Strategies for national HIV incidence surveillance

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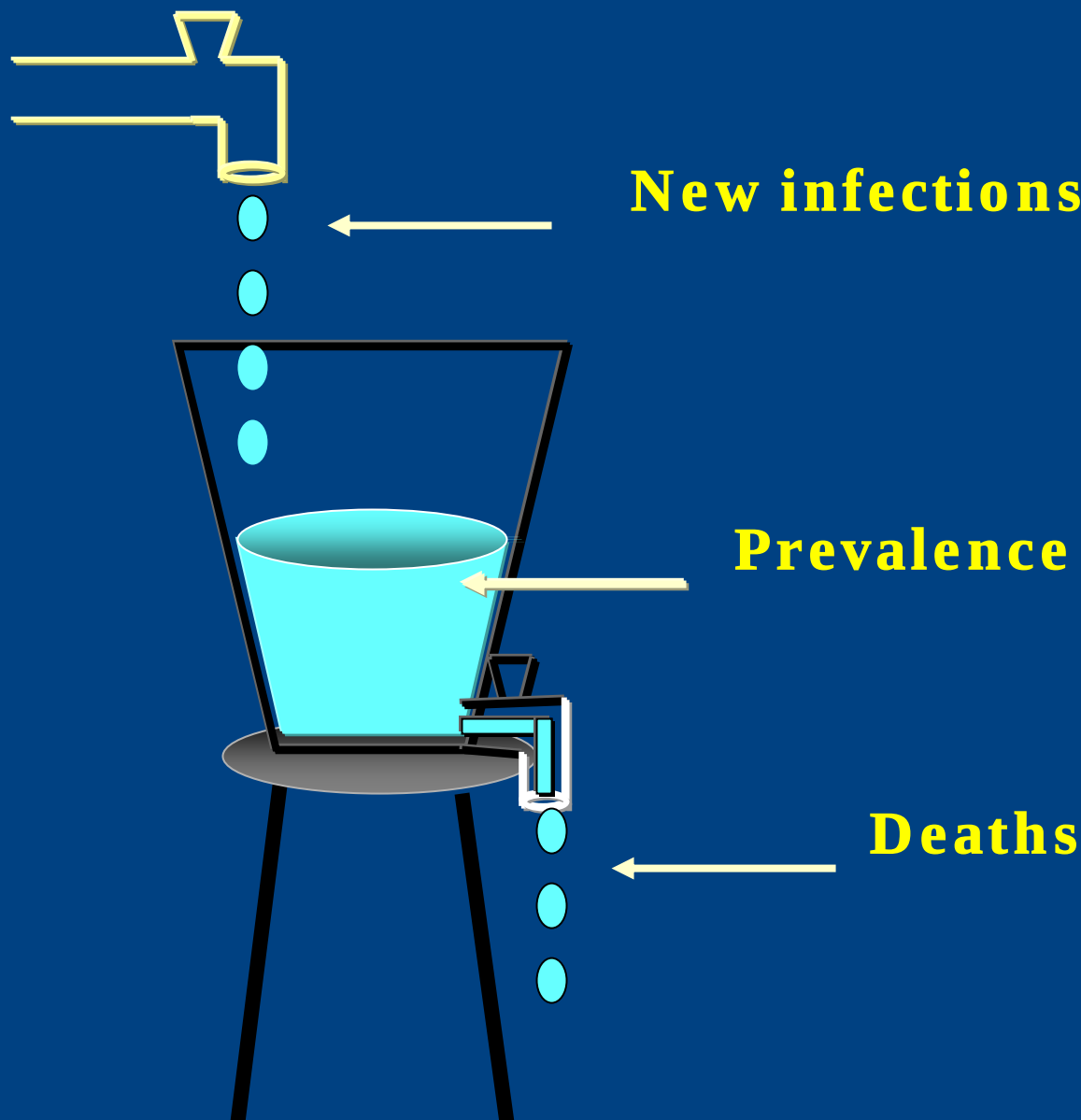
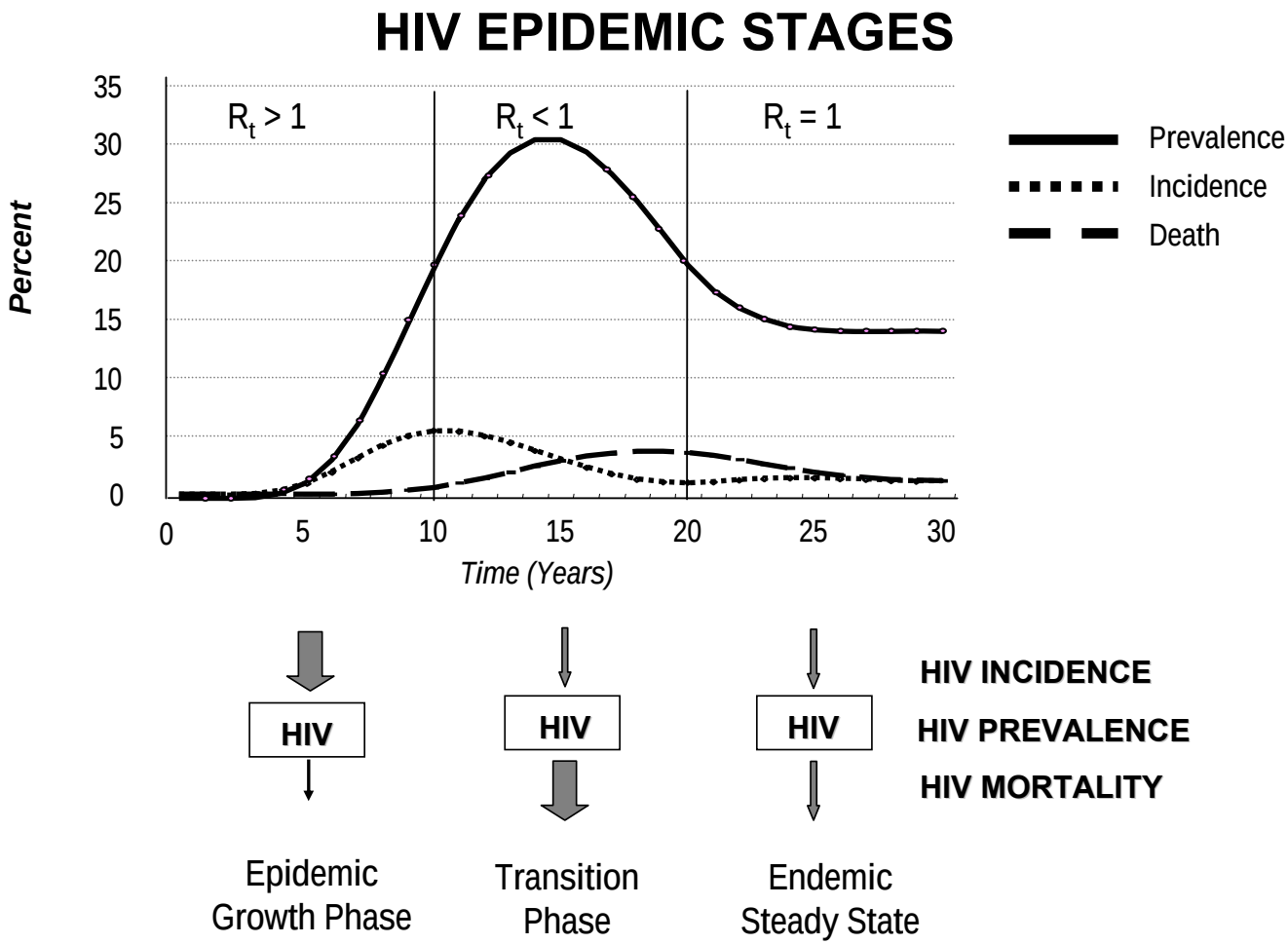
If it was so easy…



