What Impact Might the Economic Crisis have on HIV Epidemics in Southeast Asia?

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Abstract: *Objective*: To evaluate the potential impact of the current global economic crisis (GEC) on the spread of HIV.

Design: To evaluate the impact of the economic downturn we studied two distinct HIV epidemics in Southeast Asia: the generalized epidemic in Cambodia where incidence is declining and the epidemic in Papua New Guinea (PNG) which is in an expansion phase.

Methods: Major HIV-related risk factors that may change due to the GEC were identified and a dynamic mathematical transmission model was developed and used to forecast HIV prevalence, diagnoses, and incidence in Cambodia and PNG over the next 3 years.

Results: In Cambodia, the total numbers of HIV diagnoses are not expected to be largely affected. However, an estimated increase of up to 10% in incident cases of HIV, due to potential changes in behavior, may not be observed by the surveillance system. In PNG, HIV incidence and diagnoses could be more affected by the GEC, resulting in respective increases of up to 17% and 11% over the next 3 years. Decreases in VCT and education programs are the factors that may be of greatest concern in both settings. A reduction in the rollout of antiretroviral therapy could increase the number of AIDS-related deaths (by up to 7.5% after 3 years).

Conclusions: The GEC is likely to have a modest impact on HIV epidemics. However, there are plausible conditions under which the economic downturns can noticeably influence epidemic trends. This study highlights the high importance of maintaining funding for HIV programs.

Keywords: Global economic crisis, Southeast Asia, HIV epidemics, Cambodia, Papua New Guinea, HIV funding, mathematical modelling.

INTRODUCTION

The Asian Economic Crisis in 1997 led to a slowdown in HIV programs in many Southeast Asian countries [1, 2]. Similar reductions could occur due to the current Global Economic Crisis (GEC). While the potential impact of the GEC on the spread of HIV is unclear, falling government revenues may lead to reductions in international aid and funding for HIV programs in developing countries. Economic conditions may also have an indirect impact on HIV epidemics by affecting the behavior of some people (e.g. due to unemployment) which may influence HIV transmission. To evaluate the potential impact of the GEC on HIV epidemics we focused on two contrasting epidemics in Southeast Asia. We investigated the well-defined and generalized epidemics in Cambodia (where incidence is declining) and Papua New Guinea (PNG) (where incidence is increasing).

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Cambodia is particularly vulnerable to global financial perturbations due to its reliance on international exports. After strong growth in recent years Cambodia's economy has slowed markedly [3]. It has also felt the effects of political instability in Thailand, one of the main transit points for Cambodia, and experienced similar decreases in tourist arrivals [3]. Though Cambodia's HIV epidemic is declining the infection has invaded diverse population groups. The decline in incidence and prevalence has been linked to behavioral changes in sex work with an increase in condom use between sex workers and clients and a decrease in the number of men visiting sex workers [4-8]. There has also been a strong commitment from the Cambodian government and external donors resulting in targeted public health interventions and a large scale-up of antiretroviral therapy (ART) for people with HIV infection.

The economy of PNG has been underpinned by high commodity prices in recent years, leading to relatively strong economic growth. The GEC is expected to reduce this growth because of reductions in exports and commodity production. In addition, PNG's already high unemployment rate is expected to further increase especially in the mining

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industry; ~80% of adults do not have formal employment and an estimated 40% of PNG's population live in poverty [9]. Since 1994, PNG has been experiencing a steadily increasing HIV epidemic with cases detected in all regions of the country. HIV is mainly transmitted heterosexually but key factors that have been linked to HIV transmission in PNG include transactional sex, mobility, sexual violence, and gender inequality [10-12]. Recent programs have led to increases in condom use and HIV testing, with first-line ART being rolled out in numerous provinces. Most HIV programs are newly established and may be relatively fragile to economic reductions.

To investigate the potential impact of the GEC on HIV epidemics in Cambodia and PNG, mathematical models incorporating country-specific behavioral and epidemiological data were developed for both settings. These models were calibrated to accurately reflect the past and present HIV incidence, HIV prevalence, and the number of people on ART in each country. The models were then used to forecast epidemic trajectories over the next 3 years under assumptions that behavioral or program conditions may change due to economic conditions.

