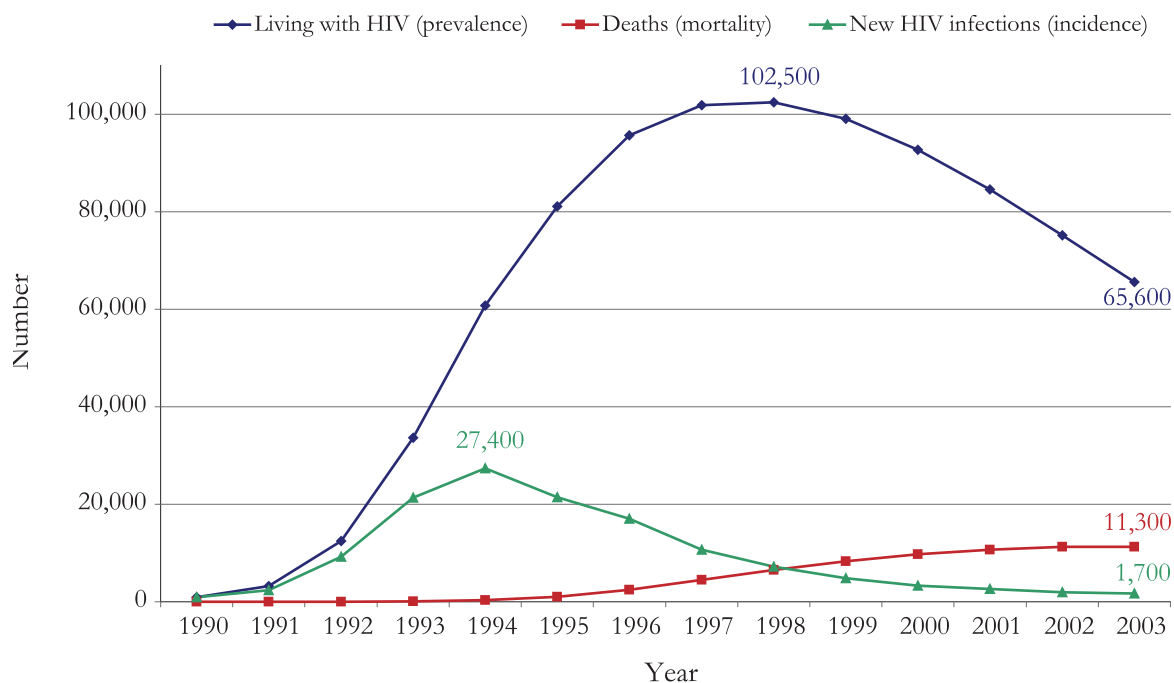
Trends in the number of people living with HIV/AIDS, newly infected with HIV, and who have died from AIDS are presented in Figure 10 for men and Figure 11 for women.

Among men, HIV incidence (number of new infections) peaked in 1994 and has declined steadily, meaning that fewer men became infected each year after 1994. Men were infected primarily through sex with FSW; declines in new HIV infections are likely related to changes in sexual behaviors of FSW and their clients

(BSS 2003). These changes include an increase in the proportion of men who use condoms consistently during sex with FSW and a decrease in the proportion of men who visit FSW.

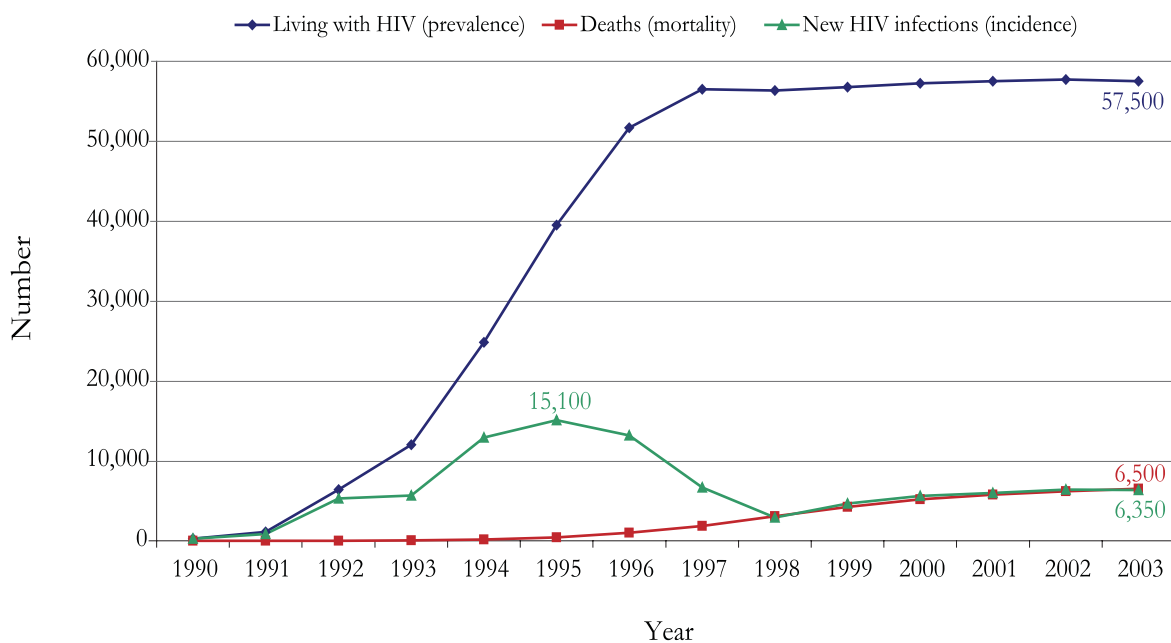
Among women, HIV incidence did not increase as quickly or to the same level as it did among men. The peak in HIV incidence among women was reached one year after the peak among men. The delayed rise in incidence among women compared with that among men supports the hypothesis that most women get infected by their husbands.

Figure 10. Estimated number* of new HIV infections (incidence) and HIV-related deaths (mortality) among Cambodian men aged 15-49, and estimated number living with HIV (prevalence)



*Estimates modeled from HSS data

Figure 11. Estimated number* of new HIV infections (incidence) and HIV-related deaths (mortality) among Cambodian women aged 15-49, and estimated number living with HIV (prevalence)



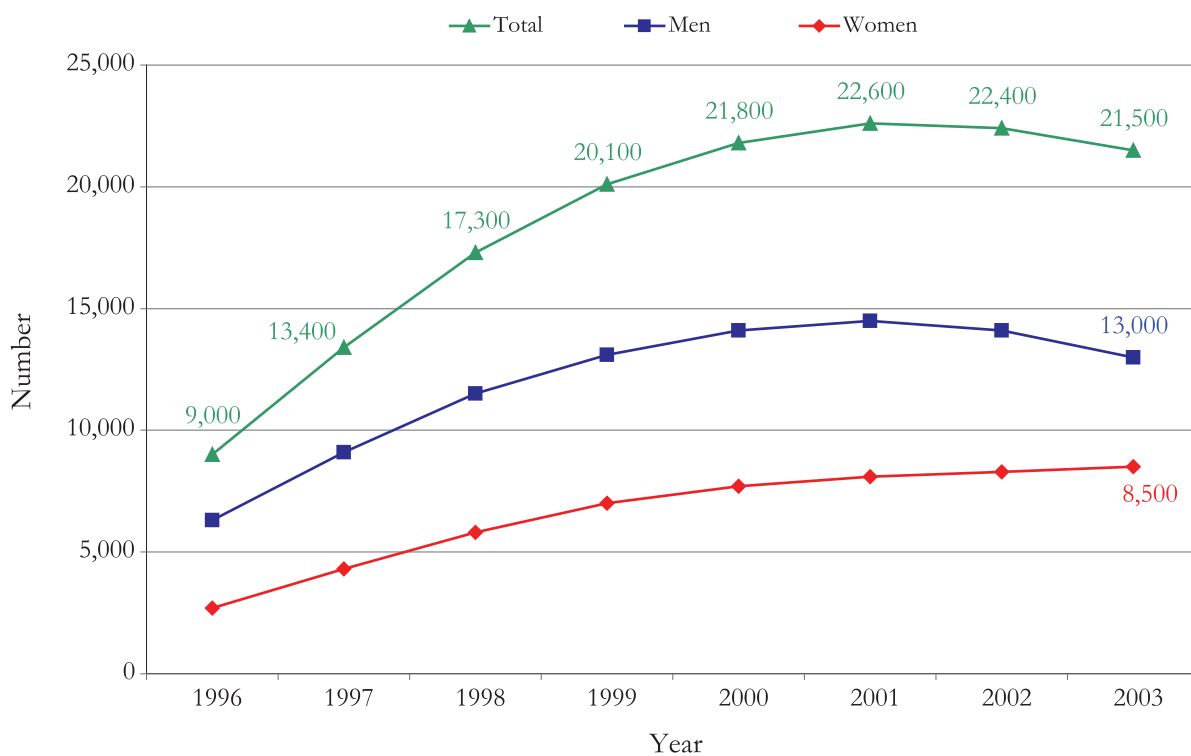
*Estimates modeled from HSS data

Since 1998, the annual number of deaths (mortality) and new HIV infections (incidence) among women has been rising at the same level, balancing the effect of one another. Consequently, the number of women living with HIV has not changed substantially since 1998. HIV-infected women primarily comprise two subpopulations: those infected while working as FSW and those infected by their husbands. The first epidemic wave of HIV among women includes both of these subpopulations (Figure 11). HSS prevalence data presented earlier suggest HIV incidence among young FSW has decreased consistently since the year 2000. In contrast, the estimated number of new HIV infections among women most likely infected by their husbands has risen over the period from 1998 through 2003, with a growing number of HIV-infected women becoming widows. The second wave of new HIV infections among women represents primarily women infected by their husbands.

Number of adults living with AIDS

The number of adults living with AIDS (Figure 12) was estimated using an average rate of progression from new HIV infection to development of AIDS. The number of people living with AIDS peaked at 22,600 in 2001 and declined slightly to 21,500 by the end of 2003. AIDS prevalence peaked among men in 2001 whereas it has grown slowly but steadily among women and has not appeared to peak. Figure 12 illustrates that a large number of people are in need of care and treatment and justifies the nationwide scale-up of continuum-of-care activities that were first implemented in Cambodia in 2002. The number of people living with AIDS represents the absolute minimum number of people in need of treatment.

