



National Agency for the Control of AIDS

MODES OF HIV  
TRANSMISSION IN NIGERIA:  
APPLICATION OF THE  
INCIDENCE PATTERNS  
MODEL  
2020

# Modes of HIV Transmission in Nigeria: Application of the Incidence Patterns Model

## Introduction

Estimates of where new HIV infections are occurring can aid prevention planning and focus efforts where they will be most effective. In 2003 a group of modelers developed the Modes of Transmission (MOT) model to use currently available information about population size, prevalence, and behaviors to determine the distribution of new infections by population group.<sup>1</sup> That model was widely applied to assist national programs to understand sources of new infection<sup>2</sup>. The model was applied in Nigeria in 2010.<sup>3</sup>

The MOT model is relatively easy to apply and can be readily adapted for additional population groups. However, it is limited in that it requires estimates of population sizes and behaviors (such as number of partners and acts per partner) that may not be readily available or poorly measured. Since it works on a single point in time it may not fully represent the contribution of different population groups over time to HIV transmission.

## Methods

In response to the limitations of the MOT model, a new model was developed in 2016 called the Incidence Patterns Model (IPM).<sup>4</sup> This model disaggregates the population by factors known to be associated with HIV acquisition including sex, marital status, geographic location, male circumcision status, ART status and key risk behaviors. It uses results from trials or observational studies to develop initial estimates of incidence by population group and then applies a Bayesian framework to estimate the distribution of new infections that best matches these data and official estimates of the total number of new adult infections. Most of the information on population size and characteristics is drawn from the Nigeria AIDS Indicator Impact Survey (NAIIS) 2018. Population size and prevalence estimates for female sex workers (FSW), men who have sex with men (MSM) and people who inject drugs (PWID)

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<sup>1</sup> Pisani E, Garnett GP, Grassly NC, Brown T, Stover J, Hankins C, et al. Back to basics in HIV prevention: focus on exposure. *BMJ* 2003;326:1384-7. PMID:12816830 <http://dx.doi.org/10.1136/bmj.326.7403.1384>

<sup>2</sup> Case KC, Ghys PD, Gouws E, Eaton JW, Borquez A, Stover J, et al. Understanding the modes of transmission model of new HIV infection and its use in prevention planning *Bull World Health Organ* 2012;90:831–838A | doi:10.2471/BLT.12.102574

<sup>3</sup> UNAIDS. New HIV Infections by mode of transmission in West Africa: A Multi-Country Analysis, March 2010, UNAIDS & World Bank.

<sup>4</sup> Borquez A, Cori A, Pufall EL, Kasule J, Slaymaker E, Price A, et al. The Incidence Patterns Model to Estimate the Distribution of New HIV Infections in Sub-Saharan Africa: Development and Validation of a Mathematical Model *PLoS Medicine*, doi:10.1371/journal.pmed.1002121, September 13, 2016.

are from the recent key populations study<sup>5,6</sup>. Since information on the HIV prevalence among female sex workers and men who have sex with men, and people who inject drugs is not available in all the states, we applied the overall HIV prevalence for the population to each state with missing prevalence.

The population groups analyzed by the model are defined as below. All groups refer to adults 15-49 years old who have had sex or inject drugs.

- Female PWID: adult females who inject drugs
- Male PWID: adult males who inject drugs
- MSM: men who have sex with men
- FSW: female sex workers
- Previously married females: women who were married but are now divorced, widowed or separated
- Previously married men, uncircumcised: men who were married but are now divorced, widowed or separated and are not circumcised
- Previously married men, circumcised: men who were married but are now divorced, widowed or separated and are circumcised
- Never married females: women who have never been married, almost all will be young women
- Never married males, uncircumcised: men who have never been married and are not circumcised
- Never married males, circumcised: men who have never been married and are circumcised
- Concordant, male uncircumcised: men or women in a union where both the man and the women are HIV-negative and the man is not circumcised
- Concordant, male circumcised: men or women in a union where both the man and the women are HIV-negative and the man is circumcised
- Serodiscordant, male positive: men or women living in a union where the man is HIV-positive and the women is HIV-negative
- Serodiscordant, female positive, male uncircumcised: men or women living in a union where the female is HIV-positive and the man is uncircumcised
- Serodiscordant, female positive, male circumcised: men or women living in a union where the female is HIV-positive and the man is circumcised

The model was calibrated to the number of new infections to the 2020 Nigeria Spectrum files by states (Nigeria\_Abia\_280420 (1).PJNZ, Nigeria\_Adamawa\_280420 (1).PJNZ, Nigeria\_Akwalbom\_280420 (1).PJNZ, Nigeria\_Anambra\_090520 (1).PJNZ, Nigeria\_Bauchi\_280420 (1).PJNZ, Nigeria\_Bayelsa\_280420.PJNZ, Nigeria\_Benue\_280420 (1).PJNZ, Nigeria\_Borno\_280420 (1).PJNZ, Nigeria\_CrossRiver\_090520 (1).PJNZ, Nigeria\_Delta\_09052020 (1).PJNZ, Nigeria\_Ebonyi\_280420.PJNZ, Nigeria\_Edo\_280420 (1).PJNZ, Nigeria\_Ekiti\_280420 (1).PJNZ, Nigeria\_Enugu\_280420 (1).PJNZ, Nigeria\_FCT\_Abuja\_280420 (1).PJNZ, Nigeria\_Gombe\_280420 (1).PJNZ, Nigeria\_Imo\_280420 (1).PJNZ, Nigeria\_Jigawa\_280420.PJNZ, Nigeria\_Kaduna\_280420 (1).PJNZ, Nigeria\_Kano\_280420 (1).PJNZ, Nigeria\_Katsina\_280420.PJNZ, Nigeria\_Kebbi\_280420.PJNZ, Nigeria\_Kogi\_280420.PJNZ, Nigeria\_Kwara\_280420.PJNZ, Nigeria\_Lagos\_280420 (1).PJNZ, Nigeria\_Nasarawa\_280420 (1).PJNZ,

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<sup>5</sup> National Agency for the Control of AIDS (NACA). Final Nigeria IBBSS 2014 Report. <https://naca.gov.ng/final-nigeria-ibbss-2014-report/>.

<sup>6</sup> GoN, CDC, UMB, Mapping Size Estimation of Key Populations in Nigeria (2019).

Nigeria\_Niger\_280420 (1).PJNZ, Nigeria\_Ogun\_280420 (1).PJNZ, Nigeria\_Ondo\_280420.PJNZ, Nigeria\_Osun\_280420.PJNZ, Nigeria\_Oyo\_090520.PJNZ, Nigeria\_Plateau\_280420.PJNZ, Nigeria\_Rivers\_280420.PJNZ, Nigeria\_Sokoto\_280420final.PJNZ, Nigeria\_Taraba\_090520.PJNZ, Nigeria\_Yobe\_280420.PJNZ and Nigeria\_Zamfara\_280420.PJNZ) and used to include population sizes and new infections by State.

The contributions of individual states to the national HIV incidence are displayed in Figure S1 in Supporting Information. Rivers, Akwa Ibom, Benue, Anambra, Imo and Lagos accounted for more than 75% of the country's new HIV infections. The ratio of the proportion of incident cases in each state to the proportion of the total population in each state a low of 0.13 in Jigawa (indicating that Jigawa contributes few new infections to the national total compared to its population size) to a high of 4.0 in Rivers (indicating that Rivers contributes four times as many new infections as would be expecting from its population size alone). That ratio was larger than 2 for Anambra, Abia, Benue, Akwa Ibom and Rivers.

Analysis of the NAHS 2018 data revealed that about 97% of adult men are circumcised. Figure S2 displays the proportion of adult men that are circumcised among never married, previously married, and married men in sero-discordant negative unions by state. Circumcision prevalence appears to be high in sero-discordant HIV negative unions, above 95% across all the states. The proportion of never married men and previously married men who are circumcised is the lowest in Yobe (about 75%) and Sokoto (about 50%), respectively.

Figures S3 and S4 show the mean age of not sexually active, never married, married, and never married men and women, respectively, and the corresponding 95% CI in each state and in Nigeria. The mean age of the sexually active and never married men is about 25 and 24 for women while the mean age of married men is close to 40 and for married women it is 33. So most never married men and women are young but, as the confidence intervals show, some are over 35 years of age.

To examine trends over time we also applied the Goals model at the national level. Goals is a mathematical model that simulates the HIV epidemic over time. It divides the adult population into males and females by risk group: not yet sexually active, in a stable union (one sexual partner in the last year), those with multiple partners in the last year, female sex workers, male clients of sex workers, men who have sex with men and people who inject drugs. HIV incidence is simulated based on the behaviors in each risk group (number of partners, contacts per partner, condom use) and factors that affect the probability of transmission per act (type of sex, stage of infections, presence of other STIs, ART use, male circumcision status). The model is fit to historical surveillance and survey data.

## Results

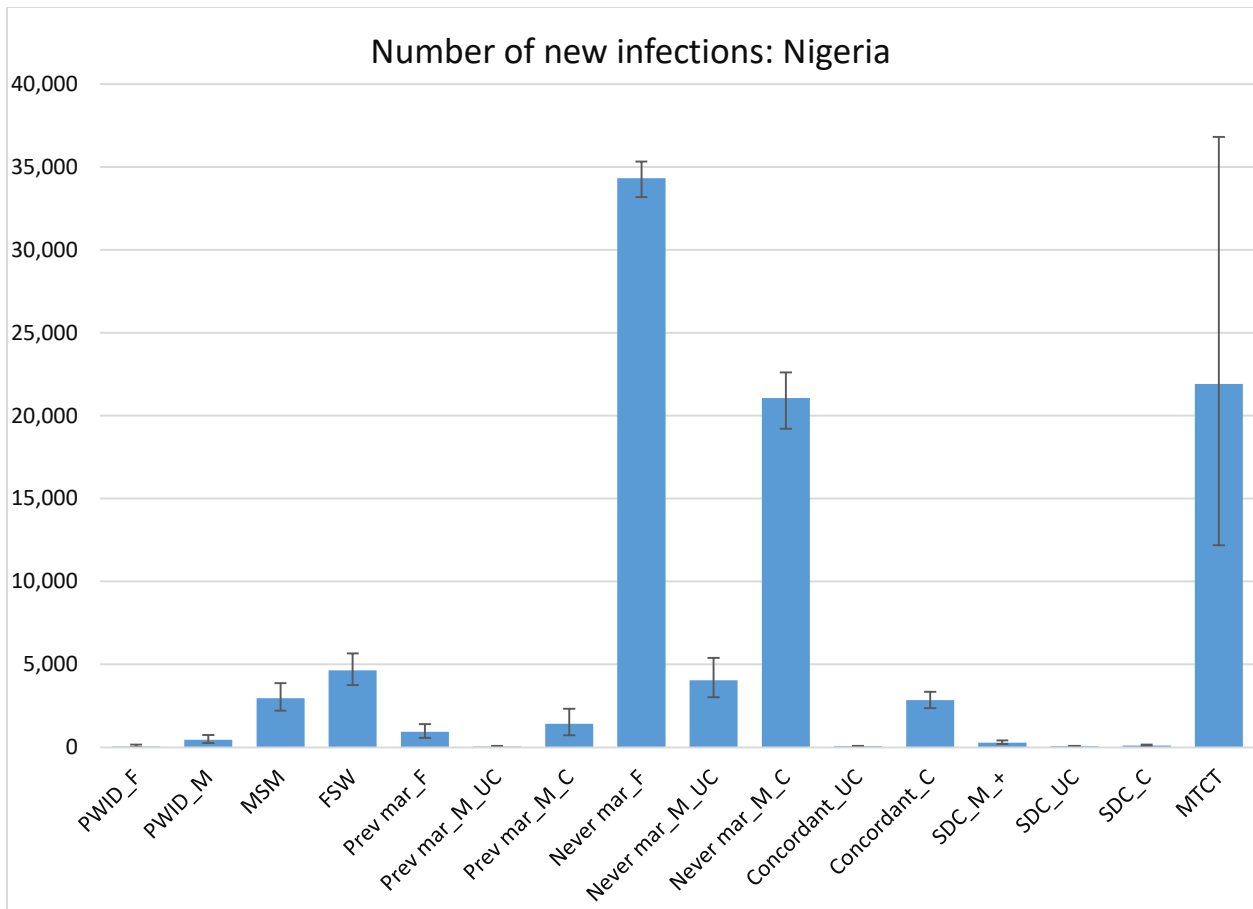
Aggregated results for Nigeria are shown in Figure 1. The number of new infections occurring in each population group is dependent on the size of the group and the incidence rate. The largest number of new infections among the adult population is estimated to occur among Never Married Females and Never Married Males. The next largest number of new infections occurs among Female Sex Workers and Men who have Sex with Men. These four population groups account for about 91% of all new infections among adults. Key populations (FSW, MSM, PWID) are estimated to account for about 11% of new infections although they represent less than 2% of the total population.

New child infections due to mother-to-child transmission represent the second source new infection accounting for 22% of all new infections. In many states the contribution is even larger. For example, in Ebonyi state, new child infections account for more than half of all new infections.

Table 1 shows the estimated population size for each group, the calculated incidence, and the number of new infections and their 95% credible intervals.

The distribution of new infections by state is shown in Figure 2. The pattern does vary across states. In the adult population, Never Married Females have the largest contribution in 84% (31/37) states followed by Sero-negative discordant couples 8% (3/37) and Never Married Males 5% (2/37). The contribution to Never Married Females to the new HIV infections varied from about 8% in Rivers to 82% in Benue. Female Sex Workers are second or third contributor among the 15 sub-populations considered in about 73% of states. The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.31 in Nigeria but varied from 0.12 to 1.2 across states. The full pattern with credible intervals is shown for each state in Figures 3-39. Table 2 provides the detailed numbers in the charts.