Relationship between incidence, prevalence, and mortality



Source: FHI Evaluation Handbook 2001

Critical Questions

Are the observed changes in HIV trends:

1. **a reflection of the natural history of the epidemic?**
2. **a product of changes in behavior?**
3. **a product of interventions?**

Factors Contributing to Observed Changes in HIV Prevalence

- Mortality, especially in mature epidemics
- Decrease in new HIV infections as a result of behavior change:
  - Effect of interventions
  - Spontaneous (e.g. close friend with HIV/AIDS)
- Population differentials related to in- and out migration patterns
- Sampling bias and/or errors in data collection

Expected increase in HIV Prevalence due to:

- Decrease in deaths in HIV infected persons as a result of antiretroviral therapy (ART)

HIV incidence more appropriate measure:

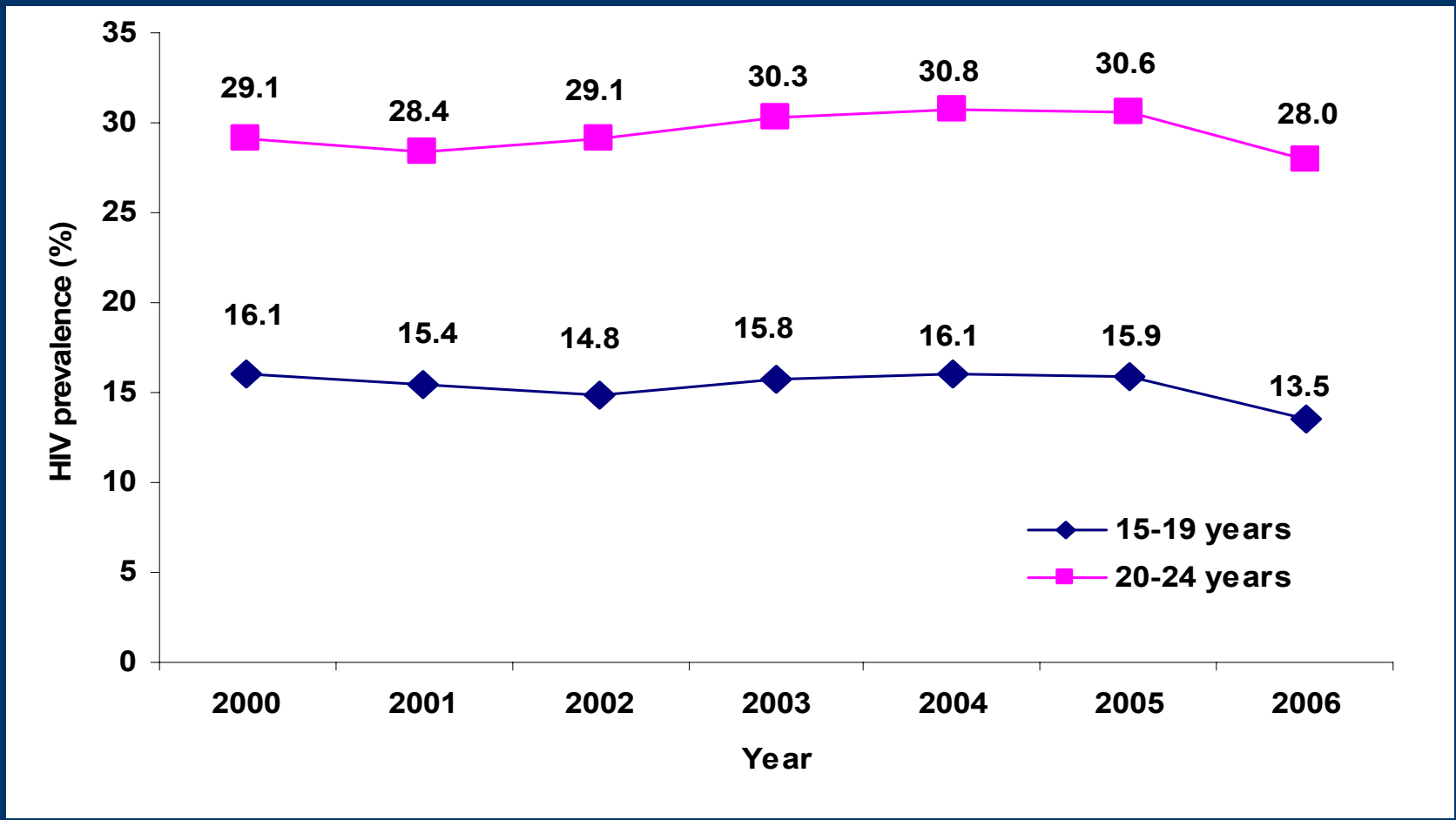
- incidence estimates enable a more timely analysis of current HIV-transmission dynamics
- the most direct means to assess the impact of national HIV prevention programs.

Estimating national HIV incidence

- **Epidemiological methods**
  - **Cohort studies *(directly observed incidence)***
  - **HIV prevalence in youngest age group**
    (as a proxy for recent infection)
  - **Mathematical modeling *(indirect incidence estimate)***

- **Laboratory- based methods**
  (direct incidence measure from cross-sectional surveys)

Antenatal HIV prevalence trends among 15-24 year olds, South Africa, 2000 - 2006



Calculating HIV incidence from age cohort prevalence in 15 to 24 year olds

- List single year age cohort prevalence in 15 to 24 year olds
- Smooth prevalence curve for all age cohorts (15-24 years)
- Calculate difference in prevalence from year to year using smoothed prevalence data
- Assuming a steady state of HIV transmission from year to year and no AIDS-related mortality

Calculating incidence from single year age cohort prevalence in 15 to 24 year olds

