

HIV in Indonesia Model (HIM)

2011: Model overview, features and launch

HIV/AIDS epidemics have resulted in large morbidity and mortality and had considerable personal and social impacts in Indonesia.

Models are useful tools for interpreting surveillance data, explaining epidemiological patterns, evaluating the population-level impact of public health programs, and forecasting epidemic trajectories. Such tools can be used to inform HIV/AIDS program management, evaluation and to design interventions that are focused and well-targeted to minimise the burden caused by HIV.

Although epidemic models have been used previously in Indonesia, for the first time a model has now been designed to be specifically customised to the unique behavioural and epidemiological context of Indonesia, including its geographical variations. The HIV in Indonesia Model (HIM) is based on the international best-practice epidemic disease modelling using interacting systems of differential equations and calibration-optimisation routines. The HIM incorporates greater biological realism of transmission, detailed history of disease stages and mixing patterns than previous models applied in the region and is based on the latest international evidence of heterogeneous transmission rates, interventions efficacies and disease progression.

The HIM is flexible for users to define and assess different targeted scenario combinations of past and future epidemic patterns and programs. The HIM is easily adaptable for application to different geographical levels within Indonesia.

The HIM has transparent

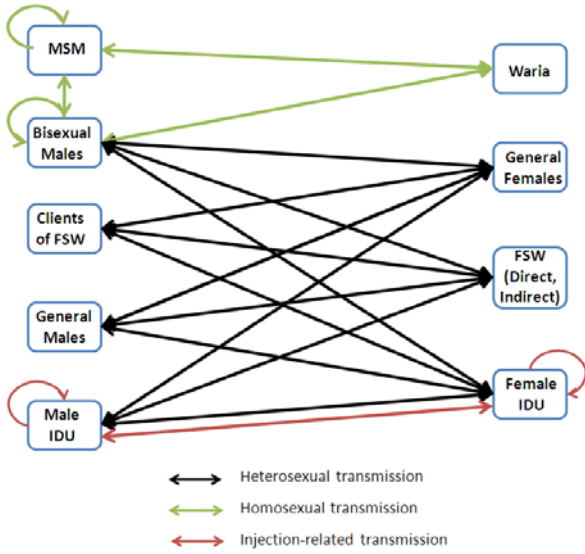
- Methodology;
- User-defined inputs;
- Epidemiological outcome indicators;
- User-controlled scenario analyses.



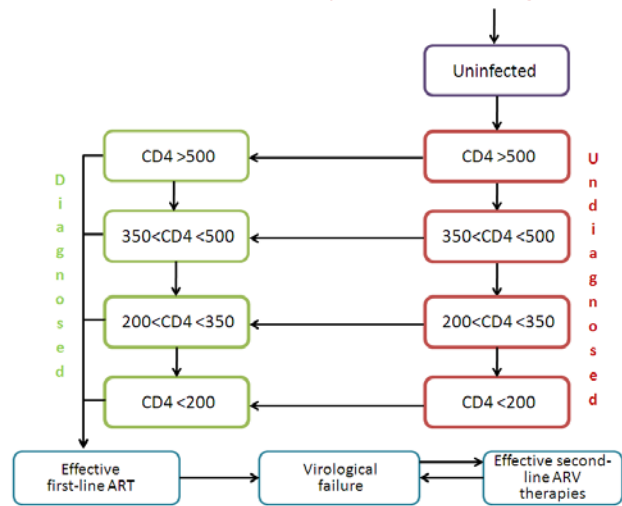
HIM

- Inputs include
 - IBBS data
 - Available epidemiological, behavioural, clinical, biological, and program data
- Automatically calibrates to match risk behaviours with epidemic trends and population outcomes
- Assesses epidemiological impact of past control programs
- Projects the future course of HIV in Indonesia under
 - Current conditions
 - Combinations of targeted interventions
- Performs uncertainty analyses
- Specific to unique populations in Indonesia, including
 - Male and Female IDU
 - Direct and Indirect Sex Workers
 - Clients of Sex Workers
 - Waria
 - Bisexual Men
 - Men who have sex with men
 - Males and Females in general population
- Specific models for
 - All Indonesia
 - Papua
 - Non-Papua
 - Sumatra
 - Riau Islands
 - Jakarta
 - West Java
 - Central Java
 - East Java
 - Bali

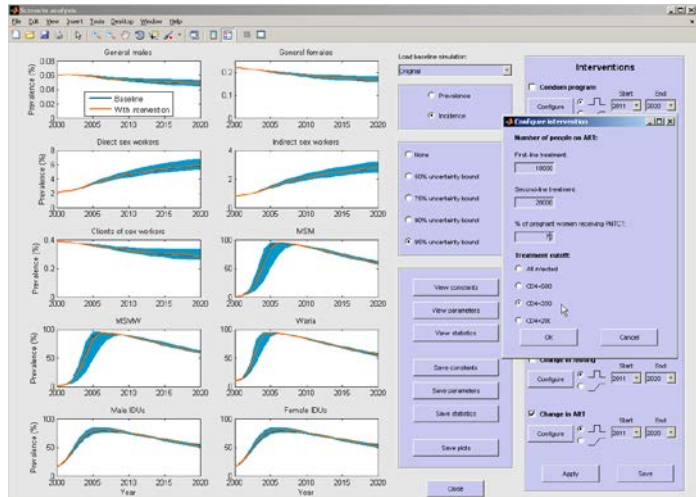
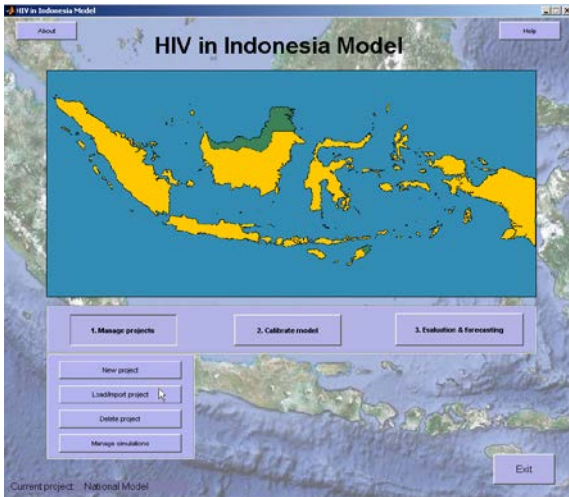
Tracking chains of transmission



Tracking outcomes of infection and differential infectiousness by disease stage



Intuitive graphical user interface with flexible options



The HIM was funded by the Australian Agency for International Development (AusAID) with support from the World Bank. It was first launched in Jakarta in 2011. HIM was designed specifically as a tool that captures the unique epidemiology, behaviours, populations and geography of Indonesia to be used for practical evaluation and development of policies and programs in Indonesia. Future versions of HIM will attempt to ensure the tool remains useful for addressing relevant issues in Indonesia and for designing optimal public health control measures. Health economic components are also planned for future versions.



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The HIM was developed for the Indonesian Ministry of Health and National AIDS Commission by the following investigator team collaborating between the University of New South Wales, Sydney, Australia and The University of Indonesia: David Wilson, Pandu Riono, Cliff Kerr, Amy Kwon, Lei Zhang, John Kaldor, Aang Sutrisna, Muhammad Noor Farid, Nasrun Hadi. Contact for more information: dwilson@unsw.edu.au; pandu.riono@gmail.com

Methods for HIV in Indonesia Model (HIM)

The HIV in Indonesia Model (HIM) has been designed to be specifically customised to the unique behavioural and epidemiological context of Indonesia. Through a consultative process it was determined that 10 distinct behavioural population groups of importance in Indonesia are:

- Male and female injecting drug users (IDU)
- Direct and indirect female sex workers (FSW)
- Clients of FSW
- Waria
- Bisexual men
- Men who have sex with men (MSM)
- Males and females in the general population.

Many of these groups exist in other countries but some groups are not common elsewhere, for example, waria is a population group specific to Indonesia. There are also important geographical differences in Indonesia that cannot be captured by a single national model. For example, the HIV epidemic in Papua is largely different to non-Papua (predominantly heterosexually driven versus largely related to injecting behaviours). Through consultation and based on perceived epidemiological importance and availability of data, it was determined that HIM should be applied to the following settings:

- Jakarta
- West Java
- East Java
- Riau Islands
- All non-Papua
- Sumatra
- Central Java
- Bali
- Papua
- All Indonesia

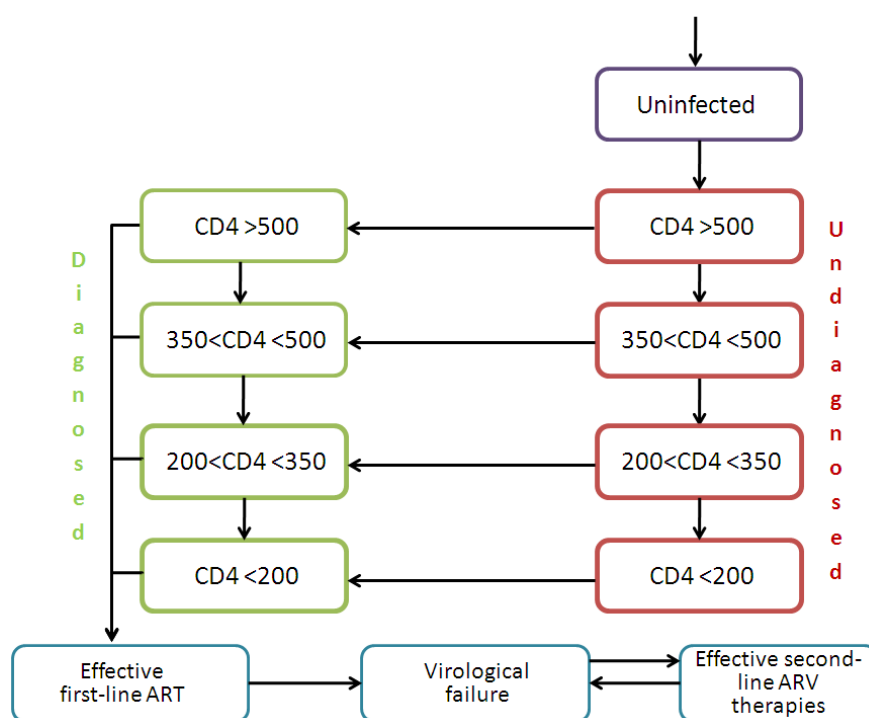
The HIM can also be applied to other locations. For example, smaller communities or regions within a given province can use baseline frameworks and parameter for the broader province but then adapt specific population sizes and behavioural parameters to reflect the context of interest.

The HIM is based on international best-practice epidemic disease modelling. It incorporates greater realism of biological transmission processes, detailed history of disease stages and mixing patterns than previous models applied in the region. Detailed descriptions of all methods of HIM are provided in this section in a transparent manner such that the strengths and limitations of the model can be clearly assessed and HIM could be independently reproduced by any other mathematical modelling group. The HIM software can be used without appreciating the methods that underlie the outcomes. However, HIM is not meant to be a 'black box' and awareness of the processes and calculations involved in producing all results can be obtained by understanding the equations and methods provided in this section.

Structure of disease progression

The HIM tracks the number of people in the population who become infected with HIV and the extent of disease progression in people living with HIV. In order to monitor the extent of infection in the population and calculate the expected demand for antiretroviral therapies, the HIM categorises the population of people living with HIV by CD4 count groupings and the rate of transition between these groupings. Furthermore, the model distinguishes between people living with HIV who have not yet been diagnosed with their HIV infection versus people who have been diagnosed (through VCT for example). People with diagnosed HIV below a CD4 threshold are eligible for antiretroviral therapies (ART); the HIM tracks the number of people who initiate first-line ART, the rate of virological failure emerging and progression to second- and subsequent-lines of ART. A schematic diagram of the structure of health states captured by the model is shown in the figure below. HIV/AIDS-related deaths and other causes of death are also included in HIM.

HIV health states in HIM



The schematic diagram of the health states in HIM can be translated into mathematical descriptions in the form of a coupled system of ordinary differential equations. One differential equation is developed for each of the 12 health states. The transitions between health states (arrows in the diagram) correspond to parameter rates in the equations. The mathematical form of the change in the number of people in each health state, with respect to time, is shown on the following page. Greek symbols are used to represent transition rates but their real-world meaning is also provided above each term.