Figure 1. Number of new infections in 2019 by population group



Key:

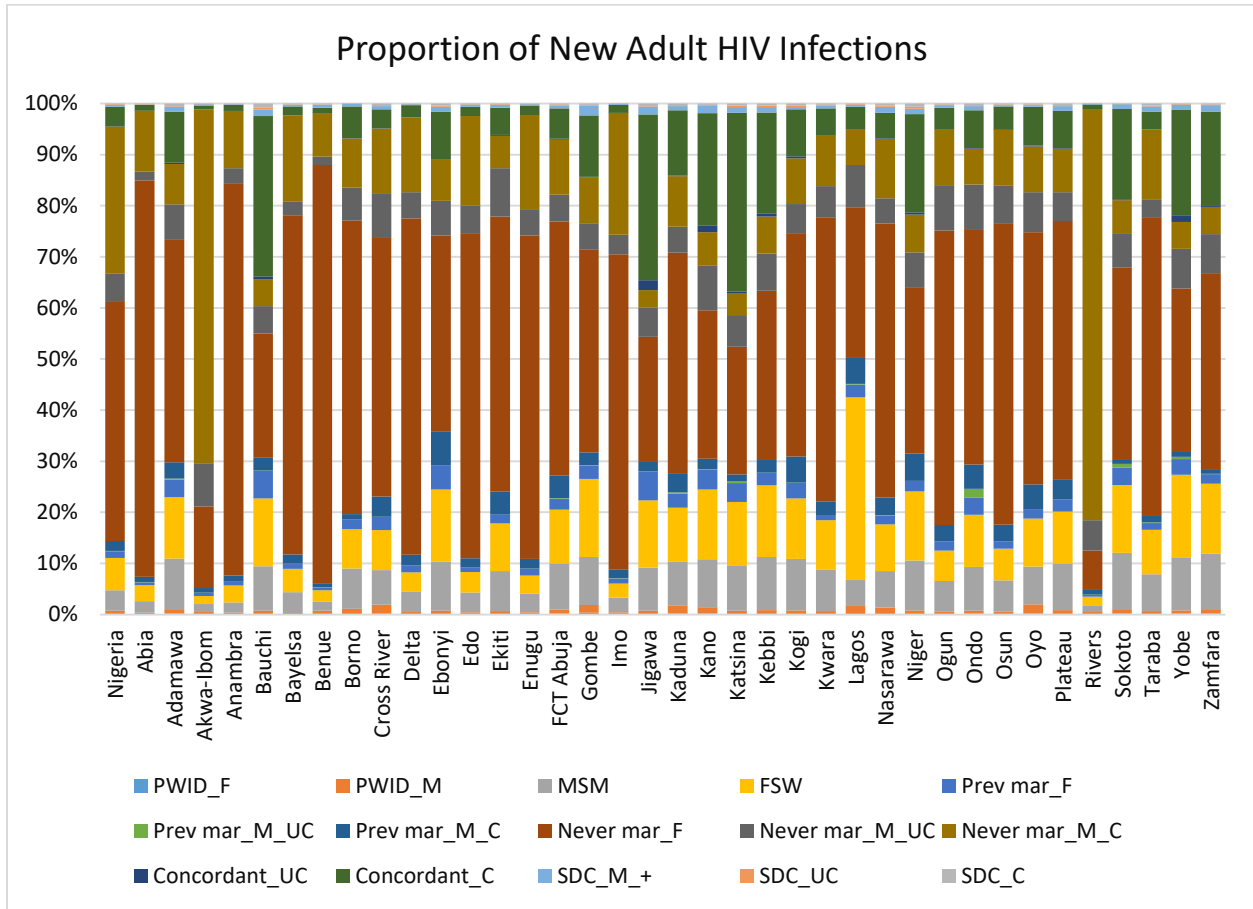
- F = Female
- M = Male
- PWID = People who inject drugs
- MSM = Men who have sex with men
- FSW = Female sex workers
- Prev mar = Previously married
- Never mar = Never married
- Concordant = Couples where both partners are uninfected
- SDC = Sero-discordant, where one partner is uninfected and one partner is infected
- M\_+ = Indicates that the male is the HIV+ partner in a discordant couple
- UC = Uncircumcised male
- C = Male who has received a medical circumcision
- MTCT = Mother-to-child-transmission

Error bars indicate the 95% credible intervals

Table 1. Population size, incidence and new infections by population group

| <b>Population</b>                   | <b>Population Size (95%CI)</b>     | <b>New Infections (95%CI)</b> | <b>Incidence (95%CI)</b> |
|-------------------------------------|------------------------------------|-------------------------------|--------------------------|
| PWID_M                              | 26,933 (230-156,610)               | 410 (255-750)                 | 1.7% (1.7%-1.9%)         |
| PWID_F                              | 5,203 (0-33,689)                   | 86 (7-162)                    | 2.1% (1.9%-2.1%)         |
| MSM                                 | 329,892 (117,966-691,811)          | 2,515 (2,219-3,870)           | 1.0% (0.9%-1.1%)         |
| FSW                                 | 506,159 (318,402-817,756)          | 4,778 (3,760-5,662)           | 1.3% (1.0%-1.4%)         |
| <b>Previously Married</b>           |                                    |                               |                          |
| Females                             | 2,154,548 (2,008,050-2,319,847)    | 974 (576-1,394)               | 0.0% (0.0%-0.1%)         |
| Males uncircumcised                 | 123,704 (77,076-149,627)           | 61 (22-83)                    | 0.1% (0.0%-0.1%)         |
| Males circumcised                   | 3,320,766 (2,737,208-3,907,669)    | 1,553 (727-2,331)             | 0.0% (0.0%-0.1%)         |
| <b>Never Married</b>                |                                    |                               |                          |
| Females                             | 11,124,456 (10,509,230-11,625,874) | 33,943 (33,187-35,323)        | 0.3% (0.2%-0.4%)         |
| Males uncircumcised                 | 476,029 (323,001-608,884)          | 4,699 (3,021-5,397)           | 1.1% (0.3%-1.7%)         |
| Males circumcised                   | 8,967,374 (8,629,793-9,025,027)    | 20,464 (19,204-22,606)        | 0.2% (0.2%-0.4%)         |
| <b>Concordant negative</b>          |                                    |                               |                          |
| Males uncircumcised                 | 1,215,446 (764,611-1,692,932)      | 80 (57-88)                    | 0.0% (0.0%-0.0%)         |
| Males circumcised                   | 48,023,562 (46,991,401-48,699,567) | 2,883 (2,369-3,346)           | 0.0% (0.0%-0.0%)         |
| <b>Concordant positive</b>          |                                    |                               |                          |
| <b>Serodiscordant</b>               |                                    |                               |                          |
| Male positive                       | 217,747 (80,848-499,342)           | 446 (197-408)                 | 0.3% (0.2%-0.6%)         |
| Female positive, male uncircumcised | 139,223 (92,678-138,299)           | 107 (43-93)                   | 0.2% (0.1%-0.2%)         |
| Female positive, male circumcised   | 251,739 (198,796-231,740)          | 160 (74-168)                  | 0.1% (0.1%-0.2%)         |
| <b>Age 0-14</b>                     |                                    |                               |                          |
| HIV+ pregnant mother                | 98,859                             | 21,905                        | 22.2%                    |
| <b>TOTAL Sexually Active</b>        | 76,889,755 (75,061,664-78,597,578) | 72,662 (65,456-80,770)        |                          |
| <b>Number not sexually active</b>   | 26,529,245 (24,821,422-28,357,336) |                               |                          |
| <b>Total population 15-49</b>       | 103,419,000                        |                               |                          |

Figure 2. Distribution of new infections by State





**Table 2. New Adult HIV Infections by Population Group and Location**

|  | Nigeria | Abia | Adamawa | Akwa-Ibom | Anambra | Bauchi | Bayelsa | Benue | Borno | Cross River | Delta | Ebonyi | Edo  | Ekiti | Enugu | FCT Abuja | Gombe | Imo  | Jigawa |
|--|---------|------|---------|-----------|---------|--------|---------|-------|-------|-------------|-------|--------|------|-------|-------|-----------|-------|------|--------|
| MSM  | 2960    | 84   | 62      | 129       | 116     | 32     | 59      | 125   | 109   | 74          | 107   | 31     | 86   | 60    | 97    | 74        | 34    | 111  | 27     |
| FSW  | 4646    | 119  | 75      | 126       | 191     | 49     | 66      | 150   | 105   | 85          | 102   | 46     | 90   | 70    | 97    | 86        | 55    | 104  | 42     |
| Previously married females                               | 943     | 21   | 22      | 54        | 40      | 20     | 14      | 36    | 27    | 29          | 34    | 15     | 22   | 14    | 39    | 17        | 10    | 39   | 18     |
| Previously married uncircumcised males                   | 45      | 3    | 1       | 3         | 0       | 0      | 0       | 2     | 0     | 0           | 0     | 0      | 0    | 0     | 0     | 1         | 0     | 0    | 0      |
| Previously married circumcised males                     | 1424    | 37   | 20      | 72        | 69      | 9      | 26      | 48    | 14    | 43          | 57    | 22     | 39   | 33    | 48    | 36        | 9     | 63   | 6      |
| Never married females                                    | 34326   | 2918 | 271     | 1291      | 4391    | 90     | 957     | 5632  | 785   | 553         | 1768  | 125    | 1427 | 408   | 1706  | 407       | 142   | 2355 | 79     |
| Never married uncircumcised males                        | 4038    | 62   | 43      | 683       | 177     | 20     | 38      | 111   | 88    | 95          | 138   | 22     | 123  | 72    | 138   | 43        | 19    | 146  | 18     |
| Never married circumcised males                          | 21063   | 450  | 49      | 5597      | 642     | 19     | 243     | 585   | 132   | 138         | 392   | 26     | 392  | 48    | 496   | 88        | 32    | 909  | 11     |
| Concordant couples with uncircumcised male               | 72      | 0    | 1       | 3         | 1       | 2      | 1       | 2     | 1     | 1           | 1     | 0      | 1    | 1     | 1     | 2         | 0     | 1    | 6      |
| Concordant couples with circumcised male                 | 2839    | 41   | 62      | 63        | 66      | 116    | 25      | 74    | 85    | 41          | 64    | 30     | 41   | 41    | 50    | 49        | 43    | 61   | 104    |
| Sero-discordant couples, male HIV+                       | 288     | 5    | 7       | 16        | 7       | 5      | 5       | 35    | 7     | 7           | 6     | 3      | 9    | 4     | 7     | 5         | 7     | 6    | 5      |
| Sero-discordant couples, female HIV+, male uncircumcised | 64      | 2    | 1       | 4         | 3       | 2      | 1       | 5     | 0     | 2           | 1     | 1      | 2    | 1     | 1     | 1         | 1     | 2    | 1      |
| Sero-discordant couples, female HIV+, male circumcised   | 112     | 4    | 2       | 9         | 6       | 3      | 2       | 14    | 1     | 4           | 2     | 1      | 3    | 1     | 2     | 2         | 1     | 2    | 1      |

**Table 2 (continued). New Adult HIV Infections by Population Group and Location**

|  | Kaduna | Kano | Katsina | Kebbi | Kogi | Kwara | Lagos | Nasarawa | Niger | Ogun | Ondo | Osun | Oyo | Plateau | Rivers | Sokoto | Taraba | Yobe | Zamfara |
|--|--------|------|---------|-------|------|-------|-------|----------|-------|------|------|------|-----|---------|--------|--------|--------|------|---------|
| MSM  | 104    | 93   | 40      | 45    | 63   | 56    | 186   | 100      | 45    | 98   | 70   | 90   | 122 | 69      | 151    | 65     | 68     | 24   | 55      |
| FSW  | 128    | 137  | 57      | 60    | 73   | 66    | 1313  | 128      | 63    | 97   | 83   | 92   | 156 | 76      | 191    | 78     | 82     | 37   | 70      |
| Previously married females                               | 33     | 39   | 17      | 11    | 19   | 6     | 93    | 25       | 10    | 27   | 28   | 22   | 28  | 18      | 48     | 20     | 12     | 7    | 9       |
| Previously married uncircumcised males                   | 3      | 0    | 2       | 0     | 0    | 0     | 4     | 1        | 0     | 1    | 13   | 0    | 0   | 0       | 0      | 4      | 1      | 1    | 0       |
| Previously married circumcised males                     | 46     | 20   | 6       | 11    | 32   | 19    | 186   | 48       | 25    | 54   | 39   | 48   | 83  | 29      | 102    | 5      | 14     | 3    | 4       |
| Never married females                                    | 523    | 289  | 113     | 142   | 271  | 382   | 1083  | 753      | 150   | 944  | 375  | 876  | 818 | 381     | 882    | 222    | 547    | 74   | 196     |
| Never married uncircumcised males                        | 62     | 87   | 28      | 31    | 35   | 43    | 305   | 69       | 32    | 146  | 73   | 111  | 130 | 42      | 678    | 40     | 32     | 18   | 39      |
| Never married circumcised males                          | 120    | 65   | 19      | 31    | 56   | 67    | 253   | 164      | 34    | 178  | 57   | 163  | 148 | 64      | 9187   | 38     | 129    | 12   | 27      |
| Concordant couples with uncircumcised male               | 2      | 12   | 2       | 3     | 2    | 1     | 5     | 1        | 2     | 2    | 1    | 1    | 3   | 1       | 2      | 1      | 1      | 3    | 1       |
| Concordant couples with circumcised male                 | 155    | 221  | 159     | 85    | 57   | 36    | 160   | 70       | 89    | 69   | 60   | 67   | 125 | 55      | 96     | 105    | 33     | 48   | 94      |
| Sero-discordant couples, male HIV+                       | 10     | 14   | 5       | 5     | 2    | 4     | 14    | 17       | 5     | 8    | 7    | 4    | 5   | 7       | 15     | 6      | 10     | 3    | 6       |
| Sero-discordant couples, female HIV+, male uncircumcised | 2      | 2    | 1       | 1     | 2    | 1     | 3     | 3        | 2     | 2    | 2    | 2    | 2   | 2       | 3      | 0      | 2      | 0    | 1       |
| Sero-discordant couples, female HIV+, male circumcised   | 4      | 3    | 2       | 2     | 3    | 2     | 6     | 6        | 3     | 3    | 2    | 3    | 3   | 2       | 5      | 0      | 3      | 0    | 1       |

*Abia state*

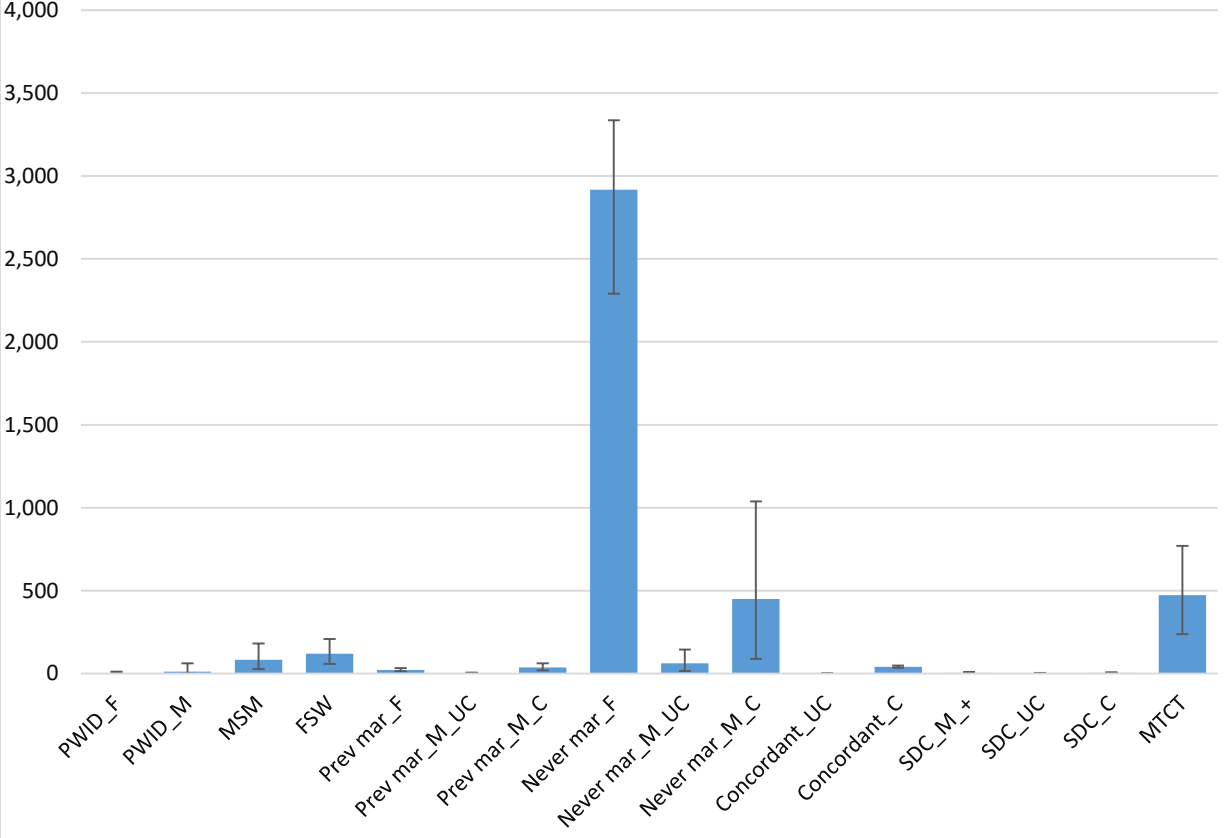
The distribution of new infections with their 95% credible interval for Abia state is displayed in Figure 3. Among adults: Never Married Females, and Never Married Males have the largest contribution, representing about 77.6%, and 13.6 % of new infections, respectively. This corresponds to more than 91 % of new infections. The contribution of key populations corresponds to about 5.75%.