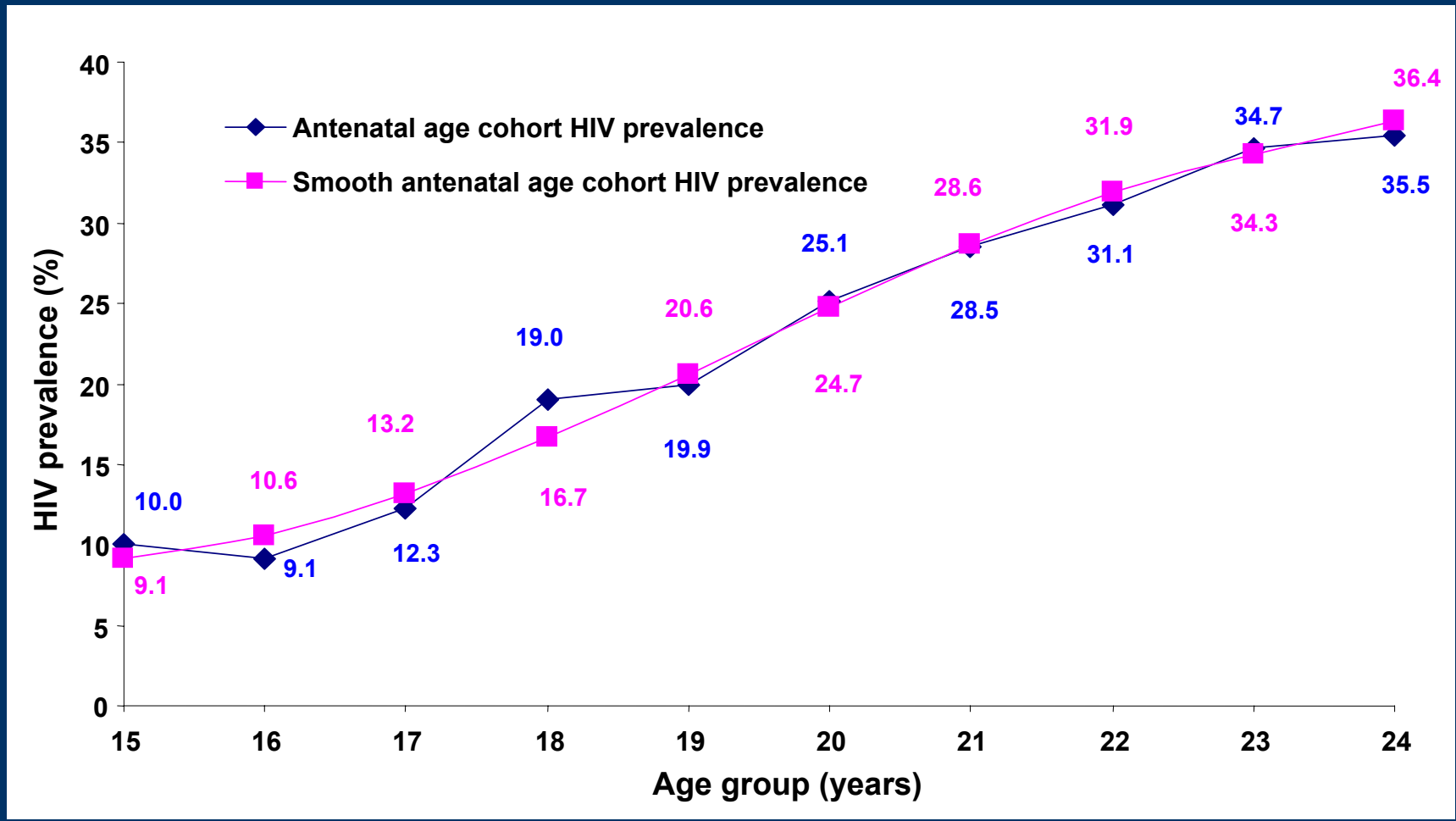
Numerator:

% difference in prevalence from year to year

Denominator:

Population at risk = 1-percentage of smoothed HIV prevalence in the previous year

HIV prevalence estimates by single year of age in 15-24 year old age cohort Antenatal Survey, South Africa 2004



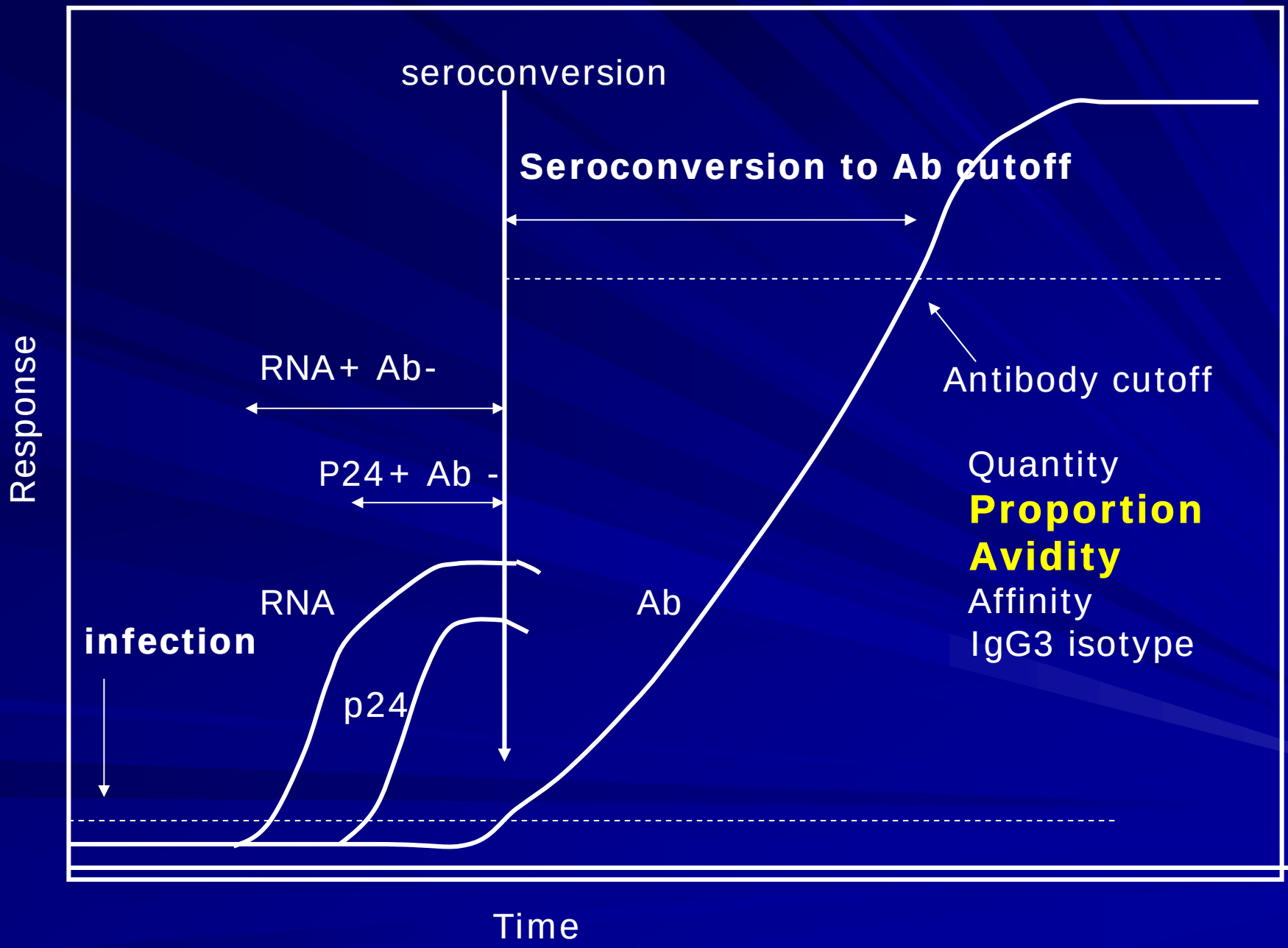
Calculation of age cohort HIV incidence among antenatal attendees, South Africa 2004

