Distribution of HIV in Cambodia: findings from the first national population survey

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Objectives: A limited number of studies in Asia have investigated HIV transmission in the general population in order to better guide preventive efforts. We examine HIV prevalence patterns in men and women aged 15–49 years in Cambodia.

Methods: The first national population-based survey was conducted in 2005, including HIV-related questionnaires and HIV test. Data were analysed separately for men and women. Logistic regression analysis, adjusted by age, was used to determine factors associated with HIV. To estimate the HIV prevalence, it was standardized by age, sex and place of residence.

Results: Among 6514 men and 8188 women, HIV prevalence was 0.61% [95% confidence interval (CI) 0.2–1.8] and 0.62% (95% CI 0.3–2.1), respectively. The prevalence in urban areas was approximately three times higher than in rural settings. The likelihood among women of being HIV positive increased with increasing age differentials between spouses. HIV among men increased with household wealth (odds ratio 5.7; 95% CI 2.0–16.4) and education (odds ratio 3.7; 95% CI 0.8–17.8). About 10% of men reported multiple partners, a behaviour strongly associated with HIV (odds ratio 4.0; 95% CI 1.3–12.5).

Conclusion: This study revealed HIV prevalence to be relatively low in the general population and substantially below previous estimates. Multiple observations were consistent with the hypothesis that the bulk of infections among men are related to sex work and most women are infected in marriage. Intervention should be focused on reducing the transmission among spouses and empower women with better access to information, education and care while sustaining preventive efforts related to sex work.
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Introduction

HIV epidemics in Asia have remained relatively low compared with those in sub-Saharan Africa. However, epidemics differ greatly in magnitude, and they have been mainly driven by either sex work, drug injection or a combination of both [1,2]. The role of demographic, socioeconomic and behavioural features in explaining differential risk of HIV infection has been well documented among defined high-risk groups in Asia [3–5]. Examples in this regard are the association between HIV and mobility, work situation and duration of commercial sex [3,5]. However, there are a limited number of studies from Asia that assess the risk of HIV on the basis of demographic characteristics and socio-economic status (SES) in the general population [6].

In Cambodia, substantial transmission of HIV took place among the general population in the 1990s [7]. The 2003 estimates of HIV prevalence by surveillance groups were

20.8% among brothel-based female sex workers (FSWs), 11.8% among nonbrothel-based FSWs, 2.5% among policemen and 2.2% among pregnant women attending antenatal care clinics (ANCs) [8]. It has been suggested that the common transmission of HIV in Cambodia in the 1990s was related to structural factors linked to conflicts and poverty associated with a growing sex industry, migration, dislocation and a high prevalence of sexually transmitted infections (STIs) [9].

More than 10 years of intensive preventive interventions targeting sex workers and their clients seem to have resulted in a drop in HIV prevalence among the defined high-risk groups (sex workers, military and police) and ANC attendees. The main intervention programmes consisted of STI care services and the 100% condom use programme (CUP), a multisector approach that involved local authorities, health workers, police, brothel owners, sex workers and outreach and peer educators. The programme's aim was to promote condom use in all brothels and sex-related establishments. This decline was convincingly supported by a reduction in HIV-related risk behaviours, STI among high-risk groups and HIV incidence [10,11]. However, the estimated HIV prevalence in Cambodia is still high in Asia.

On the basis of trend data derived from the national HIV surveillance system, the estimated prevalence in the general adult population aged 15–49 years seems likely to have peaked in 1997–1998 at about 3%, and it was reduced to 1.9% in 2003 [8]. However, the validity of surveillance-based prevalence and trends over time may be questionable [12], and there was an urgent need for validation through the use of population-based data. The first national population-based survey, the Cambodia Demography and Health Survey (CDHS), was conducted in 2005 by including a module of HIV-related questionnaires and an HIV test. We examined HIV prevalence patterns in the general population of men and women aged 15–49 years.