METHODS

We carried out detailed discussions with key stakeholders and representatives from national HIV bodies in Cambodia and Papua New Guinea, as well as economists, behavioral researchers, and international policy and development experts (listed in acknowledgements). A list of major HIV-related risk factors were identified that may change as a result of the GEC (Table **1**). These factors were grouped into two categories: (i) those that have direct effects on HIV/AIDS program resources and (ii) those that may affect the social and behavioral interactions of individuals. This list is not exhaustive and other factors may be influenced by

Table 1. Assumed Change in HIV-Related Risk Factors Due to the Economy

Risk Factor	Assumptions	Potential Change within 12 Months	
HIV Programs		**Cambodia**	**PNG**
VCT services	Optimistic	HIV testing steady condom use steady	HIV testing steady condom use steady
	Intermediate	HIV testing rate ↓ 5% condom use ↓ 5%	HIV testing ↓ 7.5% condom use ↓ 7.5%
	Pessimistic	HIV testing rate ↓ 10% condom use ↓ 10%	HIV testing ↓ 15% condom use ↓ 15%
Education and prevention	Optimistic	condom use steady partner change steady	condom use steady partner change steady
	Intermediate	condom use ↓ 5% partner change ↑ 3%	condom use ↓ 5% partner change ↑ 3%
	Pessimistic	condom use ↓ 10% partner change ↑ 5%	condom use ↓ 10% partner change ↑ 5%
Availability of antiretroviral therapy (coverage of diagnosed)	Optimistic	↑ 10% over 5 years	↑ 40% over 5 years
	Intermediate	↓ 2.5% over 5 years	↑ 25% over 5 years
	Pessimistic	↓ 5% over 5 years	↑ 10% over 5 years
Change in Behavior of People		**Cambodia**	**PNG**
Unemployment	Optimistic	no. sex workers steady demand for SW ↓ 10%	no. sex workers steady demand for SW steady
	Intermediate	no. sex workers ↑ 10% demand for SW ↓ 5%	no. sex workers ↑ 5% demand for SW ↑ 5%
	Pessimistic	no. sex workers ↑ 5% demand for SW steady	no. sex workers ↑ 10% demand for SW ↑ 10%
Injecting drug use (Cambodia); Change in condom use and sexual activity due to alcohol consumption (PNG)	Optimistic	drug use ↓ 10%	condom use steady sex activity steady
	Intermediate	drug use ↓ 5%	condom use ↓ 10% sex activity ↑ 5%
	Pessimistic	drug use steady	condom use ↓ 20% sex activity ↑ 15%
Migration	Optimistic	regular partners steady	Steady, 15% in urban
	Intermediate	contact with regular partners ↑ 7.5%	14% in urban
	Pessimistic	contact with regular partners ↑ 15%	13% in urban
Absolute changes are assumed for condom use and treatment uptake; others are relative changes.			

changes in the economy, however, these factors are thought to be the most important for potentially affecting HIV epidemics.

Direct Effects on Program Resources

The GEC makes commitments of overseas development assistance more uncertain. In Cambodia and PNG only a small proportion of funding for HIV responses comes from their own governments, with the majority of assistance coming from international funding agencies such as the Global Fund and AusAID. Some donors have signaled their intention to scale back their aid budgets. Reductions in program funds may lead to:

1) *Decreases in voluntary counseling and testing (VCT) services*, resulting in a decrease in testing rates, counseling and other prevention services. This may lead to a reduction in condom use and testing of the general population.

2) *Decreases in education and prevention activities*. If there is a reduction in media campaigns and other educational activities then condom use may decline and the rate of partner change may increase.

3) *Changes in the availability of ART or slowed rate of increase in provision.* In Cambodia there is almost universal access (~85%) to first-line ART for eligible individuals. In PNG provision of ART is currently scaling up; currently ~30% in need have access and the plan is to increase this to ~50-70% over 5 years. The majority of ART provision in both countries is externally funded and external economic pressures could have a significant impact on treatment strategies.

Behavioral and Social Factors

The GEC could have complex behavioral and social effects on heterogeneous groups of people. Key behavioral factors relevant to HIV epidemics that may be influenced by the economy include:

1) *Increases in unemployment.* The economic downturn may lead to increased unemployment and to support themselves some unemployed women may turn to transactional sex work. The number of sex workers (supply) could increase, but the number of men engaging their services (demand) may decrease. In Cambodia it is anticipated that the total number of women seeking to engage in direct and indirect sex work will increase over the short-term, mainly due to a decline in the garment industry. Reductions in tourist arrivals in Cambodia will also decrease the demand for sex work. In PNG, a relatively large proportion of women engage in transactional sex of some form. As money is not always involved in transactional sex, it is expected that transactional sex work could increase. However, newly unemployed individuals in PNG are likely to stay with their extended family in the short term and may not initially turn to transactional sex work.

2) *Decrease in injecting drug use in Cambodia.* The majority of drug use in Cambodia involves an amphetamine type stimulant (ATS); however, there is a small population of injecting drug users (IDUs) in Cambodia. With disposable income likely to decrease, use of intravenous drugs could be expected to decrease.

3) *Change in alcohol consumption and the prevalence of violence in PNG*. There are very few IDUs in PNG [10], however, alcohol is commonly brewed at home and its consumption is expected to increase with higher unemployment. Alcohol consumption is linked with decreased condom use and increased sexual assault which also tends to be unprotected.