Change in number of uninfected people

$$\frac{dS}{dt} = \pi - (\mu + \lambda) \cdot S$$

New entry into population Background death Per-capita rate of acquiring HIV

Change in number of people with undiagnosed infection (CD4 > 500)

$$\frac{dU_{500}}{dt} = \lambda S - (\mu + \mu_{500} + \tau_{500} + \eta_{500}) \cdot U_{500}$$

New infections Background death HIV-related death (CD4 > 500) Progression to 350 < CD4 < 500 Testing / diagnosis rate (CD4 > 500)

Change in number of people with diagnosed infection (CD4 > 500)

$$\frac{dD_{500}}{dt} = \eta_{500} U_{500} - (\mu + \mu_{500} + \tau_{500} + \sigma_{500}) \cdot D_{500}$$

New diagnoses Background death HIV-related death (CD4 > 500) Progression to 350 < CD4 < 500 Treatment rate (CD4 > 500)

Change in number of people with undiagnosed infection (350 < CD4 < 500)

$$\frac{dU_{350_500}}{dt} = \tau_{500} U_{500} - (\mu + \mu_{350_500} + \tau_{350_500} + \eta_{350_500}) \cdot U_{350_500}$$

Progression from CD4 > 500 Background death HIV-related death (350 < CD4 < 500) Progression to 200 < CD4 < 350 Diagnosis rate (350 < CD4 < 500)

Change in number of people with diagnosed infection (350 < CD4 < 500)

$$\frac{dD_{350_500}}{dt} = \eta_{350_500} U_{350_500} + \tau_{500} D_{500} - (\mu + \mu_{350_500} + \tau_{350_500} + \sigma_{350_500}) \cdot D_{350_500}$$

New diagnoses Progression from CD4 > 500 Background death HIV-related death (350 < CD4 < 500) Progression to 200 < CD4 < 350 Treatment rate (350 < CD4 < 500)

Change in number of people with undiagnosed infection (200 < CD4 < 350)

$$\frac{dU_{200_350}}{dt} = \tau_{350_500} U_{350_500} - (\mu + \mu_{200_350} + \tau_{200_350} + \eta_{200_350}) \cdot U_{200_350}$$

Progression from 350 < CD4 < 500 Background death HIV-related death (200 < CD4 < 350) Progression to CD4 < 200 Diagnosis rate (200 < CD4 < 350)

Change in number of people with diagnosed infection (200 < CD4 < 350)

$$\frac{dD_{200_350}}{dt} = \eta_{200_350} U_{200_350} + \tau_{200_350} D_{200_350} - (\mu + \mu_{200_350} + \tau_{200_350} + \sigma_{200_350}) \cdot D_{200_350}$$

New diagnoses Progression from 350 < CD4 < 500 Background death HIV-related death (200 < CD4 < 350) Progression to CD4 < 200 Treatment rate (200 < CD4 < 350)

Change in number of people with undiagnosed infection (CD4 < 200)

$$\frac{dU_{200}}{dt} = \tau_{200_350} U_{200_350} - (\mu + \mu_{200} + \tau_{200} + \eta_{200}) \cdot U_{200}$$

Progression from 200 < CD4 < 350 Background death HIV-related death (CD4 < 200) Progression to CD4 < 200 Diagnosis rate (CD4 < 200)

Change in number of people with diagnosed infection (CD4 < 200)

$$\frac{dD_{200}}{dt} = \eta_{200} U_{200} + \tau_{200_350} D_{200_350} - (\mu + \mu_{200} + \tau_{200_350} + \sigma_{200_350}) \cdot D_{200}$$

New diagnoses Progression from 200 < CD4 < 350 Background death HIV-related death (CD4 < 200) Progression to CD4 < 200 Treatment rate (CD4 < 200)

Change in number of people on 1st-line ART

$$\frac{dT_{1st}}{dt} = \sigma_{200_350} D_{200} + \sigma_{200_350} D_{200_350} + \sigma_{350_500} D_{350_500} + \sigma_{500} D_{500} - (\mu_{treat} + \nu) \cdot T_{1st}$$

Rate of initiating ART from each CD4 stage Death rate while on effective ART ART failure rate

Change in number of people experiencing treatment failure

$$\frac{dT_{fail}}{dt} = \nu T_{1st} + \nu_2 T_{2nd} - (\mu_{fail} + \sigma_{2nd}) \cdot T_{fail}$$

1st-line ART failure rate 2nd-line ART failure rate Death rate while failing ART Rate of initiating 2nd-line ART

Change in number of people on 2nd-line ART

$$\frac{dT_{2nd}}{dt} = \sigma_{2nd} T_{fail} - (\mu_{treat} + \nu_2) \cdot T_{2nd}$$

Rate of people initiating 2nd-line ART Death rate while on effective ART 2nd-line ART failure rate

These differential equations describe the change in the number of people in each of these disease states over continuous time where the states are: uninfected and potentially susceptible individuals (S), HIV-infected individuals that are undiagnosed (U) with their infection or HIV-infected individuals that have been diagnosed with their infection (D) and are in the CD4 categories of: $CD4 > 500$, $350 < CD4 < 500$, $200 < CD4 < 350$, $CD4 < 200$; other model states are receiving first-line antiretroviral therapies (T_{1st}), experiencing treatment failure (T_{fail}), and receiving second- and subsequent-lines of antiretroviral therapies (T_{2nd}). The HIM incorporates these 12 equations (health states) specific for each of the 10 population groups, leading to a total of 120 ordinary differential equations. The number of people in each compartment changes based on per-capita rates of disease progression, HIV testing, initiation of treatment, and mortality. Not only does this system of equations reflect the dynamics of HIV epidemics and allow tracking of the number of people at various stage of infection in a population, but it allows for differential levels of infectiousness by population group and stage of infection. Infectiousness is strongly associated with viral load. Average viral loads for each health state were used to differentially determine infectiousness levels across heterogeneous groups of HIV-infected people.

Transmission of HIV infection

The per-capita rate of becoming infected, or the 'force of infection', is the most important term in the system of mathematical equations. The rate and mathematical structure of this term depends on behaviours and differs between exposure routes and mixing between population groups. The annual per-capita risk of acquiring HIV infection per uninfected person in each population group estimates the average rate of infection through both sexual and intravenous transmissions. Sexual transmission risk depends on:

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

The stage of infection (average viral load) for the HIV-positive partner in a serodiscordant couple also influences transmission risk due to different levels of infectiousness in each infection stage.

Intravenous transmission risk depends on:

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

Mathematically, the force of infection is expressed by standard mathematical risk equations that combine the specific risk behaviours and their frequencies with biological risk probabilities per exposure event and the epidemiology of chance of contact with infected partners to quantify the average per-capita risk of acquiring infection for a given person in each of the defined population groups. These calculations are carried out dynamically to track the evolution of epidemic trajectories.

The mathematical expression for the force of infection associated with sexual behaviour is based on the standard binomial formula for accumulation of risk over multiple exposures. Separate force of infection expressions are used for casual, regular, and commercial partners and for each combination of pairings between individuals of different population groups and disease stages of the HIV-infected partner. The governing structure for the risk of infection associated with each partnership type is given by:

$$\lambda_j(t) = P \left[1 - \left(1 - (1 - \varepsilon_{\text{circ}} p_{\text{circ}}) (1 - (1 - \varepsilon_{\text{STI}}) p_{\text{STI}}) \beta \right)^{nc(1-q)} \left(1 - (1 - \varepsilon_{\text{condom}}) (1 - \varepsilon_{\text{circ}} p_{\text{circ}}) (1 - (1 - \varepsilon_{\text{STI}}) p_{\text{STI}}) \beta \right)^{ncq} \right],$$

where c is the average number of sexual partners, β is the probability of transmission per unprotected sexual act for the given partnership type (heterosexual/homosexual and regular, casual or commercial), sexual position (insertive/receptive) and health state of the infected partner, n is the frequency of sex in the given partnership, q is the frequency of condom use, $\varepsilon_{\text{condom}}$ is the efficacy of condoms, p_{circ} is the percentage of the population (males) who are circumcised, $\varepsilon_{\text{circ}}$ is the efficacy of circumcision, p_{STI} is the prevalence of ulcerative sexually transmissible infections (such as syphilis) that may act to increase the risk of HIV by a factor of ε_{STI} , and P is the dynamic prevalence level of HIV in the pool of potential partners for a given mixing interaction (including population group and health state). In order to calculate the overall per-capita risk of acquiring infection due to sexual exposure, the risk is summed over each partnership type, population group, and health states with whom the index group may interact ($\lambda_s = \sum_j \lambda_j$). The overall structure of the formula for calculating risk is consistent for each population group and region but the values of each of these parameters differ between groups and regions. Parameters for each population group are separately defined (in Excel spreadsheets that accompany the HIM software).

The mathematical expression for the force of infection associated with injecting behaviour is also based on the binomial formula for accumulating risk over multiple shared injecting events. The expression is given by:

$$\lambda_k(t) = \left\{ 1 - \left[1 - \left(1 - \varepsilon_{\text{meth}}^n p_{\text{meth}} \right) \left(1 - \varepsilon_{\text{meth}}^{\text{IDU}} p_{\text{meth}} \right) \left(1 - \varepsilon_{\text{clean}} p_{\text{clean}} \right) \beta_I \right]^{n_I s q} \right\} P,$$

where n_I is the average number of times an IDU injects per year, s is the proportion of IDUs who share syringes and q is the frequency of receptively sharing among these IDUs, β_I is the biological probability of transmission from a contaminated needle-syringe per use, p_{clean} is the proportion of reused needle-syringes that are cleaned before reuse, with efficacy $\varepsilon_{\text{clean}}$, p_{meth} is the proportion of IDUs who are in a methadone program, $\varepsilon_{\text{meth}}^{\text{IDU}}$ is the efficacy of methadone in ceasing injecting altogether and $\varepsilon_{\text{meth}}^n$ is the efficacy of methadone in reducing injecting frequency, and P is the dynamic prevalence level of HIV in the IDU population (male and female in each of the different possible health states). The per-capita risk of acquiring infection due to injecting exposure, for IDUs, is summed over male and female IDU populations and the different health states ($\lambda_I = \sum_k \lambda_k$).

The overall per-capita risk of acquiring HIV is then calculated dynamically, and continuously, as the sum of the risk from sexual and injecting behaviours: $\lambda = \lambda_s + \lambda_I$.

Mixing between population groups

The HIM tracks chains of HIV transmission through the population via different interacting population groups. Mixing between population groups can occur according to regular, casual or commercial sexual partnerships or through sharing or injecting equipment. Mixing interactions between population groups that are included in HIM are shown in the table below.

	General Females	General Males	Clients of FSW	Direct FSW	Indirect FSW	Female IDU	Male IDU	MSM	MSMW	Waria
General Females		N	N				N		N	
General Males	N			N	N	N				
Clients of FSW	N			N\$	N\$	N				
Direct FSW		N	N\$				N\$		N	
Indirect FSW		N	N\$				N\$		N	
Female IDU		N	N			I	NI		N	
Male IDU	N			N\$	N\$	NI	I			
MSM								N	N	N\$
MSMW	N			N	N	N		N	N	N\$
Waria								N\$	N\$	

N: Denotes a non-commercial sexual partnership (casual or regular)

\$: Denotes a commercial sexual partnership

I: Denotes an injection-related interaction

For each interaction between population groups, the average number of encounters is defined (sexual acts per casual, regular or commercial partnership or average number of shared injecting events); these values are specified in the Excel spreadsheets that accompany the HIM software. The HIM ensures that there is conservation of sexual acts, sexual partnerships and injecting episodes between all combinations of mixing interactions; for example, the total number of partnerships general males have with general females must always equal the total number of partnerships general females have with general males. Mixing between any given population group and people from the collective population groups with whom they may potentially interact is defined to be proportional to the respective population group sizes and sexual activity levels, that is, random mixing. An exception to this is that there is slightly greater weighting towards assortative sexual mixing for IDUs: it is assumed that male and female IDUs may have preferential sexual activity with each other than with the general population, by a degree that is informed by ratio of sexual activity of male IDUs compared with the general male population. Furthermore, it is assumed that all MSM partners are casual and waria always partake in the receptive role in penile-anal intercourse.

Data and inputs for HIM

The usefulness of any model depends on the quality of data which inform the characteristics of the populations being described by the model structure. The HIM is informed by all available behavioural data regarding sexual or injecting risk activities for each population group, biological data on disease progression and heterogeneous transmission rates, and clinical data (such as rates of VCT and antiretroviral treatment coverage). Public health programs that have been implemented over the past are indirectly captured in the model through their influence on behavioural and clinical parameters. However, data about certain interventions (such as needle exchange programs and methadone maintenance programs) are explicitly included in the HIM. Any available data from routine surveillance activities, one-off surveys, research studies, population-based data records etc were collated to inform the baseline characteristics of the HIM for each geographical region. Integrated Biological-Behavioural Surveillance (IBBS) data were heavily used. Biological parameter values (about transmission rates and disease progression) were informed by evidence from the international literature. Any data from 2000-2010 were used as inputs for the current version. Constant parameters, with respect to time, were defined to have a best estimate along with an uncertainty range (minimum and maximum estimate). Time-varying parameters were assigned a best estimate and automatic uncertainty bounds were assigned in HIM (see section on Uncertainty analyses). A flexible logistic curve was fitted to the time-varying data, using the minimum least squares method, and the logistic curve became the model input. As new data become available, they can easily be added to the inputs of HIM.

Using the input data, HIM was calibrated to match all available population-level data over time including prevalence of HIV in each population subgroup, number of people on ART, number of people who received VCT and number of HIV diagnoses.

Optimization procedure to calibrate HIM and reconcile all data sources

As a coupled system of 120 ordinary differential equations, the HIM had to be solved numerically. It was solved in Matlab using a standard finite difference algorithm that discretizes the continuous differential equations into difference equations. A unique feature of the HIM was the incorporation of formal optimization procedures around the model's numerical solver. Most epidemic models do not include this component but its relatively innovative inclusion in this study provides more rigor and robustness of the modelling results. A rationale for this feature is as follows. Mathematical models incorporate a large variety of epidemiological, behavioural, biological, clinical and social data sources into a single mechanistic framework that examines how all of these factors interact and together contribute to the observed epidemic. However, due to uncertainties, inaccuracies or heterogeneity in survey data or large complexity in the interacting factors, the large number of parameter values may not seem to be consistent when viewed as an interacting whole (e.g. if condom use increases by a certain amount in a sample of a given population group then calculations would yield estimates of change in prevalence but this might not be precisely how prevalence was observed to change). Given the uncertainty around all parameter values, within confidence intervals or plausible bounds, the optimization procedure determines how all the parameters and their complex interactions can be reconciled together to produce the observed epidemiology.

The calibration procedure commences with the assigning of a weight to all input parameters and outcomes in the model. An objective function is defined as the sum of squares of differences between the available data and the model, weighted by the assigned weights. A Trust-Reflective algorithm¹, which is a gradient-descent method but with a dynamically updating step size, was used to step in every dimension of parameter space for determining the direction of change in parameters that results in the greatest reduction in deviation between the data and the model. This algorithm iterates until a best fit is obtained within tolerance limits. A manual change of parameter values is possible in the HIM software to update the automatic calibration in the case of resulting in a local minimum that is clearly not an ideal global solution of best fit. The HIM software uses a default weight of 5 for the prevalence of each population group versus 1 for all input parameters; weightings apply across parameters and not across each datum point in time for the parameter. These weights can be adjusted by the user.

1: Conn et al. Trust-Region Methods, MPS/SIAM Series on Optimization, SIAM and MPS, 2000; Nocedal & Wright, Numerical Optimization, Springer Series in Operations Research, Springer Verlag, 1999.

Uncertainty analyses

Rather than produce a single epidemic trajectory and single estimate for each outcome indicator, the HIM has provision to carry out uncertainty analyses to reflect the fact that any calculation is based on parameter values that are imprecisely known or based on assumptions.