Age (years)	Smooth Prevalence (%)	Difference in prevalence (%)	Proportion population at risk	Incidence (%)
15	9.1			
16	10.6	1.5	0.909 (90.9%)	1.6
17	13.2	2.6	0.894 (89.4%)	2.9
18	16.7	3.5	0.868 (86.8%)	4.0
19	20.6	3.9	0.833 (83.3%)	4.8
20	24.7	4.1	0.794 (79.4%)	5.2
21	28.6	3.9	0.753 (75.3%)	5.2
22	31.9	3.3	0.714 (71.4%)	4.6
23	34.3	2.4	0.681 (68.1%)	3.5
24	36.4	2.1	0.657 (65.7%)	3.2

Laboratory- based methods

- direct incidence measure from cross-sectional surveys

Detection of early HIV infection



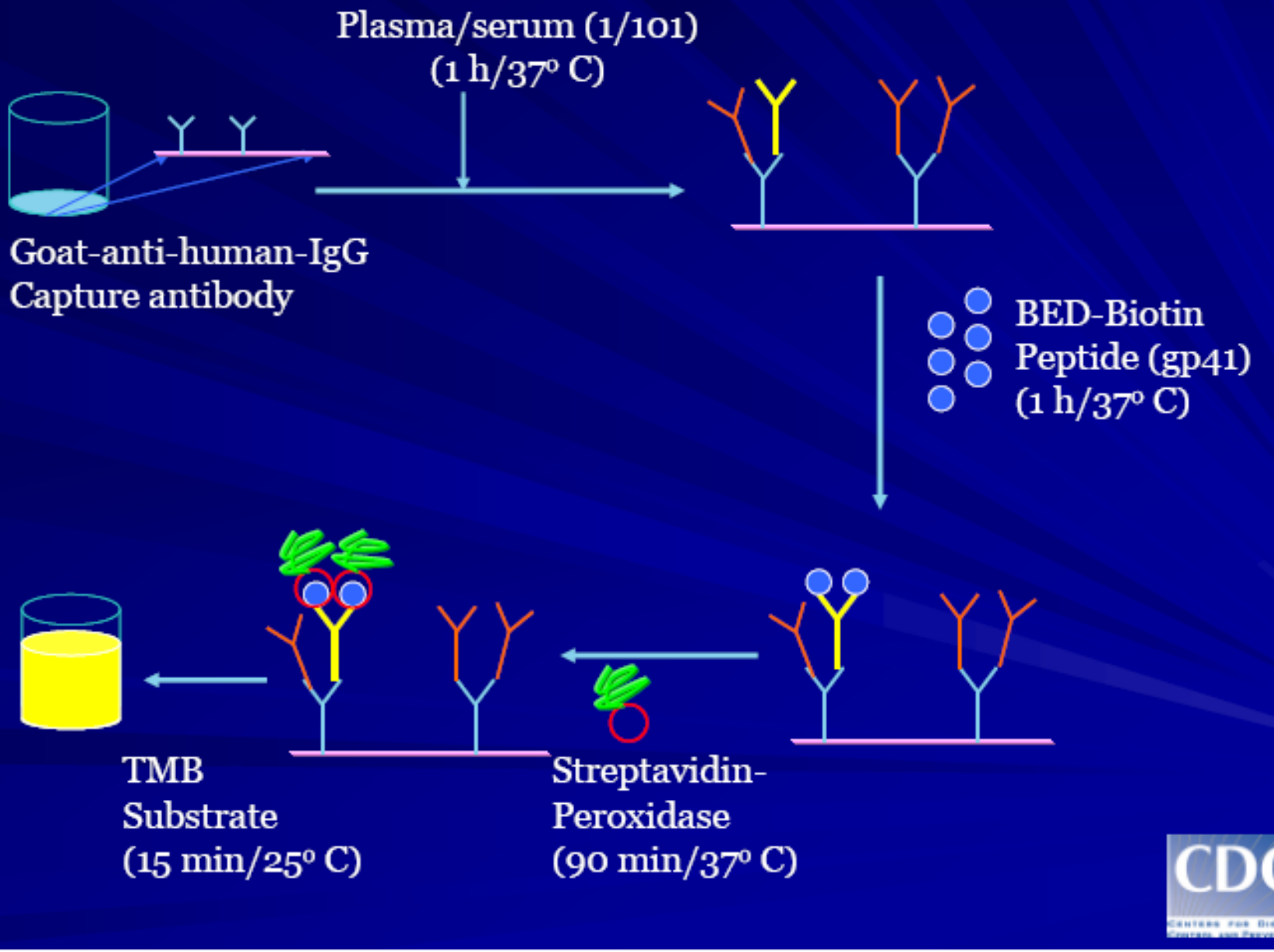
Limitations of existing assays

- Some overestimate HIV incidence due to misclassification of long-term infections as recent
- Some remain to be evaluated in larger samples with diverse HIV-1 subtypes
- Some have no HIV incidence formulas established
- In-house assays may not be reproducible

Adjusting HIV incidence estimates

- **Case-based surveillance**
  - using HIV-testing and ART history
  - Not feasible in many resource-poor settings
- **Formula-based adjustments**
  - More data needed to account for ART-related misclassification and appropriate adjustments
- **Laboratory based adjustment**
  - Sequential testing algorithm (not yet validated)