4) *Change in migration patterns*. A decrease in employment could lead to male migrant workers returning home in Cambodia, particularly in the declining construction industry. In PNG, there is net population growth in urban settings due to rural-to-urban migration. It is expected that increased unemployment will reduce the flow of people moving from rural to urban settings. Though people losing employment from the mining sector in PNG may go to towns and cities for other employment, the expectation is for a net decrease in migration rates to urban areas.

Mathematical Model

To describe the history of HIV epidemics and to forecast potential epidemic trends in the future, a mathematical transmission model and a static risk model were developed (specific details of these models are presented in the Supplemental Digital Content). These models describe the risk of HIV acquisition for six population subgroups: 1) general males, 2) male clients of female sex workers (including pimps and other core groups of men), 3) men who have sex with men (and possibly women) (MSM), 4) injecting drug users (IDUs), 5) general females, and 6) female sex workers (FSWs). The PNG population is divided into rural (85% of total population) and urban settings, with clients and FSWs only living in urban areas. Heterogeneous interactions between all of these population groups is included to reflect the complex and polymorphous nature of sexual behavior and mixing in these settings [13]. Parameter assumptions for the models are presented in Table **2**. Data specific for each setting was used to inform the mathematical models; where data was unavailable for Cambodian populations, data from Thailand was used. All model simulations and calculations were executed with Matlab® R2009a.

The transmission model describes the overall population-level transmission of HIV using four ordinary differential equations. These equations describe the temporal change in the number of people who are susceptible, HIV-infected but undiagnosed, diagnosed with HIV, and on ART. A schematic diagram of the model is shown in Fig. (**1**); this schematic is replicated for urban and rural settings in PNG with migrating people remaining in the same disease stage. In Cambodia we assume that migration describes the movement of workers between their workplace and home. Thus, any increase in unemployment likely results in men having more contact with their regular partner at home. Any migratory increase of the number of FSWs in Cambodia is

Table 2. Parameter Values Used to Calibrate the HIV Epidemic Models

Parameter	Cambodia	Urban PNG	Rural PNG
Males			
Average number of regular sexual partners per year	0.58[a]	2 [21, 22]	2 [21, 22]
Average number of casual sexual partners per year	0.88[a]	6.9 [11, 23, 24]	9[a]
Condom use in casual partnerships with general females	30% [12, 25-27]	10% [22]	10% [22]
Condom use in regular partnerships with general females	30% [12, 25-27]	5% [23]	5%[a]
Prevalence of HIV	0.8% [13, 28]	1% [29]	2% [29]
Prevalence of other sexually transmitted infections	1%[a]	5% [29-32]	15.7% [31]
Male Clients of Female Commercial Sex Workers			
Proportion of the population	6.5% [33]	26%	0%[a]
Number of visits to sex workers per year	62 [34, 35]	18 [10, 11, 21, 36]	N/A
Condom use in acts between clients and sex workers	95% [34]	60% [22, 23]	N/A
Prevalence of HIV	5%[a]	2% [29]	N/A
Prevalence of other sexually transmitted infections	1.5%[a]	1.5% [29-32]	N/A
Men who have Sex with Men (MSM)			
Proportion of the population	1.5% [28, 37-41]	3% [22, 23]	3% [22, 23]
Average number of male sexual partners per year	25 [34, 42]	30 [11, 23]	5[a]
Average number of female sexual partners per year	3 [34, 42]	30 [11, 23]	10[a]
Condom use in penetrative acts between MSM	80% [34, 42]	23% [11, 23, 29]	7.5%[a]
Condom use in penetrative acts between MSM and women	80% [34, 42]	50% [11, 23, 29]	7.5%[a]
Prevalence of HIV	7.5% [42]	2.5%[a]	3%[a]
Prevalence of other sexually transmitted infections	1.3% [34, 42]	20% [11]	20%[a]
Injecting Drug Users (IDUs)			
Proportion of the population	0.25% [43-47]	0%[a]	0%[a]
Average number of injecting partners per year	2 [48]	N/A	
Average frequency of injecting per year	400 [49-51]	N/A	
Percentage of injections using equipment from other IDUs	15% [48]	N/A	
Percentage of shared syringes that are cleaned before re-use	70% [52]	N/A	
Average number of regular sexual partnerships	0.5 females 0.25 FSW [27, 53, 54]	N/A	
Average number of contacts IDUs have with FSWs per year	2 [27, 53]	N/A	
Prevalence of HIV	15% [52]	N/A	
Prevalence of other sexually transmitted infections	16% [52]	N/A	
Females (Including those that Engage in Transactional Sex)			
Prevalence of HIV	0.8% [55, 56]	1.5% [29]	2% [29]
Prevalence of other sexually transmitted infections	1% [57]	6% [30, 31]	15.7% [31]
Sexual behavior parameters	Balance with male behavioral values		
Female commercial sex workers (FSWs)			
Proportion of the population	1.5% [58-60]	2% [10]	0%[a]
Average number of regular sexual partnerships	0.5 [34, 42]	1.4 [10, 11, 61]	N/A
Condom use in acts between FSWs and regular partners	85% [34, 62]	40% [22, 23]	N/A
Average number of casual sexual partnerships, outside sex work, that FSWs have per year	3.2 [34, 42]	8.9[a]	N/A
Condom use in acts between FSWs and casual partners	80% [34, 42]	60% [10, 29]	N/A
Prevalence of HIV	15% [55]	15% [36, 63, 64]	N/A
Prevalence of other sexually transmitted infections	3.5% [57]	25% [36, 65]	N/A
Sexual activity between FSWs and clients	Balance with client behavioral values		