Methods

Sampling strategy and HIV testing
CDHS 2005 data were used with permission from the National Institute of Public Health (NIPH). The survey was approved by the National Ethics Committee for Health Research of Cambodia and Institutional Review Boards of the collaborating agencies. The CDHS was a national representative sample of women and men from all 24 provinces, aged 15–49 years. The survey used a two-stage sampling design with urban and rural stratification. In the first stage, 557 villages (clusters) were selected, with a probability proportional to the village size, from the national sampling frame updated by the National Institute of Statistics. The second stage

involved the selection of households from the household lists using systematic sampling [13]. All women in the selected households were eligible for interviewing. In the 50% subsample, all women and men eligible for interviews were also eligible for an HIV test after providing their informed consent. Interviews were conducted face-to-face and sex matched. All interviewers were trained for 5 weeks, followed by a full week of field practice. The detail of the interviewing method and data collection was described elsewhere [13]. Blood samples were collected by finger-stick dried blood spot (DBS) cards, and HIV testing was conducted at the NIPH. DBS specimens were tested for HIV antibodies with ELISA 1 (Vironostika HIV Uniform II; Biomerieux SA, Marcy-l'Étoile, France) because of its high sensitivity (100%). All positive samples and 10% of negative samples by ELISA 1 were subsequently tested with ELISA 2 (Murex 1.2.0) because of its high specificity (98.9%). External quality control was performed by the US Centers for Disease Control and Prevention Atlanta laboratory [14].

Statistical analysis
We analysed the male and female data sets separately using Stata 10 (Stata Corp, College Station, Texas, USA) taking into account sampling weights, cluster effects and urban–rural stratification in order to assess risk profiles of the population related to HIV infection. The sampling weight is an inverse of sampling probabilities that were calculated separately for each sampling stage and each cluster [15]. Within the scope of this paper, we limited our variables to demographic characteristics, SES and a variable related to risk behaviour, that is, multiple sex partners, comparing those who reported more than one partner in the past year with those who reported only one partner, in order to examine differential risks by sex. Chi-squared and t-tests were used to compare differences between urban and rural populations with respect to demographic characteristics, SES indicators, education level, wealth, risk behaviour and HIV status. Logistic regression was used to analyse factors associated with HIV with adjustment for age group. HIV prevalence estimates were standardized using the national population for 2005 as the standard [16].

Provinces were grouped into three geographical regions: the Thailand border region (Banteay Meanchey, Pursat, Battambang, Pailin, Odor Meanchey, Koh Kong and Sihanouk Ville), the central region (Kampong Chhnang, Kampong Speu, Kampong Thom, Kandal, Phnom Penh and Siem Reap) and the Vietnam border region (Kampong Cham, Kratie, Prey Veng, Svay Rieng, Takeo, Kampot-Kep, Preah Vihear-Steung Treng and Rattana-kiri-Mondulkiri). Urban populations were defined as people living in provincial capitals, whereas rural populations were those living elsewhere. The survey did not directly collect data on household income or expenditure. Data were collected on dwelling and household characteristics, goods and assets, which were

subsequently used to generate a standardized score called the household wealth index that reflected the household's economic status. It has been suggested that the wealth index is highly comparable to conventionally measured consumption expenditures [17]. The original five wealth quintiles of the households in the data were redistributed into three categories: poorest/poor (low), middle and rich/richest (high).

Results

Overall, 90% of the men (6514/7229) and 95% of the women (8188/8638) agreed to be interviewed and provided blood samples to be tested for HIV. Table 1 illustrates in detail the sociodemographic characteristics of the participants. Urban residents represented about 24% of all participants. The mean age for men was 28.8 years (median 27 years) and for women was 29.9 years (median 29 years). The younger age group (15–24 years) represented about 40% of the participants. Divorced/widow(er) or separated represented less than 3% of the men and 10% of the women. Both educational attainment and employment pattern depended clearly on residence

and sex (Table 1). About 80% of urban and 35% of rural respondents were ranked high according to the household wealth index. There was a strong association between wealth index and the highest level of education attained. The rich/richest group was likely to be more educated than the poorest/poor for both men (66.6 vs. 16.5%; $P < 0.001$) and women (75.4 vs. 21.3%; $P < 0.001$).