To carry out an uncertainty analysis, degrees of uncertainty in all input parameters should be assigned. The Excel spreadsheet accompanying the HIM software contains minimum and maximum plausible limits for constant parameters but point estimates for time-varying parameters. A normal curve is assigned for each parameter range, from which to sample in the uncertainty analysis, with a standard deviation equal to one-twentieth the width of the defined uncertainty bound. Time-varying parameters are assigned uncertainty bounds in the HIM software up to $\pm 20\%$ of the parameter estimates. Furthermore, all parameters have 'hard' limits to their bounds to ensure realism (e.g. all proportions must be bounded between 0 and 1).

The HIM generates uncertainty in outcomes by running 40 simulations, each simulation using a different set of parameters sampled from the defined uncertainty distributions associated with each model input. Degrees of uncertainty limits can then be reported, as decided by the user:

- 95% uncertainty limit (defined by 2nd and 39th values / 40 simulations at each time step)
- 90% uncertainty limit (3rd and 38th values / 40)
- 75% uncertainty limit (6th and 35th values / 40)
- 50% uncertainty limit (11th and 30th values / 40).

HIM results

The HIM is able to produce any epidemiological indicator associated with the population groups and health states for any year, past or future projected. A list of summary indicators automatically produced by the HIM software for each population group and overall is:

- Prevalence
- Annual incidence
- Annual number of people who commence 1st line treatment
- Annual number of people who commence 2nd line treatment
- Annual number of HIV/AIDS-related deaths
- Number of undiagnosed people living with HIV/AIDS
- Number of people with $CD4 > 500$
- Number of people with $350 < CD4 < 500$
- Number of people with $200 < CD4 < 350$
- Number of people with $CD4 < 200$
- Number of people eligible for treatment
- Number of people eligible for second-line treatment
- Cumulative number of people on ART
- Cumulative incidence
- Cumulative number of deaths due to HIV
- Children exposed to HIV
- Children infected with HIV.

Scenario analyses

The HIM can be used to explore scenarios, namely, the expected epidemiological course of HIV epidemics under different conditions. Compared to actual conditions, the HIM can be used to

Assess the past

- What if a public health program had not been implemented and a risk factor remained at pre-intervention levels?
- What would have happened if changes in behaviour or clinical practice occurred earlier/later or to a smaller/greater extent?

Forecast the future

- What is the expected profile of the HIV epidemic over the next 10 years if conditions remain at current levels?
- What impact will implementation of a specific targeted intervention have on the HIV epidemic?
- What will be the expected synergistic effect of implementing multiple interventions simultaneously or in a staggered manner?

The HIM software is setup to allow easy past evaluation and future forecasts of

- Condom programs
- Circumcision interventions
- Changes in numbers of partners
- Needle exchange programs
- Methadone maintenance programs
- Change in testing rates
- Change in ART rates (including first-line, second-line therapies, and PMTCT).

However, changes in any parameters of the model can be relatively easily made and the HIM simulate epidemic trajectories under any conditions.

Due to the potential complex nature of the possible effect of distribution of needle-syringes among IDUs, the HIM also contains a special evaluation tool to evaluate needle-exchange programs.

Evaluation of the epidemiological impact of needle-exchange programs

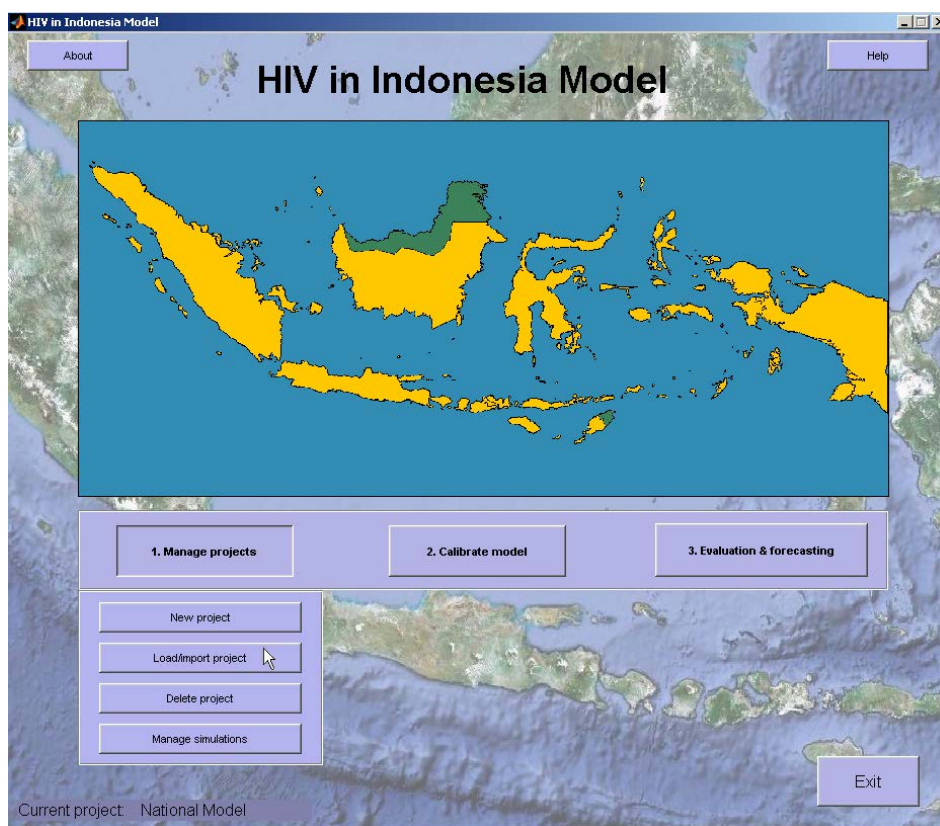
Free distribution of needle-syringes is expected to decrease sharing of injecting equipment. The extent of expected change is not known from empirical data as it a hypothetical scenario. However, if it is assumed that the saturation in need for sterile injecting equipment has not been reached and greater supply would result in greater coverage then a mathematical relationship can be developed that balances the total number of units in circulation with how they were used; e.g. the total number of needle-syringes available in the population, from personal purchasing and free distribution from harm reduction programs, must equal the sum of total number of needle-syringes used in personal injections, shared injections, and units that are not used. Based on this rationale, if P needle-syringes are in circulation each year ($P = P_1 + P_2$, where P_1 is the number distributed through needle-exchange programs and P_2 is the number purchased through pharmacies) and a proportion ω of all needle-syringes are not used, then the number of needle-syringes that are used is $P(1 - \omega)$. The number of needle-syringes used for individual injecting episodes among non-sharing IDUs is $nN(1-s)/\delta_p$, where N is the size of the IDU population, n is the average number of injections per IDU per year, s is the proportion of IDUs who share needle-syringes, and δ_p is the average number of times each non-shared needle-syringe is used before it is disposed. Similarly, the total number of needle-syringes used for individual injecting among all IDUs who share some of the time is $nN(1-s)/\delta_p$ and the total number of syringes used in sharing events is $nqsN/\delta_s$, where q is the proportion of injections that are shared for sharing IDUs. Therefore,

$$P(1 - \omega) = \frac{nN(1-s)}{\delta_p} + \frac{n(1-q)sN}{\delta_p} + \frac{nqsN}{\delta_s} = nN \left[\frac{1-qs}{\delta_p} + \frac{qs}{\delta_s} \right]$$

defines a relationship between the total number of needle-syringes in circulation and the use of needle-syringes. Changes in the number of needle-syringes distributed through needle-exchange programs are likely to change any, or all, of the following factors in a way that is consistent with this balancing relationship: the number of needle-syringes purchased through pharmacies (P_2), the proportion of needle-syringes that remain unused (ω), the proportion of IDUs who share injecting equipment (s), the proportion of injections that are shared (q), or the average number of times each needle-syringe is used (in shared (δ_s) or individual (non-shared) injections (δ_p)). Changes to ω and δ_p will not influence transmission levels but changes to s , q and δ_s could potentially result in large reductions in incidence. Changes in P_2 could then affect other parameters that may influence incidence. This balancing relationship was used to calculate the expected change in the sharing rate according to changes in the total number of needle-syringes distributed. In the HIM software, users are able to alter any or all of these parameters in a way that is consistent with this balancing equation, leading to an assumption about sharing rates from which the HIM estimates the expected epidemiological profile and compares with the status quo.

Graphical User Interface

The HIM was developed in computer code programmed in Matlab. A graphical user interface was designed for easy simulation of the model presented in this report, allowing choice of analyses over geographical regions and different scenarios. An accompanying document contains a user manual for use of the HIM software.



The HIM was developed for the Indonesian Ministry of Health and National AIDS Commission by the following investigator team collaborating between the University of New South Wales, Sydney, Australia and The University of Indonesia: David Wilson, Pandu Riono, Cliff Kerr, Amy Kwon, Lei Zhang, John Kaldor, Aang Sutrisna, Muhammad Noor Farid, Nasrun Hadi.

For more information about the HIM methods contact: dwilson@unsw.edu.au

Population Profile:

General Population

Male: 111,388,812
Female: 114,955,715

Female Sex Workers & Clients

Direct: 106,011
Indirect: 108,043
Clients: 3,241,244

Intravenous Drug Users

Male: 101,553
Female: 4,231

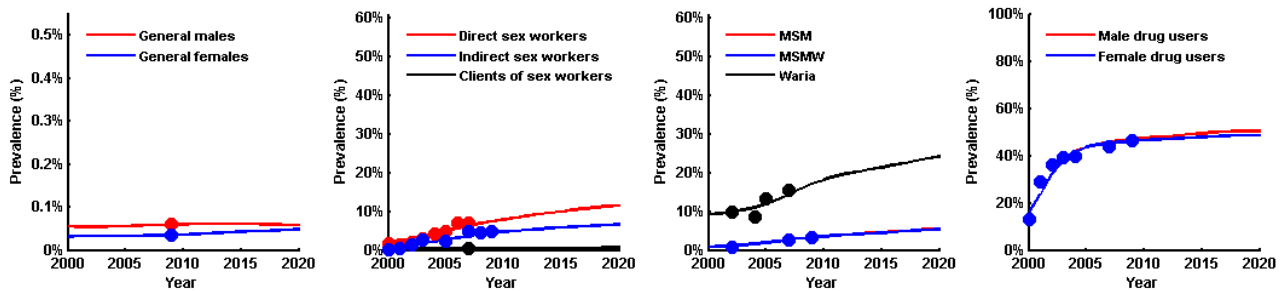
Men who have sex with men:

MSM: 535,170
Bisexual: 159,856
Waria : 32,065



The HIM was applied to all populations in Indonesia, averaging input data across provinces. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

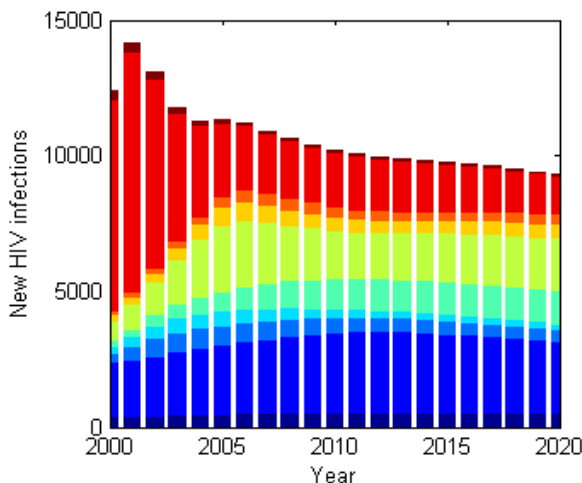
Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in Indonesia, along with AEM estimates and seroprevalence data.



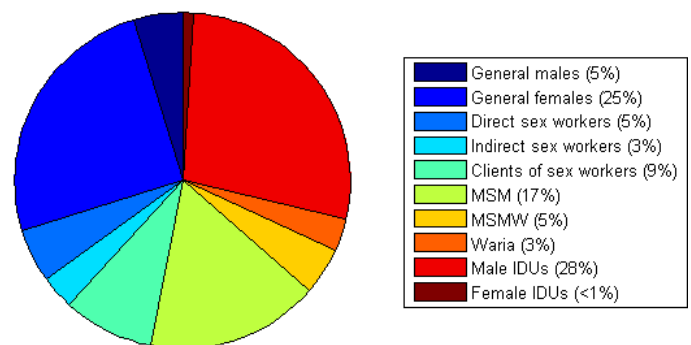
Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for Indonesia calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Figure 2: Incidence (new infections) in Indonesia estimated by HIM

Annual new infections over time



New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological indicators is shown in Table 1.

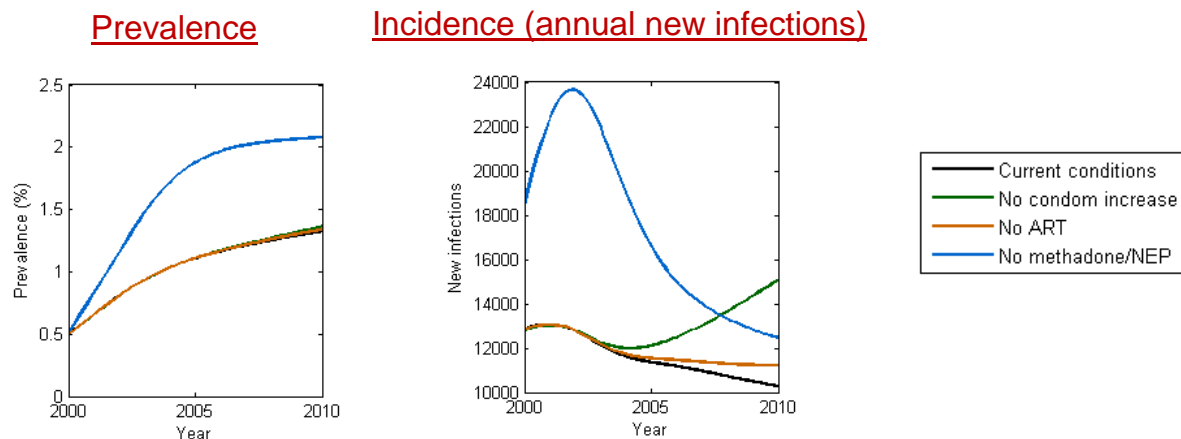
Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	234,529	320,161
New HIV infections	16,721	19,793
HIV/AIDS-related deaths	4,805	5,713
Adults eligible for first-line ART	92,066	85,362
Adults requiring second-line ART	3,150	17,299
Children exposed to HIV	3,105	4,799
Children infected with HIV	1,299	2,009

Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in Indonesia are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in Indonesia across all population groups if programs/behaviours had not changed over the past 10 years.