[a]Assumption. The population is split 1:1 between men and women for Cambodia and 1.2:1 for PNG [66]. The model also assumes the following. The presence of an STI increases HIV transmission risk by 4-5 fold [67-69]. A casual partnership involves 1 penetrative sex act and a regular partnership involves 75-100 acts per year. The baseline probability of HIV transmission per sexual act is 0.0008 for female-to-male transmission [70, 71], 0.001 for male-to-female transmission [70, 71], and 0.008 for male-to-male transmission [72]. Treatment reduces the transmission rate by 95% [73]. HIV transmission risk using a contaminated needle/syringe is 0.008 [74, 75]. The effectiveness of condoms is 90% [76, 77] and cleaning of syringes has effectiveness of 75% [78, 79]. People remain in the sexually mixing population for 45 years for PNG and 35 years for Cambodia, the rate of diagnosis of HIV-infection (i.e., testing rate) increased linearly from 0.14 (2003) to 0.5 (2009) for Cambodia, and is taken to be 0.2 for urban PNG and 0.12 for rural PNG. The time from infection to AIDS-related death for untreated HIV-infected individuals is 10 years [80-82], and rate of death for treatment-eligible individuals on ART is 0.05 [83-86]. The rate at which diagnosed cases initiate therapy is taken to linearly increase from 0 in 2003 to 1.2 in 2009 for Cambodia. Before 2009, this rate is taken to be 0.25 and 0.125 for urban and rural PNG, respectively, and then increases to match treatment plans. The rate at which HIV-infected people on ART stop treatment is assumed to be 0.5.

incorporated in the increasing unemployment scenario. This model was used to forecast potential trends in HIV epidemics from 2009 to 2012 for each scenario in Table **1**.

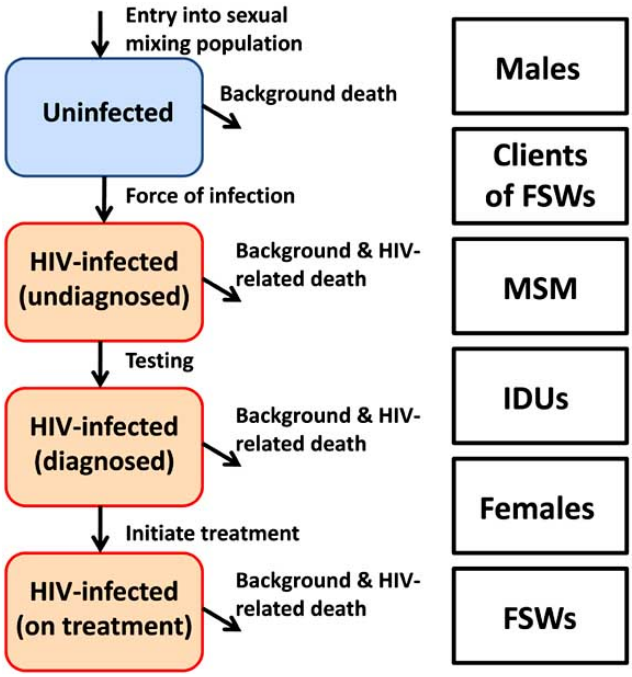

Fig. (1). Schematic diagram of mathematical model.

To more accurately account for the variation in HIV risk and prevalence in each population group, a static risk equation model was used to estimate the probability of HIV acquisition per uninfected person per year. The static risk equations, weighted by the population sizes, were consistent with the overall population-level 'force of infection' term for incidence in the dynamic models applied to Cambodia and PNG. The annual risk of acquiring HIV infection per uninfected person was calculated for each population group and as a weighted average across all groups. These risks were calculated for 2009 and 2012. The potential change in annual risk of acquiring HIV per uninfected person due to the GEC was then calculated. The estimated number of people on treatment in 2012 was provided by the transmission model.