Figure 12. Estimated number* of persons aged 15-49 living with AIDS at the end of each year, Cambodia, 1996-2003



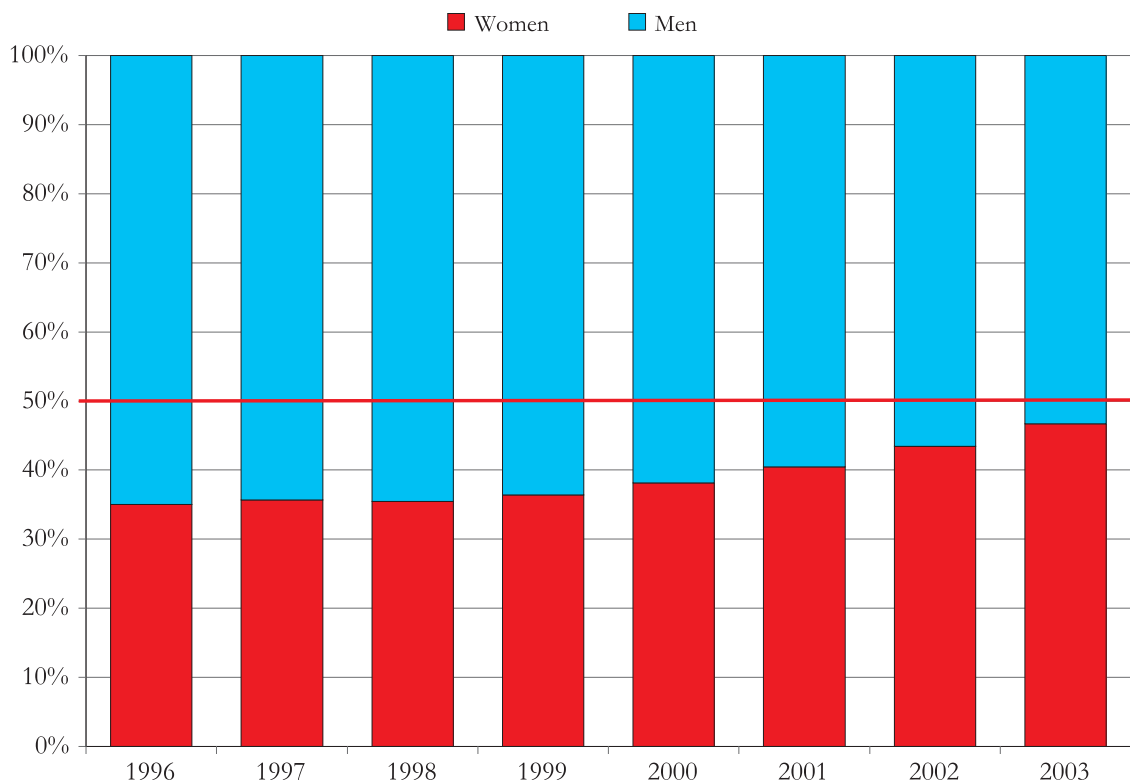
*Estimates modeled from HSS data

Women represent a growing proportion of persons living with HIV

Figure 13 illustrates the growing proportion of women among persons living with HIV. As the epidemic has matured, the proportion of women among adults living with HIV has increased from 36% in 1996 to almost 50% in 2003. The increasing proportion of women among persons living with HIV has an impact on the relative proportions of HIV infections attributable to various HIV transmission routes. In other words, an increasing proportion of new infections may be attributable to mother-to-child transmission as HIV-infected women become pregnant and pass on the virus through delivery and breastfeeding. Cambodian women give birth to about 4 children, on average; in the absence of preventive treatment, likelihood of HIV transmission

from mother to child is 33%. If one in three infants who are exposed becomes infected, and women have four children after they themselves become infected, each infected woman can give birth to more than one infected child. Rapid scale-up of programs aimed at preventing mother-to-child transmission are urgently needed.

Figure 13. Percent distribution of Cambodian adults living with HIV by sex, 1996 through 2003





DISCUSSION AND CONCLUSIONS

Cause for continued cautious optimism and serious concern

In recent years there has been cause for cautious optimism in Cambodia because HSS data have indicated that the HIV epidemic is slowing down. The prevalence of HIV has declined or stabilized in all sentinel populations, and great strides have been made in reducing risk behaviors that drive the spread of HIV. Although the decline in prevalence among adult men in Cambodia is partially due to HIV related deaths, HIV incidence among men has markedly declined from an estimated peak of 27,400 new infections in 1994 to approximately 1,700 in 2003. These data provide strong evidence that prevention efforts have had an impact on the epidemic by influencing the reduction in proportions of men engaging in commercial sex (the main engine of early HIV spread in Cambodia) and increased proportion of commercial sex transactions in which condoms are consistently used.

The reduction in new infections among males (primarily clients of sex workers) translated into similar reductions among the female partners of these men, as evidenced by a decrease in estimated new HIV infections from 15,100 in 1995 to 2,930 in 1998 (*Figure 11*). Of serious concern, however, is that since 1998, HIV incidence among women appears to be rising slowly, to as high as 6,350 new infections in 2003, almost four times the number among men in the same year.

Continued high prevalence of HIV infection among female sex workers

Despite declining prevalence among FSW, and declining incidence among young FSW, HIV prevalence and incidence of new infections is still very high. The prevalence of HIV among FSW overall is 21.4%; 8.3% of FSW younger than 20 are HIV infected, among whom the majority of HIV infections are likely to be

recent. The pattern of continued high incidence in FSW may seem surprising considering the decline in new infections among their clients. However, high rates of condom use can be expected to be more protective for clients of FSW than for the women themselves—despite condoms being used in the majority of commercial sex acts, individual FSW, on average, have far more unprotected sex acts than their male partners, making them highly vulnerable to HIV infection and other sexually transmitted infections. The current levels of new infections among FSW are unacceptably high and indicate that prevention efforts among FSW and their clients, while having made some headway, are not yet sufficient.

Continued high levels of husband-to-wife and mother-to-child transmission

The continued high incidence of HIV among FSW means that the potential for a new wave of infections among clients of FSW is a very real danger, especially if current levels of condom use are not sustained. The relative proportions of men and women living with HIV are almost equal now, and husband-to-wife transmission is still a major area of concern. Approximately 6,350 new infections occurred among women in 2003, almost four times the number among men. If a second wave in the number of men becoming infected occurs, the situation among women will become even worse. Given that an estimated 57,500 women are thought to have been living with HIV at the end of 2003, the number of children infected through mother-to-child transmission can be expected to rise. Although HIV prevalence among FSW is still high, surveillance data suggest that prevention programs aimed at reducing commercial sex-related risk have paid off for both FSW and their male clients and need to be sustained. Urgently needed are prevention programs aimed at reducing husband-to-wife and mother-to-child transmission.

LIMITATIONS



Lack of male sentinel populations

A weakness of the surveillance system in Cambodia is the lack of direct measures of HIV prevalence among men other than police. Given the difficulties posed in interpreting the police data (described above), HIV prevalence among men in the general population is estimated indirectly from ANC data (see Appendix III, Technical Notes). Despite these limitations, the 2003 estimates make epidemiologic sense given what is known about changes in behavioral patterns, i.e., lower proportions seeking commercial sex and higher proportions using condoms consistently. If levels of men buying sex start to increase or levels of consistent condom use start to decline, resulting increases in HIV prevalence among clients will not be reflected by the surveillance data for several years. This is several years too late! The only data currently available to track changes in male risk are from the behavioral surveillance system. Although a better and more immediate source of HIV prevalence data among men is needed, most countries, including Cambodia, are struggling with the lack of good data on the general male population. The Cambodia Demographic and Health Survey conducted in 2005 will provide an estimate of HIV prevalence among Cambodia's household population, both male and female.

Refusal rates

The HSS system in Cambodia relies on participation of sentinel group members. Although HIV testing is performed in an unlinked, anonymous fashion, the system does not use leftover blood specimens which have been collected for other purposes and then tested for HIV. Each person who provides a blood sample for HSS does so with the knowledge that their blood will be tested for HIV, and with the knowledge that the results

of the test will not be available to them. They are also informed that all identifiers will be removed so that the results of the test can never be linked to them. The degree of participation bias caused by this system is not known. What is known is that national refusal rates range from a high of 7.6% among IFSW to a low of 1.9% among ANC women. This is of concern, because if persons who know they are HIV positive are less likely to participate than those who are not, then overall prevalence among this group could be underestimated. The rate of refusal (4.5%) among police is of concern and non-participation may have been underestimated. The fact that police are more or less a "closed cohort" because of minimal recruitment of new police over the last several years makes interpretation of trend data problematic. How much of the declining prevalence is due to mortality or drop-out of HIV positive men from the police force as opposed to decreasing numbers of new infections is difficult to say.

Representativeness of ANC women

Sentinel surveillance systems are designed to track trends of HIV at sentinel sites, but the sentinel populations are never fully representative of the population-at-large. Although ANC women are considered to be the best proxy available for prevalence among women in general, it is not known to what degree the ANC population overrepresents or underrepresents the prevalence of HIV in women in Cambodia. Of concern are the facts that the ANC population is sexually active and also that <50% of pregnant women in Cambodia seek antenatal care from clinics. Comparison of prevalence among the household female population and the ANC population provides a calibration factor. For this reason, careful consideration must be given to how ANC data is applied to the population at large for the purpose of estimating the number of HIV infected people in Cambodia.

Lack of information on the ratio of infected males to females

Given the lack of data on the general male population in the HSS, national estimates of HIV prevalence rely heavily on assumptions about the ratio of infected males to females (see Appendix III, Technical Notes). Currently, the sources of information used to set the value for this ratio come primarily from reported AIDS cases, HIV screening of blood donations and TB patients, hospital in-patients and the International Organization of Migration (IOM). All of these data sources vary in the accuracy or completeness of information on gender and include their own inherent biases, rendering the accuracy and validity of the male-to-female ratio used to make national estimates less than optimal.

Quality control

Although the HIV surveillance system is fairly robust because of the large samples sizes at the national level, there are still many potential sources of error. Key among them are sampling error, participation bias, field supervision, handling of specimens, and laboratory quality control. Because NCHADS national surveillance staff are not able to supervise data collection in all the provinces at all times, some problems occurring at the provincial level might go undocumented. The surveillance capacity of NCHADS needs to be enhanced and expanded if the quality of the surveillance system is to be sustained. Maintaining a strong surveillance system should be a high priority, given that HIV prevalence (1.9%) in Cambodia is still quite high and another wave of the epidemic bringing a large number of new HIV infections could occur quickly.