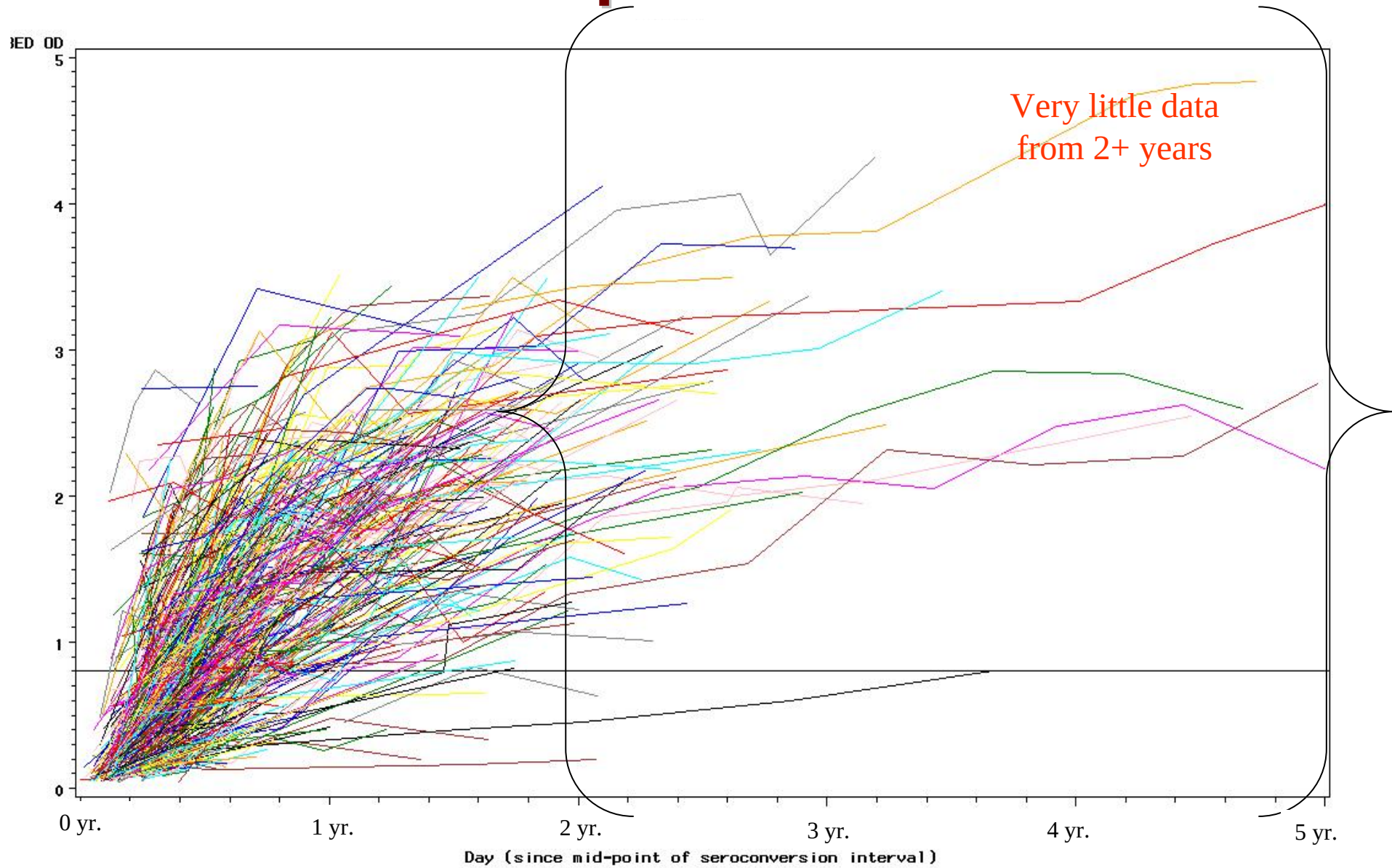
Schematic of the BED-CEIA



BED window periods at 0.8 cutoff

Subtypes	Country	Window (95% CI)
AD	Kenya	171 (150-199)
B	Amsterdam	127 (113-152)
B	Thailand	143 (118-170)
C	**Zimbabwe**	**181 (165-198)**
C	Ethiopia	167 (154-180)
E	Thailand	115 (106-125)

BED OD values over time in seroconverter panels



BED incidence adjustments

- **BED validation meeting, CDC 2006:**
  - **Sensitivity/Specificity Adjustment (McDougal et al.)**
  - **Specificity Adjustment (Hargrove et al.)**
  - **Validated for HIV-1 subtypes B and C (2 532 specimens from 1 192 individuals)**

National HIV Household Survey South Africa 2005

- First national survey with HIV incidence testing
- Study population: 2 years and older
- Anonymous HIV testing of dried blood spot specimens
- Final sample: 23 275 interviewed, 15 851 tested for HIV

BED HIV-1 Incidence Estimates National HIV survey, South Africa 2005

- BED HIV incidence CEIA applied to confirmed HIV-positive specimens
- BED CEIA performed at NICD, Johannesburg
- BED HIV incidence estimates based on adjusted incidence calculation

BED HIV incidence calculation

$$I = \frac{F\,(365/w)\,N_{inc}}{N_{neg} + F\,(365/w)\,N_{inc}/2} \times 100$$

$$\text{Adjustment Factor (McDougal)} = \frac{(R/P) + \gamma - 1}{(R/P)\,(\alpha - \beta + 2\gamma - 1)}$$