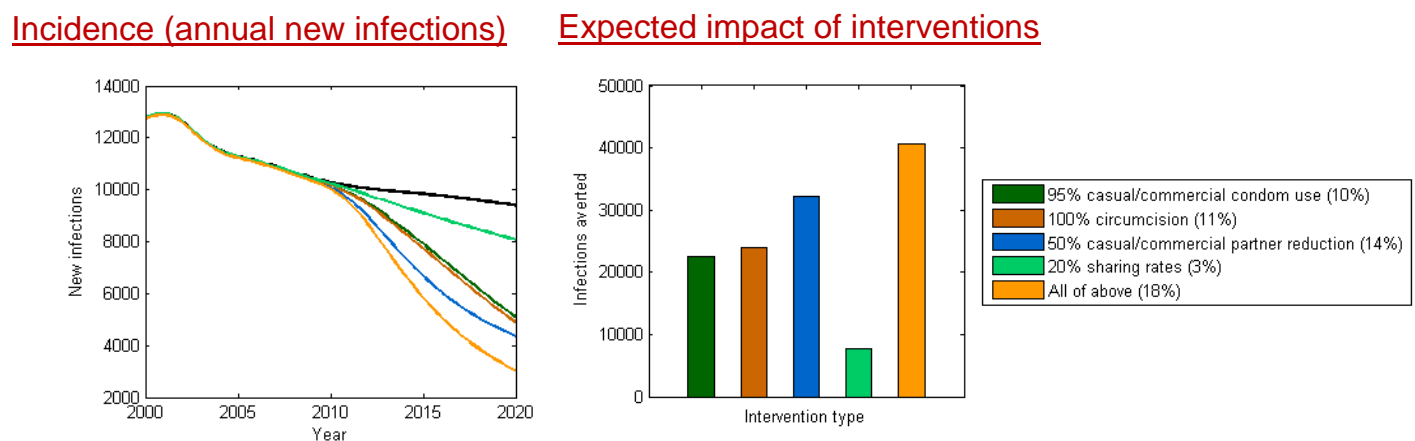
Had programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

- Needle-exchange and methadone programs have averted an estimated 62,167 (49%) HIV infections among IDU;
- ART programs have averted an estimated 3,299 (3%) HIV infections;
- Condom promotion has averted an estimated 16,147 (13%) HIV infections overall.

Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in Indonesia according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.



Non-Papua

Population Profile:

General Population
 Male: 110,111,880
 Female: 113,646,374

Female Sex Workers & Clients
 Direct: 101,260
 Indirect: 103,138
 Clients: 3,091,610

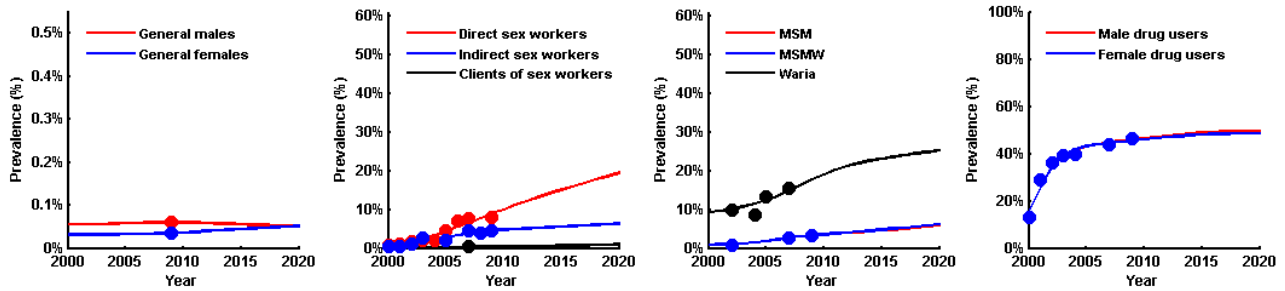
Intravenous Drug Users

Male: 101,479
 Female: 4,228
 Men who have sex with men:
 MSM: 525,015
 Bisexual: 156,823
 Waria : 31,593



The HIM was applied to populations in non-Papua, with location-specific data. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

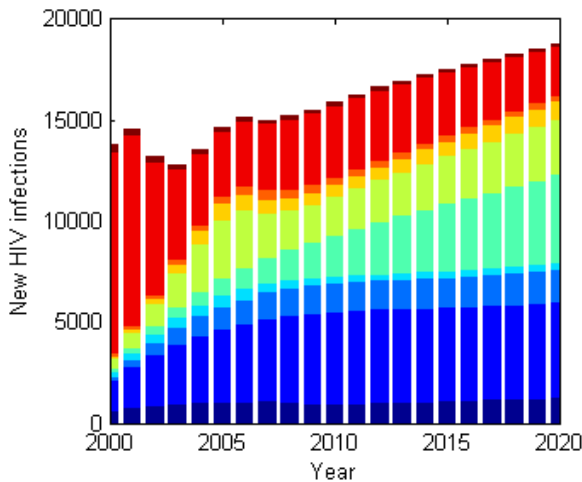
Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in non-Papua, along with AEM estimates and seroprevalence data.



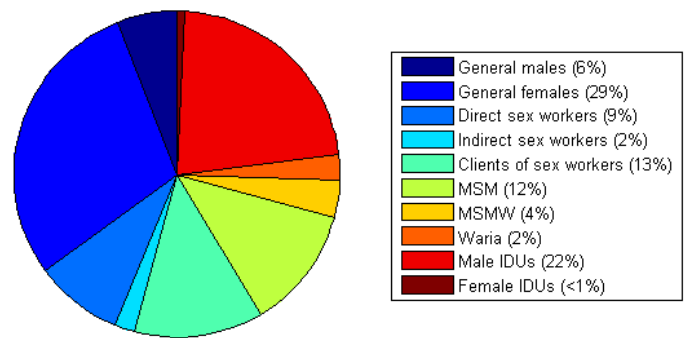
Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for non-Papua calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Figure 2: Incidence (new infections) in non-Papua estimated by HIM

Annual new infections over time



New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological indicators is shown in Table 1.

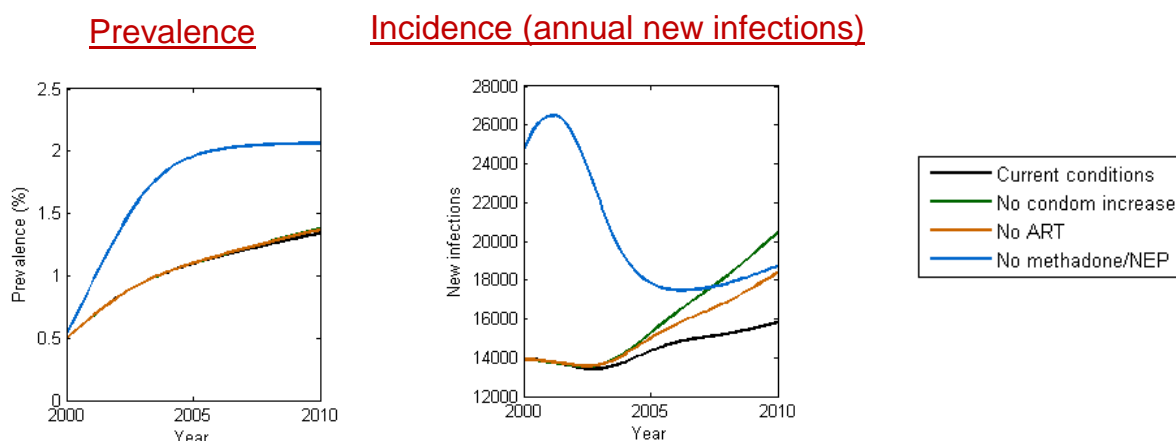
Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	226,840	307,990
New HIV infections	15,891	18,738
HIV/AIDS-related deaths	4,559	5,353
Adults eligible for first-line ART	90,354	83,704
Adults requiring second-line ART	3,062	16,956
Children exposed to HIV	2,851	4,391
Children infected with HIV	1,193	1,838

Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in non-Papua are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in non-Papua across all population groups if programs/behaviours had not changed over the past 10 years.



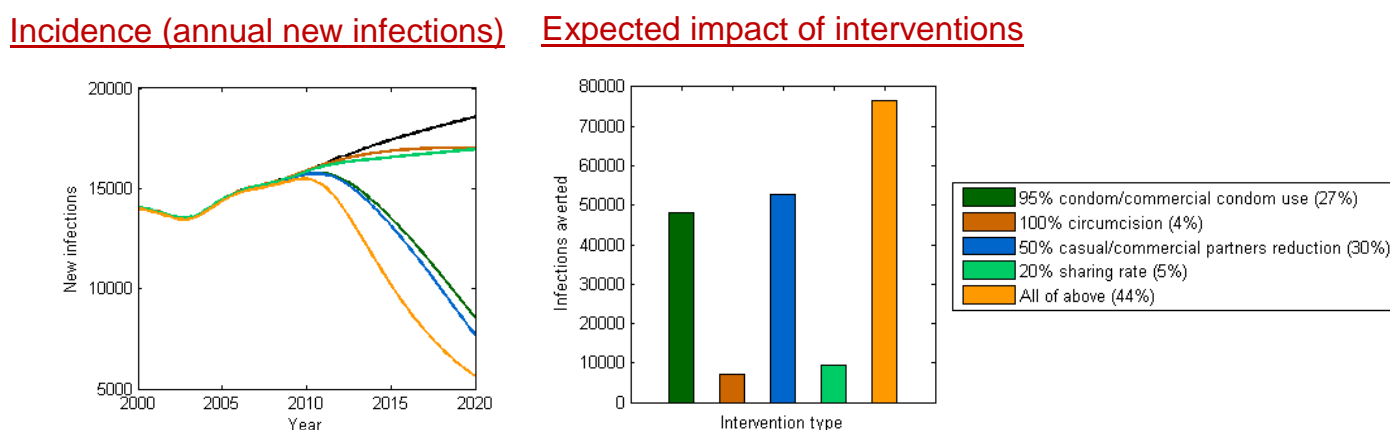
Had programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

- Needle-exchange and methadone programs have averted an estimated 66,160 (42%) HIV infections among IDU;
- ART programs have averted an estimated 9,787 (6%) HIV infections;
- Condom promotion has averted an estimated 16,708 (11%) HIV infections overall.

Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in non-Papua according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.



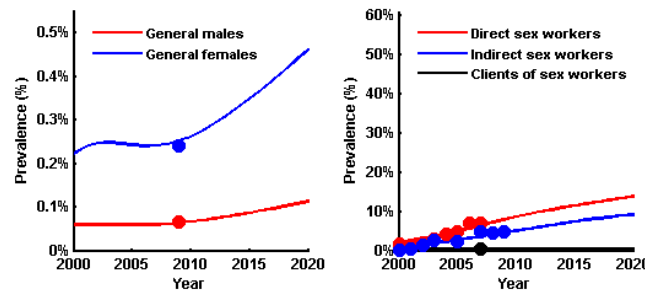
Tanah Papua

Population Profile:
General Population
 Male: 1,290,659
 Female: 1,309,344
Female Sex Workers & Clients
 Direct: 4,751
 Indirect: 4,905
 Clients: 149,641



The HIM was applied to populations in Tanah Papua, with location-specific data. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in Tanah Papua, along with AEM estimates and seroprevalence data.

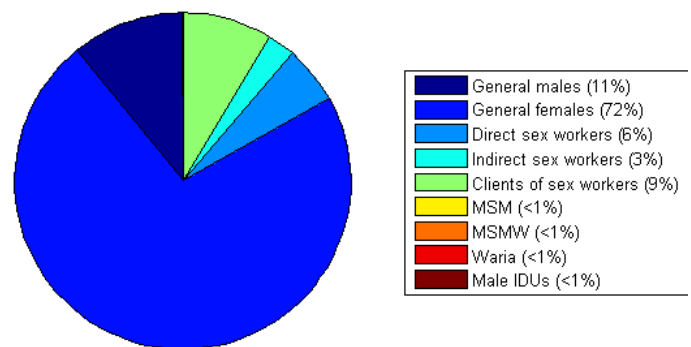
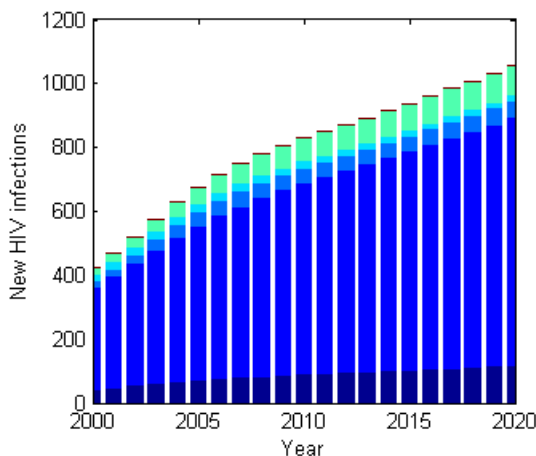


Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for Tanah Papua calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Figure 2: Incidence (new infections) in Tanah Papua estimated by HIM

Annual new infections over time

New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological indicators is shown in Table 1.