About 88% of never married women were younger than 30-years during the Survey and, among them, about 80% were sexually active before 20 years. Only 26% (95%CI: 22%-31%) in that sub-population had less than 2 partners during the last 12 months, and 53% (95%CI: 48%-59%) were employed. The majority, 73% (95%CI: 69%-78%), completed High School or below; 50% (95%CI: 41%-58%) had ever gave birth, and only 32% (95%CI: 27%-38%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.13.

Figure 3. Distribution of new adult HIV infections in Abia State

Number of new infections: Abia



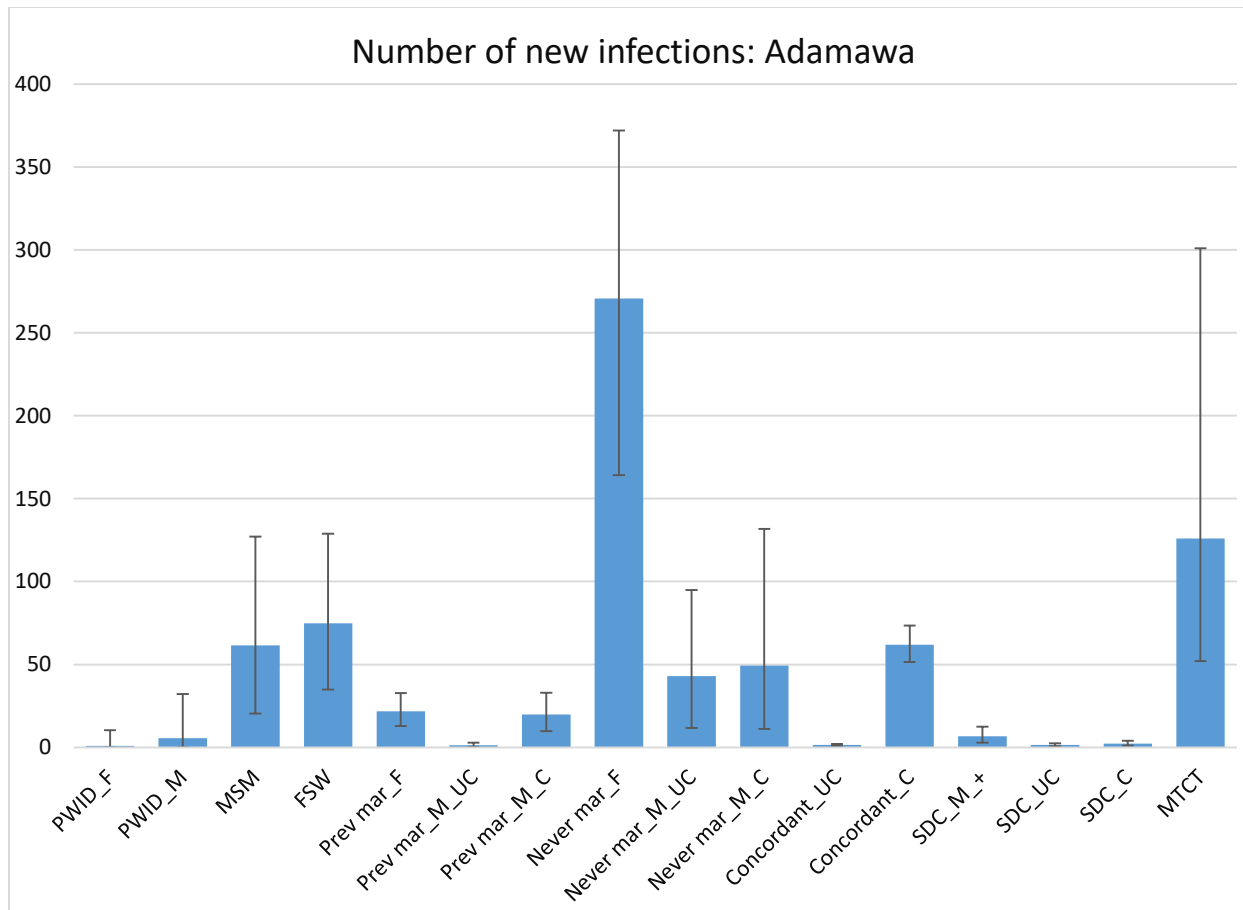
### *Adamawa state*

The distribution of new infections with their 95% credible interval for Adamawa state is displayed in Figure 4. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Sero-Concordant Couples, and Men who have Sex with Men have the largest contribution, representing about 43.5%, 14.8%, 12%, 9.96%, and 9.89 % of new infections, respectively. This corresponds to more than 90 % of new infections. The contribution of key populations corresponds to about 22.9%.

Never married women were mostly younger than 30-years during the Survey (80%) and, among them, about 84% were sexually active before 20 years. About 85% (95%CI: 78%-91%) in that sub-population reported only 1 partner during the last 12 months, and 65% (95%CI: 57%-73%) were employed. The majority, 93% (95%CI: 89%-97%), completed High School or below; 90% (95%CI: 83%-95%) had ever gave birth, and only 26% (95%CI: 18%-34%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.21.

Figure 4. Distribution of new adult HIV infections in Adamawa State



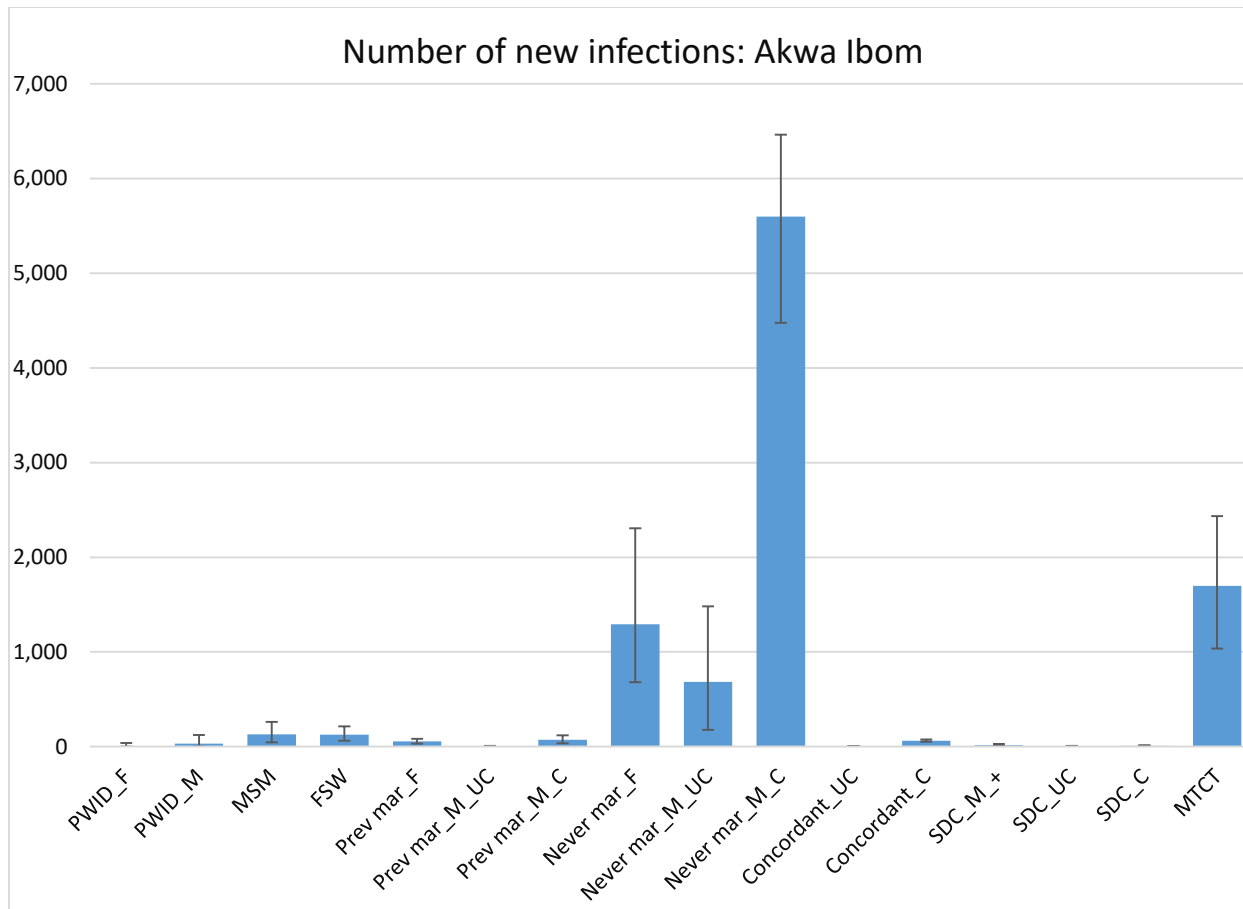
#### *Akwa Ibom state*

The distribution of new infections with their 95% credible interval for Akwa Ibom state is displayed in Figure 5. Among adults: Never Married Males, and Never Married Females have the largest contribution, representing about 77.7%, and 16 % of new infections, respectively. This corresponds to more than 93 % of new infections. The contribution of key populations corresponds to about 3.6%.

The majority of never married women were younger than 30-years during the Survey (about 90%) and, among them, about 92% were sexually active before 20 years. Only 19% (95%CI: 15%-24%) in that sub-population had less than 2 partners during the last 12 months, and 68% (95%CI: 63%-73%) were employed. The majority, 78% (95%CI: 73%-82%), completed High School or below; 41% (95%CI: 33%-50%) had ever gave birth, and only 33% (95%CI: 28%-38%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.21.

Figure 5. Distribution of new adult HIV infections in Akwa Ibom State



*Anambra state*

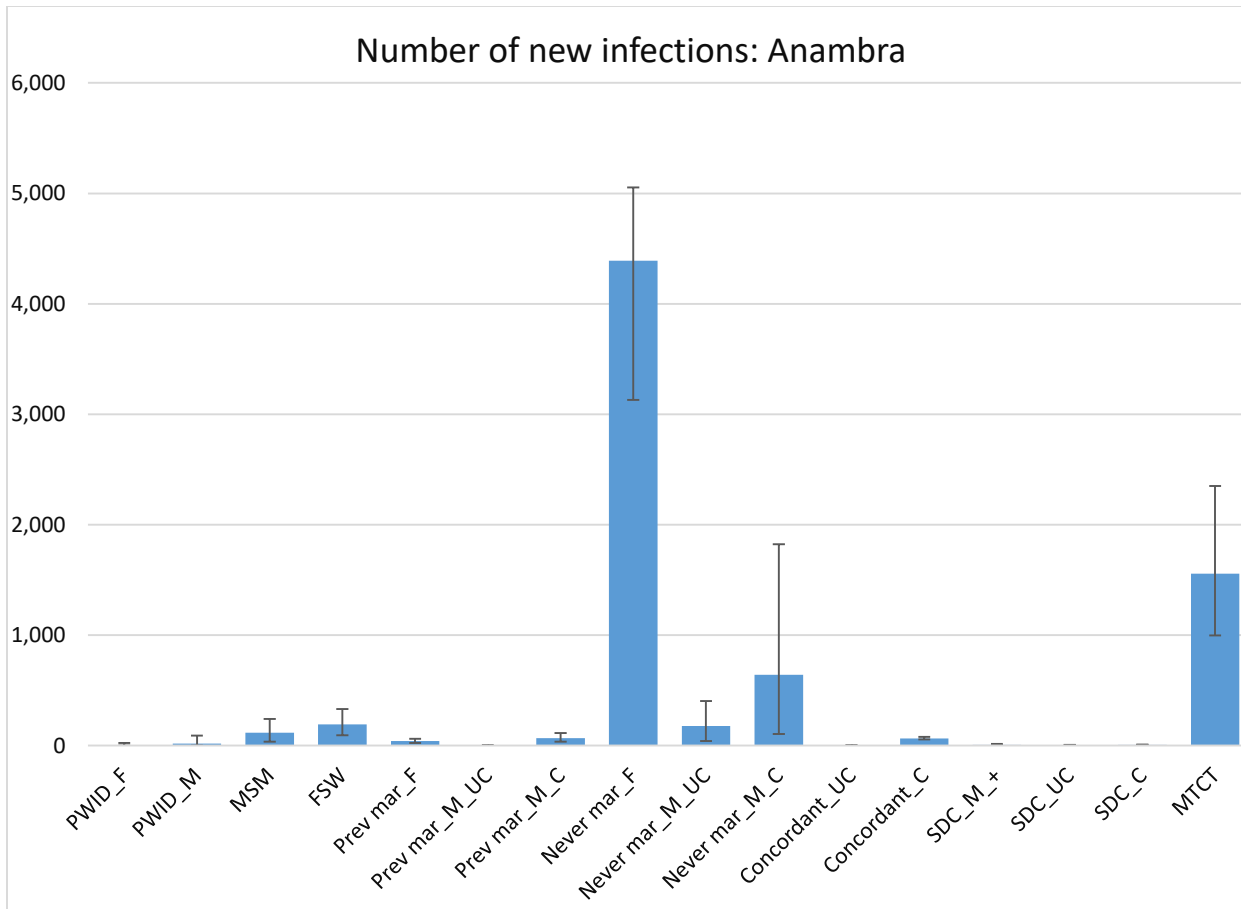
The distribution of new infections with their 95% credible interval for Anambra state is displayed in Figure 6. Among adults: Never Married Females, and Never Married Males have the largest contribution, representing about 76.7%, and 14.3 % of new infections, respectively. This corresponds to more than 90 % of new infections. The contribution of key populations corresponds to about 5.69%.