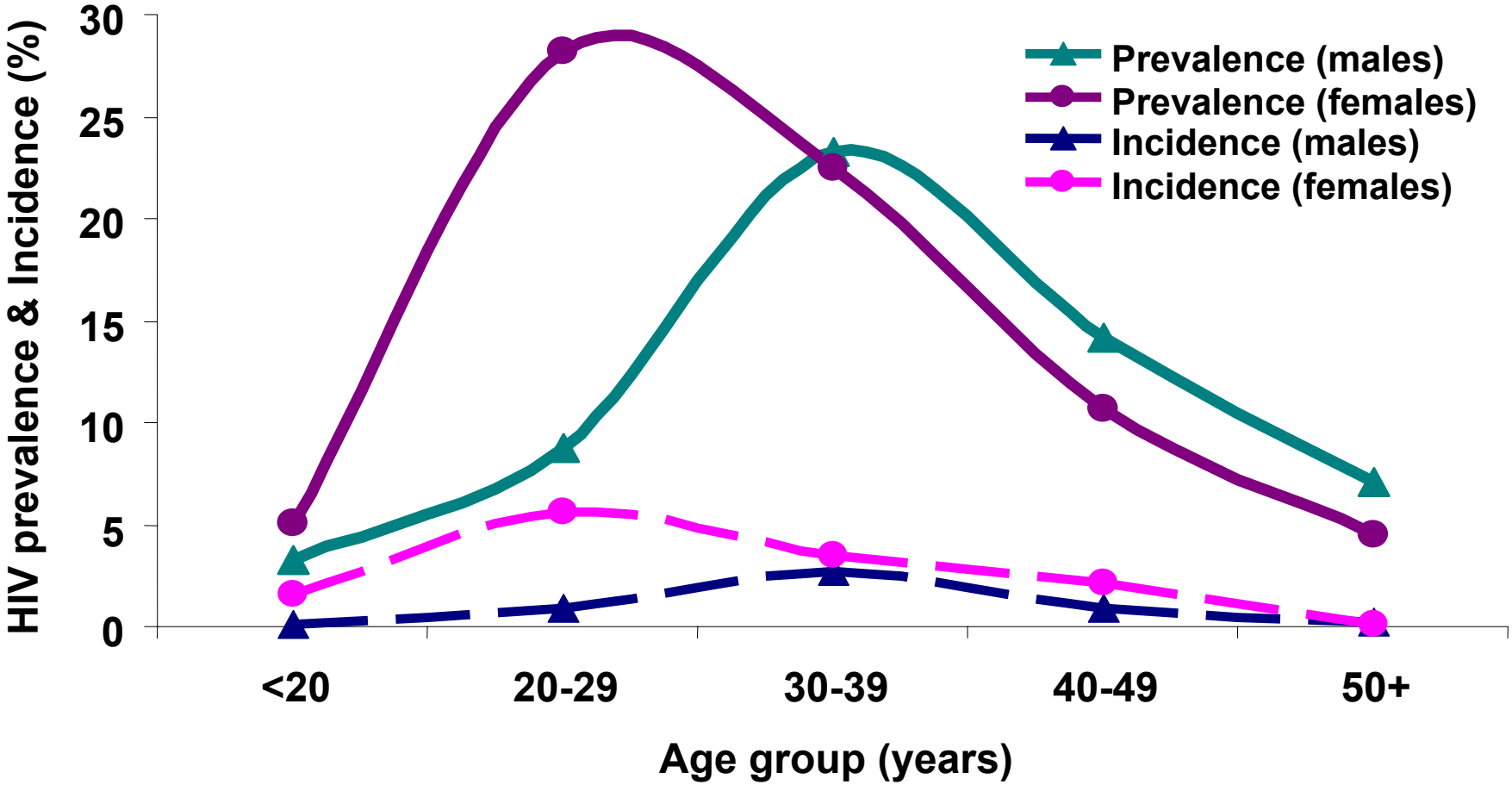
Window period = 180 days

Incidence = number of new infections per year per 100 persons at risk (% / year)

HIV incidence % and number of new infections by age group, South Africa 2005

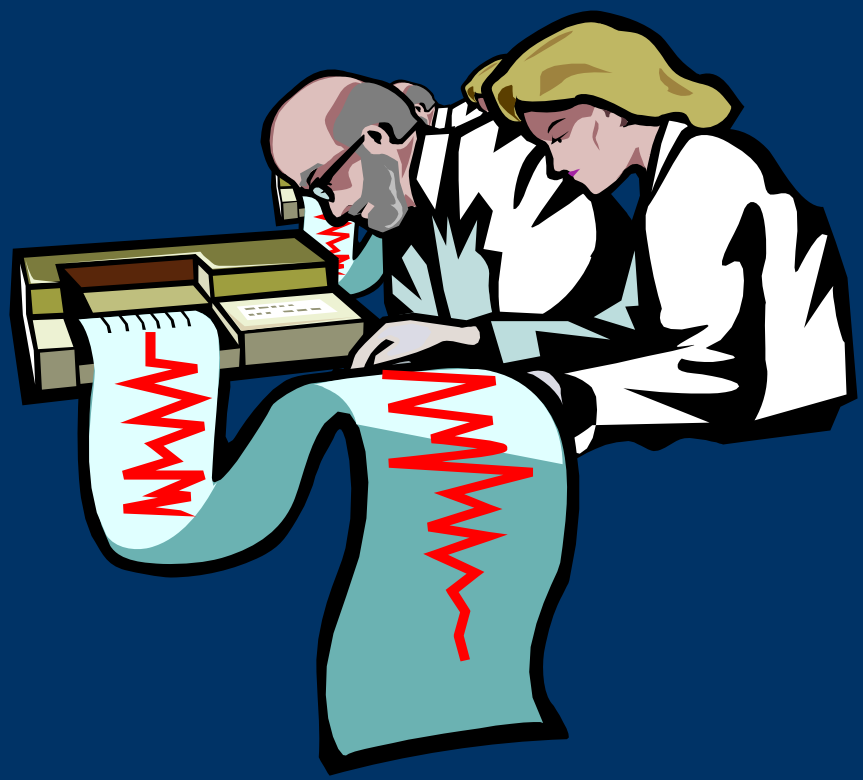
Age group (years)	Weighted sample (n)	HIV incidence % per year [95%CI]	Estimated number of new infections per year (n)
≥ 2	44 513 000	1.4 [1.0 - 1.8]	571 000
2-14	13 253 000	0.5 [0.0 - 1.2]	69 000
15-24	9 616 000	2.2 [1.3 - 3.1]	192 000
15-49	24 572 000	2.4 [1.7 – 3.2]	500 000