HIV prevalence differentials

Tables 2 and 3 show the distribution of HIV prevalence according to selected factors. Both urban men and women had a significantly higher HIV prevalence than their rural peers. The age-standardized prevalence was 0.61% [95% confidence interval (CI) 0.2–1.8] among men and 0.62% (95% CI 0.3–2.1) among women. HIV infection among urban men was about four times higher than among rural men [odds ratio (OR) 3.8; 95% CI 1.6–9.3]. Similarly, HIV prevalence among urban women was 3.1 times higher than among rural women (95% CI 1.6–5.9).

Tables 2 and 3 revealed the highest prevalence among men aged 30–39 years (1.23%), among women aged 25–29 years (1.28%) and the lowest prevalence in the less than 20-year-old age group. The mean age difference

Table 1. Selected sociodemographic characteristics of general men and women aged 15–49 years in national population survey 2005, Cambodia.

	Men (n = 6514)		Women (n = 8188)	
	Urban, n = 1487 % (n)	Rural, n = 5027 % (n)	Urban, n = 2001 % (n)	Rural, n = 6187 % (n)
Age groups (years)				
15–19	24.2 (383)	24.7 (1274)	23.5 (467)	20.0 (1256)
20–24	21.2 (2740)	17.7 (874)	21.3 (389)	17.8 (1097)
25–29	11.8 (188)	12.3 (629)	12.3 (249)	11.7 (759)
30–39	23.0 (336)	25.2 (1229)	23.7 (486)	26.5 (1608)
40–49	19.8 (306)	20.1 (1021)	19.3 (410)	24.0 (1467)
Age difference between spouses (years)				
No age differences	ND	ND	21.7 (253)	30.3 (1157)
1–4	ND	ND	38.8 (449)	43.2 (1668)
5–9	ND	ND	23.7 (268)	20.0 (814)
≥10	ND	ND	15.8 (133)	6.5 (282)
Marital status				
Single	43.8 (619)	37.5 (1866)	38.9 (715)	29.4 (1744)
Married	53.0 (823)	60.4 (3057)	52.1 (1106)	61.8 (3927)
Divorced, separated and widowed	3.2 (45)	2.1 (104)	10.0 (180)	8.8 (516)
Educational attainment				
No schooling	4.7 (101)	10.0 (591)	13.1 (329)	21.4 (1541)
Primary school	31.5 (551)	51.1 (2710)	46.4 (971)	58.3 (3512)
Secondary school and higher	63.8 (835)	38.0 (1726)	40.5 (701)	20.3 (1134)
Current employment				
No job	24.9 (340)	15.4 (767)	12.9 (239)	8.0 (465)
Professional, technical and sales jobs	26.2 (324)	9.5 (422)	42.2 (740)	16.8 (952)
Agricultural jobs	16.2 (370)	60.1 (3144)	32.0 (790)	66.2 (4285)
Manual labour and service jobs	32.7 (453)	15.0 (694)	12. (215)	9.0 (461)
Wealth index				
Low	10.7 (253)	39.3 (2218)	10.4 (335)	41.8 (2842)
Middle	6.7 (168)	22.8 (1172)	6.7 (218)	22.7 (14070)
High	82.6 (1066)	37.9 (1637)	82.9 (1448)	35.5 (1938)
Stay away from home for >1 month in total in the past 12 months	17.3 (164)	21.1 (681)	12.8 (658)	21.3 (438)

ND, no data available.

Table 2. The distribution of HIV prevalence and its association with sociodemographic characteristics, general men aged 15–49 in a national population survey 2005, Cambodia[a].