PROGRAMMATIC IMPLICATIONS



- Approximately one-fifth of FSW were living with HIV at the end of 2003. Efforts to reduce the risk of HIV infection among sex workers should be intensified. Such efforts should include improved condom promotion efforts for clients and FSW, expanded STD treatment services and education about seeking appropriate services for STD care, and provision of alternatives to sex work for young women.
- A large number (6,350 in the year 2003) of general population women were estimated to have been newly infected with HIV, the majority infected by their husbands. Intensive efforts to prevent husband-to-wife transmission are urgently needed. Such programs need to reach male clients of FSW and their regular female partners, sweethearts, and wives. These might include encouraging voluntary premarital HIV screening by couples, expanding access to and encouraging use of voluntary confidential counseling and testing (VCCT) services, integrating VCCT services into primary health or reproductive health settings for both men and women, and making prenatal HIV screening routine.
- Approximately 57,500 women of child-bearing age are currently living with HIV. Those who become pregnant are at risk of transmitting HIV to their children. Expansion and strengthening of programs to prevent mother-to-child transmission are urgently needed. Consideration must be given to implementation of routine prenatal HIV screening and linkage to preventive services and continuum-of-care activities.
- Current HIV/AIDS prevention interventions should be evaluated for their effectiveness. These include the 100% condom use, condom social marketing, peer education and outreach, STI case management, and VCCT programs.
- The health care system needs to prepare for an increasing number of HIV-infected people requiring care. In 2003, an estimated 123,100 adults in Cambodia were living with HIV. Among these, 21,500 were estimated to have AIDS. An estimated 8,050 persons were newly infected in 2003 and similar numbers may be expected for the next several years.



SURVEILLANCE RECOMMENDATIONS

Recommendations for improving the surveillance system in Cambodia fall roughly into five categories:

1. Collecting better quality data relevant to the Cambodian epidemic;
2. Strengthening capacity for data analysis and dissemination;
3. Improving the estimation process;
4. Making better use of the data; and
5. Expanding capacity of national surveillance staff to do all of the above.

Data Collection

- The HIV Surveillance Technical Working Group should meet routinely and participate in making decisions, acting on recommendations, and coordinating the surveillance partners.
- Better data on HIV and risk behaviors in the general male population is needed. The 2005 Cambodia Demographic and Health Survey (CDHS) will include HIV testing among household men and women. These data will be useful for comparing with HSS.
- Ad hoc investigations of other sub-populations which may play a role in HIV spread in Cambodia are needed. These sub-populations may include groups at high risk for infection based on behavior or groups with high levels of infection. Two groups for whom data are needed are drug users (injection and non-injection) and men who have sex with men.
- Although DHS 2000 indicated that most single women are not sexually active, this situation should be monitored for change and validated with qualitative studies.
- More supervision is needed to strengthen the quality of field work, including data collection, HIV testing, and recording of results.

- More timely collection and processing of surveillance data are needed. This issue cannot be addressed properly unless more human resources are made available to do the work and frequent delays in material procurement are addressed.
- Recent improvements to laboratory quality control (including analysis and use of quality control data) need to be sustained.

Data analysis

- Adequate time and resources (both human and financial) need to be mobilized for timely and proper analysis of surveillance data.
- Capacity of national surveillance staff to analyze and interpret data needs to be enhanced and dependence on external partners needs to be reduced.
- Better documentation of the programmatic response is needed in terms of level and intensity of effort. These are necessary for interpreting current surveillance trends and helping determine whether current efforts are adequate.

Improving estimates

- Better documentation of the ratio of infected males to females from several data sources is needed to improve the estimation process.
- Calibration studies to characterize differences between ANC attendees and women in the population at large in terms of HIV prevalence are needed. A calibration factor may be obtained by conducting HSS among ANC women and comparing with data from household women obtained from the 2005 CDHS.



Data Use

- Improved ways of translating surveillance findings into action are urgently needed.
- As a start, different products of the surveillance system tailored to the needs of the many different stakeholders including the MOH, NCHADS, NAA, multilateral and bilateral donors, NGOs and the target populations being surveyed should be made available. Again, this requires adequate financial and human resources and human capacity development.

Expand staff capacity

- National surveillance staff capacity needs to be strengthened. Staff who leave need to be replaced and their replacements should be provided with training necessary to sustain continuity of the system.
- Attempts should be made to identify additional Cambodian institutions that can assist in analysis of surveillance data, ad hoc study design, implementation and analysis, and future modeling and projection efforts. This will provide a more stable and sustainable basis for use of data, and provide support for national surveillance staff.



APPENDIX I

HSS SENTINEL SITES AND GROUPS, 1992-2003

Table 1. Summary of changes in HSS sentinel sites and groups from 1992 through 2003

	YEAR												
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
P R O V I N C E S	PNP	No survey	PNP BMC BTB SHV SRP	PNP BMC BTB SHV SRP KDL KHK PST RTK	PNP BMC BTB SHV SRP KDL KHK PST RTK KCM KCN KPT KRT KSP PVG STG SVG TKO	PNP BMC BTB SHV SRP KDL KHK PST RTK KCM KCN KPT KRT KSP PVG STG SVG TKO KEP KTH MDK PVH	PNP BMC BTB SHV SRP KDL KHK PST RTK KCM KCN KPT KRT KSP PVG STG SVG TKO KTH PAL	PNP BMC BTB SHV SRP KDL KHK PST RTK KCM KCN KPT KRT KSP PVG STG SVG TKO KTH PAL	PNP BMC BTB SHV SRP KDL KHK PST RTK KCM KCN KPT KRT KSP PVG STG SVG TKO KTH PAL PVH	No survey	PNP BMC BTB SHV SRP KDL KHK PST RTK KCM KCN KPT KRT KSP PVG STG SVG KTH PAL PVH	PNP BMC BTB SHV SRP KDL KHK PST RTK KCM KCN KPT KRT KSP PVG STG SVG TKO KTH KEP KTH PVH OM	
	G R O U P S	FSW TB POL MIL ANC	No survey	FSW TB POL MIL ANC	FSW TB POL MIL ANC IFSW	FSW TB POL MIL ANC	FSW TB POL MIL ANC HINP	FSW - POL - - - - - - - - MWR	FSW TB POL - - ANC BEG FRL HINP HH	FSW TB POL - - ANC IFSW - HINP - - - -	No survey	FSW TB POL - - ANC IFSW	FSW - POL - - ANC IFSW - - - - - -

Provinces:

- BMC: Banteay Meanchey
- BTB: Battambang
- KCM: Kampong Cham
- KCN: Kampong Chhnang
- KSP: Kampong Speu
- KTH: Kampong Thom
- KPT: Kampot
- KDL: Kandal
- KHK: Koh Kong
- KRT: Kratie
- MDK: Mondul Kiri
- OM: Oddar Meanchey
- PAL: Pailin
- PNP: Phnom Penh
- PVG: Prey Veng
- PVH: Preah Vihear
- RTK: Ratanak Kiri
- SRP: Siem Reap
- SHV: Sihanoukville
- STG: Stung Treng
- SVG: Svay Rieng
- TKO: Takeo

Groups:

- ANC: Antenatal clinic attendees
- BEG: Beer girls
- FSW: Female sex workers (brothel-based)
- FRL: Freelance
- HH: Household
- HINP: Hospital in-patients
- IFSW: Informal FSW (non-brothel-based)
- MIL: Military personnel
- MWR: Married women of reproductive age
- POL: Police personnel
- STD: Sexually transmitted disease patients
- TB: Tuberculosis patients

APPENDIX II



HSS 2003 ANC SITES

ANC women were recruited from 42 provincial-capital and 94 remaining-district sites. ANC sites seeing fewer than 100 women per month in urban areas and fewer than 30 women in rural areas were excluded from the sampling frame. Although

efforts were made to sample from the same sites as those sampled in 2002, some substitutions were made: 6 provincial-capital sites were replaced with 12 sites not sampled in 2002; 26 remaining-district sites were replaced with 29 other sites. Two additional provinces were included in HSS 2003, accounting for another three provincial-capital and nine remaining-district sites.

Table 1: HSS 2003 ANC Sites

No.	Provinces (n=22)	Provincial capital sites (n=42)	Remaining district sites (n=94)		
1	Banteay Meanchey	Serey Sophorn	Bort Tran Reu Sey Krok Phnom Tuch	Poi Pet Kum Ru Svay Chek	Chhub Vary Sras Chhik
2	Battambang	Svay Por Chamka Samroung Anlung Vel	Chrey Phnom Sampov Peam Ek	O Dam Bang I Ou Mal	
3	Kampong Cham	Beung Kok RHAC	Chrey Vean Sakun	Prey Chhor-Kang Meas Tmoung Khmum	
4	Kampong Chhnang	Kampong Chhnang Psa Chhnang	Chhrey Bak Borri Bo Prey Khmer	Ak Pikwat Sala Lekpram	
5	Kampong Speu	Roka Tep Chhum Krovvan	Kang Pisey Pres Sre Srang		
6	Kampong Thom	Kampong Thom Acha Lak Sro Yov	Tang Krosain Balang Baray		
7	Kampot	Krain Ampel	Chhuk Kampong Trach Tany		
8	Kandal	Takmao Svay Rolum	Siem Reap Beung Kasang		
9	Koh Kong	Smach MeanChhey			

(Table continued on following page)

Table 1: HSS 2003 ANC Sites (continued)

No.	Provinces (n=22)	Provincial capital sites (n=42)	Remaining district sites (n=94)		
10	Kratie	Roka Kandal Ourysey	Sandan Sambo Kanh Chha		
11	Oddar Meanchey	Sam Rong	Bus Sbov Kon Kreal O Smach	Anlung Veng Trorp. Brasath Kok Morn	Kok Khpous Am Pel Chung Kal
12	Pailin	Soun Kuma	Sala Krao		
13	Phnom Penh	Kak Kabathkrorhorm 7 Makara			
14	Preah Vihear	MCH Phsa Kampongbronnak	Saang Cheb Chhom Ksan	Ro Vieng Ko Len Phnom Dek	Snuol
15	Prey Veng	Kampong Leav Munti Pethkat	Ang Reach Preak Ksay	Muti Pethnakloeng	
16	Pursat	Peal Gneak Prey Nhi	Kak Deang Kror Kor Kror Vagn	Tror Pang Chhorng Boeng Kna (Bakan) Me Toek (Bakan)	
17	Ratanak Kiri	Ban Lung	Kon Mom O Yadav	Lom Phath Veun Sey	
18	Siem Reap	Mundul I Chhreav Sambo Por Mean Chey Chun Kaneas	Pouk Brasat Bakang Sam Roung San Veuy	Prey Chhrouk Sor Sor Sadom Kampong Kadey Kampong Takov	Teuk Vel Dam Dek San Dek Pres Dak
19	Sihanoukville	Referral Hospital Krong	Andong Thmor Stoeng Hav Veal Rinh		
20	Stung Treng	Stung Treng	Srah Reussey Kom Phun Siem Bang	Thala Boriwat Sre Krosang	
21	Svay Rieng	Svay Rieng Sang Khor Chek Bas Sak Chom Long	Svay Chrum Don Sor Chork	Prea Ponlea Kandeang Riey Krolko	
22	Takeo	Roka Knung RHAC	Prey Lvea Sam Rong		

APPENDIX III



TECHNICAL NOTES

Data adjustments

Based on results of quality control (QC) laboratory testing, province-specific false positive and false negative rates were calculated for each sentinel group (FSW, IFSW, policemen, and ANC women). These rates were applied to results to adjust for interprovincial differences in test performance.