RESULTS

The dynamic transmission model accurately reflected the HIV epidemics in Cambodia and PNG (Fig. **2**). Forecasts of the expected impact of the economic crisis on HIV diagnoses, incident infections, and prevalence, for intermediate assumptions (Table **1**) suggest that the GEC may have a relatively modest impact on the HIV epidemics in these countries.

In Cambodia, HIV incidence may increase moderately (by an estimated maximum of ~10% over three years) if changes in VCT and education lead to reductions in HIV testing and condom use, and increases in partner change (Fig. **2b**). The increase in incidence is not expected to translate into increases in HIV diagnoses. The change in the number of HIV diagnoses due to the GEC is likely to be minimal (Fig. **2c**) because the GEC is expected to cause only a small increase in the overall number of undiagnosed people living with HIV, even with the expected changes to VCT.

In contrast, HIV incidence and diagnoses in PNG could be considerably affected by the GEC (Fig. **2e**, **f**). Intermediate assumptions for increased violence and alcohol use could lead to increases in incidence and new diagnoses of 17% and 11% respectively over 3 years. Pessimistic assumptions (Table 1) could lead to larger increases in incidence and new diagnoses, however, moderate assumptions for most potential scenarios lead to relatively little change (Fig. **2e**, **f**). For PNG the model predicts that there will be a slight decrease in diagnoses in the scenario of decreasing VCT as less people will be tested each year.

Fig. (**3**) illustrates the estimated change in the risk of HIV acquisition for each population subgroup. The factors of greatest concern in Cambodia are decreases in VCT and education. These particularly affect male clients and FSWs. For these population groups increased unemployment is likely to reduce HIV risk due to decreased demand for sex work (Fig. **3a**). However, the increase in the number of sex workers in the population means that the number of new HIV infections among FSWs is expected to increase. In PNG, the factors of greatest concern are increases in violence and alcohol, decreases in ART roll out, and decreases in VCT and education (Fig. **3b**). Increasing unemployment in PNG is expected to lead to only a minimal increase in risk for clients and negligible change in risk for FSWs. Similarly, migration away from urban areas has minimal effect on risk because the majority of people live in rural areas. Finally, changes in ART roll out in PNG have a larger effect on clients and FSWs because treatment is more accessible in urban areas. These results suggest that the effects of the economy on HIV programs could have a greater impact on epidemics than those related to unemployment.

The models predicted that a reduction in ART coverage or rollout has little impact on HIV incidence and diagnoses (Fig. **2**). However, ART may have a significant impact on the number of HIV/AIDS-related deaths. The model suggests that the coverage of ART is the most important factor determining the number of AIDS-related deaths in Cambodia over the next 3 years; however, the total number of deaths is unlikely to be highly influenced by the GEC: -1.2% in the optimistic case, ~0.4% in the intermediate case, and ~0.8% increase in HIV deaths for the pessimistic case. In contrast, the number of AIDS-related deaths in PNG could be highly affected by economic change. ART availability is being scaled-up substantially in PNG from the relatively low levels at present. If the economy reduces this planned provision of ART then it could greatly affect the number of AIDS-related deaths (by ~10%). In PNG other factors that lead to increased incidence (such as decreases in condom use) can also result in increases in AIDS-related deaths. The combined effect of all possible scenarios in PNG (Table **1**) results in a ~2.1% increase in AIDS deaths in the optimistic case, ~7.5% increase in AIDS deaths in the immediate case, and ~14% increase in AIDS deaths in the pessimistic case from 2009 to 2012.

DISCUSSION

This study estimated the effect that the GEC was likely to have on selected factors that are understood to play an