	Urban (n = 1487)		Rural (n = 5027)		Total (n = 6514)		
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	Age-adjusted OR (95% CI)
Crude HIV prevalence	1487	1.56 (0.8–3.2)	5027	0.43 (0.3–0.7)	6514	0.61 (0.4–1.0)	3.8 (1.6–9.3)[b]
Adjusted HIV prevalence[c]		1.46 (0.5–4.6)		0.40 (0.1–1.1)		0.61 (0.2–1.8)	
Geographical region[d]							
Thai border	509	0.92 (0.3–2.6)	1086	0.50 (0.2–1.2)	1595	0.61 (0.3–1.2)	1
Central	503	1.95 (0.7–5.2)	1662	0.57 (0.3–1.2)	2165	0.88 (0.5–1.7)	1.5 (0.6–3.9)
Vietnamese border	475	1.25 (0.5–3.0)	2279	0.29 (0.1–0.8)	2754	0.36 (0.2–0.8)	0.6 (0.2–1.6)
Age groups (years)							
15–19	383	0.0	1274	0.07 (0.0–0.5)	1657	0.06 (0.0–0.4)	NA
20–24	274	0.0	874	0.26 (0.0–0.8)	1148	0.22 (0.0–0.7)	NA
25–29	188	1.49 (0.3–7.6)	629	0.43 (0.1–1.8)	817	0.60 (0.2–1.7)	NA
30–39	336	3.40 (1.0–10.7)	1229	0.85 (0.4–1.8)	1565	1.23 (0.6–2.4)	NA
40–49	306	3.04 (1.3–7.1)	1021	0.50 (0.2–1.7)	1327	0.91 (0.4–1.9)	NA
Marital status							
Single	619	0.20 (0.0–0.5)	1866	0.05 (0.0–0.4)	2485	0.04 (0.0–0.3)	1
Married	823	2.79 (1.3–5.8)	3057	0.56 (0.3–1.0)	3880	0.88 (0.6–1.4)	3.8 (0.8–17.2)
Divorced/separated/widowed	45	1.63 (0.3–7.6)	104	2.81 (0.6–11.6)	149	2.54 (0.7–8.8)	13.6 (2.4–79.0)
Educational attainment							
No schooling	101	0.0	591	0.37 (0.0–1.5)	692	0.34 (0.0–1.3)	1
Primary school	551	2.06 (0.8–5.3)	2710	0.28 (0.1–0.6)	3261	0.47 (0.3–0.9)	1.8 (0.4–8.4)
Secondary school and higher	835	1.43 (0.5–4.4)	1726	0.65 (0.3–1.3)	2561	0.84 (0.5–1.5)	3.7 (0.8–17.8)
Current employment							
No job	340	0.0	767	0.12 (0.0–0.9)	1107	0.09 (0.0–0.7)	1
Agricultural jobs	370	0.25 (0.0–1.8)	3144	0.25 (0.1–0.5)	3514	0.25 (0.1–0.5)	0.6 (0.1–9.4)
Professional, technical and sales jobs	324	1.17 (0.2–5.9)	422	1.40 (0.5–3.8)	746	1.32 (0.6–3.1)	2.8 (0.2–41.7)
Manual labour and service jobs	453	3.70 (2.0–6.9)	694	0.85 (0.4–2.1)	1147	1.70 (1.0–2.9)	4.3 (0.3–58.2)
Wealth index							
Low	253	1.39 (0.2–9.5)	2218	0.15 (0.0–0.4)	2471	0.21 (0.0–0.5)	1
Middle	168	0.0	1172	0.16 (0.0–0.6)	1340	0.15 (0.0–0.6)	0.7 (0.1–3.9)
High	1066	1.71 (0.8–3.8)	1637	0.89 (0.5–1.6)	2703	1.13 (0.7–1.8)	5.7 (2.0–16.4)
Stayed away from home for >1 month in the past 12 months							
≤1 month	602	1.14 (0.4–3.4)	1750	0.48 (0.2–1.1)	2352	0.60 (0.3–1.2)	1
>1 month	164	0.86 (0.2–3.6)	681	0.25 (0.0–1.0)	845	0.32 (0.1–0.9)	0.6 (0.2–2.2)
Have at least two partners in the past 12 months (among those who had sex in the past 12 months)							
One partner	806	2.34 (1.3–4.3)	2982	0.36 (0.2–0.7)	3788	0.66 (0.4–1.1)	1
At least two partners	137	0.0	208	2.93 (1.2–7.2)	345	2.08 (0.8–5.2)	4.0 (1.3–12.5)