QC testing demonstrated that test performance of the rapid testing algorithm was excellent in most provinces. Sensitivity (ability to identify HIV-positive specimens), however, was lower than the 99% expected. Because QC results indicated lower than expected sensitivity, and because the NLPH QC testing results had been externally validated (98% agreement with US CDC laboratory results), the QC results were used to adjust the raw survey data. Because not all provinces had false negatives or false positives, adjustments were made by province.

For example, 7 of 22 provinces achieved 100% sensitivity and 100% specificity (using NLPH quality control results as the gold standard). Notably, however, a few provinces had lower than expected sensitivity. The small proportion of false negatives identified among the ANC group was found to have a substantial impact on estimated HIV prevalence. Using the ANC group to illustrate variation in test performance:

- Quality control testing of 1,227 ANC specimens found 9 false negatives and 1 false positive.
- Overall, sensitivity (proportion of all positives correctly identified by HSS) was 93.62% and specificity (proportion of all negatives correctly identified) was 99.91%.
- Test performance varied by province—sensitivity was 100% in 17 of 22 provinces, but was as low as 50% in one province which had 3 false negatives.
- Specificity was 100% in all but one province where specificity was 97%.

Steps used to adjust data for each sentinel group in 2003:

1. The total number of false positive specimens per province was estimated by multiplying the percent false positive in the province-specific QC sample by the total number of HIV-seropositive specimens in that province.
2. The total number of false negative specimens per province was estimated by multiplying the percent false negative in the province-specific QC sample by the total number of HIV-seronegative specimens in that province.
3. The number of HIV-seropositive specimens per province was adjusted by subtracting the estimated number of false positives and adding the estimated number of false negatives;
4. Likewise, the number of HIV-seronegatives per province was adjusted by subtracting the estimated number of false negatives and adding the estimated number of false positives;
5. The adjusted numbers were used to estimate HIV seroprevalence:

Adjusted HIV prevalence percent =

$$\left(\frac{\text{Adjusted number of positives}}{\text{Total number tested}} \right) \times 100$$

Steps used to adjust HSS 1999, 2000, and 2002 data for each sentinel group were similar to those used to adjust the 2003 data except that province-specific false-positive and false-negative rates were not available. An assumption was made that test performance would vary little by province because the tests were performed at the central level.

Steps used to adjust HSS data collected prior to 1999 also were similar. Although quality control results were not available for those years, the Consensus Working Group agreed to use three-year (1999, 2000, and 2002) group-specific averages of false-positive and false-negative rates to adjust data collected prior to 1999. Rates used to adjust the data are shown in Table 3.

Table 1. False-positive and false-negative rates by sentinel group and survey year

	1999	2000	2002	1999-2002 average	2003
FSW					
False Positive	7.12	4.16	10.88	7.39	3.77
False Negative	10.00	3.08	3.08	5.39	1.55
IFSW					
False Positive	15.35	11.23	11.90	12.83	0.00
False Negative	3.08	1.54	1.54	2.05	2.05
Police					
False Positive	21.69	10.49	17.69	16.62	5.61
False Negative	0.00	0.71	0.00	0.24	0.53
ANC Women					
False Positive	21.01	24.29	25.52	23.61	0.75
False Negative	0.74	0.00	0.37	0.37	0.82

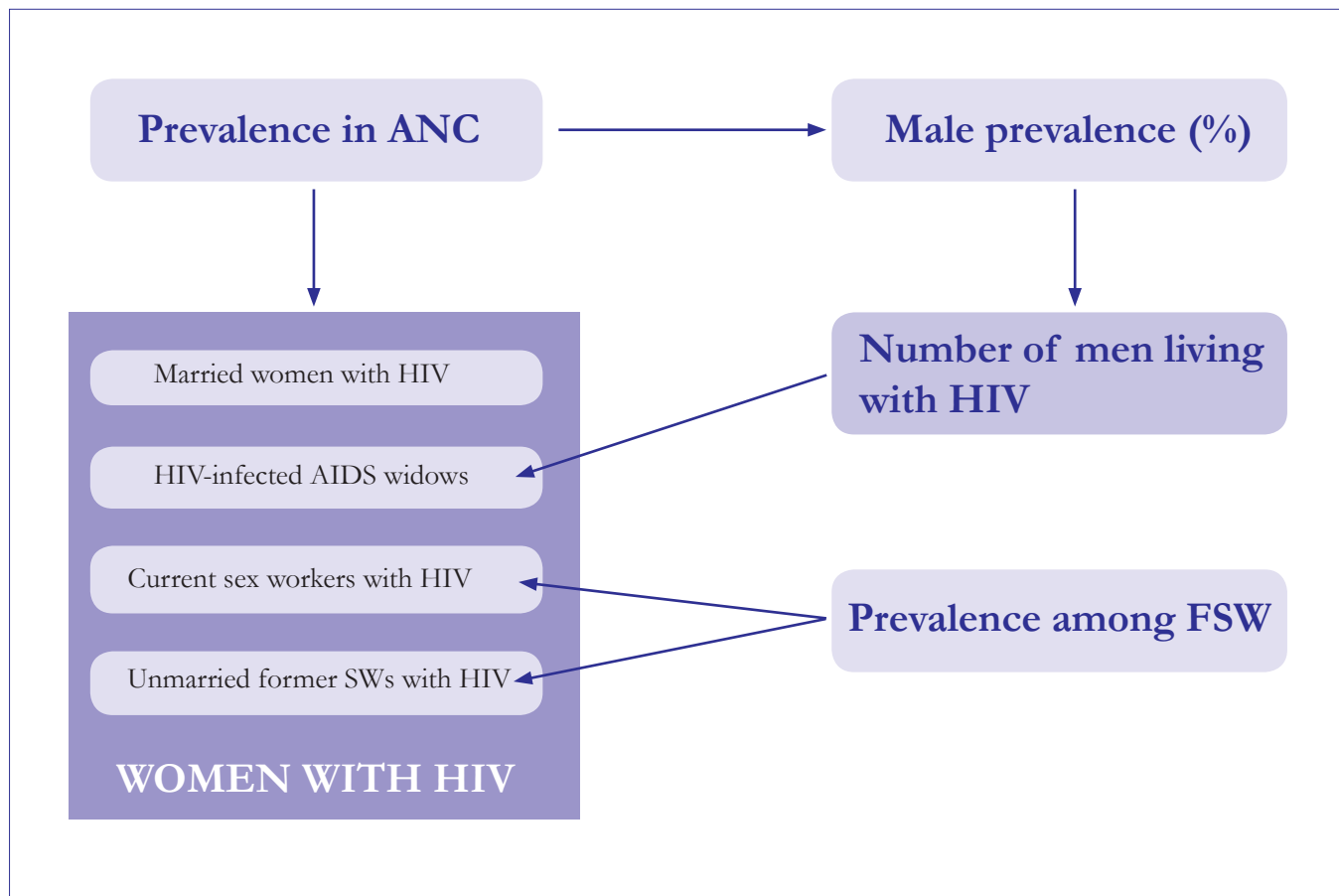
Confidence intervals

Point prevalence presented in this report are statistical estimates, not exact numbers. To account for error in the estimate, a 95% confidence interval is used to give a range of estimates within which the true estimate lies 95% of the time if the sample were drawn repeatedly. Confidence intervals for 2003 HIV prevalence in each sentinel group were constructed around the aggregated, adjusted, weighted or self-weighted point prevalence estimates using the bootstrap procedure and SAS statistical software (SAS Institute Inc., Cary, North Carolina). The bootstrap method is a computer-based resampling procedure for assigning measures of accuracy to statistical estimates by resampling from the original data set. Estimates are conditional on province, i.e., based on the assumption that the laboratory quality control results varied by province.

Estimating the number of people living with HIV/AIDS

HSS data are used to estimate prevalence in sentinel groups. However, none of the sentinel groups, alone or combined, represent the Cambodian population at large. Sentinel data do, however, provide the basis for calculations performed to estimate HIV prevalence and trends among Cambodians aged 15 to 49 years. Although not precise, these estimates are reasonable approximations of the epidemic dynamics and levels of HIV in the country.

Figure 1: Subgroups of the Cambodian population for which the number of people with HIV/AIDS was estimated and the data used for each specific calculation



Framework for estimating the number of people living with HIV/AIDS in Cambodia

Figure 1 illustrates how groups were compartmentalized and what data were used for estimating the number of people living with HIV in each of the groups. Following Table 2 is a detailed description of steps used to model the epidemic.