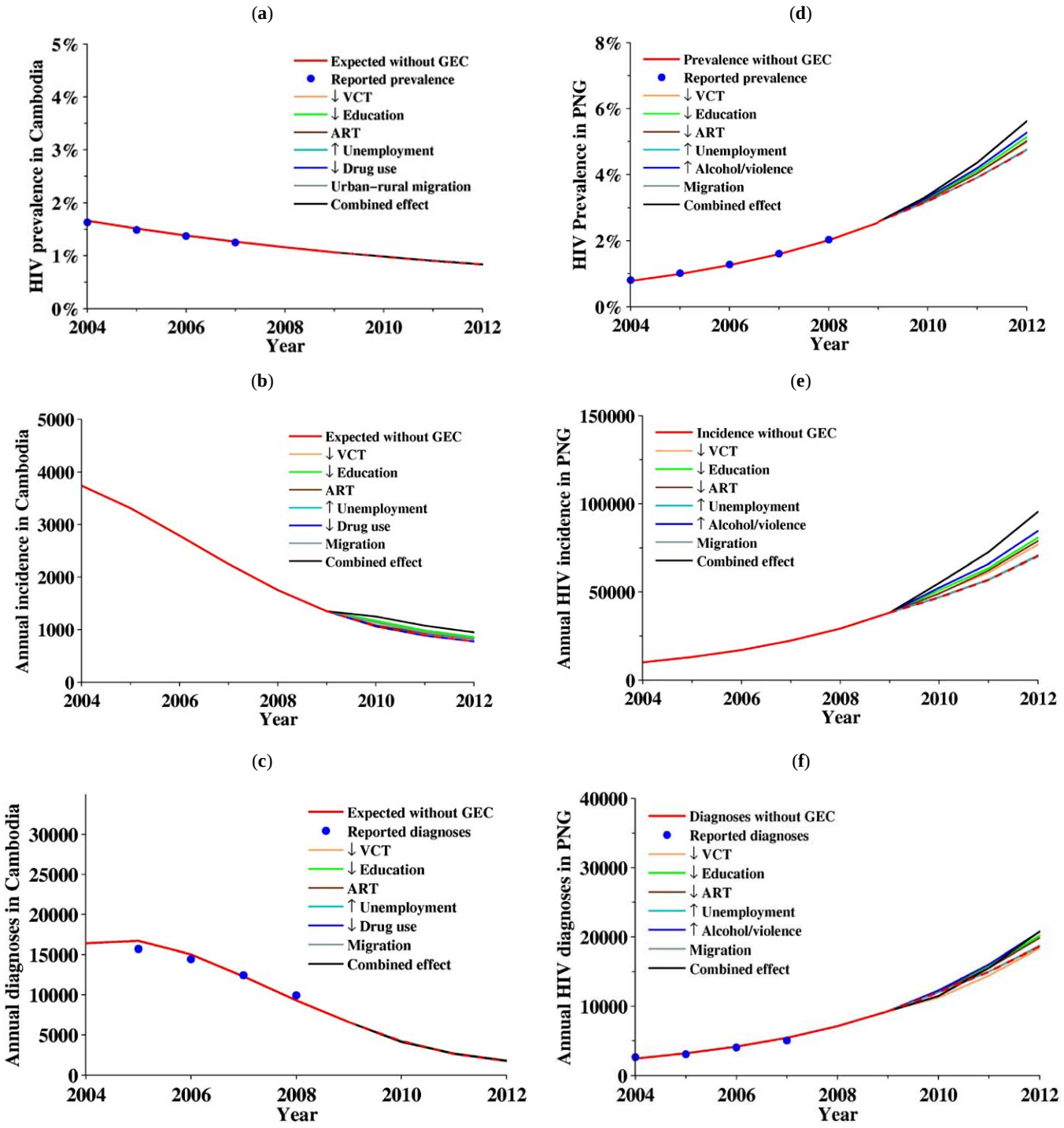

Fig. (2). Model-based projections for Cambodia and PNG based on changes due to the economy: (**a**) HIV prevalence in Cambodia; (**b**) HIV incidence in Cambodia; (**c**) number of diagnoses in Cambodia; (**d**) HIV prevalence in PNG; (**e**) HIV incidence in PNG; (**f**) number of diagnoses in PNG. The blue dots represent available data in these countries since 2004.

important role in modulating HIV transmission rates. Pessimistic, intermediate, and optimistic scenarios were considered for each factor. Mathematical models were used to investigate the expected epidemiological effect in Cambodia and PNG to determine whether the economic crisis may potentially have a significantly adverse impact on HIV epidemics. The model-based results suggest that HIV risk, incidence, and diagnoses will be only modestly affected due to the GEC with decreases in HIV programs having a higher impact than changes in unemployment and population movement. Overall, the model predicts that HIV epidemic profiles in established and emerging epidemics are not likely to alter significantly due to the economic crisis. For example, the effect of the economy on the HIV epidemic in Cambodia could be 'hidden' by the surveillance system (Fig. **2c**).

These findings are consistent with other qualitative reports on the potential impact of the global economic

downturn on HIV/AIDS epidemics [14]. The current study highlights the high importance of maintaining HIV prevention and treatment programs, particularly VCT services and the provision of ART, which are largely funded by external sources. VCT and ART are well-established in Cambodia with an increase in more costly second-line therapy needed as the failure rate of first-line ART increases. In PNG, both VCT services and first-line ART are relatively new initiatives and are not well-established. Any volatility in these programs could be largely detrimental to PNG's HIV response, which aims to increase VCT services and achieve universal treatment access over the next 5-10 years. This volatility in external funding suggests that Governments will need to play a greater role in directly funding HIV programs. This is particularly pertinent for PNG, where Government expenditure for HIV has decreased (despite an increasing epidemic). However, such an increase should be considered in the context of other funding priorities such as reducing poverty and unemployment, and increasing the provision of food.