CI, confidence interval; NA, not applicable; OR, odds ratio.
[a]Comparing across the column when reading the HIV prevalence (i.e. urban vs. rural). When reading the estimated OR in the total column (n = 6514), the categories of one variable across the row were compared.
[b]This OR of HIV prevalence was adjusted with age group, and rural was used as a reference.
[c]Adjusted for age group and urban vs. rural using the national standard population 2005.
[d]Thai border provinces (Banteay Meanchey, Pursat, Battambang, Pailin, Odor Meanchey, Koh Kong and Sihanouk Ville); Central (Kampong Chhnang, Kampong Speu, Kampong Thom, Kandal, Phnom Penh and Siem Reap); Vietnamese border provinces (Kampong Cham, Kratie, Prey Veng, Svay Rieng, Takeo, Kampot-Kep, Preah Vihear-Steung Treng and Rattanakiri-Mondulkiri).

between women and their spouses was about 3–4 years, and 30% of the women were about at least 5 years younger than their husbands. HIV prevalence varied with the age difference between women and their husbands, and was the highest when differed by more than 10 years (OR 5.2; 95% CI 1.6–16.5). The likelihood of being HIV seropositive differed greatly by marital status, that is, HIV transmission had been limited to those having ever been married. In the youngest age group, most men were single (>80%), whereas among women, a significantly higher rate of infection was observed in married compared with single women (0.76 vs. 0.10%; P = 0.006).

Higher educational attainment (secondary/higher) tended to be positively associated with the risk of infection among men (OR 3.7; 95% CI 0.8–17.8), especially among highly educated urban men (Table 2), and tended to be negatively correlated in women. However, among the youth, HIV prevalence was less than 0.1% in the highly educated compared with about 0.8% in noneducated men and women. Men without jobs and those working in agricultural sectors were found to have a very low HIV prevalence (<0.25%) compared with men in professional jobs (1.32%) or labour/service jobs (1.7%). No such differences were observed in women across job categories. The wealth index was found to be significantly correlated with HIV. Men who scored high on the wealth index had the highest HIV prevalence (OR 5.7; 95% CI 2.0–16.4). The pattern was similar among women (OR 2.0; 95% CI 1.0–4.2). Among sexually active people, 9.3% of men reported multiple sex partners, about 65% of whom were sex workers. Urban men reported multiple sex partners at about twice the rate (16.6%; 95% CI 13.0–20.9) of rural

Table 3. The distribution of HIV prevalence and its association with sociodemographic characteristics, general women aged 15–49 years in a national population survey 2005, Cambodia[a].