Table 2. Data and sources used in modeling

Data	Organization/ Author	Reference	Year
HIV prevalence among ANC women, brothel-based FSW, and IFSW	National Center for HIV/AIDS Dermatology and STDs (NCHADS)	HIV Sentinel Surveillance (HSS)	1996, 1997, 1998, 1999, 2000, 2001, 2003
Cambodian population size by age, sex, and province	National Institute of Statistics (NIS)	Population projections	1993 to 2003
Cambodian population size by age, sex and province	U.S. Bureau of the Census	Online data base	1990 to 1993
Brothel-based FSW and IFSW population size	NCHADS		1998 to 2003
Percent distribution of women by urban and rural residence and age group	NIS and ORC Macro	Demographic and Health Survey (DHS) 2000	2000
Male-to-female ratio among HIV-infected TB patients	NCHADS	HSS	1994 to 2001
Correction factor for estimating HIV prevalence in the general population from ANC HIV prevalence	Saphonn V, Hor LB, Ly SP, Chuon S, Saidel T, and Detels R	How well do antenatal clinic attendees represent the general population? <i>Int J Epi</i> 2002; 31:449-55	1999
Median duration in sex-trade business	NCHADS	Behavioral Surveillance Survey (BSS)	1997, 1998, 1999, 2001, 2003
Age distribution of brothel-based FSW and IFSW	NCHADS	BSS	1997, 1998, 1999, 2001, 2003
Proportion of men aged 15-49 who are currently married	NIS and ORC Macro	DHS 2000	2000
Heterosexual contact transmission probability to estimate husband-to-wife transmission	Gisselquist D and Potterat JJ	Heterosexual transmission of HIV in Africa: an empiric estimate. <i>Int J STD & AIDS</i> 2003; 14:162-173.	2003
Survival data	Rangsin R, Chiu J, Khamboonruang C, <i>et al.</i>	The natural history of HIV-1 infection in young Thai men after seroconversion. <i>J Acquir Immune Defic Syndr.</i> 2004 May 1;36(1):622-9.	2004

Step-by-step Modeling of the Cambodian HIV Epidemic

1. Estimating the number of HIV-infected pregnant women who attend ANC clinics

The Estimation and Projection Package (EPP), freeware developed by UNAIDS and WHO, was used to smooth ANC prevalence by province and age groups. We used EPP to estimate national HIV prevalence among pregnant women attending ANC clinics, weighted for provincial population size, and smooth the data by age group (15 to 19, 20 to 24, 25 to 29, and 30 to 49 years) and residence (defined as urban/rural). For a given year, smoothed HIV prevalence percent for age- and residence (urban/rural)-specific groups is multiplied by both the number of Cambodian women in each age band (data source: Population Projections, NIS) and the proportion of women residing in urban or rural areas (data source: DHS 2000, NIS and ORC Macro). The sum of these products provides the number of pregnant ANC clinic attendees estimated to be living with HIV at the end of a given year. Life tables were constructed using survival rates among persons not receiving antiretroviral therapy (based on UNAIDS and Thai cohort data) to back-calculate HIV incidence and mortality among HIV-infected pregnant women for each year since the beginning of the epidemic.

2. Estimating the number of HIV infected women in the general population

HIV prevalence among pregnant women seeking antenatal care does not represent HIV prevalence among all pregnant women or all women in the general population. Not all pregnant women seek antenatal care. A substantial proportion of women in the general population are not sexually active, whereas all pregnant women are. For the 1999 HSS, blood specimens were collected from two independent groups of women: household women and pregnant women attending

ANC clinics. Comparison of HIV prevalence in these two groups provided a correction factor to calibrate the extrapolation of prevalence from pregnant women to the general population (assuming that women in households are representative of women in the general population). Although this factor is not expected to remain constant over time, it was applied for each year of the epidemic presented in this report.

HIV prevalence estimates to which these corrections were applied were obtained by using EPP to smooth province-specific data that were weighted for population size. Survival rates were used to construct life tables (see Step 1) that allowed us to back-calculate HIV incidence and mortality for each year since the beginning of the epidemic.

3. Estimating the number of HIV-infected men

Because no data are available on HIV prevalence among men in the general population, this must be estimated indirectly. This specific calculation was done using the male-to-female ratio of HIV-infected tuberculosis patients. This ratio has not remained constant over time. The early phase of the epidemic was largely driven by infections between sex workers and their clients and was therefore characterized by a small number of women and a larger number of men. As the epidemic has matured, infected men have passed on the virus to their spouses, resulting in growing numbers of HIV-infected women and a lower male-to-female ratio. Sex ratio data were fit in a declining exponential function using Solver in Microsoft Excel. Year-specific male-to-female sex ratios used to estimate the number of HIV-infected men ranged from 5.4 in 1990 to 1.1 in 2003. For a given year, the number of men living with HIV was obtained by multiplying HIV prevalence among women from the general population by the sex ratio and the number of Cambodian men aged 15 to 49 years.

4. Estimating the number of currently working female sex workers with HIV

The number of currently working brothel-based female sex workers living with HIV was estimated by: (1) multiplying the population of brothel-based FSW in each survey province by the province-specific smoothed HIV prevalence among brothel-based FSW (to estimate the number of HIV-infected brothel-based FSW per province); and (2) summing the estimated numbers (provided by NCHADS) of HIV-infected brothel-based FSW per province to derive a national total.

The sentinel group of informal (non-brothel-based) FSW has comprised several subgroups of women with varying levels of risk for HIV exposure. Relative proportions of each of the subgroups vary by province and survey year making it difficult to make conclusions about HIV prevalence in the entire IFSW population. The number of currently working IFSW living with HIV was estimated by multiplying the national estimate of HIV prevalence among IFSW (11.7%) by the estimated number (provided by NCHADS) of IFSW in Cambodia.

Survival rates were used to construct life tables (see Step 1) that allowed us to back-calculate incidence and mortality for each year since the beginning of the epidemic.

5. Estimating the number of unmarried former female sex workers living with HIV

Former brothel-based female sex workers:

The number of women leaving the profession every year was calculated using the rate of turnover among staff in the sex-trade (data source: BSS 2003). In the absence of data on HIV status of women who remain or leave sex work, we assumed that HIV prevalence among those who continued working and those leaving the profession was similar. The number of unmarried former brothel-based FSW living with HIV was estimated by:

1. Multiplying the smoothed HIV prevalence among brothel-based FSWs in a given year by the number of brothel-based FSW who left the profession that year;
2. Estimating the number of survivors in each consecutive year from life tables constructed from survival rates that allowed us to estimate incidence and mortality for each year (see Step 1) since the beginning of the epidemic;
3. Using the age distribution of brothel-based FSW (source: BSS) to estimate the relative proportions of HIV-infected former brothel-based FSW by age group; and
4. Multiplying percentages of Cambodian women who are unmarried (DHS 2000) by the estimated numbers of HIV-infected former brothel-based FSWs, by age group, assuming that former FSW have the same probability of getting married as other Cambodian women of the same age.

Former informal female sex workers:

The same steps described above for estimating the number of unmarried former brothel-based FSW living with HIV were used to estimate the number of unmarried former IFSW living with HIV.

6. Estimating the number of HIV-infected AIDS widows

HIV-infected AIDS widows (women whose husbands died from AIDS) were estimated from number of men living with HIV. Married men living with HIV were estimated by multiplying the number of men living with HIV by the proportion of Cambodia men who are married (DHS 2000). Life tables were constructed to estimate the number of men surviving from one year to the next (see Step 1). The number of infected wives was estimated by applying the husband-to-wife transmission probability (data source: Gisselquist and Potterat), i.e., the average annual sexual transmission from married men to their wives. Finally, life tables were constructed to estimate the number of women who died after having been infected by their husbands.

APPENDIX IV



DATA TABLES

Table 1. HIV seroprevalence¹ among sentinel populations in Cambodia, 2003

No.	Provinces	FSW		IFSW		POLICE		ANC					
		No. tested	Prev. %	No. tested	Prev. %	No. tested	Prev. %	No. tested	Prev. %	PC ²	RD ³	PC + RD	
1	Banteay Meanchey	150	26.7	150	5.3	300	3.3	300	2.2	300	1.9	600	2.0
2	Battambang	149	29.5	150	9.3	310	3.3	299	1.9	300	1.7	599	1.8
3	Kampong Cham	150	17.3	150	14.7	300	2.2	300	2.2	300	1.8	600	2.1
4	Kampong Chhnang	96	24.0	40	10.0	300	2.0	300	2.3	299	1.4	599	1.5
5	Kampong Speu	108	20.4	11	(-) ⁵	300	1.9	300	2.9	200	2.7	500	2.8
6	Kampong Thom	90	26.7	50	14.0	299	1.2	300	2.3	300	1.9	600	2.1
7	Kampot	77	19.5	59	16.9	303	1.2	299	1.7	301	1.5	600	1.6
8	Kandal	130	16.8	97	12.4	169	2.8	202	2.0	195	0.6	397	1.6
9	Koh Kong	100	29.0	123	2.4	167	12.8	134	2.8	NS ⁴	2.1	134	2.5
10	Kratie	81	11.1	61	1.6	301	1.2	310	0.7	188	0.4	498	0.5
11	Oddar Meanchey	110	25.5	19	21.1	300	(-) ⁶	169	(-)	302	(-)	471	(-)
12	Pailin	131	29.0	44	9.1	121	5.8	98	3.2	NS	2.3	98	2.7
13	Phnom Penh	147	23.8	136	14.0	258	4.0	572	1.7	NS	(-)	572	1.7
14	Preah Vihear	46	19.6	29	10.3	300	1.2	268	1.0	300	(-)	568	1.1
15	Prey Veng	130	13.8	63	9.5	285	2.0	297	2.3	285	1.4	582	1.8
16	Pursat	128	23.4	27	14.8	300	2.0	301	1.5	300	1.2	601	1.3
17	Ratanak Kiri	37	21.6	9	(-)	147	2.2	250	1.3	161	0.9	411	1.1
18	Siem Reap	151	24.5	151	18.0	301	2.9	300	4.2	300	1.7	600	2.9
19	Sihanouk Ville	150	15.3	152	19.2	307	4.0	199	3.2	145	2.0	344	2.7
20	Stung Treng	58	24.1	6	(-)	191	1.6	166	2.4	189	1.4	355	1.9
21	Svay Rieng	66	9.1	39	15.4	288	2.2	283	1.7	297	1.0	580	1.4
22	Takeo	126	29.2	67	11.9	251	2.1	283	1.3	275	1.0	558	1.1

¹ All data adjusted for quality control; police and ANC data were smoothed with EPP

² PC: Provincial Capital

³ RD: Remaining District

⁴ NS: Not sampled

⁵ (-) denotes numbers too small to produce reliable estimates

⁶ (-) denotes that data were available for only one year and that smoothed estimates could not be generated