Most never married women were younger than 30-years during the Survey (93%) and, among them, about 76% were sexually active before 20 years. Only 33% (95%CI: 28%-39%) in that sub-population had less than 2 partners during the last 12 months, and 50% (95%CI: 44%-55%) were employed. The majority, 67% (95%CI: 61%-72%), completed High School or below; 61% (95%CI: 50%-72%) had ever gave birth, and only 36% (95%CI: 31%-42%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.27.

Figure 6. Distribution of new adult HIV infections in Anambra State





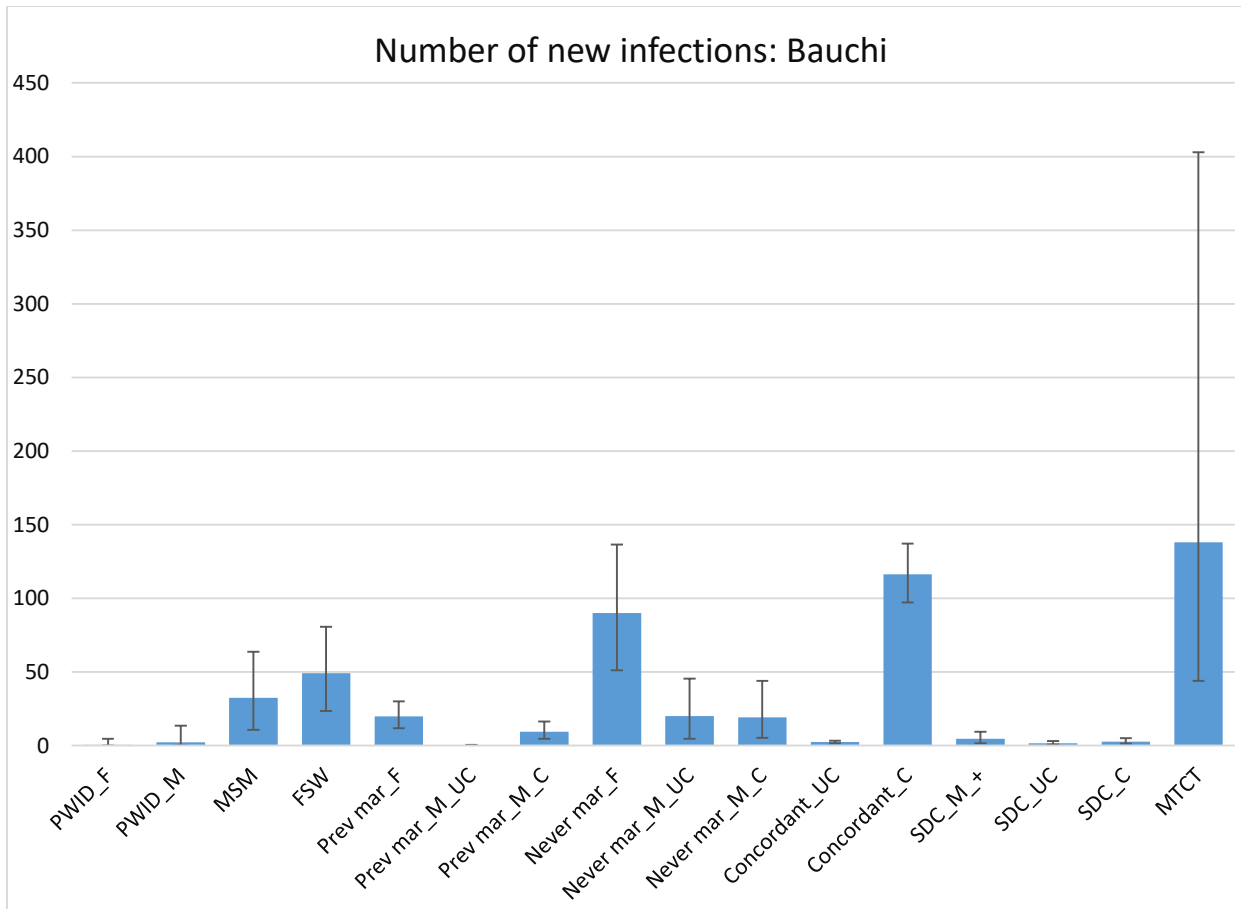
### *Bauchi state*

The distribution of new infections with their 95% credible interval for Bauchi state is displayed in Figure 7. Among adults: Sero-Concordant Couples, Never Married Females, Female Sex Workers, Never Married Males, Men who have Sex with Men, and Previously Married Females have the largest contribution, representing about 31.4%, 24.3%, 13.3%, 10.5%, 8.75%, and 5.36 % of new infections, respectively. This corresponds to more than 93 % of new infections. The contribution of key populations corresponds to about 22.7%.

Never married women were mostly younger than 30-years during the Survey (83%) and, among them, about 95% were sexually active before 20 years. About 95% (95%CI: 89%-100%) in that sub-population reported only 1 partner during the last 12 months, and 74% (95%CI: 63%-85%) were employed. The majority, 82% (95%CI: 69%-94%), completed High School or below; 53% (95%CI: 39%-67%) had ever gave birth, and only 5% (95%CI: 1%-11%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.42.

Figure 7. Distribution of new adult HIV infections in Bauchi



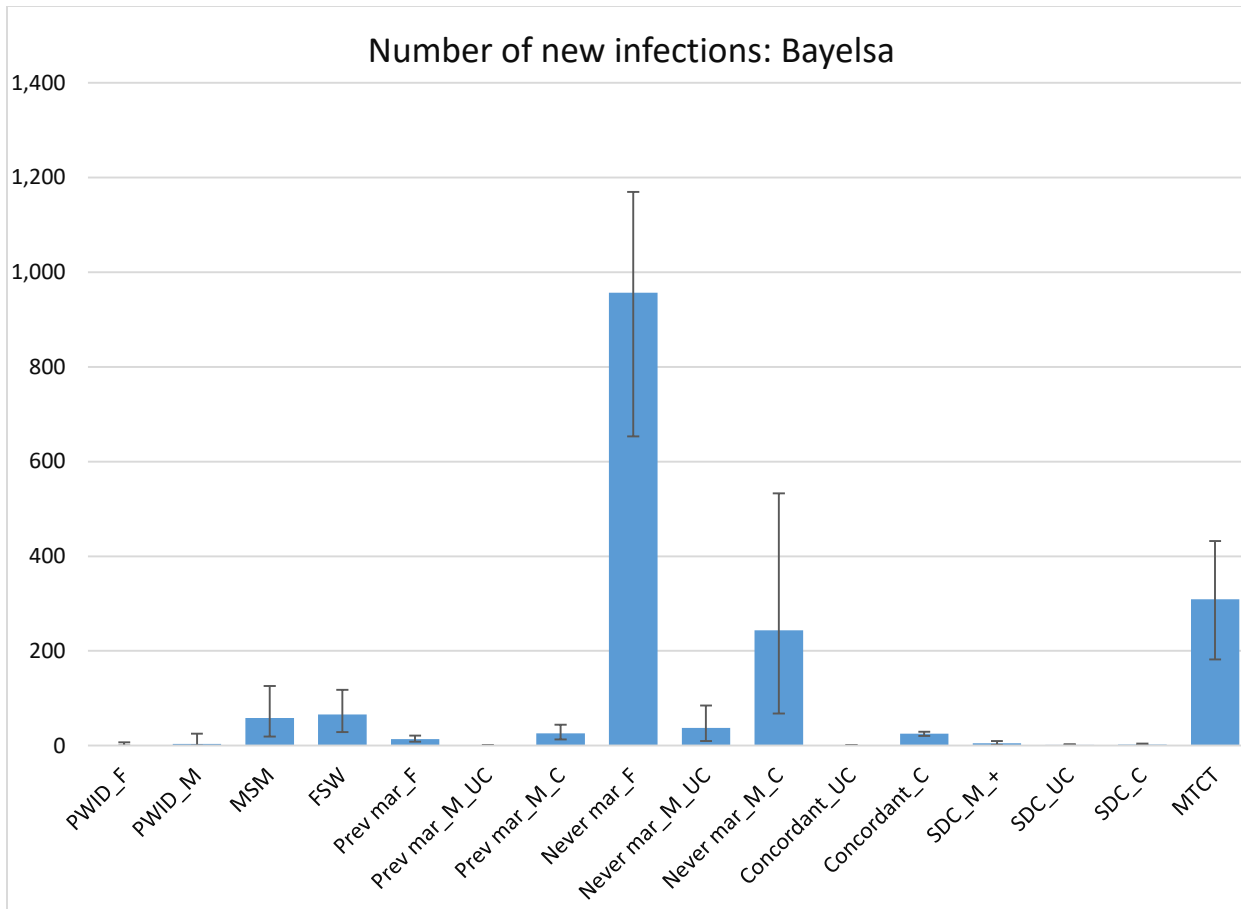
### *Bayelsa state*

The distribution of new infections with their 95% credible interval for Bayelsa state is displayed in Figure 8. Among adults: Never Married Females, Never Married Males, and Female Sex Workers have the largest contribution, representing about 66.4%, 19.5%, and 4.57 % of new infections, respectively. This corresponds to more than 90 % of new infections. The contribution of key populations corresponds to about 8.92%.

A large majority of never married women were younger than 30-years during the Survey (90%) and, among them, about 94% were sexually active before 20 years. Only 25% (95%CI: 21%-30%) in that sub-population had less than 2 partners during the last 12 months, and 69% (95%CI: 64%-74%) were employed. The majority, 80% (95%CI: 76%-84%), completed High School or below; 54% (95%CI: 47%-61%) had ever gave birth, and only 15% (95%CI: 11%-19%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.21.

Figure 8. Distribution of new adult HIV infections in Bayelsa State



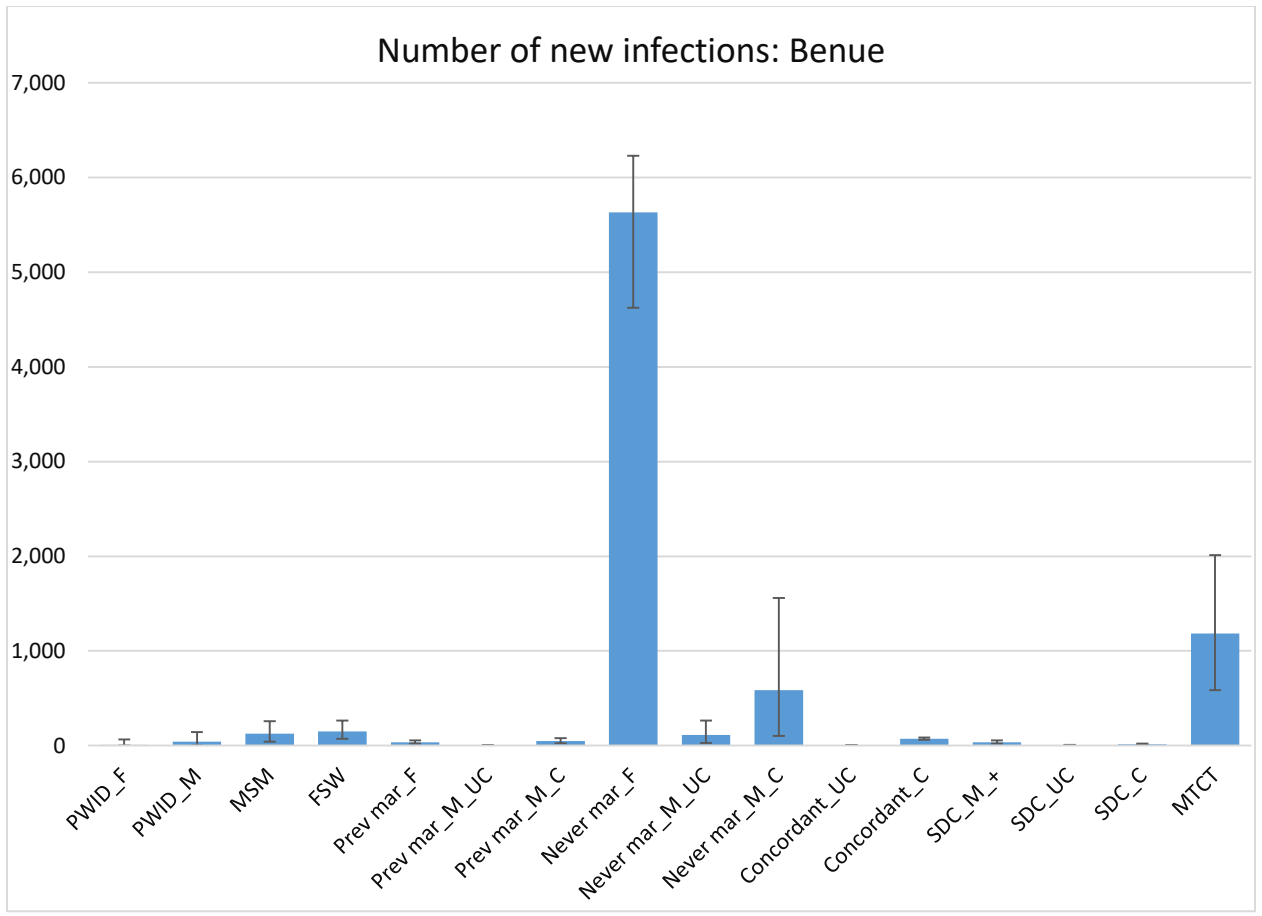
### *Benue state*

The distribution of new infections with their 95% credible interval for Benue state is displayed in Figure 9. Among adults: Never Married Females, and Never Married Males have the largest contribution, representing about 82%, and 10.1 % of new infections, respectively. This corresponds to more than 92 % of new infections. The contribution of key populations corresponds to about 4.72%.

About 85% of never married women were younger than 30-years during the Survey and, among them, about 90% were sexually active before 20 years. About 87% (95%CI: 81%-93%) in that sub-population reported only 1 partner during the last 12 months, and 75% (95%CI: 68%-82%) were employed. The majority, 88% (95%CI: 82%-94%), completed High School or below; 33% (95%CI: 18%-49%) had ever gave birth, and only 36% (95%CI: 28%-46%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.17.