	Urban (n = 2001)		Rural (n = 6187)		Total (n = 8188)		
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	Age-adjusted OR (95% CI)
Crude HIV prevalence	2001	1.31 (0.8–2.1)	6187	0.45 (0.3–0.7)	8188	0.60 (0.4–0.8)	3.1 (1.6–5.9)[b]
Adjusted HIV prevalence[c]		1.34 (0.5–5.0)		0.44 (0.3–1.4)		0.62 (0.3–2.1)	
Geographical region[d]							
Thai border	735	1.00 (0.5–2.2)	1399	0.74 (0.4–1.4)	2134	0.82 (0.5–1.3)	1
Central	653	1.71 (0.9–3.2)	2051	0.31 (0.1–0.7)	2704	0.63 (0.4–1.1)	0.7 (0.4–1.5)
Vietnamese border	613	0.53 (0.2–1.7)	2737	0.47 (0.2–0.9)	3350	0.47 (0.3–0.9)	0.5 (0.2–1.2)
Age groups (years)							
15–19	467	0.0	1256	0.07 (0.0–0.2)	1723	0.05 (0.0–0.1)	NA
20–24	389	0.81 (0.2–2.9)	1097	0.53 (0.2–1.2)	1486	0.58 (0.3–1.2)	NA
25–29	249	1.89 (0.4–8.3)	759	1.14 (0.5–2.7)	1008	1.28 (0.6–2.7)	NA
30–39	486	2.46 (1.1–5.3)	1608	0.42 (0.2–0.9)	2094	0.74 (0.4–1.3)	NA
40–49	410	1.68 (0.6–5.0)	1467	0.45 (0.2–1.0)	1877	0.63 (0.3–1.2)	NA
Age difference between spouses (years)							
No age difference	253	0.31 (0.0–2.3)	1157	0.50 (0.2–1.2)	1410	0.48 (0.2–1.1)	1
1–4	449	1.41 (0.5–4.2)	1668	0.32 (0.1–0.9)	2117	0.46 (0.2–1.0)	1.0 (0.3–2.9)
5–9	268	0.52 (0.1–2.2)	814	0.62 (0.3–1.4)	1082	0.60 (0.3–1.3)	1.2 (0.4–3.4)
≥10	133	6.8 (2.8–15.5)	282	0.84 (0.3–2.5)	415	2.58 (0.5–5.6)	5.3 (1.7–16.4)
Marital status							
Single	715	0.13 (0.0–0.5)	1744	0.06 (0.0–0.7)	2459	0.04 (0.0–0.5)	1
Married	1106	1.80 (1.0–3.3)	3927	0.47 (0.3–0.8)	5033	0.66 (0.5–1.0)	7.3 (1.3 –39.5)
Divorced/separated/widowed	180	3.85 (1.6–9.2)	516	1.54 (0.7–3.4)	696	1.95 (1.1–3.6)	23.4 (4.0–137.2)
Educational attainment							
No schooling	329	2.53 (0.8–7.9)	1541	0.56 (0.3–1.2)	1870	0.78 (0.4–1.5)	1
Primary school	971	1.35 (0.6–3.0)	3512	0.48 (0.3–0.8)	4483	0.60 (0.4–1.0)	0.9 (0.4–1.9)
Secondary school and higher	701	0.87 (0.4–2.1)	1134	0.27 (0.0–0.8)	1835	0.44 (0.2–0.9)	0.7 (0.2–2.1)
Current employment							
No job	239	0.0	465	0.38 (0.0–1.7)	704	0.29 (0.0–1.3)	1
Agricultural jobs	790	1.58 (0.7–3.5)	4285	0.48 (0.3–0.8)	5075	0.58 (0.4–0.9)	0.3 (0.05–1.8)
Professional, technical and sales jobs	740	1.60 (0.7–3.6)	952	0.30 (0.1–0.8)	1692	0.74 (0.4–1.4)	0.4 (0.05–2.3)
Manual labour and service jobs	215	1.10 (1.6–7.3)	461	0.45 (0.0–2.6)	676	0.60 (1.6–2.2)	0.3 (0.04–2.7)
Wealth index							
Low	335	0.21 (0.7–6.4)	2842	0.36 (0.2–0.7)	3177	0.44 (0.3–0.8)	1
Middle	218	0.59 (0.0–4.1)	1407	0.33 (0.1–1.1)	1625	0.35 (0.1–1.0)	0.8 (0.2–2.8)
High	1448	1.27 (0.7–2.3)	1938	0.64 (0.4–1.1)	3386	0.84 (0.6–1.3)	2.0 (1.0–4.2)
Stayed away from home for >1 month in the past 12 months							
≤1 month	658	0.81 (0.3–2.4)	1463	0.61 (0.3–1.3)	2721	0.66 (0.4–1.2)	1
>1 month	143	1.29 (0.3–5.2)	438	1.50 (0.6–3.5)	581	1.47 (0.7–3.10)	2.4 (0.9–6.4)
Have at least two partners in the past 12 months (those who had sex in past 12 months)							
One partner	1092	1.74 (0.9–3.2)	3895	0.43 (0.3–0.7)	4987	0.60 (0.4–0.9)	ND
At least two partners	7	0.0	6	0.0	13	0.0	ND

CI, confidence interval; NA, not applicable; ND, no data available; OR, odds ratio.
[a]Comparing across the column when reading the HIV prevalence (i.e. urban vs. rural). When reading the estimated OR in the total column (n = 8188), the categories of one variable across the row were compared.
[b]This OR of HIV prevalence was adjusted with age group, and rural was used as a reference.
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men (7.9%; 95% CI 6.6–9.4). In contrast, fewer than 1% of women reported multiple sex partners. Men who reported multiple sex partners were four times more likely to be infected than those with a single partner (95% CI 1.3–12.5) (Table 2).