Table 2. HIV seroprevalence¹ among sentinel groups in Cambodia, 1996 - 2003

Sentinel group	Year																	
	1996		1997		1998		1999		2000		2002 ⁴		2003					
	No. tested	Prev. %	No. tested	Prev. %	No. tested	Prev. %	No. tested	Prev. %	No. tested	Prev. %	No. tested	Prev. %	No. tested	Prev. %				
FSW	1,859	41.1	1,132	43.0	2,284	43.2	2,259	41.8	2,180	38.0	2,109	23.6	2,411	16.8				
IFSW	NS ³		NS		1,358	18.4	1,488	19.3	1,799	15.6	1,232	14.3	1,633	11.7				
Policemen	1,775	4.3	1,325	4.5	2,650	4.4	4,141	4.2	4,711	3.8	4,375	3.1	5,796	2.7				
ANC attendees	3,429	1.9	5,003	2.3	NS	2.5	5,397	2.5	6,562	2.5	9,166	2.3	10,867	2.1				
Military personnel	1,429	5.9	1,249	7.1	NS		NS		NS		NS		NS					
Tuberculosis patients	1,826	3.9	1,035	5.0	NS		2,166	7.9	2,739	6.0	2,356	8.4	NS					
Hospital inpatients	NS		1,155	6.0	1,173	12.2	1,061	11.0	1,016	10.0	NS		NS					
MWR ²	NS		NS		8,879	2.4	NS		NS		NS		NS					
Household men	NS		NS		NS		3,069	1.8	NS		NS		NS					
Household women	NS		NS		NS		3,066	1.2	NS		NS		NS					

¹ FSW, police, and ANC data were adjusted for quality control (QC), weighted for province-specific population size, and EPP-smoothed;

IFSW data were QC-adjusted; data for other sentinel groups were not adjusted, weighted, or smoothed

² MWR: Married women of reproductive age

³ NS: Not sampled

⁴ No survey in 2001

Table 3: HIV seroprevalence¹ among ANC women by province,² age group, and year, 1996-2003

Province	HIV Seroprevalence Percent among ANC Women															
	15-24							25 +								
	1996	1997	1998	1999	2000	2001	2002	2003	1996	1997	1998	1999	2000	2001	2002	2003
Banteay Meanchey	2.0	2.1	2.1	2.0	1.9	1.8	1.8	1.7	2.4	3.1	3.3	3.3	3.1	2.9	2.6	2.3
Battambang	0.9	1.5	1.9	2.0	2.0	1.9	1.8	1.6	1.3	2.0	2.2	2.2	2.2	2.1	2.1	2.0
Kampong Cham	0.8	1.1	1.3	1.4	1.3	1.2	1.2	1.1	1.0	1.8	2.7	3.1	3.1	3.0	2.8	2.5
Kampong Chhnang	0.8	1.3	1.6	1.7	1.7	1.5	1.4	1.2	0.9	1.5	2.0	2.2	2.2	2.1	1.9	1.7
Kampong Speu	0.5	1.0	1.6	2.2	2.6	2.7	2.7	2.7	0.7	1.3	2.1	2.7	3.0	3.2	3.2	3.1
Kampong Thom	0.3	0.6	1.0	1.5	1.9	2.1	2.1	2.0	0.8	1.5	2.1	2.4	2.5	2.4	2.4	2.3
Kampot	0.1	0.2	0.4	0.6	0.9	1.2	1.4	1.5	1.0	1.6	2.0	2.1	2.1	2.1	2.1	2.0
Kandal	1.9	1.9	1.8	1.6	1.4	1.2	1.0	0.9	2.8	2.7	2.6	2.5	2.4	2.2	2.1	1.9
Koh Kong	4.4	4.6	4.4	4.1	3.7	3.3	2.8	2.4	5.0	5.0	4.8	4.5	4.1	3.6	3.1	2.6
Kratie	0.9	0.9	0.8	0.7	0.6	0.5	0.4	0.3	1.5	1.5	1.4	1.3	1.2	1.0	0.9	0.7
Pailin	1.3	2.4	2.9	3.0	2.9	2.8	2.7	2.5	2.2	3.2	3.6	3.6	3.5	3.3	3.1	2.8
Phnom Penh	2.4	2.7	2.6	2.4	2.2	1.9	1.7	1.4	3.3	3.6	3.5	3.3	3.0	2.7	2.4	2.0
Preah Vihear	0.1	0.1	0.2	0.4	0.6	0.7	0.8	0.8	0.2	0.3	0.6	0.9	1.2	1.4	1.4	1.4
Prey Veng	1.3	1.7	1.8	1.8	1.7	1.5	1.3	1.1	1.8	2.5	2.7	2.7	2.6	2.4	2.2	2.0
Pursat	1.8	2.1	2.1	2.0	1.9	1.7	1.4	1.2	2.7	2.6	2.5	2.3	2.1	1.9	1.6	1.4
Ratanak Kiri	1.7	1.8	1.7	1.6	1.4	1.3	1.1	0.9	2.7	2.9	2.8	2.7	2.4	2.1	1.8	1.5
Siem Reap	2.4	3.6	4.1	4.1	3.8	3.5	3.1	2.7	2.8	3.9	4.3	4.3	4.1	3.8	3.4	3.0
Sihanoukville	2.2	3.1	3.4	3.4	3.3	3.1	2.9	2.6	2.4	3.6	4.1	4.1	3.9	3.6	3.2	2.8
Stung Treng	1.3	1.9	2.1	2.1	2.0	1.8	1.7	1.5	1.8	2.5	2.7	2.7	2.5	2.4	2.2	2.0
Svay Rieng	1.7	2.1	2.2	2.1	2.0	1.8	1.5	1.3	3.0	3.3	3.3	3.1	2.8	2.5	2.1	1.8
Takeo	0.6	1.0	1.2	1.3	1.2	1.1	1.0	0.9	1.3	2.2	2.7	2.8	2.7	2.5	2.3	2.0

¹ Data were smoothed with EPP and 2003 data were adjusted for quality control

² Oddar Meanchey province not included because data are available only for 2003 and smoothed estimates could not be generated

Table 4. Banteay Meanchey: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Banteay Meanchey	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	53.1 (156)	56.2 (198)	52.7 (202)	52.5 (148)	37.8 (150)		35.4 (171)	26.7 (150)		
Age <20 years			48.8	45.5	26.3		28.2	7.7		
Age ≥20 years			56.8	54.0	40.8		36.5	28.5		
Informal female sex workers			21.1 (94)	11.4 (126)	13.2 (150)		18.9 (45)	5.3 (150)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	10.6 (68)	9.6 No Survey ⁵	8.6 (160)	7.5 (150)	6.4 (150)	5.3 No Survey ⁵	4.2 (170)	3.3 (300)		
ANC PC ²	2.6	3.1	3.2	3.2	3.0	2.7	2.5	2.2		
ANC RD ³	2.0	2.7	2.9	2.9	2.7	2.5	2.2	1.9		
Total ANC (PC+RD)	2.2 (178)	2.9 (263)	3.2 (420) ⁴	3.1 (106)	2.9 (150)	2.6 No Survey ⁵	2.3 (250)	2.0 (600)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 5. Battambang: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Battambang	HIV prevalence percent, by year (Sample size)								
	1996	1997	1998	1999	2000	2001	2002	2003	
Sentinel Group									
Female sex workers	56.5 (156)	46.7 (102)	52.1 (150)	40.0 (161)	31.0 (147)		11.9 (159)	29.5 (149)	
Age <20 years			47.1	19.5	25.7			14.6	
Age ≥20 years			54.0	44.9	32.9			35.2	
Informal female sex workers			19.5 (103)	20.2 (101)	23.1 (150)		11.5 (130)	9.3 (150)	
Sentinel Group <i>Data smoothed with EPP</i>									
	1996	1997	1998	1999	2000	2001	2002	2003	
Policemen	9.5 (86)	8.8 (126)	7.9 (152)	7.0 (160)	6.0 (298)	No Survey ⁵	4.1 (298)	3.3 (311)	
ANC PC ²	1.2	1.9	2.2	2.2	2.2	2.1	2.0	1.9	
ANC RD ³	1.0	1.7	2.0	2.0	2.0	1.9	1.8	1.7	
Total ANC (PC+RD)	1.1 (180)	1.8 (253)	2.1 (800) ⁴	2.1 (374)	2.1 (401)	2.0 No Survey ⁵	1.9 (600)	1.8 (600)	

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 6. Kampong Cham: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Kampong Cham	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	30.1 (154)		30.1 (150)	34.0 (157)	30.4 (150)		23.3 (133)	17.3 (150)		
Age <20 years			32.0	24.1	19.1		26.3	12.1		
Age ≥20 years			28.8	37.9	33.0		22.4	18.8		
Informal female sex workers			9.0 (100)	26.9 (200)	14.8 (152)		13.9 (98)	14.7 (150)		
Sentinel Group <i>Data smoothed with EPP</i>										
	1996	1997	1998	1999	2000	2001	2002	2003		
Policemen	2.7 (161)	3.0 (112)	3.0 (150)	2.9 (301)	2.7 (299)	2.5 No Survey ⁵	2.3 (307)	2.2 (300)		
ANC PC ²	0.9	1.7	2.3	2.5	2.6	2.5	2.4	2.2		
ANC RD ³	0.6	1.2	1.9	2.3	2.3	2.2	2.1	1.8		
Total ANC (PC+RD)	0.8 (232)	1.5 (268)	2.1 (600) ⁴	2.4 (566)	2.5 (487)	2.4 No Survey ⁵	2.3 (715)	2.1 (600)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 7. Kampong Chhnang: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Kampong Chhnang	HIV prevalence percent, by year (Sample size)								
	1996	1997	1998	1999	2000	2001	2002	2003	
Sentinel Group									
Female sex workers	39.5 (116)	43.9 (130)	40.0 (150)	45.7 (130)	42.9 (112)		34.8 (68)	24.0 (96)	
Age <20 years			49.2	34.2	20.5		13.9	5.3	
Age ≥ 20 years			37.5	47.5	46.6		37.5	28.6	
Informal female sex workers			13.7 (88)	24.0 (47)	13.0 (38)		22.4 (29)	10.0 (40)	
Sentinel Group <i>Data smoothed with EPP</i>									
Policemen	3.2 (171)	3.1 No Survey ²	2.9 (150)	2.8 (298)	2.6 (300)	2.4 No Survey ²	2.2 (285)	2.0 (300)	
ANC PC ²	0.9	1.9	2.8	3.1	3.1	2.9	2.6	2.3	
ANC RD ³	0.6	1.0	1.4	1.6	1.7	1.6	1.5	1.4	
Total ANC (PC+RD)	0.7 (258)	1.4 (222)	1.8 (400) ⁴	2.0 (301)	2.0 (300)	1.9 No Survey ²	1.7 (500)	1.5 (599)	