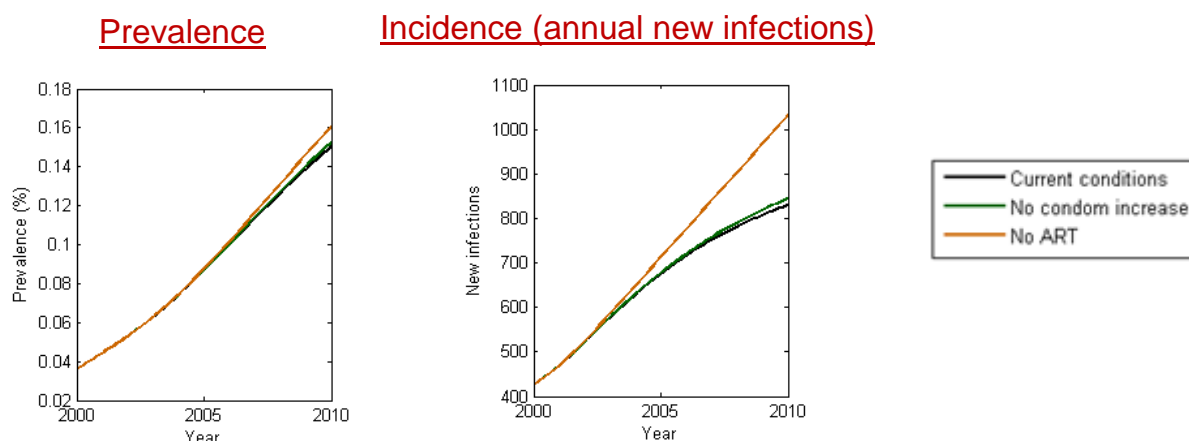
Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	7,689	12,171
New HIV infections	830	1,055
HIV/AIDS-related deaths	246	360
Adults eligible for first-line ART	1,712	1,658
Adults requiring second-line ART	88	343
Children exposed to HIV	254	408
Children infected with HIV	106	171

Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in Tanah Papua are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in Tanah Papua across all population groups if programs/behaviours had not changed over the past 10 years.



Had programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

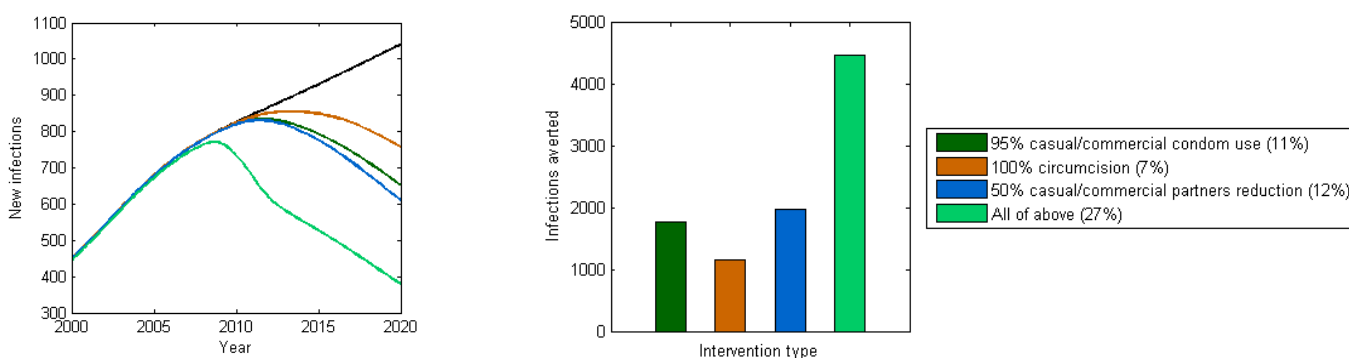
- ART programs have averted an estimated 699 (10%) HIV infections;
- Condom promotion has averted an estimated 49 (1%) HIV infections overall.

Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in Tanah Papua according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.

Incidence (annual new infections) Expected impact of interventions



Bali

Population Profile:

General Population

Male: 1,623,000
Female: 1,750,000

Female Sex Workers & Clients

Direct: 3,945
Indirect: 6738
Clients: 139,505

Intravenous Drug Users

Male: 2,900
Female: 120

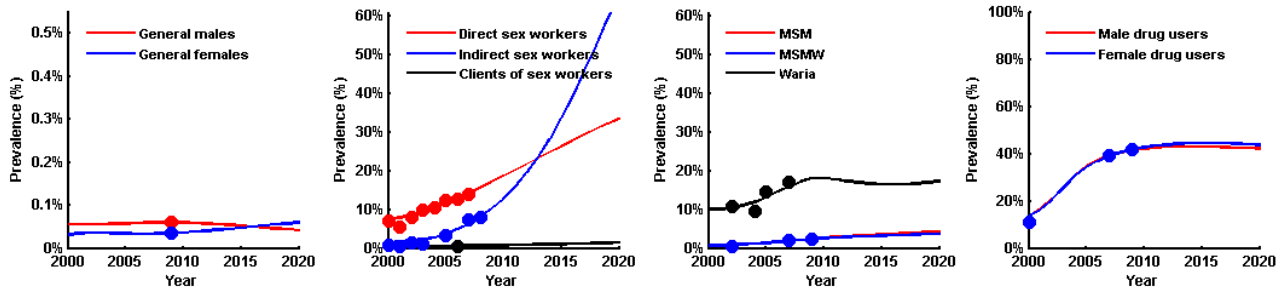
Men who have sex with men:

MSM: 19,866
Bisexual: 5,934
Waria : 923



The HIM was applied to populations in Bali, with location-specific data. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in Bali, along with AEM estimates and seroprevalence data.

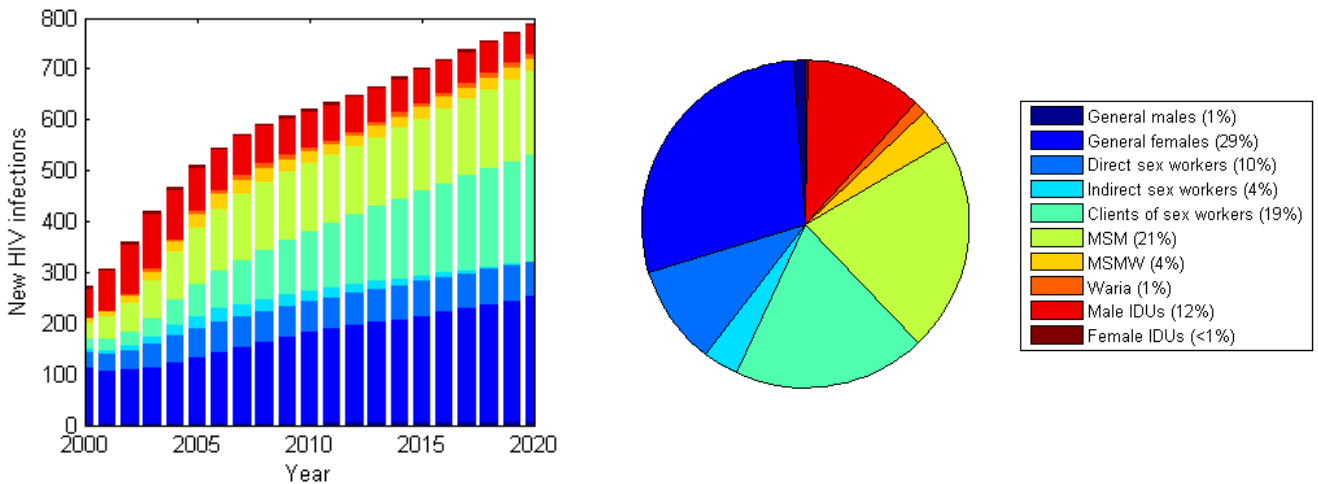


Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for Bali calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Figure 2: Incidence (new infections) in Bali estimated by HIM

Annual new infections over time

New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological indicators is shown in Table 1.

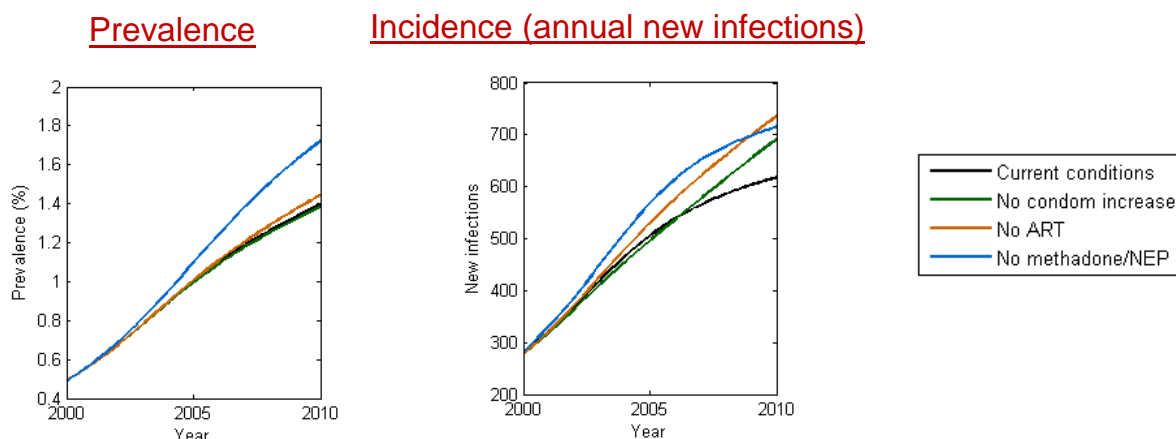
Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	6,766	10,406
New HIV infections	612	788
HIV/AIDS-related deaths	139	213
Adults eligible for first-line ART	1,881	1,740
Adults requiring second-line ART	133	511
Children exposed to HIV	102	172
Children infected with HIV	43	72

Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in Bali are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in Bali across all population groups if programs/behaviours had not changed over the past 10 years.



Had programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

- Needle-exchange and methadone programs have averted an estimated 426 (8%) HIV infections among IDU;
- ART programs have averted an estimated 610 (12%) HIV infections;
- Condom promotion has averted an estimated 122 (2%) HIV infections overall.

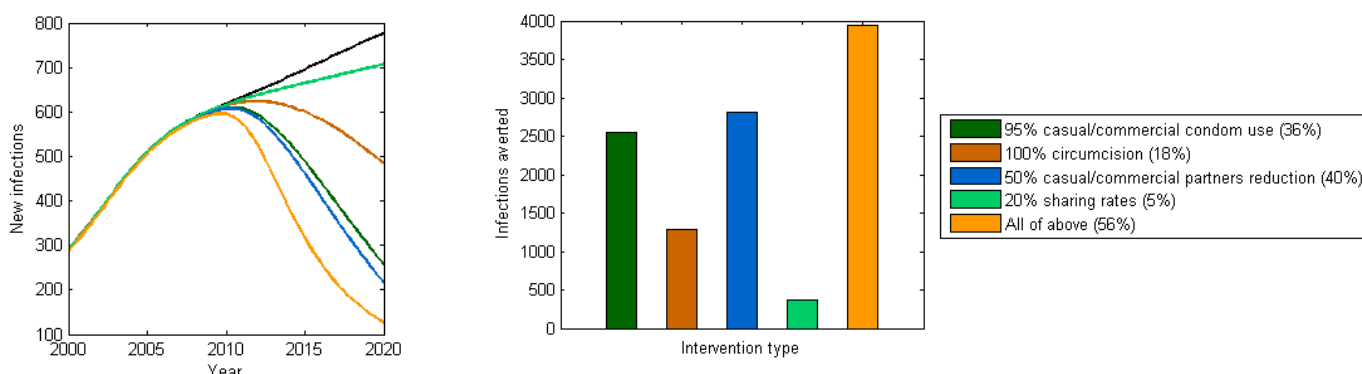
Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in Bali according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.

Incidence (annual new infections)

Expected impact of interventions



Central Java

Population Profile:

General Population

Male: 15,384,710
Female: 16,520,925

Female Sex Workers & Clients

Direct: 10,548
Indirect: 6,997
Clients: 291,904

Intravenous Drug Users

Male: 7,911
Female: 330

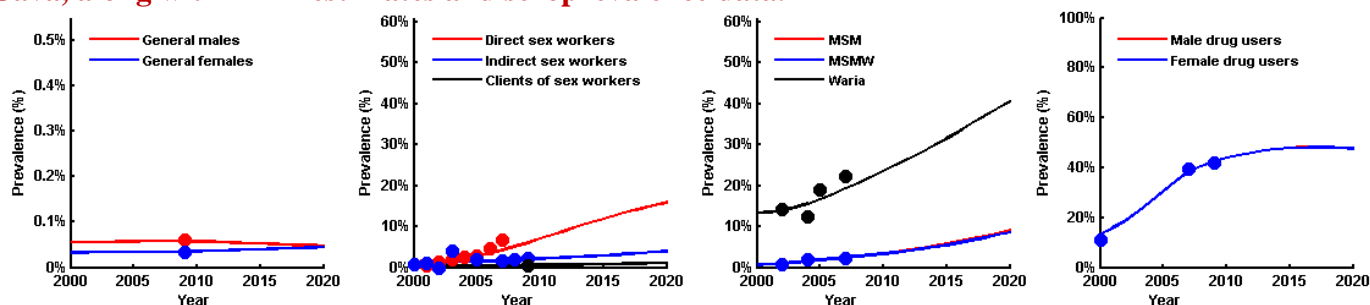
Men who have sex with men:

MSM: 89,295
Bisexual: 26,673
Waria : 2,107



The HIM was applied to populations in Central Java, with location-specific data. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

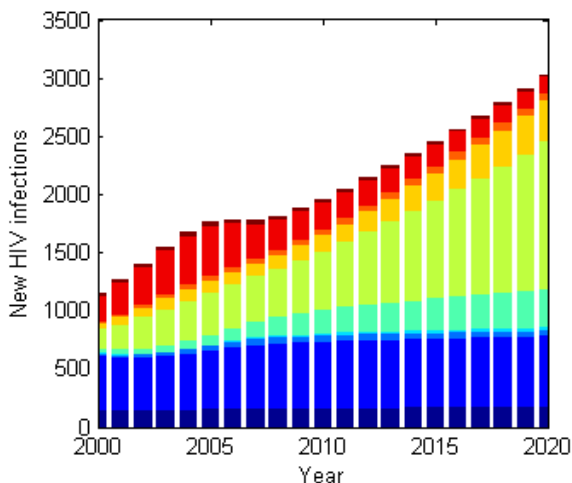
Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in Central Java, along with AEM estimates and seroprevalence data.