In this study, potential changes in key factors of relevance to HIV and the GEC were explored, along with sensitivity ranges around these assumptions. The models developed in this study were calibrated to accurately reflect the unique epidemiology of Cambodia and PNG and were based on the best data available, but they cannot capture the full degree of complexity that exists in transmission-related mixing, behavior, and HIV programs. Furthermore, some of the assumptions regarding the impact of the GEC (Table **1**) are speculative and are not empirically based as there are limited sources of data on how the economic crisis may affect HIV/AIDS program funds or social determinants related to HIV risk. More study is required to ascertain such behavioral shifts and to inform the response required to prevent adverse consequences for HIV incidence, morbidities and mortalities. For instance we assumed that the GEC will decrease drug use in Cambodia, however, it is possible that drug use may be stable or actually increase with unemployment [15]; though such an increase would have a similar moderate effect on our results. We also assumed that any change due to the GEC is maintained from 2009 to 2012 and ignored any potential improvements in economic conditions over the short term or behavior changes that are likely to have a short duration. Overall, the modeling highlights that prevention efforts must continue among the core groups that could be affected by the GEC in both settings (Fig. **3**) and among those most at risk for acquiring HIV. The trends in HIV epidemics are not expected to change markedly in the coming years. This may indicate the relative independence of HIV risk from economic fluctuations. However, one area where the GEC may have an important impact is on those living with HIV. A weaker economy may affect access to therapy (e.g., affording transport to clinics) and food security and, hence, disease progression. This was not considered in the current model.

The last decade has been strong economically, enhancing international efforts to manage the HIV pandemic [16]. For example, funds have been intensified and mobilized for the large scale-up of ART in resource-constrained countries [17]. The majority of funds for HIV prevention, care and treatment in Cambodia and in PNG are externally provided from the Global Fund, international government development organizations (such as AusAID), and non-government organizations. Despite this increased commitment, the United Nations health-related targets of the Millennium Development Goals are unlikely to be achieved by 2015 [18] and all commitments for HIV programs are unlikely to be fully realized. A downturn in the funds available for the provisions of antiretroviral drugs may result in declining supplies, a smaller range of medications, particularly second and third line medications, and decreased availability to life-sustaining ART for the many people in need. This could also result in poorer treatment compliance, increased viral resistance and possibly transmission of resistant viral strains. HIV prevention efforts may also be unsustainable due to decreases in program funding. A judicious mix of funding sources and disbursement channels could be important for responding to HIV epidemics [19]. We are in an age where HIV still infects more people than the rate of ART roll-out [20]. It is of very high importance that funding for HIV programs are maintained, if not increased, by external donors and governments, regardless of the economic conditions.

ACKNOWLEDGEMENTS

The design of the mathematical model was carried out by R Gray, K Heymer, A Hoare, J Kwon, H Thein, D Wilson. R Gray implemented the models, analyzed the results, and was involved in writing the manuscript; K Heymer obtained parameter estimates and calibrated the Cambodian models; A Hoare wrote the computer code for the models; J Kwon provided parameter estimates for IDUs in Cambodia; H Thein reviewed relevant economic literature; N Lote and P Siba provided data and guidance for contextualizing the model to the PNG setting; S Saramony and V Saphonn provided data and guidance for contextualizing the model to the Cambodian setting; H Worth and J Kaldor acted in an advisory manner and assisted in ascertaining realistic assumptions; D Wilson conceived, designed, and supervised the study and was involved in writing the manuscript. All authors saw and approved the final version of the manuscript.

The authors would like to thank the following people for their advice and guidance through this project, particularly around the formation of assumptions about the potential change in behavior due to changes in the economy: Michael O'Leary, World Health Organization (Cambodia) and Cambodia Country Coordinating Mechanism for Global Fund; William Yeka, Family Health International, Papua New Guinea; Roslyn Morauta, Papua New Guinea Country Coordinating Mechanism for the Global Fund for AIDS, TB and Malaria; Tony Barnett, London School of Economics and London School of Hygiene and Tropical Medicine; Bill Bowtell, Pacific Friends of the Global Fund, Lowy Institute for International Policy; Ashley Townshend, Pacific Friends of the Global Fund, Lowy Institute for International Policy; David Carpenter, Australian Agency for International Development (AusAID); Robyn Biti, Australian Agency for International Development (AusAID); Deborah Muirhead, Australian Agency for International Development (AusAID); and Andrew Laing, Australian Agency for International Development (AusAID).