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 8. Kampong Speu: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Kampong Speu	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	49.6 (115)		46.7 (119)	35.7 (96)	37.3 (117)		31.4 (119)	20.4 (108)		
Age <20 years			34.8 49.2	37.6 34.7	46.8 35.6		9.8 34.0	11.8 23.1		
Informal female sex workers			9.0 (25)	11.4 (20)	29.3 (22)		1.6 (20)	- ⁶ (11)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	2.3 (92)	2.8 No Survey ²	3.0 (150)	2.9 (300)	2.7 (300)	2.5 No Survey ²	2.2 (285)	1.9 (300)		
ANC PC ²	0.7	1.4	2.1	2.6	2.9	2.9	2.9	2.9		
ANC RD ³	0.5	1.1	1.8	2.3	2.6	2.7	2.7	2.7		
Total ANC (PC+RD)	0.6 (210)	1.2 (250)	1.9 (400) ⁴	2.4 (265)	2.7 (300)	2.8 No Survey ²	2.8 (498)	2.8 (500)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 9. Kampong Thom: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Kampong Thom	HIV prevalence percent, by year (Sample size)							
	1996	1997	1998	1999	2000	2001	2002	2003
Sentinel Group								
Female sex workers			34.2 (95)	35.2 (78)	29.2 (82)		20.6 (84)	26.7 (90)
Age <20 years			30.0	35.2	34.0		3.2	- ⁶
Age ≥ 20 years			35.1	34.1	28.0		22.4	31.2
Informal female sex workers			31.2 (79)	23.6 (51)	15.0 (52)		9.7 (53)	14.0 (50)
Sentinel Group <i>Data smoothed with EPP</i>								
Policemen	2.5 No Survey ⁵	2.4 (105)	2.3 (146)	2.1 (294)	1.9 (300)	1.7 No Survey ⁵	1.5 (285)	1.2 (299)
ANC PC ²	0.6	1.1	1.8	2.2	2.4	2.4	2.4	2.3
ANC RD ³	0.3	0.7	1.2	1.6	1.9	2.0	2.0	1.9
Total ANC (PC+RD)	0.5 No Survey ⁵	1.0 (248)	1.6 (395) ⁴	2.0 (250)	2.2 (300)	2.2 No Survey ⁵	2.2 (473)	2.1 (600)

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 10. Kampot: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Kampot	HIV prevalence percent, by year (Sample size)								
	1996	1997	1998	1999	2000	2001	2002	2003	
Sentinel Group									
Female sex workers	41.9 (77)		58.9 (67)	53.4 (56)	42.3 (57)		32.4 (53)	19.5 (77)	
Age <20 years			59.2	47.7	31.7		27.7	- ⁶	
Age ≥20 years			58.9	54.2	45.3		33.1	20.8	
Informal female sex workers			22.7 (62)	11.9 (47)	30.2 (64)		8.4 (38)	16.9 (59)	
Sentinel Group <i>Data smoothed with EPP</i>									
Policemen	4.3 (105)	3.9 (118)	3.5 (147)	3.0 (155)	2.5 (302)	2.0 No Survey ⁵	1.6 (297)	1.2 (303)	
ANC PC ²	0.6	1.1	1.5	1.6	1.7	1.7	1.7	1.7	
ANC RD ³	0.3	0.6	1.1	1.4	1.5	1.6	1.5	1.5	
Total ANC (PC+RD)	0.4 (208)	0.8 (275)	1.2 (407) ⁴	1.5 (255)	1.6 (306)	1.6 No Survey ⁵	1.6 (500)	1.6 (600)	

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 11. Kandal: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Kandal	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	17.4 (105)	22.4 (115)	24.4 (103)	37.0 (104)	27.0 (78)		23.0 (100)	16.8 (130)		
Age <20 years			36.5	36.0	7.5		13.1	⁶		
Age ≥20 years			22.0	36.4	34.0		26.4	11.8		
Informal female sex workers			9.8 (100)	17.3 (100)	25.7 (65)		12.4 (40)	12.4 (98)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	6.8 (97)	6.4 (162)	6.0 (150)	5.4 (150)	4.7 (150)	4.1 No Survey ⁵	3.4 (142)	2.8 (169)		
ANC PC ²	2.7	3.3	3.4	3.2	3.0	2.7	2.3	2.0		
ANC RD ³	1.8	1.6	1.4	1.2	1.1	0.9	0.7	0.6		
Total ANC (PC+RD)	2.5 (200)	2.5 (208)	2.4 (400) ⁴	2.2 (300)	2.1 (300)	1.9 No Survey ⁵	1.8 (495)	1.6 (397)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 12. *Koh Kong: HIV seroprevalence,¹ by sentinel group and year, 1996-2003*

Province Koh Kong	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	51.1 (119)	51.0 (100)	41.5 (134)	45.2 (151)	52.9 (140)		47.0 (112)	29.0 (100)		
Age <20 years			40.0	50.4	32.6		32.6	- ⁶		
Age ≥20 years			44.9	42.4	56.6		53.4	36.7		
Informal female sex workers			17.1 (74)		15.2 (83)		12.5 (71)	2.4 (123)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	16.0 (7)	19.7 (100)	20.5 (151)	19.8 (150)	18.4 (149)		14.8 (107)	12.8 (167)		
ANC PC ²	5.0	4.9	4.7	4.4	4.0		3.2	2.8		
ANC RD ³	4.5	4.4	4.1	3.7	3.3		2.5	2.1		
Total ANC (PC+RD)	4.7 (38)	4.8 (82)	4.6 (252) ⁴	4.3 (100)	3.9 (159)		3.0 (211)	2.5 (134)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 13. Kratie: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Kratie	HIV prevalence percent, by year (Sample size)								
	1996	1997	1998	1999	2000	2001	2002	2003	
Sentinel Group									
Female sex workers	30.6 (77)		27.5 (100)	29.5 (102)	33.0 (81)		24.2 (90)	11.1 (81)	
Age <20 years			27.5	21.8	38.4		3.2	⁻⁶	
Age ≥20 years			27.5	30.5	30.9		27.4	13.0	
Informal female sex workers			9.7 (56)	21.9 (35)	16.9 (57)		13.1 (45)	1.6 (61)	
Sentinel Group <i>Data smoothed with EPP</i>									
	1996	1997	1998	1999	2000	2001	2002	2003	
Policemen	2.2 (108)	2.1 No Survey ⁵	2.0 (137)	1.8 (303)	1.7 (300)	1.5 No Survey ⁵	1.4 (300)	1.2 (301)	
ANC PC ²	1.3	1.3	1.3	1.2	1.1	0.9	0.8	0.7	
ANC RD ³	0.9	0.8	0.8	0.7	0.6	0.6	0.5	0.4	
Total ANC (PC+RD)	1.2 (350)	1.1 (270)	1.0 (810) ⁴	0.9 (200)	0.8 (254)	0.7 No Survey ⁵	0.6 (419)	0.5 (498)	

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 14. Oddar Meanchey: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Oddar Meanchey	HIV prevalence percent, by year (Sample size)							
	1996	1997	1998	1999	2000	2001	2002	2003
Sentinel Group								
Female sex workers								25.5 (110)
Age <20 years								29.0
Age ≥20 years								31.1
Informal female sex workers								21.1 (19)
Sentinel Group ⁴								
Policemen								1.7 (300)
Total ANC (PC ² +RD ³)								3.0 (471)

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Because data were available only for 2003 and smoothed estimates could not be generated, raw survey data are presented

Table 15. Pailin: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Pailin	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers				37.1 (110)	45.8 (124)		29.2 (109)	29.0 (131)		
Age <20 years				17.1	30.2		20.3	14.3		
Age ≥ 20 years				19.9	40.2		31.2	31.8		
Informal female sex workers				13.4 (69)	9.0 (70)		5.2 (24)	9.1 (44)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	2.6 No Survey ⁵	4.1 No Survey ⁵	5.4 No Survey ⁵	6.1 (162)	6.4 (61)	6.3 No Survey ⁵	6.1 (93)	5.8 (121)		
ANC PC ²	2.3	3.1	3.4	3.4	3.4	3.3	3.3	3.2		
ANC RD ³	1.4	2.4	3.0	3.2	3.1	2.9	2.6	2.3		
Total ANC (PC+RD)	1.8 No Survey ⁵	2.6 No Survey ⁵	3.1 No Survey ⁵	3.3 (181)	3.3 (182)	3.1 No Survey ⁵	2.9 (341)	2.7 (99)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 16. Phnom Penh: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Phnom Penh	HIV prevalence percent, by year (Sample size)								
	1996	1997	1998	1999	2000	2001	2002	2003	
Sentinel Group									
Female sex workers	42.0 (173)	44.4 (162)	59.1 (150)	49.8 (154)	27.6 (152)		19.2 (162)	23.8 (147)	
Age <20 years			54.3	46.8	29.2		13.9	11.6	
Age ≥ 20 years			60.5	52.0	26.6		20.8	28.8	
Informal female sex workers			8.1 (100)	8.4 (210)	10.7 (153)		13.5 (145)	14.0 (136)	
Sentinel Group <i>Data smoothed with EPP</i>									
Policemen	7.5 (153)	7.5 No Survey ⁵	7.2 (150)	6.7 (153)	6.1 (166)	5.5 No Survey ⁵	4.7 (169)	4.0 (258)	
Total ANC (PC ² +RD ³)	3.0 (186)	2.9 (248)	2.7 (400) ⁴	2.5 (511)	2.3 (600)	2.1 No Survey ⁵	1.9 (696)	1.7 (572)	

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 17. *Preah Vihear: HIV seroprevalence,¹ by sentinel group and year, 1996-2003*