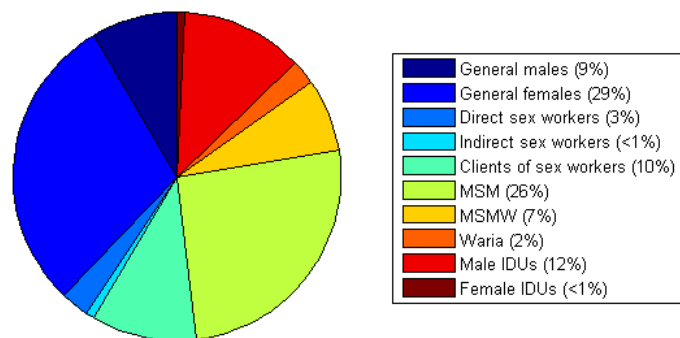
Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for Central Java calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Figure 2: Incidence (new infections) in Central Java estimated by HIM

Annual new infections over time



New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological indicators is shown in Table 1.

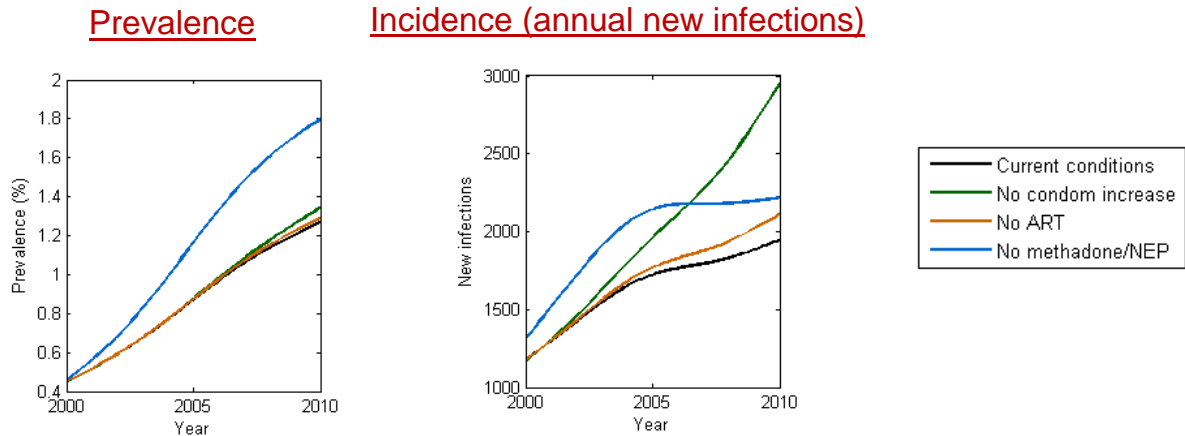
Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	27,300	38,584
New HIV infections	1,957	3,026
HIV/AIDS-related deaths	730	916
Adults eligible for first-line ART	12,366	13,883
Adults requiring second-line ART	287	1,568
Children exposed to HIV	361	475
Children infected with HIV	151	199

Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in Central Java are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in Central Java across all population groups if programs/behaviours had not changed over the past 10 years.



Had programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

- Needle-exchange and methadone programs have averted an estimated 3,565 (20%) HIV infections among IDU;
- ART programs have averted an estimated 646 (4%) HIV infections;
- Condom promotion has averted an estimated 3762 (21%) HIV infections overall.

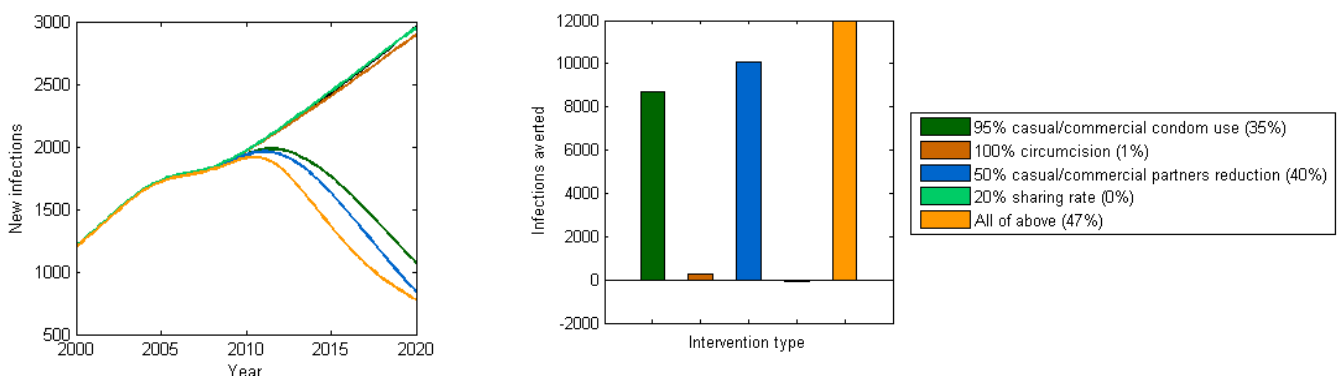
Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in Central Java according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.

Incidence (annual new infections)

Expected impact of interventions



Population Profile:

General Population

Male: 17,350,587
Female: 18,292,218

Female Sex Workers & Clients

Direct: 14,363
Indirect: 4,727
Clients: 360,094

Intravenous Drug Users

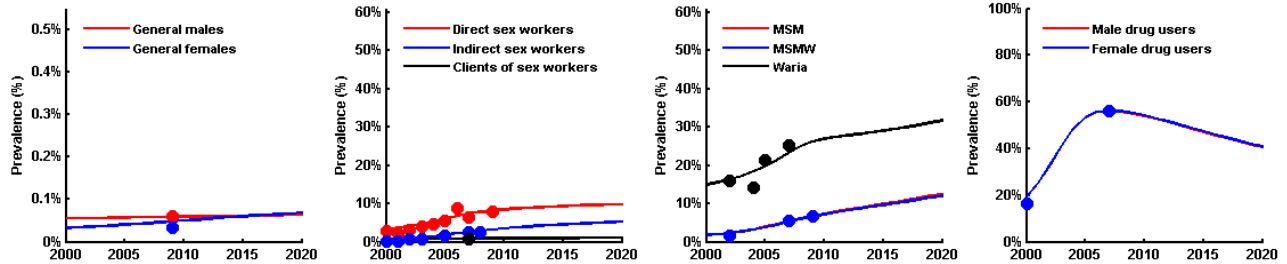
Male: 21,416;
Female: 892

Men who have sex with men:

MSM: 61,240
Bisexual: 18,293
Waria : 4170

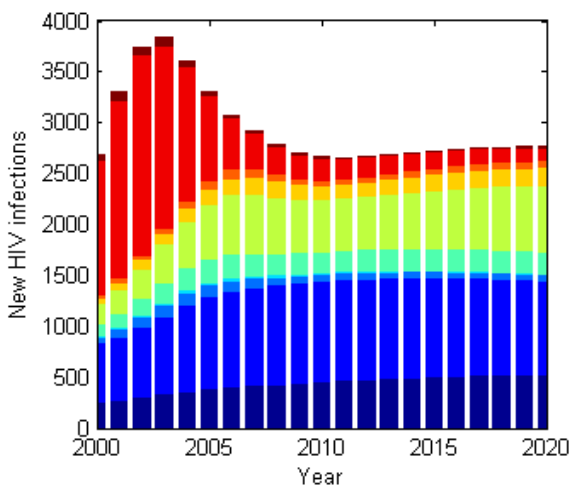
The HIM was applied to populations in East Java, with location-specific data. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in East Java, along with AEM estimates and seroprevalence data.

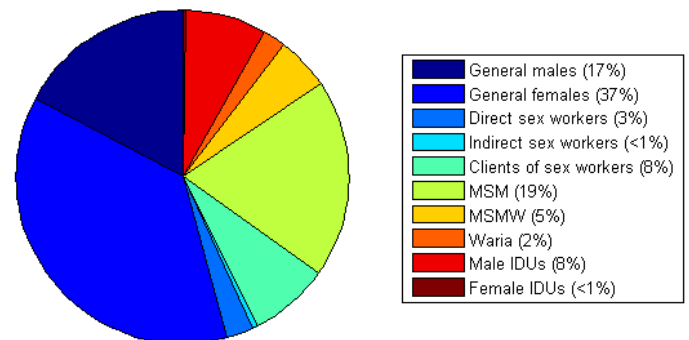


Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for East Java calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Annual new infections over time



New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological

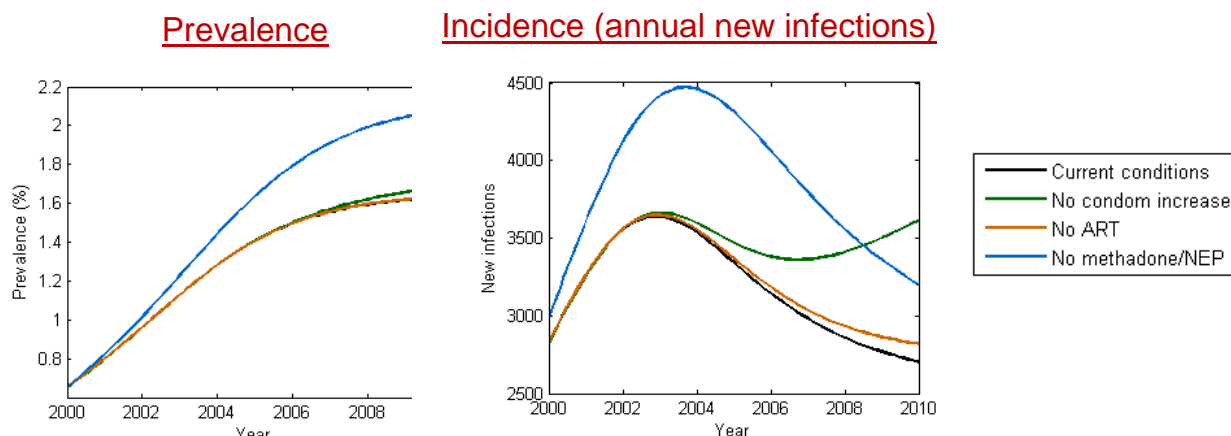
Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in East Java are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in East Java across all population groups if programs/behaviours had not changed over the past 10 years.

Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	45,381	53,056
New HIV infections	2,662	2,765
HIV/AIDS-related deaths	1,108	1,270



If all programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

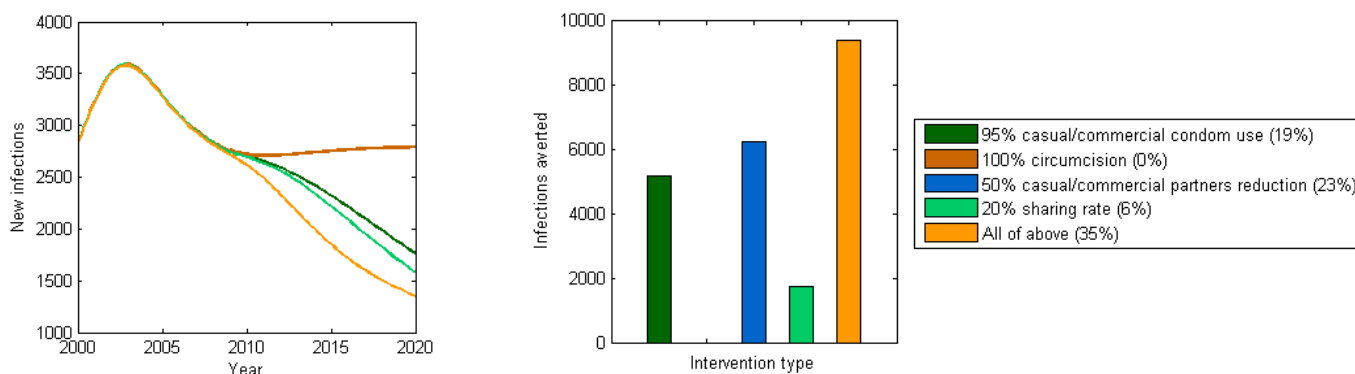
1. Needle-exchange and methadone programs have averted an estimated 7,243 (21%) HIV infections among IDU;
2. ART programs have averted an estimated 436 (1%) HIV infections;
3. Condom promotion has averted an estimated 3,013 (9%) HIV infections overall.

Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in East Java according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.

Incidence (annual new infections) Expected impact of interventions



Jakarta

Population Profile:

General Population

Male: 3,792,998
Female: 4,510,875

Female Sex Workers & Clients

Direct: 13,627
Indirect: 22,384
Clients: 460,310

Intravenous Drug Users

Male: 26,738
Female: 1,114

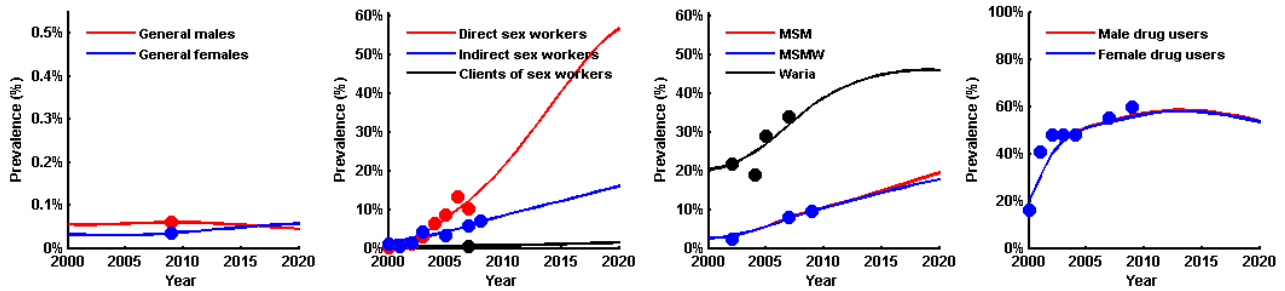
Men who have sex with men:

MSM: 76,342
Bisexual: 22,804
Waria : 2,008



The HIM was applied to populations in Jakarta, with location-specific data. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

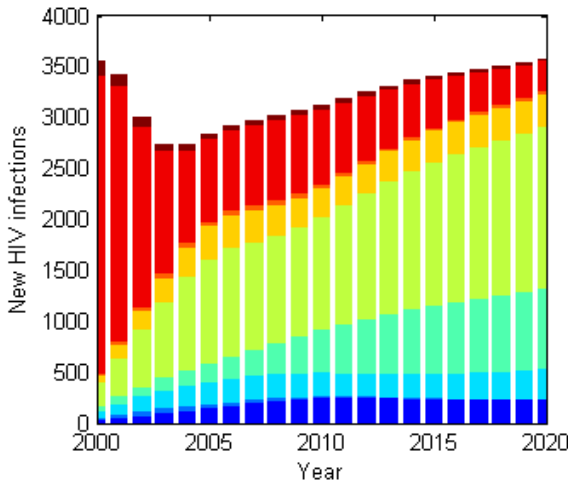
Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in Jakarta, along with AEM estimates and seroprevalence data.