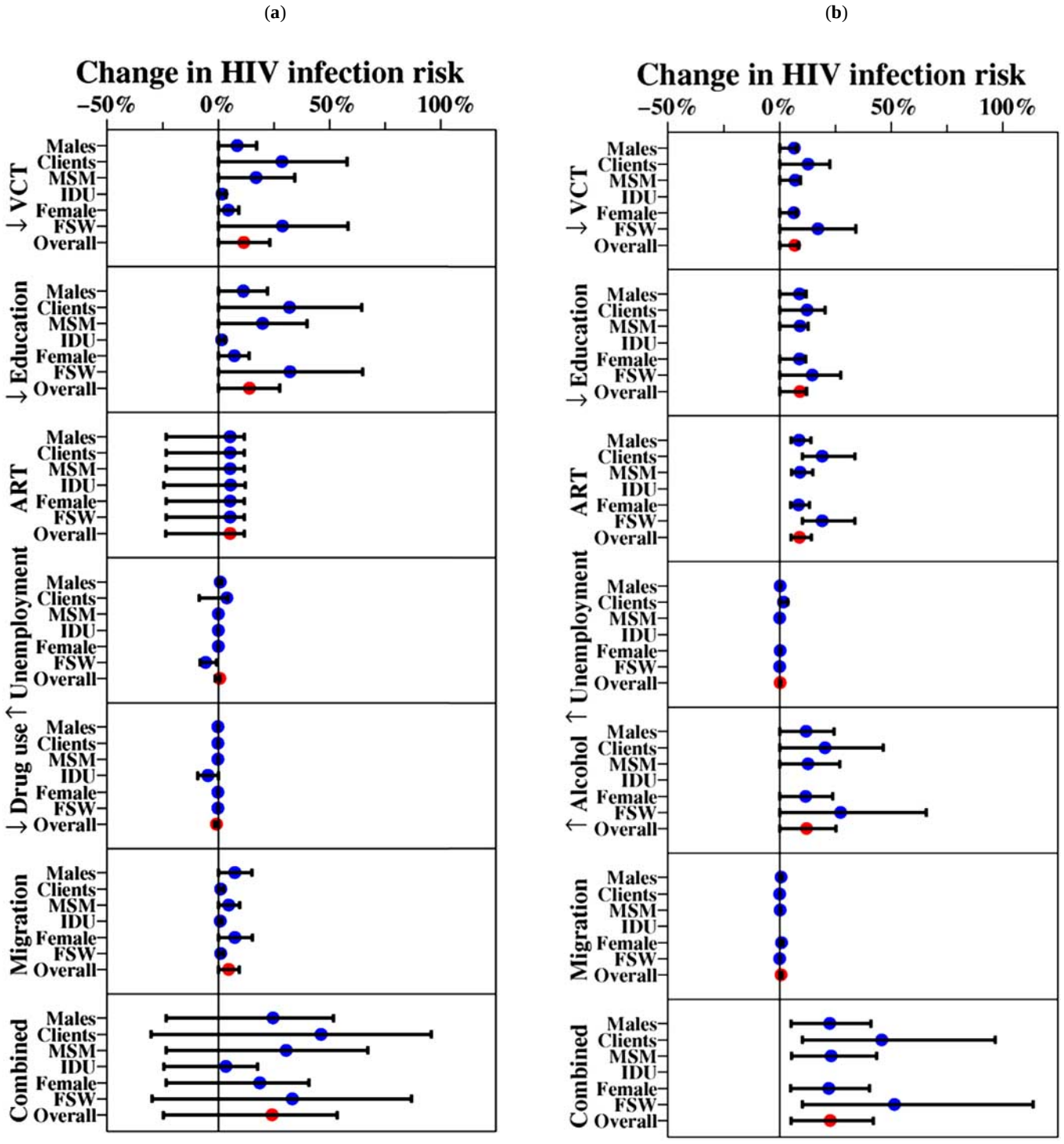

Fig. (3). Change in HIV incident risk per person in each population group (blue dots) and overall (red dots) due to the economic crisis in (a) Cambodia and (b) PNG. Error bars denote incident risk due to optimistic and pessimistic assumptions. For PNG the results for Male Clients and FSW only apply to urban settings. For other population groups the change in risk is for the urban and rural populations combined. In our model we assumed there were no IDUs in PNG.

We acknowledge funding support from the Australian Agency for International Development ("AusAID"), of the Department of Foreign Affairs and Trade. The National Centre in HIV Epidemiology and Clinical Research is funded by the Australian Government Department of Health and Ageing and is affiliated with the Faculty of Medicine, The University of New South Wales.

SUPPLEMENTARY MATERIAL

This article also contains the supplementary material and it can be viewed online at publisher's website along with the article.

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Received: August 9, 2009 **Revised: August 9, 2009** **Accepted: August 11, 2009**