Figure 9. Distribution of new adult HIV infections in Benue State



### *Borno state*

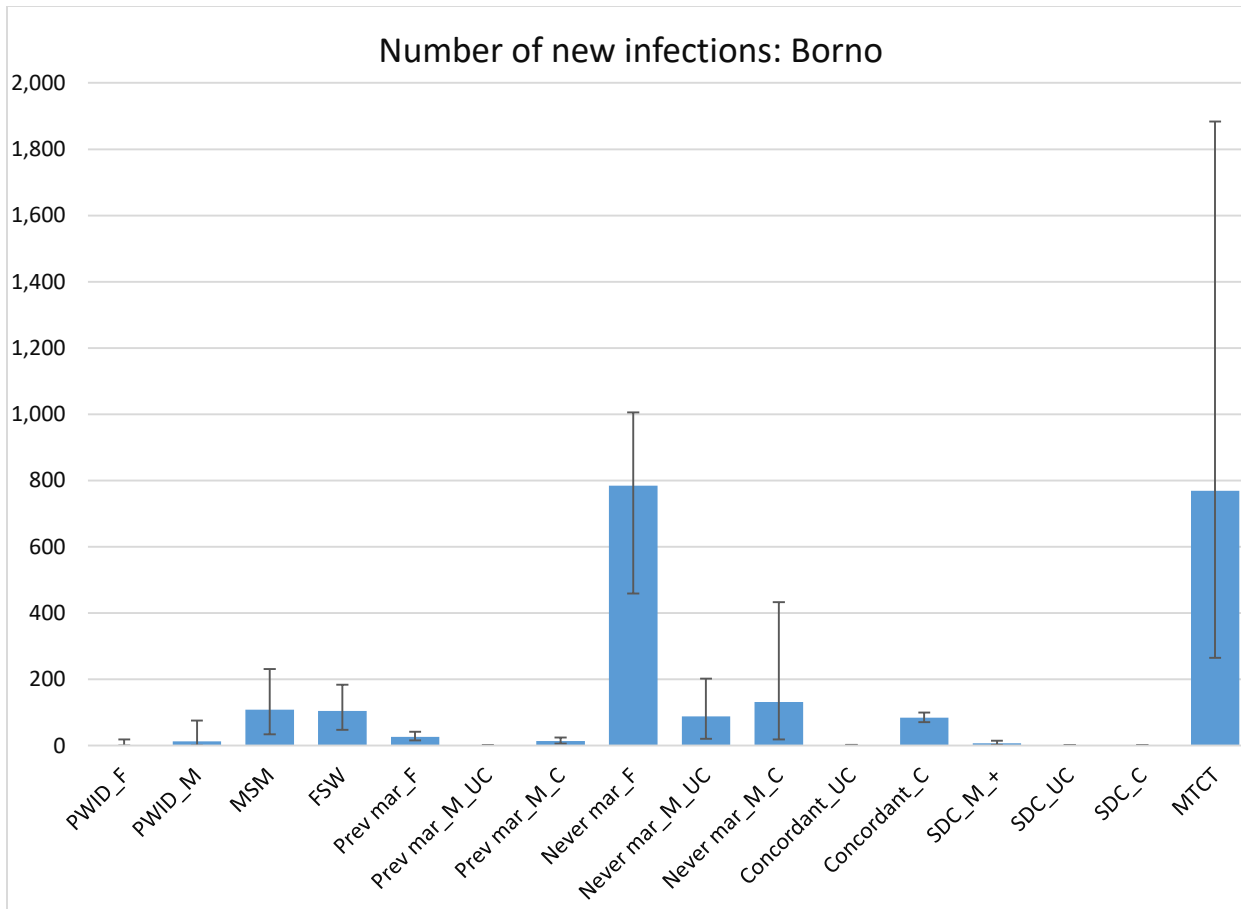
The distribution of new infections with their 95% credible interval for Borno state is displayed in Figure 10. Among adults: Never Married Females, Never Married Males, Men who have Sex with Men, Female Sex Workers, and Sero-Concordant Couples have the largest contribution, representing about 57.4%, 16.1%, 7.94%, 7.66%, and 6.2 % of new infections, respectively. This corresponds to more than 95 % of new infections. The contribution of key populations corresponds to about 16.7%.

Roughly 69% of never married women were younger than 30-years during the Survey and, all of them were sexually active before 20 years. About 96% (95%CI: 87%-100%) in that sub-population reported only 1 partner during the last 12 months, and 68% (95%CI: 48%-87%) were employed. The majority, 91% (95%CI: 69%-100%), completed High School or below; 86% (95%CI: 69%-100%) had ever gave birth, and only 3% (95%CI: 2%-10%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.56.

Figure 10. Distribution of new adult HIV infections in Borno State





### *Cross River state*

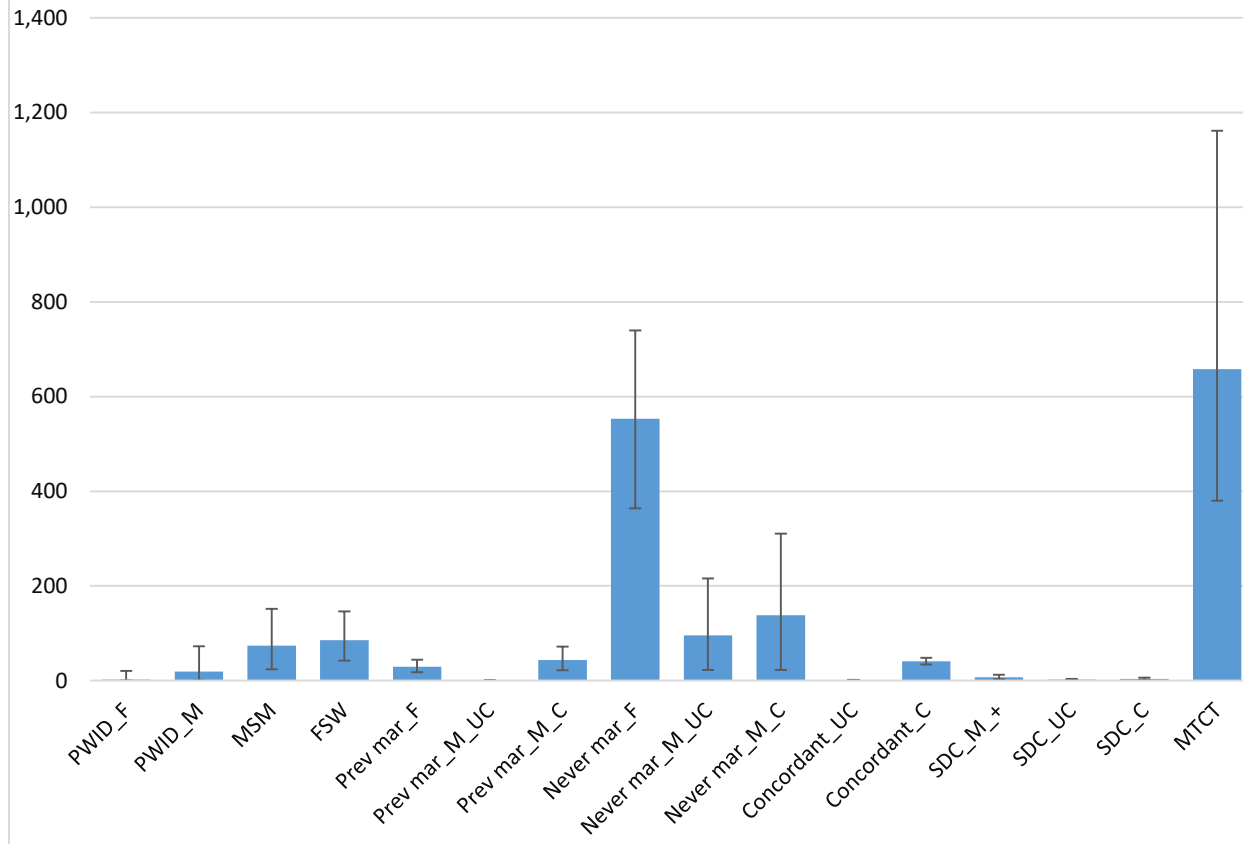
The distribution of new infections with their 95% credible interval for Cross-River state is displayed in Figure 11. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, and Previously Married Men have the largest contribution, representing about 50.6%, 21.3%, 7.79%, 6.75%, and 3.96 % of new infections, respectively. This corresponds to more than 90 % of new infections. The contribution of key populations corresponds to about 16.5%.

Most never married women were younger than 30-years during the Survey (about 92%) and, among them, about 90% were sexually active before 20 years. Only 27% (95%CI: 22%-31%) in that sub-population had less than 2 partners during the last 12 months, and 71% (95%CI: 67%-76%) were employed. The majority, 82% (95%CI: 78%-85%), completed High School or below; 58% (95%CI: 51%-66%) had ever gave birth, and only 29% (95%CI: 25%-34%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.60.

Figure 11. Distribution of new adult HIV infections in Cross River State

Number of new infections: Cross River



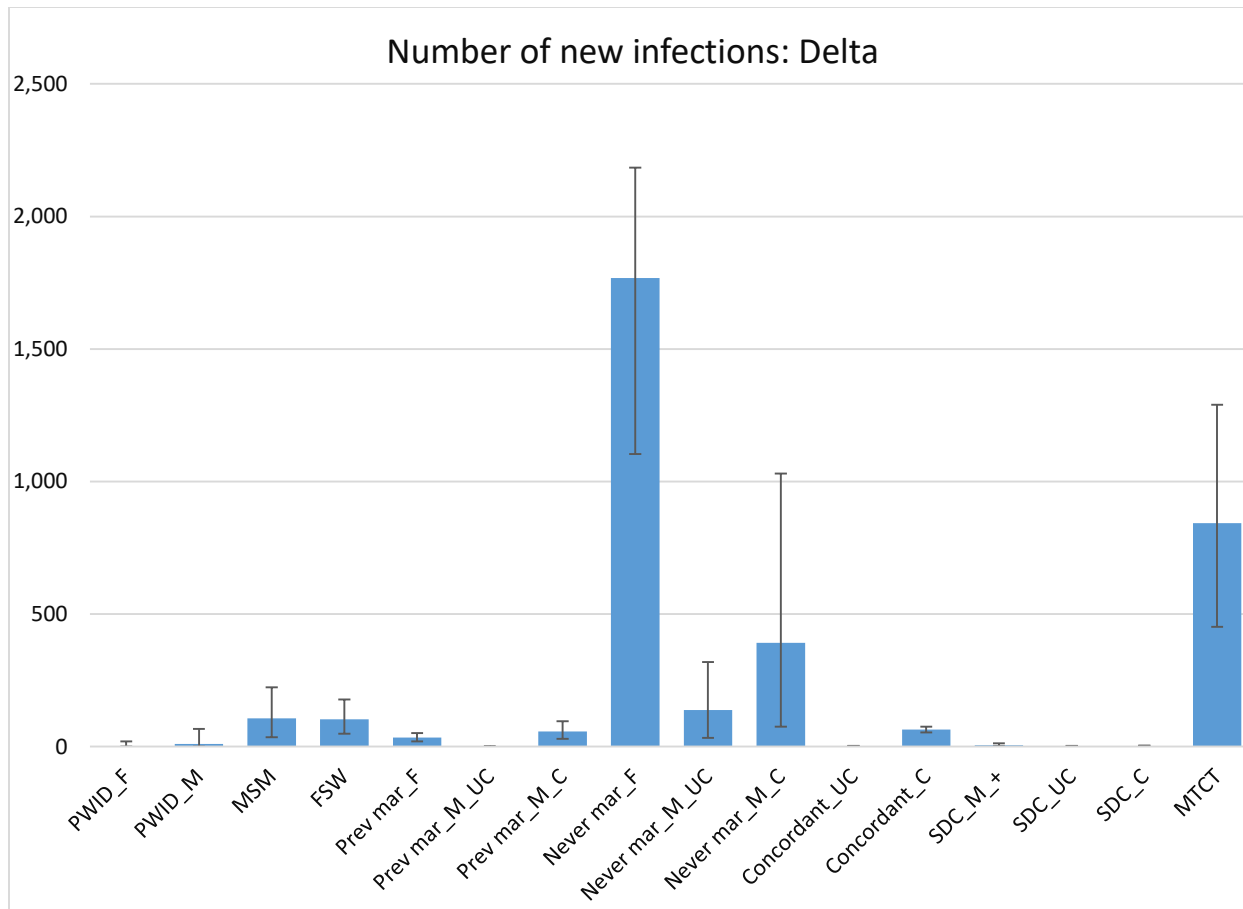
### *Delta state*

The distribution of new infections with their 95% credible interval for Delta state is displayed in Figure 12. Among adults: Never Married Females, Never Married Males, Men who have Sex with Men, and Female Sex Workers have the largest contribution, representing about 65.8%, 19.7%, 3.98%, and 3.82 % of new infections, respectively. This corresponds to more than 93 % of new infections. The contribution of key populations corresponds to about 8.25%.

About 88% of never married women were younger than 30-years during the Survey and, among them, about 87% were sexually active before 20 years. Only 19% (95%CI: 15%-23%) in that sub-population had less than 2 partners during the last 12 months, and 67% (95%CI: 62%-72%) were employed. The majority, 82% (95%CI: 78%-86%), completed High School or below; 42% (95%CI: 35%-50%) had ever gave birth, and only 17% (95%CI: 12%-21%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.31.