HIV prevalence and HIV incidence by age and sex, South Africa 2005

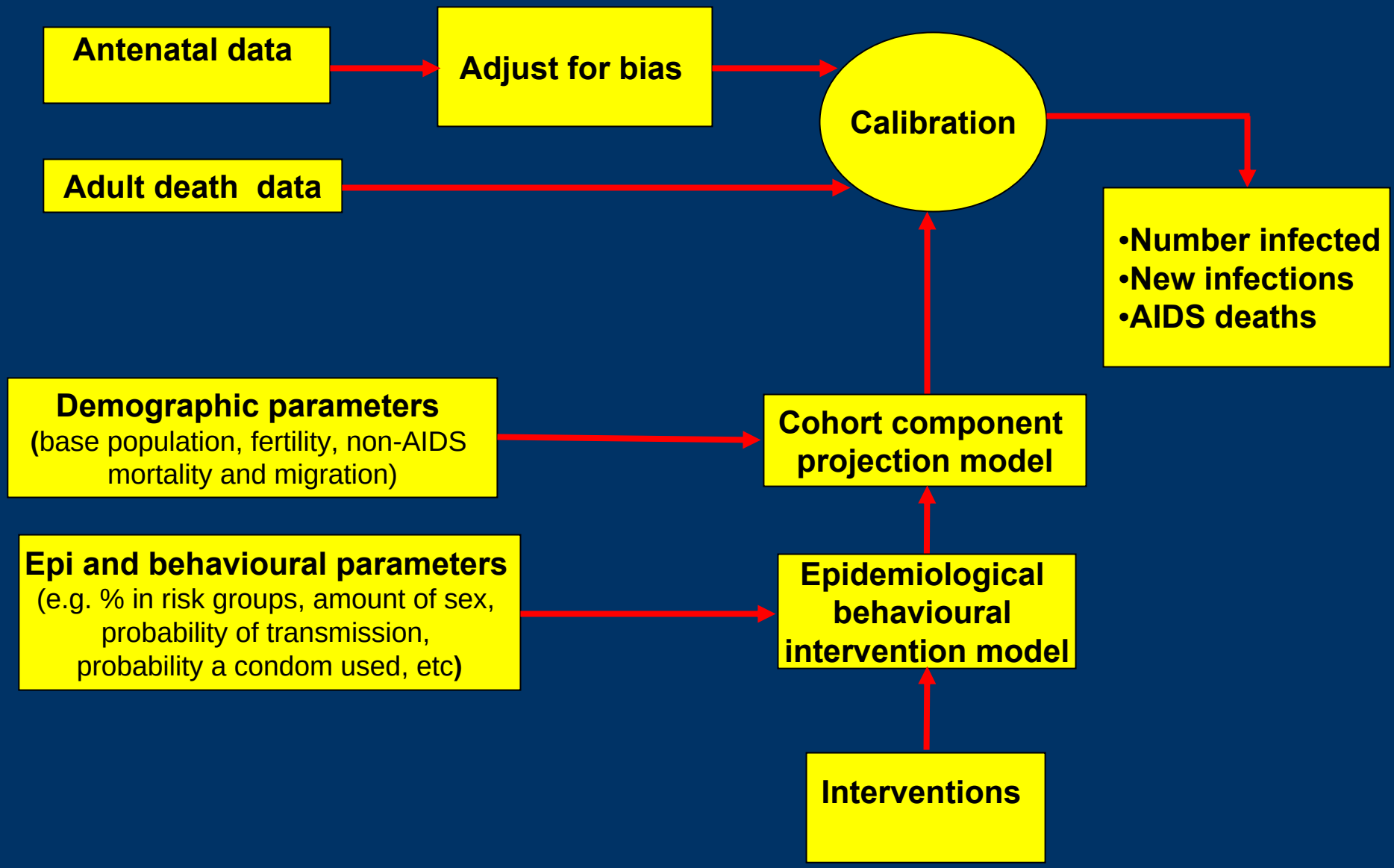


Rehle *et al.* SAMJ 2007; 97: 194-199

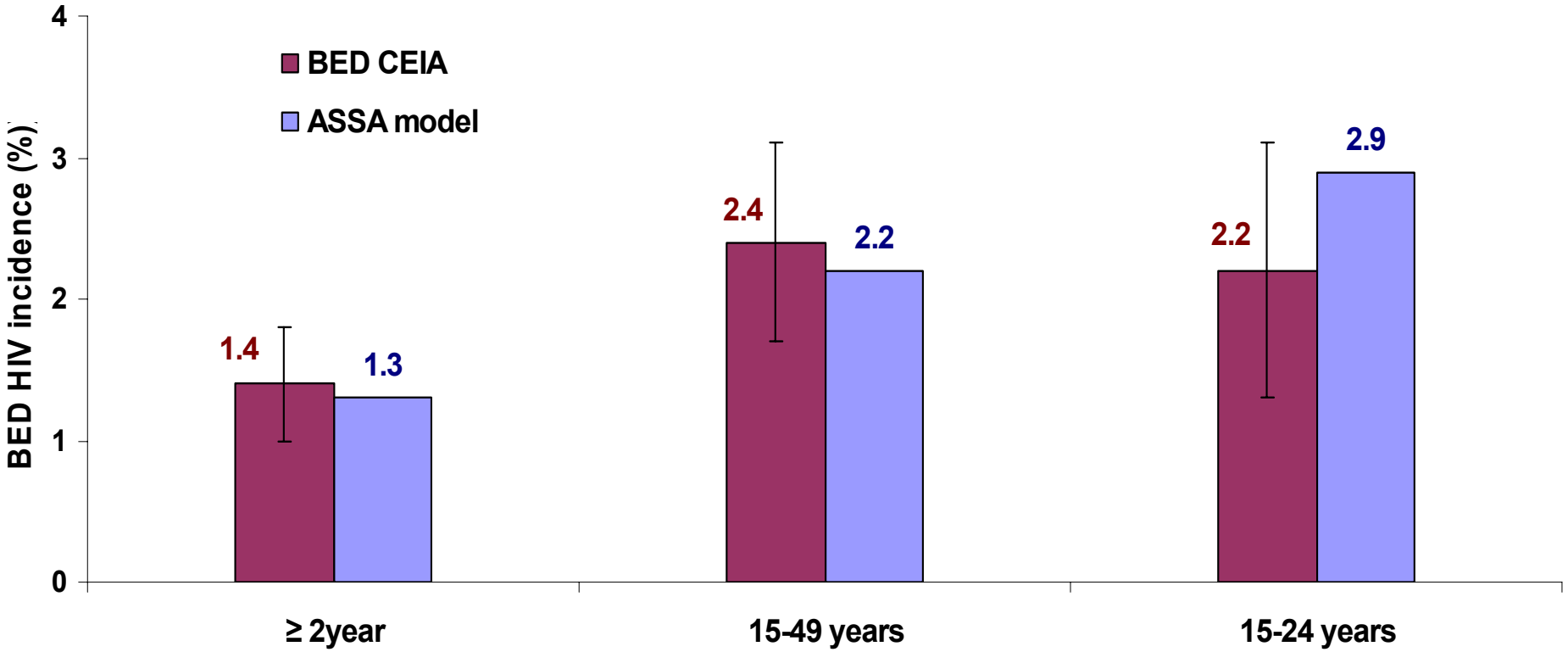
Are the adjusted BED HIV incidence estimates plausible?