Discussion

This survey revealed the HIV prevalence to be relatively low and substantially below previous estimates based on

the surveillance system among ANC attendees, that is, 0.6 vs. 1.9%. The prevalence did not differ by sex but was substantially higher in urban than in rural settings and among married individuals than among singles. Furthermore, a high age difference between spouses substantially increased the risk among women of being HIV infected. The two indicators used for SES revealed somewhat different association between sex and infection. The prevalence among men increased in correlation with both household wealth and education level, whereas among women, infection increased with household wealth but tended to decrease with education level. Women did not

report nonmarital sex, whereas 10% of the men reported more than one sex partner in the previous year. The majority of these men reported paid sex. This finding, together with the observed sociodemographic pattern of HIV, suggests that most women were infected by their spouses.

Our study indicated a positive relationship between the household wealth index and HIV infection. A number of studies [18,19] showed that wealth, rather than poverty, has been positively related to HIV prevalence in the past. However, a possible interpretation is that the rates may differ by sex. In our setting, in which the HIV epidemic is mainly driven by sex work and male clients, paid and extramarital sex were likely to be strongly associated with higher SES among men. In contrast, the higher HIV prevalence among women in the wealthier quintiles is likely to be linked to their husbands' behaviours rather than the women themselves. Hargreaves and Glynn [20] have previously suggested this precise relationship. This seems to be supported by our finding of higher education to increase the risk of HIV among men but not among women. Studies [20–23] in the earlier stages of HIV epidemics in Africa reported a positive association between educational attainment and HIV. However, this pattern later reversed to a situation in which HIV became negatively associated with education level [23–26]. In Cambodia, where the magnitude of the epidemic is still relatively low, educated men may feel freer to engage in risky behaviours associated with different types of sex work. On the contrary, educated women may be more independent in terms of economic and negotiation power with their partners regarding safer sex behaviour. There is a need for intensive interventions aimed at curbing the transmission between spouses while sustaining the preventive programme efforts focused on commercial sex [8,27].

We found the likelihood of HIV infection among women to increase with the age difference between spouses. Furthermore, the age-specific HIV prevalence among women peaked about 5 years earlier than among men, and among spouses, the women were on average 4 years younger than men. This has also been reported in African settings [28,29]. As older men were more likely to be infected with HIV, the age mixing pattern seems to play a major role in the transmission from the older partners to the younger women [2,29]. In Africa, this type of sexual mixing pattern (young women forming sexual relationships with older partners) is observed in nonmarital sex, and there have been suggestions that efforts to reduce it could be an important HIV preventive strategy [28].

Surveys are faced with a number of potential biases. In our survey, the nonresponse was low and is not likely to have substantially affected the results. The second concern is that survival among HIV-infected individuals may be associated with SES [18], that is, longer survival among the better off than among the poor due to better access to care and treatment. However, this type of bias is not likely to be substantial as the scaling up of antiretroviral treatment began in 2005. Social desirability bias is well known in surveys and is especially true when asking women about past sexual practices [30]. However, a study [31] among female factory workers in Cambodia found that fewer than 4% of women reporting never having had sex tested positive for sexually acquired herpes simplex virus. This study [31] confirmed a high reliability of behavioural data that were consistent with biological data. A final concern is the possible bias that may be due to the undersampling of some unreachable groups (i.e., high-risk groups, migrant workers). However, the Cambodia's Consensus Group found little impact on HIV estimates when taking into account these nonhousehold populations [32]. In the result update of HIV estimates for Cambodia, both the trends of surveillance data and CDHS 2005 data were taken into account to get a better HIV prevalence estimate. The previous estimate that was purely based on ANC surveillance data is likely to overestimate the true prevalence [32].

In summary, this first national population survey revealed the HIV prevalence to be relatively low and substantially below previous estimates. The 100% CUP has been shown to be highly effective in Cambodia and should therefore remain as the core preventive strategy. Furthermore, there is an obvious need to develop interventions to reduce the HIV transmission from men to women. In this regard, efforts to empower women for better access to information, education and care seem critically important.

Acknowledgements

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