Figure 12. Distribution of new adult HIV infections in Delta State



*Ebonyi state*

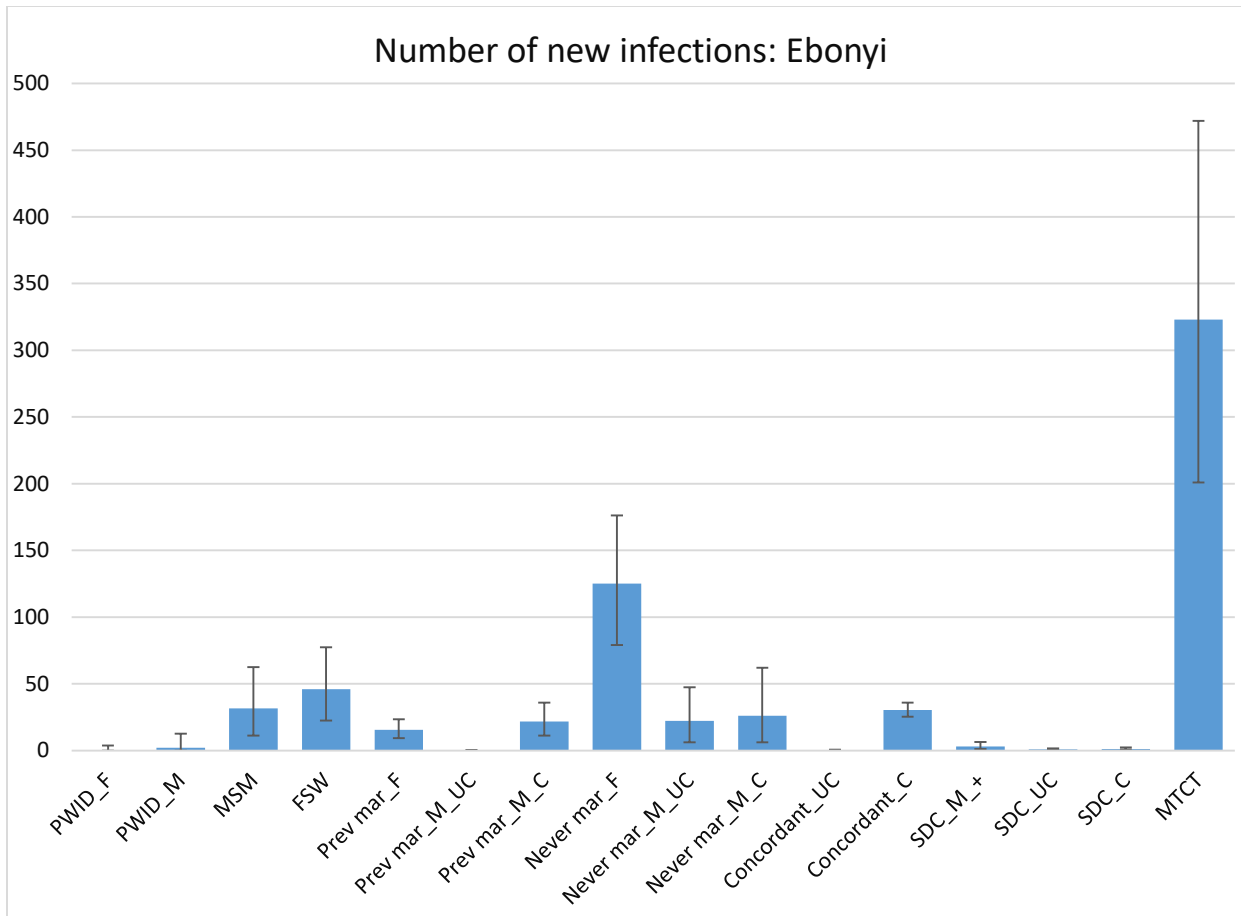
The distribution of new infections with their 95% credible interval for Ebonyi state is displayed in Figure 13. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, Sero-Concordant Couples, and Previously Married Men have

the largest contribution, representing about 38.3%, 14.8%, 14.1%, 9.63%, 9.33%, and 6.7 % of new infections, respectively. This corresponds to more than 92 % of new infections. The contribution of key populations corresponds to about 24.4%.

Most never married women were younger than 30-years during the Survey (~95%) and, among them, about 83% were sexually active before 20 years. Only 15% (95%CI: 11%-20%) in that sub-population had less than 2 partners during the last 12 months, and 64% (95%CI: 58%-70%) were employed. The majority, 85% (95%CI: 80%-89%), completed High School or below; 56% (95%CI: 44%-67%) had ever gave birth, and only 28% (95%CI: 23%-34%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 1.1, meaning that there are more new child infections than adult infections in all population groups. This occurs because new infections among adults have dropped to low levels recently (since coverage of ART among PLHIV is about 70%), but prevalence still remains relatively high and the coverage of PMTCT programs is low.

Figure 13. Distribution of new HIV infections in Ebonyi State



### *Edo state*

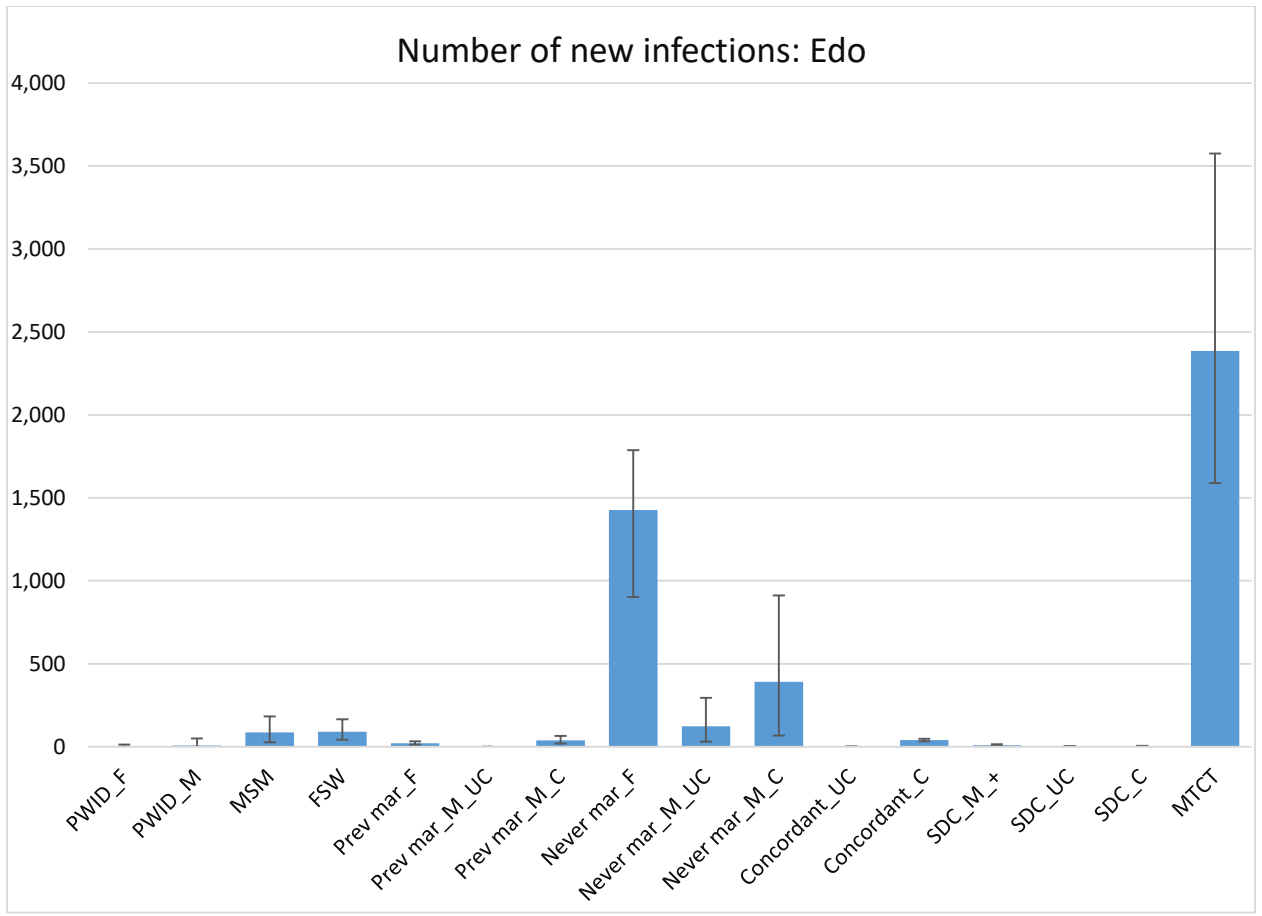
The distribution of new infections with their 95% credible interval for Edo state is displayed in Figure 14. Among adults: Never Married Females, Never Married Males, and Female Sex Workers have the largest contribution, representing about 63.6%, 22.9%, and 4 % of new infections, respectively. This corresponds to more than 90 % of new infections. The contribution of key populations corresponds to about 8.27%.

The majority of never married women were younger than 30-years during the Survey (91%) and, among them, roughly 83% were sexually active before 20 years. Only 21% (95%CI: 16%-26%) in that sub-population had less than 2 partners during the last 12 months, and 61% (95%CI: 55%-67%) were employed. The majority, 70% (95%CI: 64%-75%), completed High School or below; 28% (95%CI: 19%-38%) had ever gave birth, and only 25% (95%CI: 19%-30%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 1.1.

Figure 14. Distribution of new HIV infections in Edo State





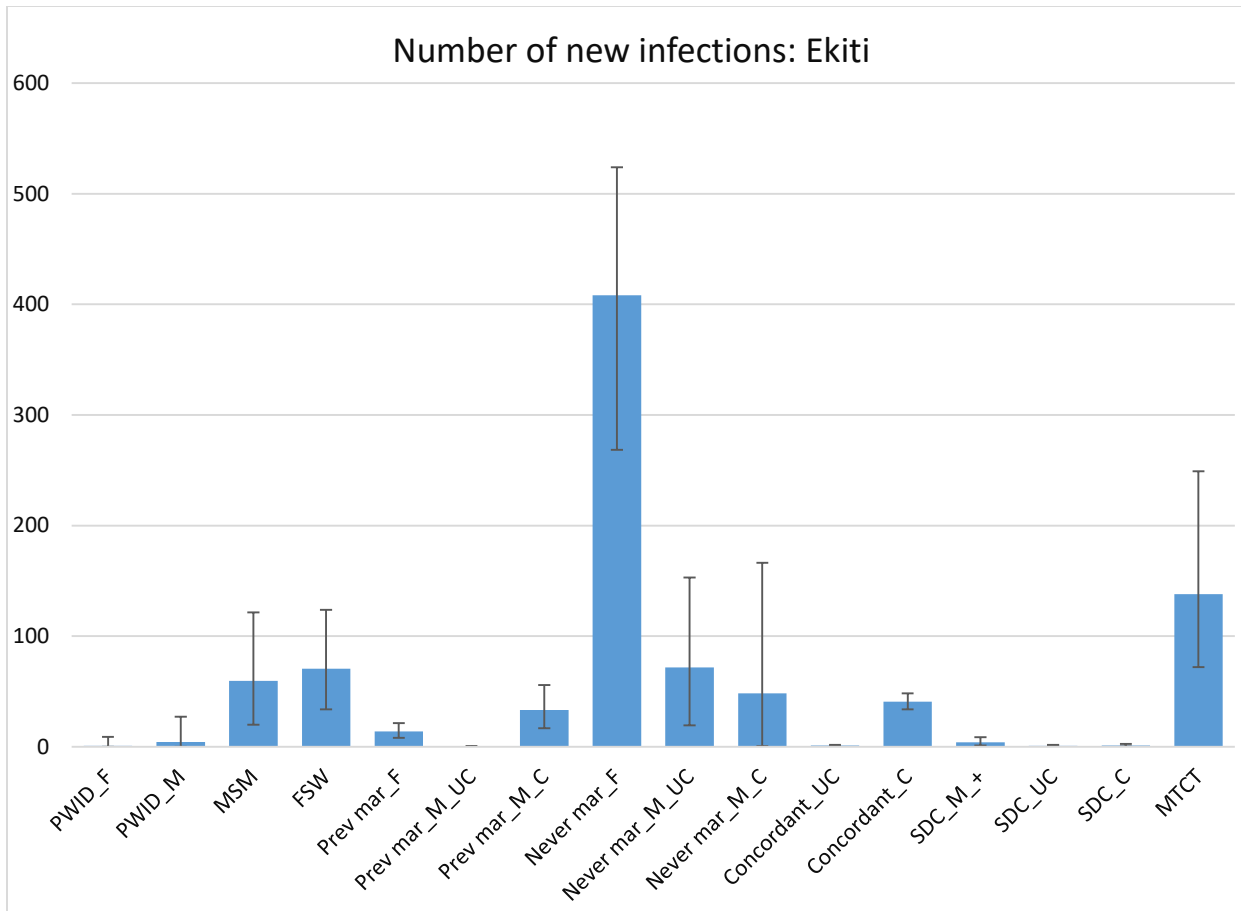
### *Ekiti state*

The distribution of new infections with their 95% credible interval for Ekiti state is displayed in Figure 15. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, and Sero-Concordant Couples have the largest contribution, representing about 53.8%, 15.8%, 9.29%, 7.86%, and 5.38 % of new infections, respectively. This corresponds to more than 92 % of new infections. The contribution of key populations corresponds to about 17.8%.

Never married women were mostly younger than 30-years during the Survey (95%) and, among them, about 82% were sexually active before 20 years. Only 16% (95%CI: 11%-21%) in that sub-population had less than 2 partners during the last 12 months, and 57% (95%CI: 51%-64%) were employed. The majority, 74% (95%CI: 68%-80%), completed High School or below; 62% (95%CI: 51%-74%) had ever gave birth, and only 33% (95%CI: 26%-40%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.18.

Figure 15. Distribution of new HIV infections in Ekiti



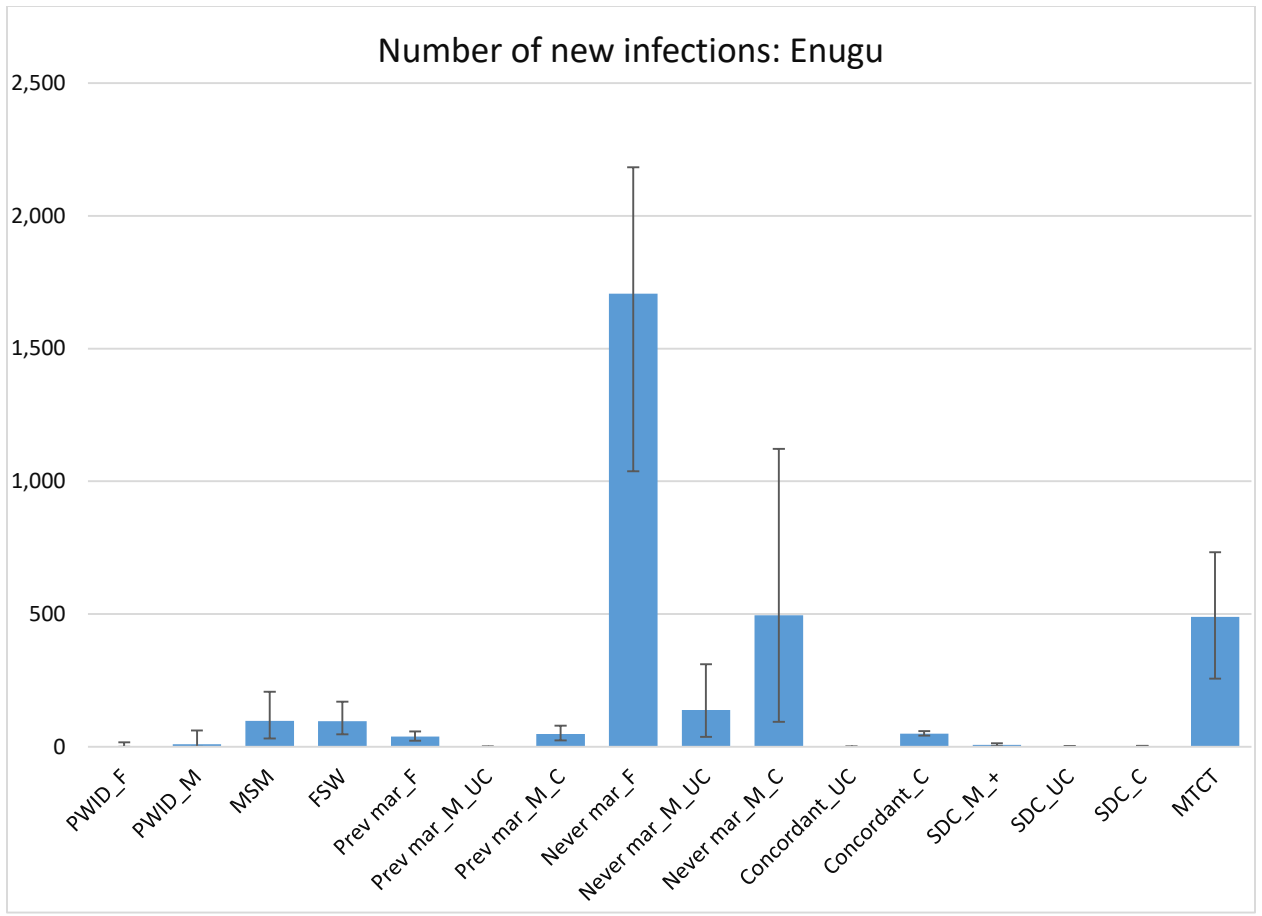
### *Enugu state*

The distribution of new infections with their 95% credible interval for Enugu state is displayed in Figure 16. Among adults: Never Married Females, Never Married Males, and Men who have Sex with Men have the largest contribution, representing about 63.3%, 23.5%, and 3.6 % of new infections, respectively. This corresponds to more than 90 % of new infections. The contribution of key populations corresponds to about 7.64%.