Province Preah Vihear	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers		25.0 (20)			15.4 (46)		29.0 (50)	19.6 (46)		
Age <20 years					10.9		3.2	- ⁶		
Age ≥20 years					16.8		32.5	22.5		
Informal female sex workers					8.3 (39)		1.6 (17)	10.3 (29)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	1.6 No Survey ⁵	1.8 (101)	1.8 No Survey ⁵	1.7 No Survey ⁵	1.6 (277)	1.5 No Survey ⁵	1.4 (227)	1.2 (300)		
Total ANC (PC ² +RD ³)	0.1 No Survey ⁵	0.2 (183)	0.4 No Survey ⁵	0.7 No Survey ⁵	0.9 (296)	1.1 No Survey ⁵	1.1 (432)	1.1 (568)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 18. Prey Veng: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Prey Veng	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	31.6 (91)		31.3 (150)	17.0 (150)	19.4 (149)		18.0 (151)	13.8 (130)		
Age <20 years			42.7	14.5	3.1		21.1	5.6		
Age ≥20 years			27.1	17.5	21.5		16.5	15.2		
Informal female sex workers			31.1 (100)	28.5 (100)	11.5 (149)		12.4 (32)	9.5 (63)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	3.5 (133)	No Survey ⁵	3.5 (150)	3.2 (150)	3.0 (150)	No Survey ⁵	2.4 (157)	2.0 (286)		
ANC PC ²	1.9	2.4	2.5	2.5	2.4	2.4	2.3	2.3		
ANC RD ³	1.4	1.6	1.7	1.6	1.6	1.5	1.5	1.4		
Total ANC (PC+RD)	1.5 (452)	2.1 (230)	2.3 (400) ⁴	2.3 (190)	2.3 (300)	2.1 No Survey ⁵	2.0 (500)	1.8 (582)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 19. Pursat: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Pursat	HIV prevalence percent, by year (Sample size)								
	1996	1997	1998	1999	2000	2001	2002	2003	
Sentinel Group									
Female sex workers	48.8 (103)		61.5 (131)	53.6 (100)	57.5 (70)		57.7 (71)	23.4 (128)	
Age <20 years			56.5	30.7	30.9		46.1	7.4	
Age ≥20 years			62.6	57.4	61.8		60.5	27.7	
Informal female sex workers			26.0 (25)	22.4 (17)	10.9 (75)		13.4 (66)	14.8 (27)	

Sentinel Group <i>Data smoothed with EPP</i>	1996	1997	1998	1999	2000	2001	2002	2003
Policemen	3.2 (58)	3.5 (137)	3.5 (153)	3.3 (299)	3.0 (303)	2.7 No Survey ⁵	2.3 (302)	2.0 (300)
ANC PC ²	3.3	3.2	3.0	2.7	2.4	2.1	1.8	1.5
ANC RD ³	1.2	1.6	1.8	1.8	1.7	1.5	1.3	1.2
Total ANC (PC+RD)	2.2 (174)	2.4 (279)	2.4 (404) ⁴	2.2 (103)	2.0 (400)	1.8 No Survey ⁵	1.5 (500)	1.3 (601)

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 20. Ratanak Kiri: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Ratanak Kiri	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	36.2 (20)	35.5 (38)	24.3 (33)	49.4 (32)	23.4 (23)		14.3 (31)	21.6 (37)		
Age <20 years			18.2	51.4	18.6		3.2	16.7		
Age ≥ 20 years			25.9	48.5	24.9		18.8	22.6		
Informal female sex workers			22.0 (30)	16.0 (32)	27.7 (40)		5.9 (20)	- ⁶ (9)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	0.5 (74)	1.1 (111)	1.8 No Survey ⁵	2.3 (98)	2.5 (96)	2.5 No Survey ⁵	2.4 (140)	2.2 (147)		
ANC PC ²	2.5	2.5	2.3	2.2	2.0	1.7	1.5	1.3		
ANC RD ³	1.5	1.7	1.6	1.5	1.4	1.2	1.1	0.9		
Total ANC (PC+RD)	2.2 (113)	2.2 (201)	2.1 (386) ⁴	1.9 (183)	1.7 (310)	1.5 No Survey ⁵	1.3 (399)	1.1 (411)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 21. Siem Reap: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Siem Reap	HIV prevalence percent, by year (Sample size)								
	1996	1997	1998	1999	2000	2001	2002	2003	
Sentinel Group									
Female sex workers	48.4 (100)		38.8 (150)	24.1 (150)	28.6 (150)		34.9 (160)	24.5 (151)	
Age <20 years			25.9	17.2	22.5		23.4	6.7	
Age ≥20 years			46.1	28.3	32.6		37.9	32.1	
Informal female sex workers			30.2 (100)	22.2 (100)	19.0 (150)		20.6 (150)	18.0 (151)	
Sentinel Group <i>Data smoothed with EPP</i>									
Policemen	8.3 (100)	7.7 No Survey ⁵	7.0 (150)	6.2 (150)	5.3 (140)	4.4 No Survey ⁵	3.6 (169)	2.9 (301)	
ANC PC ²	2.8	4.7	5.7	5.9	5.7	5.3	4.8	4.2	
ANC RD ³	2.4	2.8	2.9	2.7	2.5	2.2	1.9	1.7	
Total ANC (PC+RD)	2.6 (248)	3.7 (204)	4.2 (400) ⁴	4.2 (300)	3.9 (300)	3.6 No Survey ⁵	3.3 (500)	2.9 (600)	

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 22. Sihanoukville: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Sihanoukville	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	50.5 (99)		55.6 (150)	46.7 (150)	23.6 (150)		25.9 (148)	15.3 (150)		
Age <20 years			45.9	36.7	12.9		7.9	3.6		
Age ≥20 years			60.7	46.9	25.1		28.3	18.0		
Informal female sex workers			22.6 (100)	18.1 (15)	10.3 (150)		15.8 (152)	19.2 (152)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	11.5 (51)	10.7 No Survey ⁵	9.7 (153)	8.5 (150)	7.3 (155)	6.2 No Survey ⁵	5.0 (150)	4.0 (309)		
ANC PC ²	2.8	4.0	4.3	4.2	4.1	3.8	3.5	3.2		
ANC RD ³	2.2	2.4	2.4	2.3	2.2	2.1	2.1	2.0		
Total ANC (PC+RD)	2.3 (95)	3.5 (278)	4.0 (400) ⁴	4.0 (200)	3.8 (257)	3.5 No Survey ⁵	3.1 (222)	2.7 (347)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

Table 2.3. *Stung Treng: HIV seroprevalence,¹ by sentinel group and year, 1996-2003*

Province Stung Treng	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	20.3 (60)	25.5 (53)	34.8 (51)	34.8 (55)	38.5 (50)		28.4 (65)	24.1 (58)		
Age <20 years			54.1	39.6	36.2		9.8	- ⁶		
Age ≥20 years			30.6	32.2	39.2		32.9	30.4		
Informal female sex workers			10.7 (20)	3.3 (14)	27.7 (20)		27.5 (10)	- (6)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	0.2 (77)	0.4 (113)	0.7 (129)	1.0 (152)	1.2 (216)	1.4 No Survey ⁵	1.5 (192)	1.6 (191)		
ANC PC ²	2.6	2.6	2.6	2.5	2.5	2.4	2.4	2.4		
ANC RD ³	0.6	1.0	1.4	1.6	1.6	1.6	1.5	1.4		
Total ANC (PC+RD)	1.6 (264)	2.2 (172)	2.3 (405) ⁴	2.3 (163)	2.2 (271)	2.1 No Survey ⁵	2.0 (316)	1.9 (355)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 24. *Svay Rieng: HIV seroprevalence,¹ by sentinel group and year, 1996-2003*

Province Svay Rieng	HIV prevalence percent, by year (Sample size)									
	1996	1997	1998	1999	2000	2001	2002	2003		
Sentinel Group										
Female sex workers	37.3 (69)	26.6 (88)	27.5 (100)	32.4 (92)	9.9 (56)		33.8 (73)	9.1 (66)		
Age <20 years			24.8	34.4	10.3		41.8	- ⁶		
Age ≥20 years			28.8	31.0	9.6		30.7	10.3		
Informal female sex workers			17.1 (57)	14.9 (61)	6.1 (58)		23.7 (47)	15.4 (39)		
Sentinel Group <i>Data smoothed with EPP</i>										
Policemen	0.4 (106)	0.6 (140)	0.8 (150)	1.1 (266)	1.4 (300)	1.8 No Survey ⁵	2.0 (300)	2.2 (288)		
ANC PC ²	4.6	4.3	3.9	3.5	3.0	2.6	2.1	1.7		
ANC RD ³	1.1	1.5	1.6	1.6	1.5	1.3	1.2	1.0		
Total ANC (PC+RD)	2.8 (325)	2.8 (223)	2.6 (400) ⁴	2.5 (349)	2.2 (399)	2.0 No Survey ⁵	1.7 (599)	1.4 (580)		

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group

Table 25. Takeo: HIV seroprevalence,¹ by sentinel group and year, 1996-2003

Province Takeo	HIV prevalence percent, by year (Sample size)								
	1996	1997	1998	1999	2000	2001	2002	2003	
Sentinel Group									
Female sex workers	27.2 (69)	26.8 (58)	41.8 (99)	37.6 (83)	13.9 (96)			29.2 (126)	
Age <20 years			44.9	30.7	15.7			⁶	
Age ≥20 years			39.7	38.5	12.6			18.3	
Informal female sex workers			7.8 (45)	24.8 (53)	18.4 (62)			11.9 (67)	

Sentinel Group <i>Data smoothed with EPP</i>	1996	1997	1998	1999	2000	2001	2002	2003
Policemen	2.2 (128)	2.8 No Survey ⁵	3.0 (122)	3.0 (300)	2.9 (299)	2.6 No Survey ⁵	2.4 No Survey ⁵	2.1 (251)
ANC PC ²	1.3	1.5	1.5	1.5	1.4	1.4	1.3	1.3
ANC RD ³	0.4	0.7	1.0	1.2	1.2	1.2	1.1	1.0
Total ANC (PC+RD)	0.8 (218)	1.2 No Survey ⁵	1.4 (800) ⁴	1.4 (300)	1.3 (290)	1.3 No Survey ⁵	1.2 No Survey ⁵	1.1 (558)

¹ 2003 data adjusted for results of laboratory quality control

² PC=Provincial capital

³ RD=Remaining district

⁴ Women at reproductive age, includes pregnant and nonpregnant women

⁵ Group not surveyed, prevalence estimate obtained by modeling with EPP

⁶ Denominator too small to present seroprevalence in this group



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