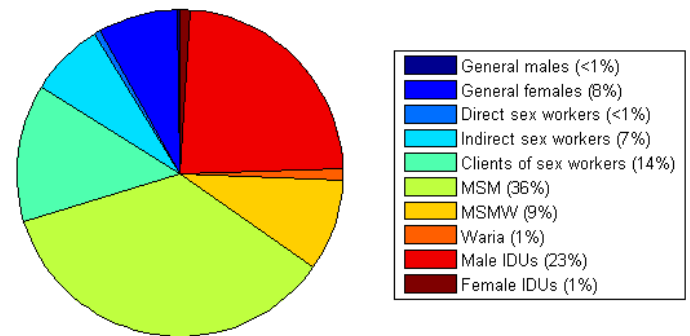
Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for Jakarta calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Figure 2: Incidence (new infections) in Jakarta estimated by HIM

Annual new infections over time



New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological indicators is shown in Table 1.

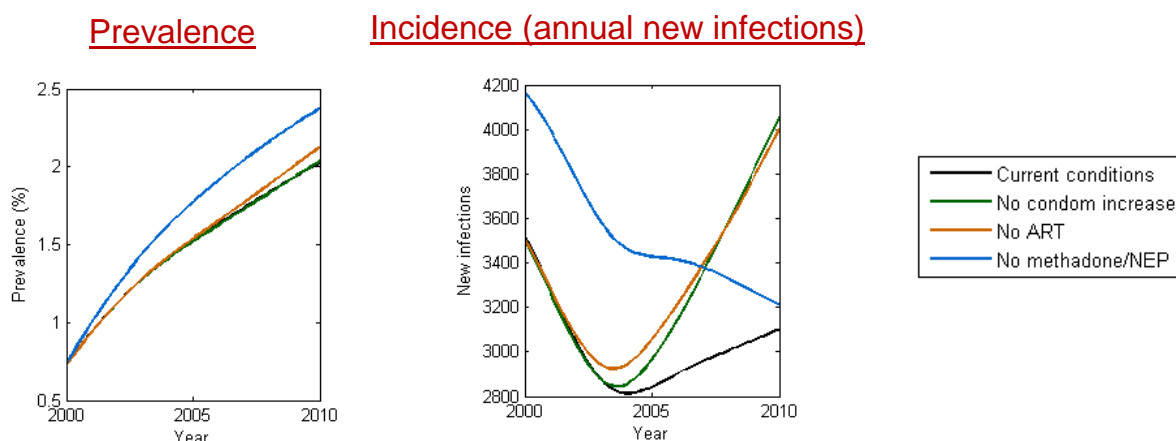
Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	38,712	57,378
New HIV infections	3,124	3,581
HIV/AIDS-related deaths	446	664
Adults eligible for first-line ART	13,945	11,053
Adults requiring second-line ART	543	3,117
Children exposed to HIV	225	354
Children infected with HIV	94	148

Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in Jakarta are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in Jakarta across all population groups if programs/behaviours had not changed over the past 10 years.



Had programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

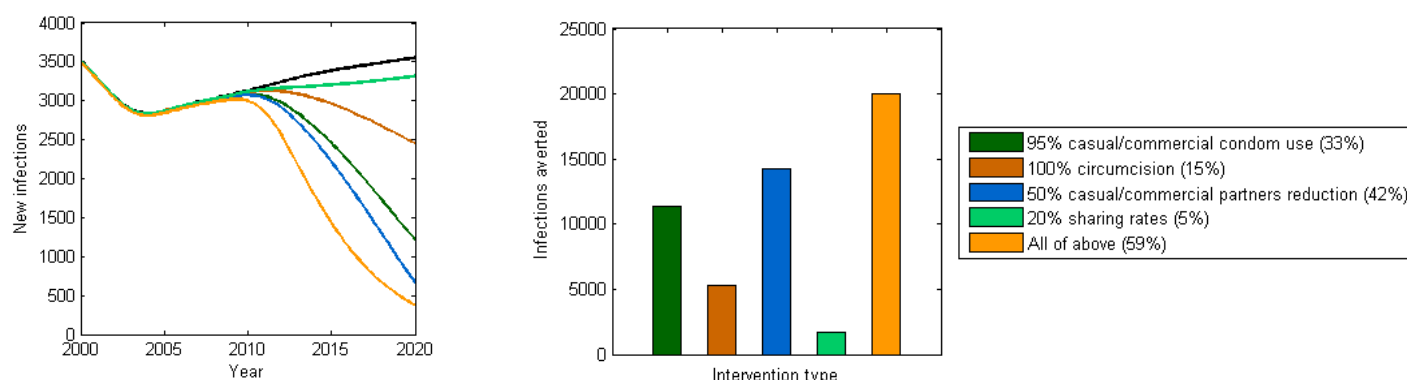
- Needle-exchange and methadone programs have averted an estimated 5,610 (17%) HIV infections among IDU;
- ART programs have averted an estimated 3,372 (10%) HIV infections;
- Condom promotion has averted an estimated 3,060 (9%) HIV infections overall.

Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in Jakarta according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.

Incidence (annual new infections) Expected impact of interventions



North Sumatra

Population Profile:

General Population

Male: 6,327,385
Female: 6,514,240

Female Sex Workers & Clients

Direct: 5,590
Indirect: 6,942
Clients: 184,960

Intravenous Drug Users

Male: 5,477
Female: 228

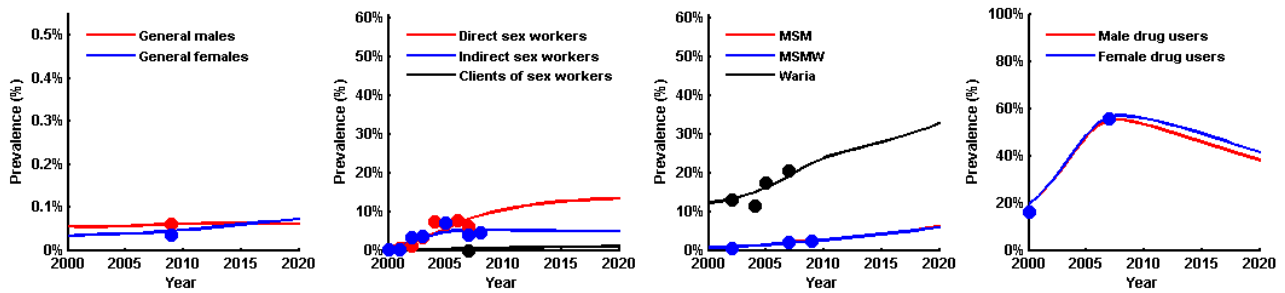
Men who have sex with men:

MSM: 15,520
Bisexual: 4,635
Waria: 1,622



The HIM was applied to populations in North Sumatra, with location-specific data. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

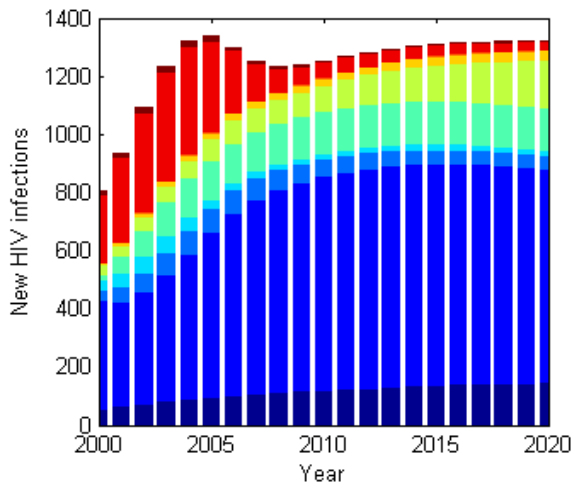
Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in North Sumatra, along with AEM estimates and seroprevalence data.



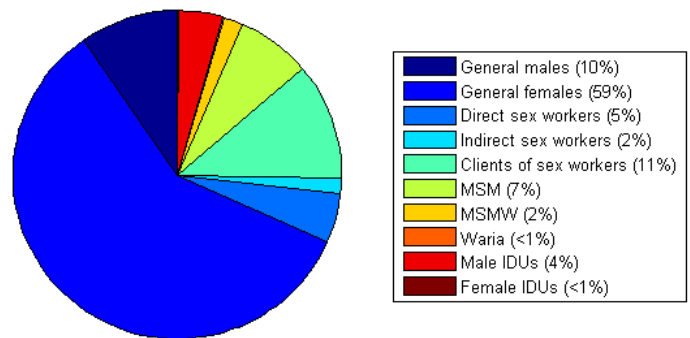
Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for North Sumatra calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Figure 2: Incidence (new infections) in North Sumatra estimated by HIM

Annual new infections over time



New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological indicators is shown in Table 1.

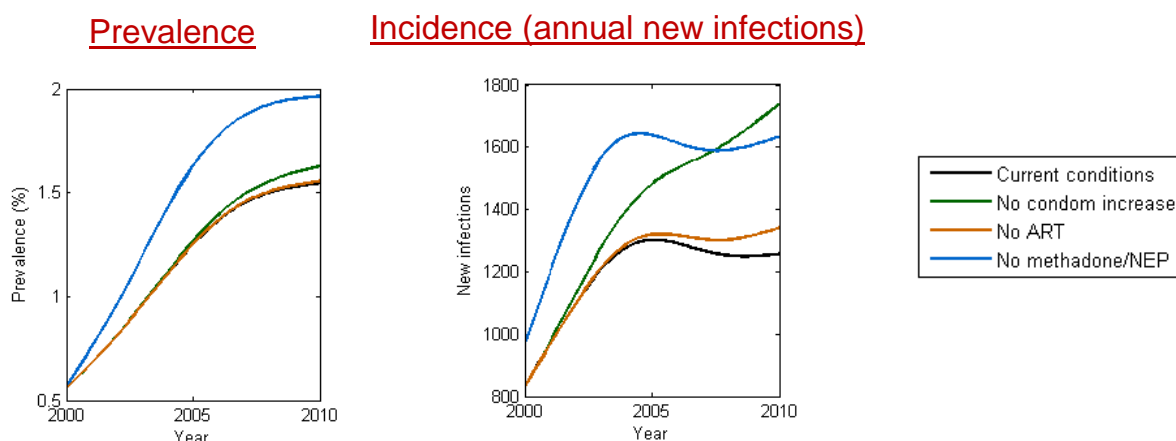
Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	14,682	20,028
New HIV infections	1,252	1,320
HIV/AIDS-related deaths	417	576
Adults eligible for first-line ART	5,274	6,283
Adults requiring second-line ART	126	791
Children exposed to HIV	294	475
Children infected with HIV	123	199

Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in North Sumatra are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in North Sumatra across all population groups if programs/behaviours had not changed over the past 10 years.



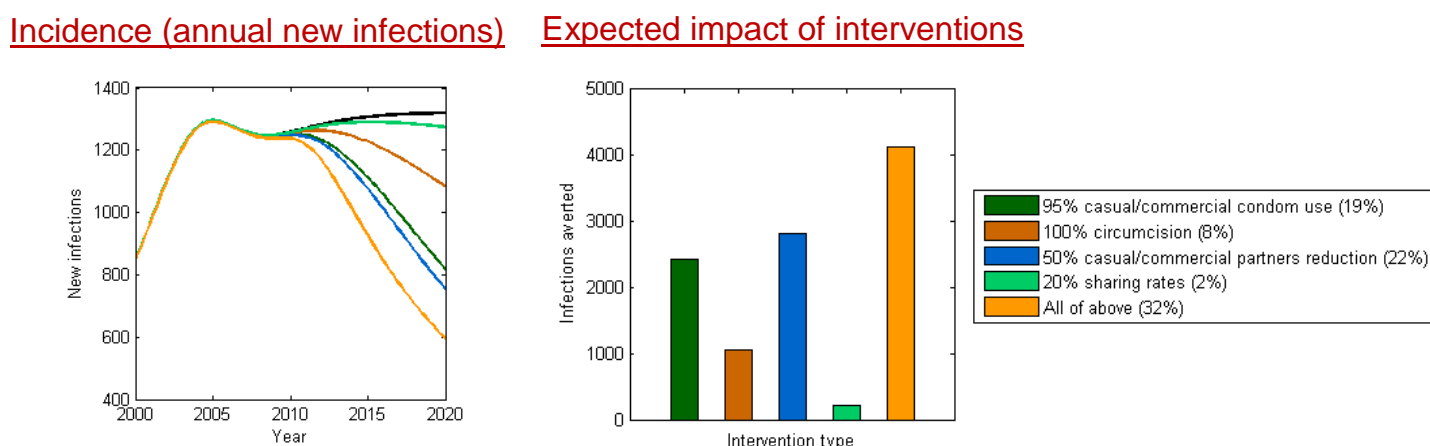
Had programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

- Needle-exchange and methadone programs have averted an estimated 9,661 (37%) HIV infections among IDU;
- ART programs have averted an estimated 3,179 (12%) HIV infections;
- Condom promotion has averted an estimated 10,726 (41%) HIV infections overall.

Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in North Sumatra according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.