About 90% of never married women were younger than 30-years during the Survey and, among them, about 73% were sexually active before 20 years. Only 27% (95%CI: 22%-32%) in that sub-population had less than 2 partners during the last 12 months, and 58% (95%CI: 53%-64%) were employed. The majority, 75% (95%CI: 70%-79%), completed High School or below; 50% (95%CI: 39%-62%) had ever gave birth, and only 42% (95%CI: 37%-48%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.18.

Figure 16. Distribution of new HIV infections in Enugu



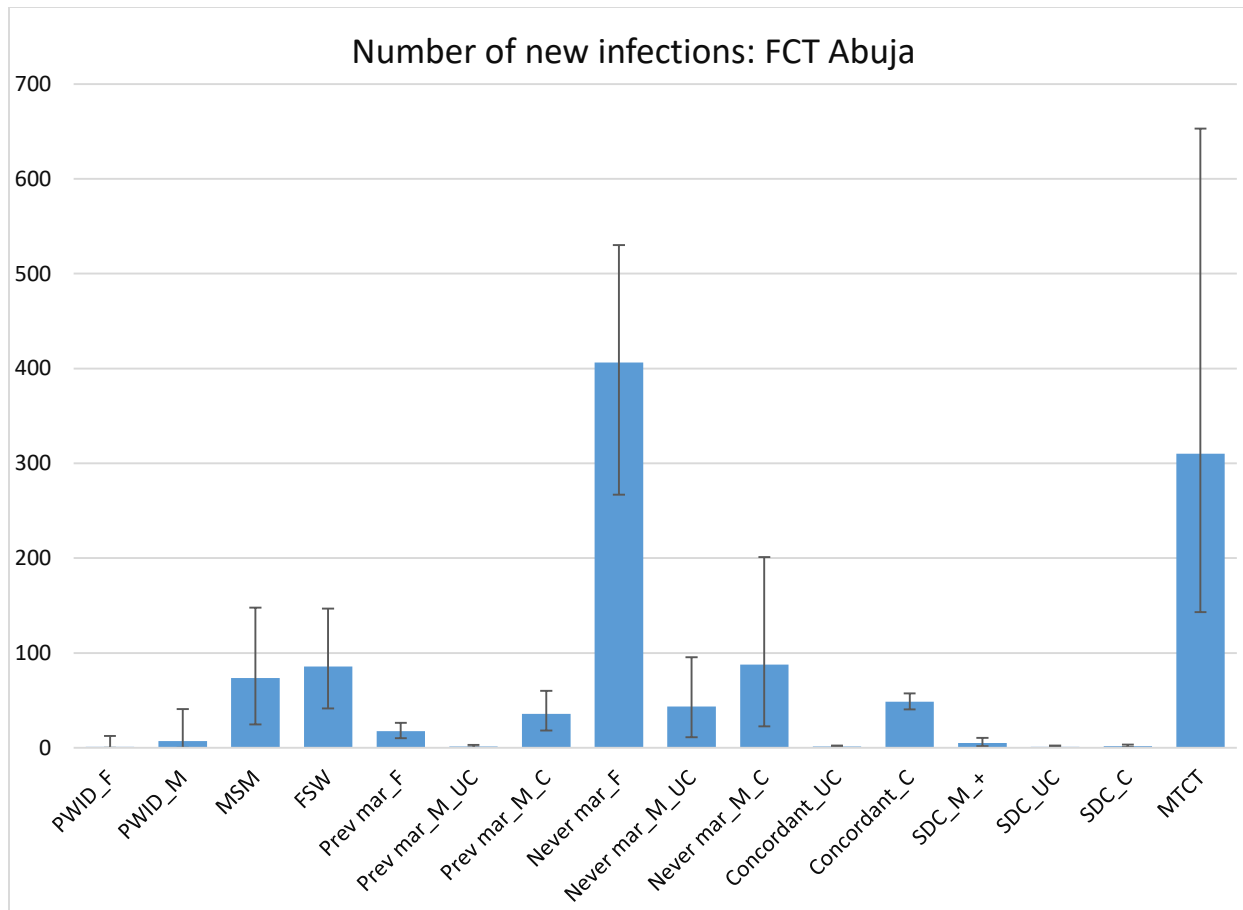
### *FCT Abuja state*

The distribution of new infections with their 95% credible interval for FCT Abuja state is displayed in Figure 17. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, and Sero-Concordant Couples have the largest contribution, representing about 49.7%, 16%, 10.5%, 9.01%, and 5.94 % of new infections, respectively. This corresponds to more than 91 % of new infections. The contribution of key populations corresponds to about 20.5%.

Most never married women were younger than 30-years during the Survey (87%) and, among them, about 65% were sexually active before 20 years. Only 19% (95%CI: 14%-24%) in that sub-population had less than 2 partners during the last 12 months, and 53% (95%CI: 46%-60%) were employed. The majority, 67% (95%CI: 60%-73%), completed High School or below; 50% (95%CI: 37%-63%) had ever gave birth, and only 45% (95%CI: 38%-52%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.39.

Figure 17. Distribution of new HIV infections in FCT Abuja



*Gombe state*

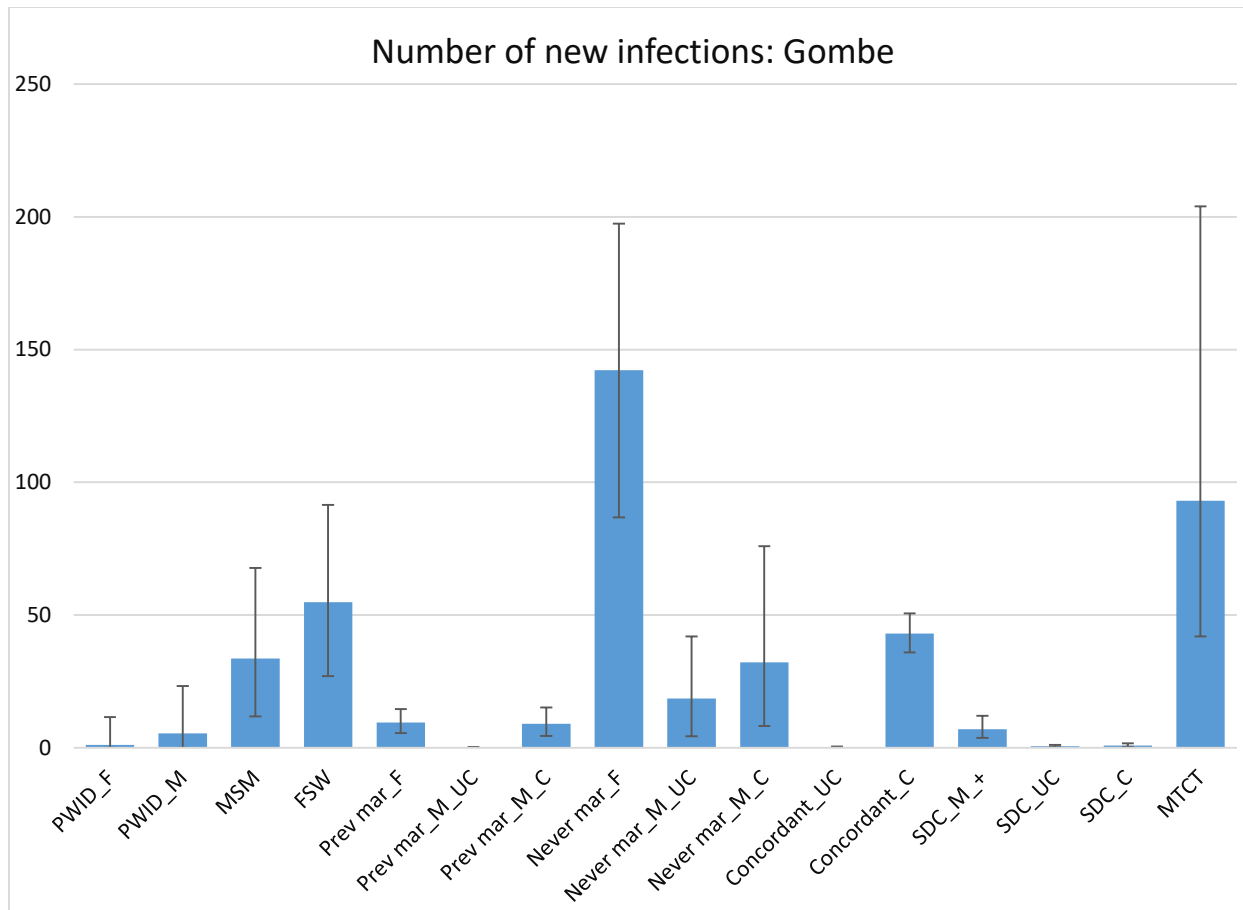
The distribution of new infections with their 95% credible interval for Gombe state is displayed in Figure 18. Among adults: Never Married Females, Female Sex Workers, Never Married Males, Sero-Concordant Couples, and Men who have Sex with Men have the largest contribution, representing about 39.7%, 15.3%, 14.2%, 12%, and 9.4 % of new infections, respectively. This corresponds to more than 90 % of new infections. The contribution of key populations corresponds to about 26.5%.

A large proportion (80%) of never married women were younger than 30-years during the Survey and, among them, about 87% were sexually active before 20 years. Only 16% (95%CI: 10%-23%) in that sub-population had less than 2 partners during the last 12 months, and 87% (95%CI: 82%-92%) were employed. The majority, 91% (95%CI: 86%-96%), completed High School or below; 69% (95%CI: 61%-78%) had ever gave birth, and only 21% (95%CI: 14%-28%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.28.

Figure 18. Distribution of new HIV infections in Gombe





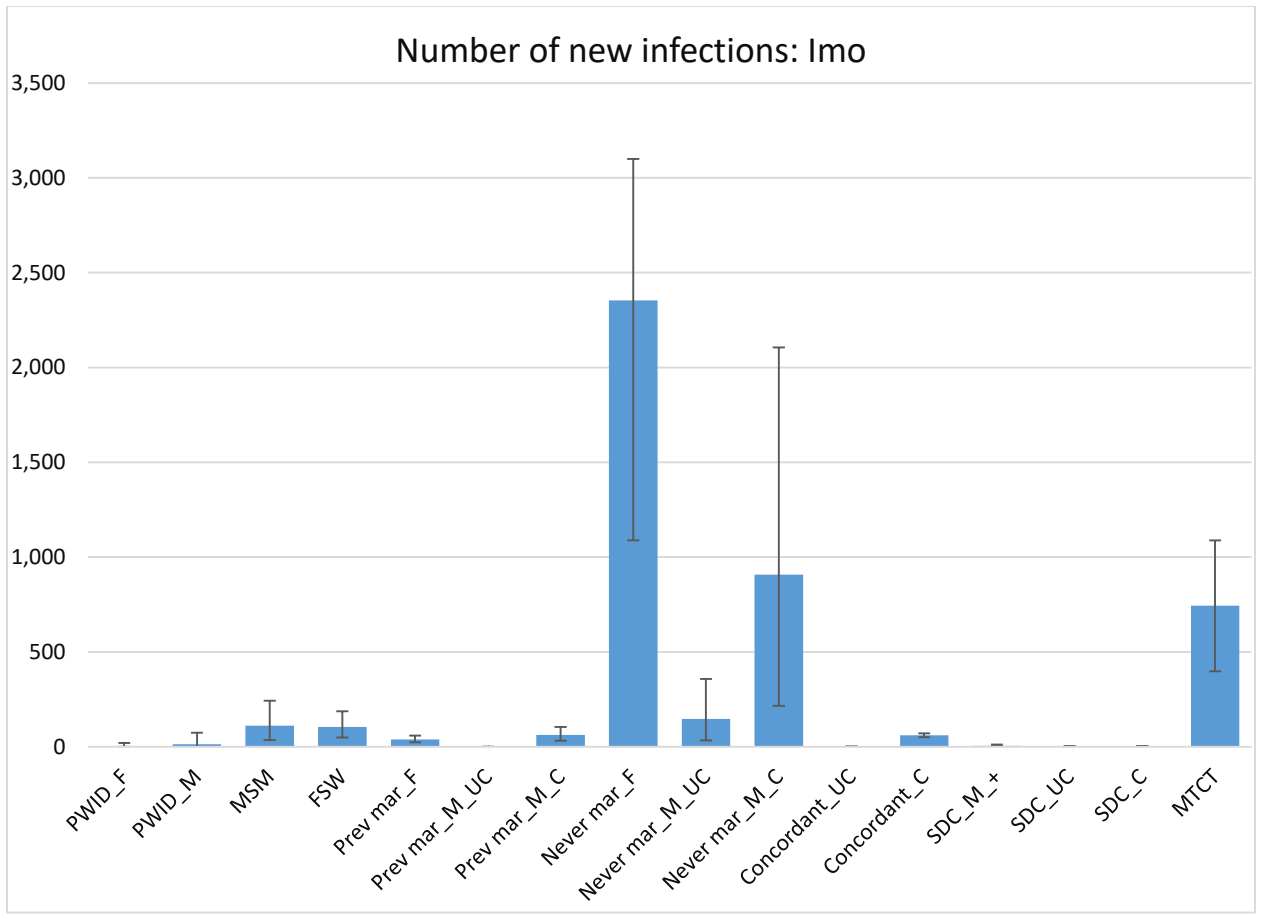
*Imo state*

The distribution of new infections with their 95% credible interval for Imo state is displayed in Figure 19. Among adults: Never Married Females, Never Married Males, and Men who have Sex with Men have the largest contribution, representing about 61.8%, 27.7%, and 2.92 % of new infections, respectively. This corresponds to more than 92 % of new infections. The contribution of key populations corresponds to about 6.05%.