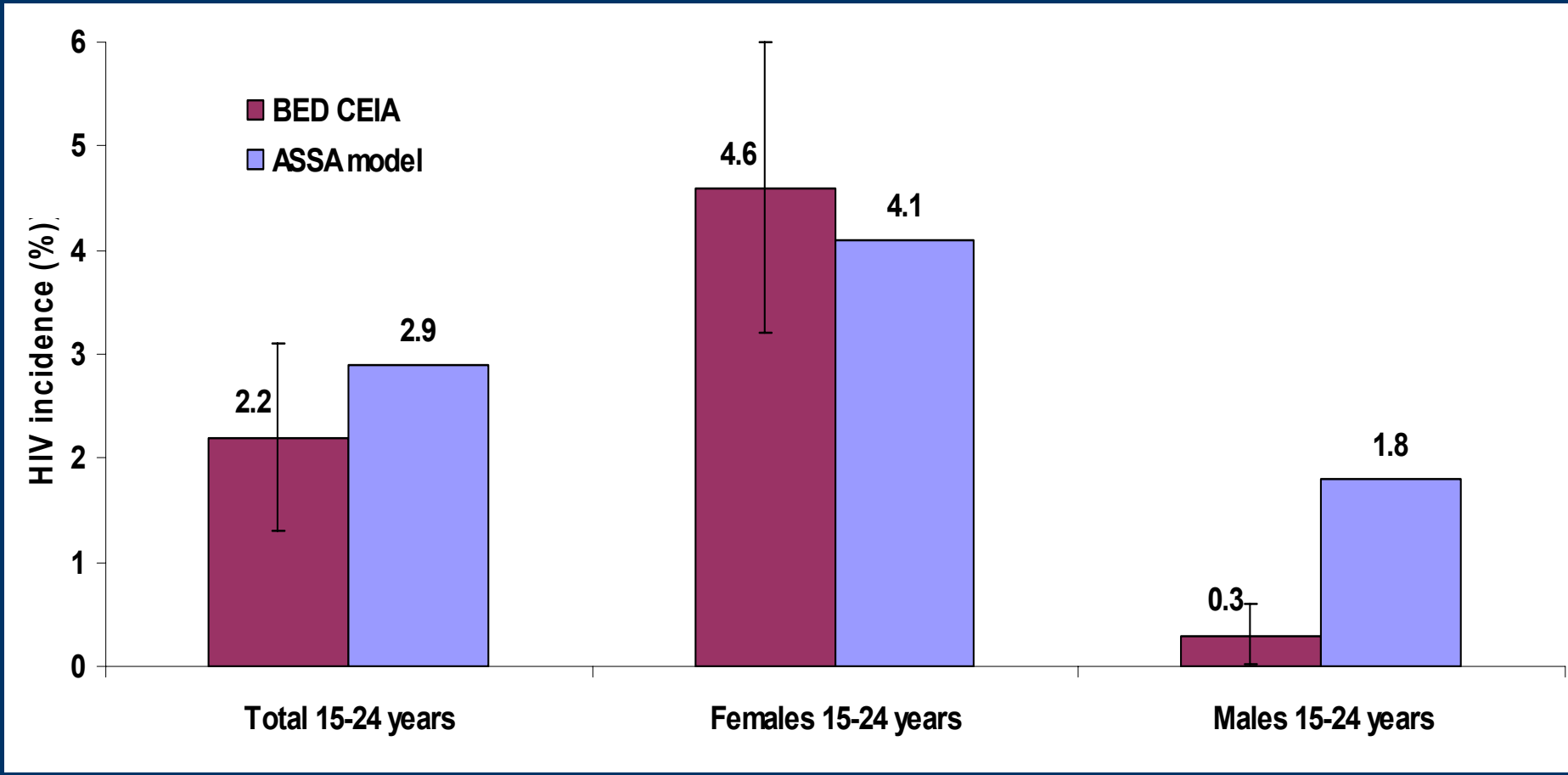
ASSA model


Antenatal data
Adjust for bias
Calibration
Adult death data
•Number infected
•New infections
•AIDS deaths
Demographic parameters
(base population, fertility, non-AIDS mortality and migration)
Cohort component projection model
Epi and behavioural parameters
(e.g. % in risk groups, amount of sex, probability of transmission, probability a condom used, etc)
Epidemiological behavioural intervention model
Interventions

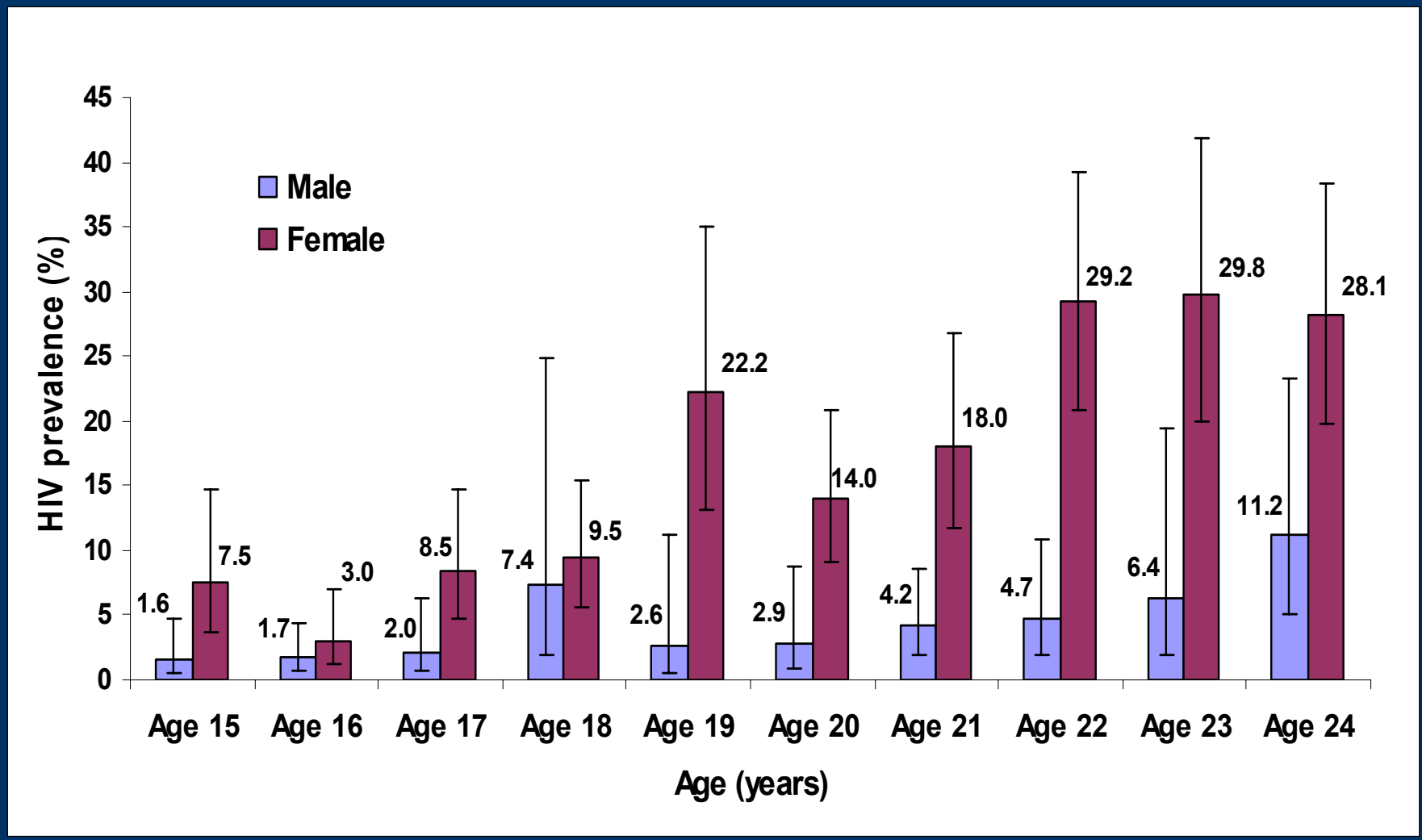
BED HIV incidence vs ASSA model (estimates for 2005)



BED HIV incidence vs ASSA model: male and female youth 15-24 years



HIV prevalence in youth by single year of age HSRC 2005



HIV incidence and behaviour HSRC 2005 (age group 15 – 49 years)

Variable	HIV incidence (% per year)
Marital status	
Single	3.0
Married	1.3
Widowed	5.8
Sexual history	
Sexually active in the past 12 months	2.4
Current pregnancy	5.2
Condom use at last sex (15-24 yrs)	
Yes	2.9
No	6.1

(Rehle et al. S Afr Med J 2007; 97: 194-199)

Conclusion

- **Incidence measures are generally better than prevalence measures for assessing current HIV-transmission dynamics and the impact of HIV prevention programs**
- **Laboratory-based HIV incidence estimation from representative cross-sectional surveys is method of choice for national HIV incidence surveillance**
- **The adjusted BED HIV incidence estimates provided valid national HIV incidence estimates for South Africa**