Population Profile:

General Population

Male: 738,519
Female: 943,308

Female Sex Workers & Clients

Direct: 4,547
Indirect: 6,526
Clients: 106,763

Intravenous Drug Users

Male: 1,177
Female: 49

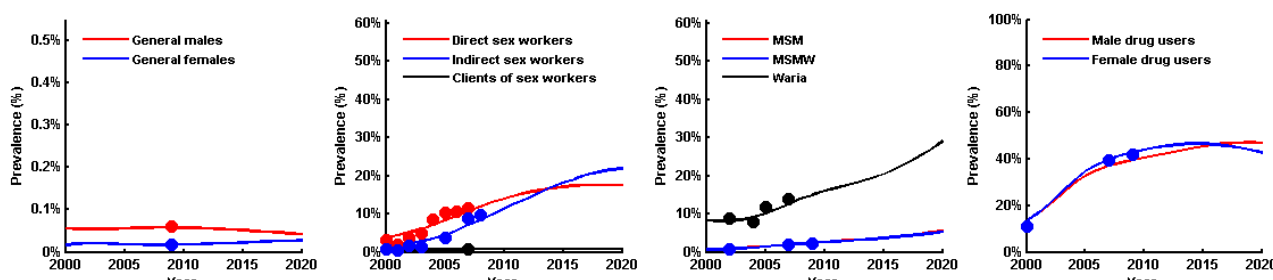
Men who have sex with men:

MSM: 7,901
Bisexual: 2,360
Waria : 990



The HIM was applied to populations in Riau Islands, with location-specific data. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

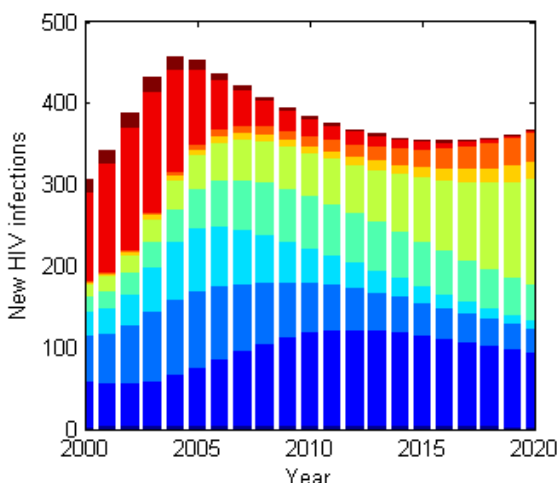
Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in Riau Islands, along with AEM estimates and seroprevalence data.



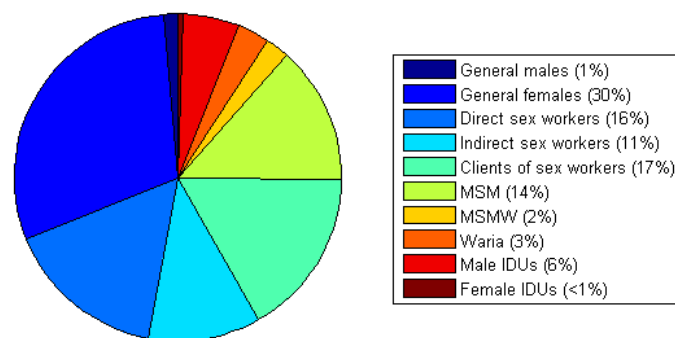
Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for Riau Islands calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Figure 2: Incidence (new infections) in Riau Islands estimated by HIM

Annual new infections over time



New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological indicators is shown in Table 1.

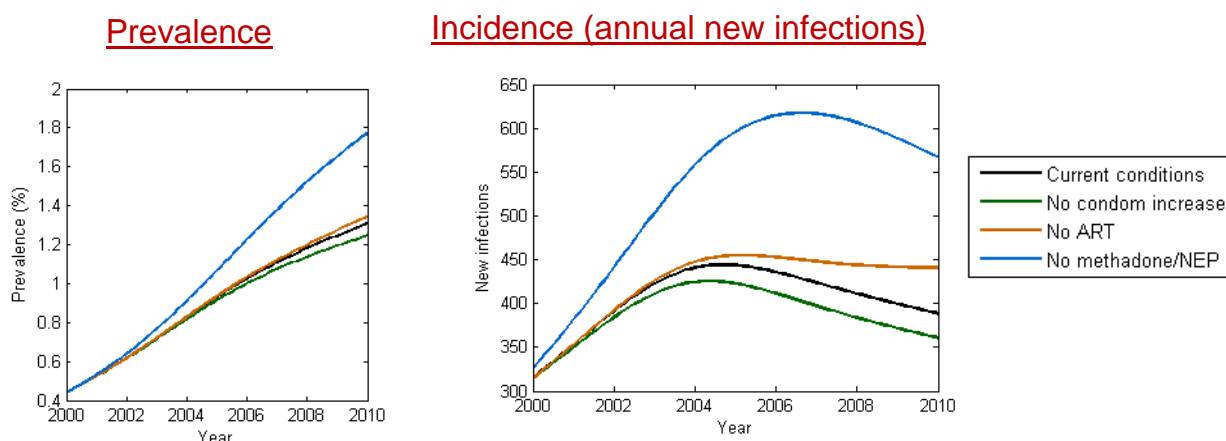
Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	5,304	6,508
New HIV infections	384	368
HIV/AIDS-related deaths	122	176
Adults eligible for first-line ART	2,090	1,744
Adults requiring second-line ART	99	575
Children exposed to HIV	97	126
Children infected with HIV	41	53

Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in Riau Islands are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in Riau Islands across all population groups if programs/behaviours had not changed over the past 10 years.



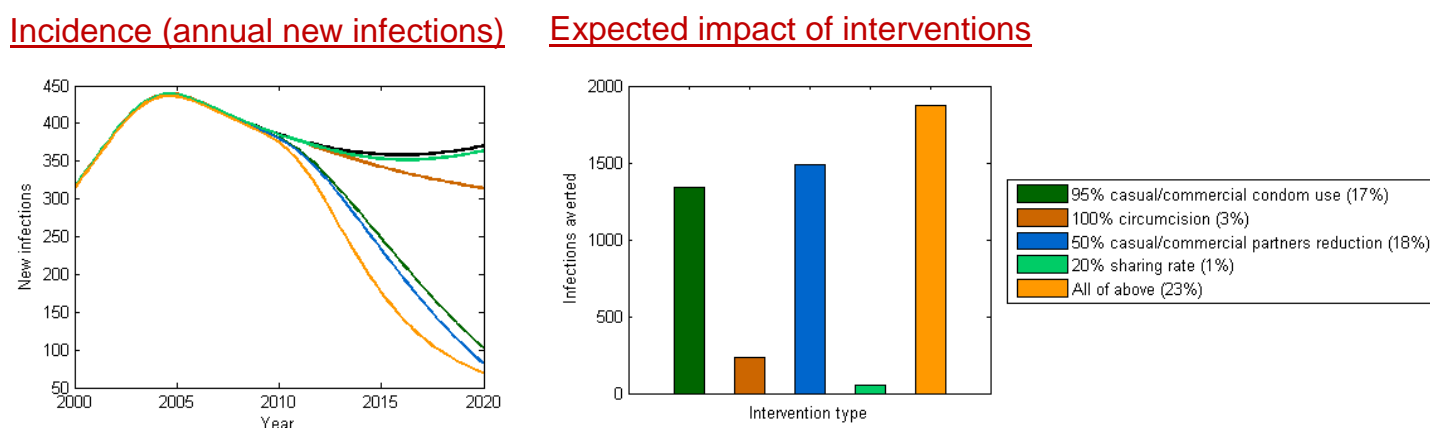
Had programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

- Needle-exchange and methadone programs have averted an estimated 1,374 (31%) HIV infections among IDU;
- ART programs have averted an estimated 190 (4%) HIV infections;
- Condom promotion has averted an estimated 194 (4%) HIV infections overall.

Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in Riau Islands according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.



West Java

Population Profile:

General Population

Male: 20,675,594
Female: 20,536,609

Female Sex Workers & Clients

Direct: 16,445
Indirect: 9,244
Clients: 439,511

Intravenous Drug Users

Male: 16,849;
Female: 702

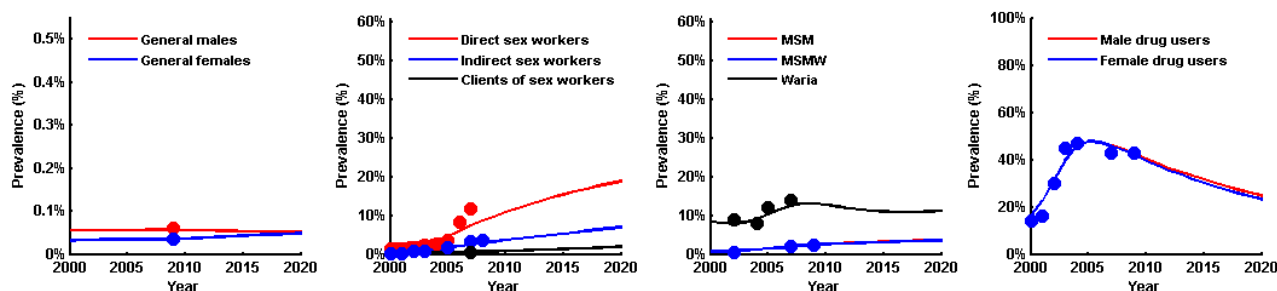
Men who have sex with men:

MSM: 112,093
Bisexual: 33,482
Waria: 2,871



The HIM was applied to populations in West Java, with location-specific data. HIM was consistent with AEM trajectories and available seroprevalence data (Figure 1).

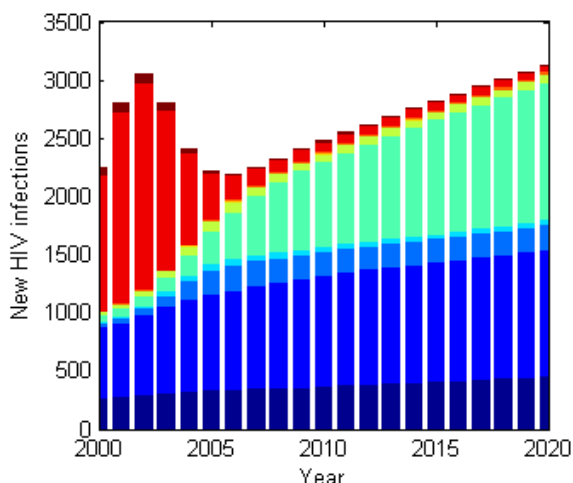
Figure 1: HIM-based prevalence trajectories/forecasts for various population subgroups in West Java, along with AEM estimates and seroprevalence data.



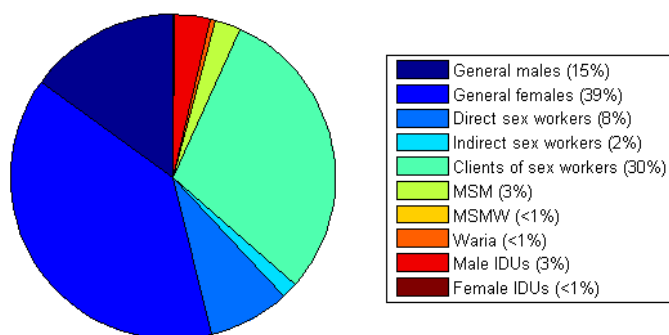
Matching data on HIV prevalence and all behavioural levels and trends for each population group as well as data on total numbers of HIV diagnoses and coverage of antiretroviral therapy, the HIM for West Java calculated the trends in expected HIV incidence (new infections) overall and by each population group (Figure 2).

Figure 2: Incidence (new infections) in West Java estimated by HIM

Annual new infections over time



New infections in 2010



The HIM is flexible for producing plots and statistics for numerous indicators. A summary of some of the important epidemiological indicators is shown in Table 1.

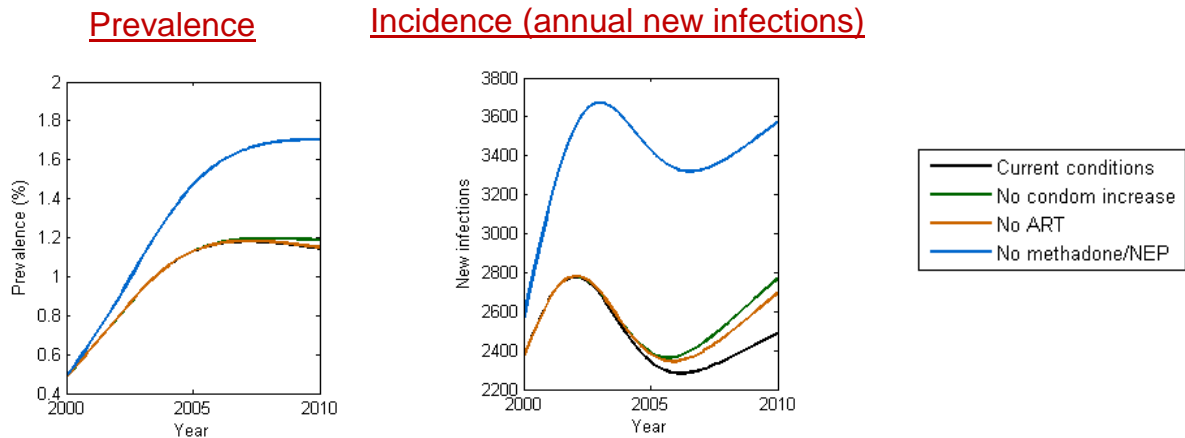
Table 1: Concise summary of indicators

Number of:	In 2010	Forecasted in 2020
Adults living with HIV/AIDS	36,483	45,432
New HIV infections	2,478	3,129
HIV/AIDS-related deaths	1,168	1,332
Adults eligible for first-line ART	15,521	12,521
Adults requiring second-line ART	372	2,069
Children exposed to HIV	534	774
Children infected with HIV	224	324

Evaluating past programs

The HIM can be used to evaluate past epidemic trends and the population-level impacts of changes in public health programs and/or behaviours. Single interventions or synergistic effects of multiple combined interventions can be investigated with HIM. The estimated impacts of some example programs in West Java are shown in Figure 3.

Figure 3: Estimated prevalence and incidence of HIV in West Java across all population groups if programs/behaviours had not changed over the past 10 years.



Had programs and behaviours not changed over the period 2000-2010, there would have been additional HIV infections.

- Needle-exchange and methadone programs have averted an estimated 9,822 (36%) HIV infections among IDU;
- ART programs have averted an estimated 714 (3%) HIV infections;
- Condom promotion has averted an estimated 987 (4%) HIV infections overall.

Designing control strategies for reducing future transmission

Public health programs and policies are ideally designed by a strong evidence base. One component of such evidence is the expected epidemiological impact of scaling-up or introducing different control measures. The HIM was used to forecast the expected HIV epidemiological trajectory in West Java according to current conditions or associated with various example interventions (Figure 4).

Figure 4: Projections of new HIV infections, and infections averted, for various intervention scenarios.