Most never married women were younger than 30-years during the Survey (88%) and, among them, about 78% were sexually active before 20 years. Only 27% (95%CI: 22%-32%) in that sub-population had less than 2 partners during the last 12 months, and 60% (95%CI: 54%-65%) were employed. The majority, 75% (95%CI: 70%-80%), completed High School or below; 54% (95%CI: 43%-65%) had ever gave birth, and only 31% (95%CI: 26%-36%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.19.

Figure 19. Distribution of new HIV infections in Imo



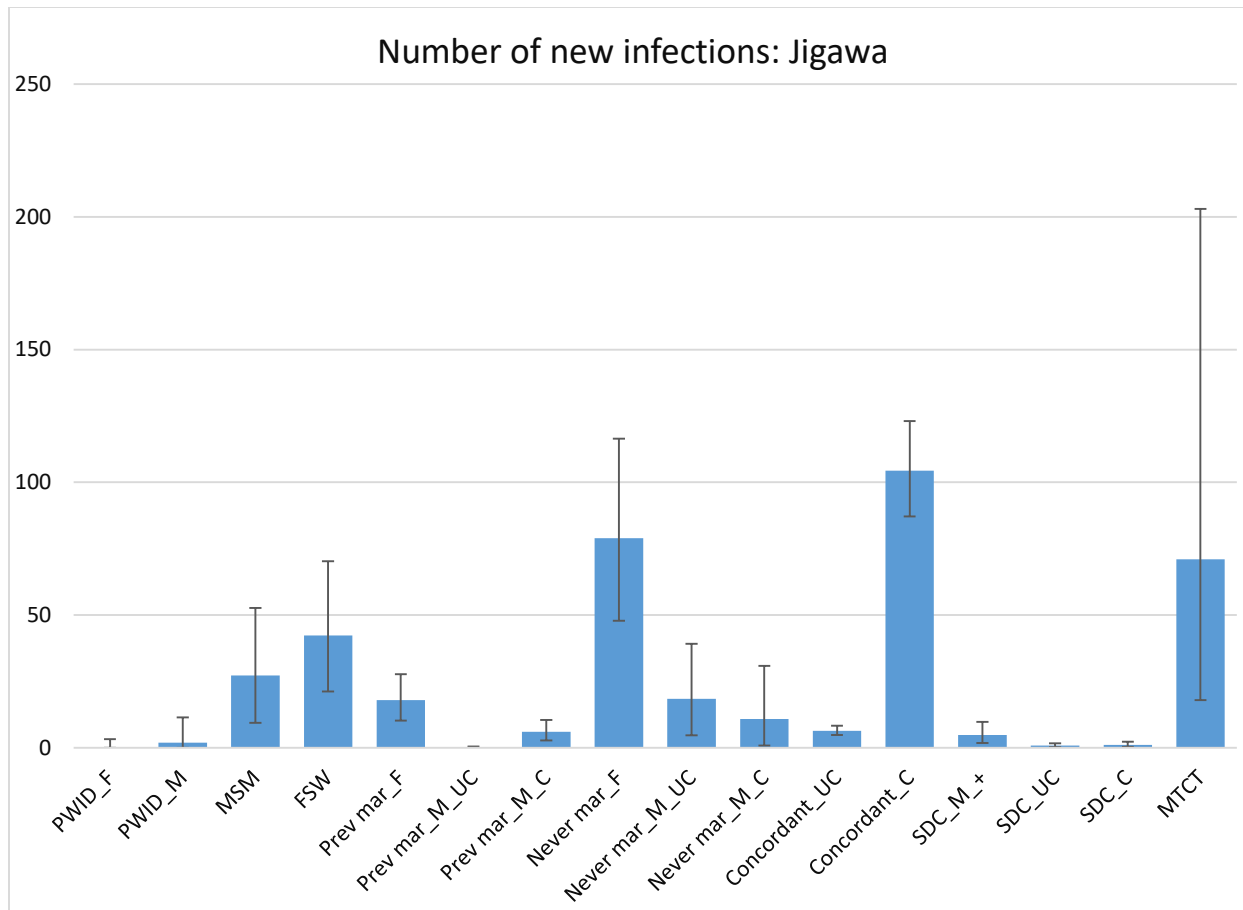
### *Jigawa state*

The distribution of new infections with their 95% credible interval for Jigawa state is displayed in Figure 20. Among adults: Sero-Concordant Couples, Never Married Females, Female Sex Workers, Never Married Males, Men who have Sex with Men, and Previously Married Females have the largest contribution, representing about 32.4%, 24.5%, 13.2%, 9.11%, 8.49%, and 5.57 % of new infections, respectively. This corresponds to more than 93 % of new infections. The contribution of key populations corresponds to about 22.3%.

Compared to other states, fewer (72%) never married women were younger than 30-years during the Survey and, among them, about 99% were sexually active before 20 years. About 98% (95%CI: 95%-100%) in that sub-population reported only 1 partner during the last 12 months, and 94% (95%CI: 89%-97%) were employed. The majority, 65% (95%CI: 55%-73%), completed No formal education; 76% (95%CI: 69%-84%) had ever gave birth, and only 0% (95%CI: 0%-3%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.26.

Figure 20. Distribution of new HIV infections in Jigawa



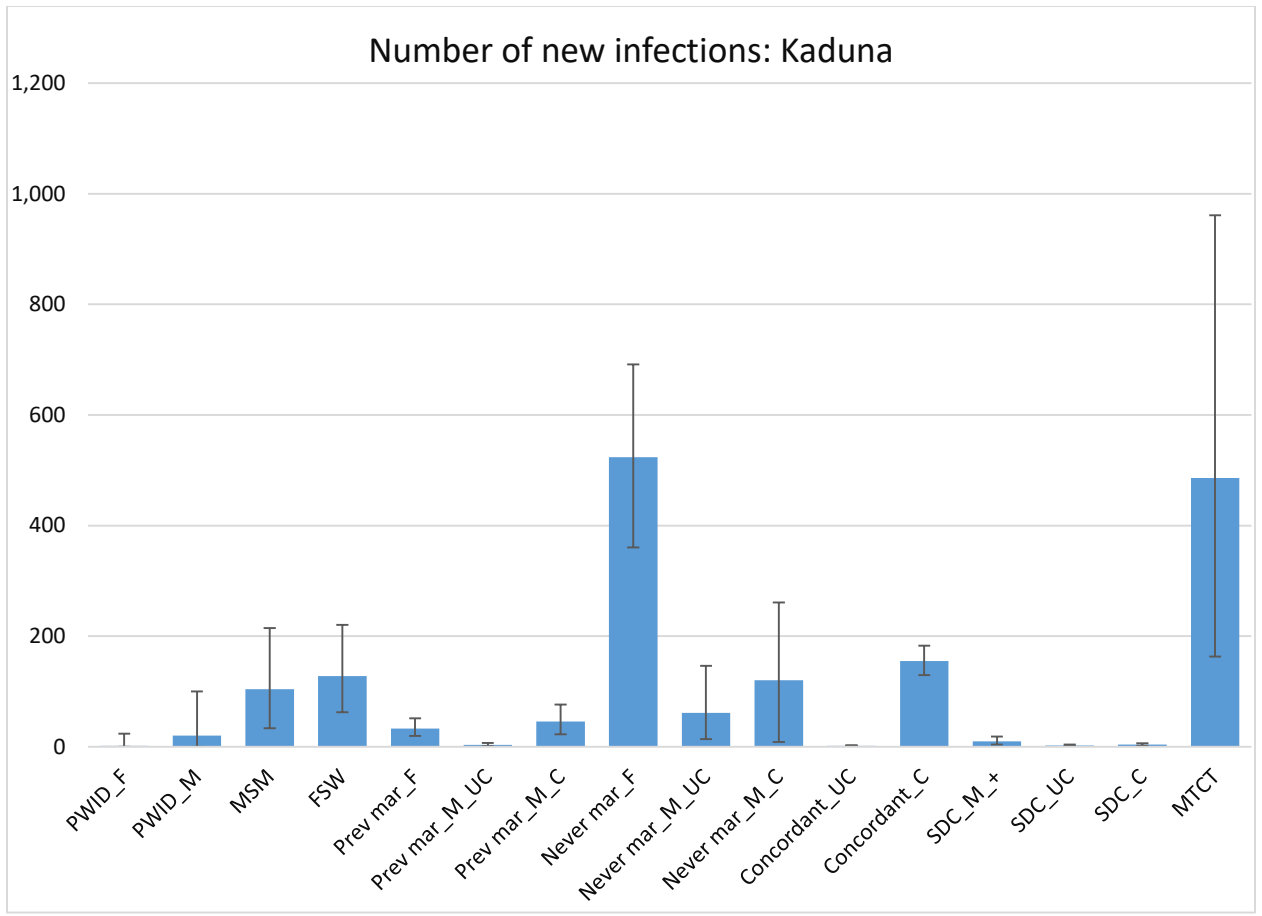
*Kaduna state*

The distribution of new infections with their 95% credible interval for Kaduna state is displayed in Figure 21. Among adults: Never Married Females, Never Married Males, Sero-Concordant Couples, Female Sex Workers, Men who have Sex with Men, and Previously Married Men have the largest contribution, representing about 43.1%, 15%, 12.8%, 10.5%, 8.56%, and 4.03 % of new infections, respectively. This corresponds to more than 93 % of new infections. The contribution of key populations corresponds to about 20.9%.

Most never married women were younger than 30-years during the Survey (79%) and, among them, about 87% were sexually active before 20 years. About 90% (95%CI: 84%-94%) in that sub-population reported only 1 partner during the last 12 months, and 80% (95%CI: 73%-87%) were employed. The majority, 60% (95%CI: 51%-68%), completed High School or below; 72% (95%CI: 63%-80%) had ever gave birth, and only 20% (95%CI: 14%-28%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.4.

Figure 21. Distribution of new HIV infections in Kaduna State



### *Kano state*

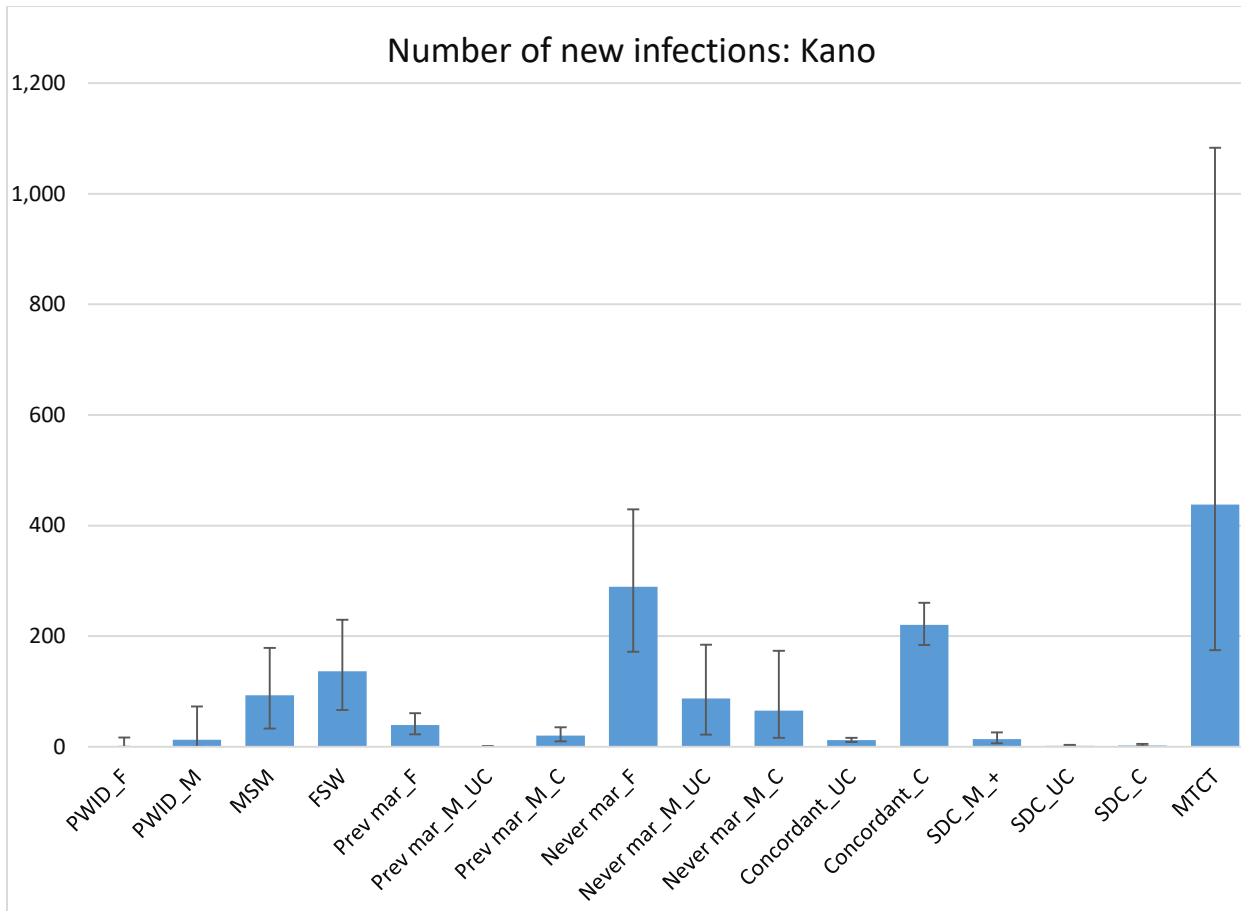
The distribution of new infections with their 95% credible interval for Kano state is displayed in Figure 22. Among adults: Never Married Females, Sero-Concordant Couples, Never Married Males, Female Sex Workers, Men who have Sex with Men, and Previously Married Females have the largest contribution, representing about 29%, 22.1%, 15.3%, 13.7%, 9.35%, and 3.93 % of new infections, respectively. This corresponds to more than 93 % of new infections. The contribution of key populations corresponds to about 24.5%.

About 77% of never married women were younger than 30-years during the Survey and, among them, about 94% were sexually active before 20 years. About 93% (95%CI: 85%-99%) in that sub-population reported only 1 partner during the last 12 months, and 91% (95%CI: 85%-96%) were employed. The majority, 47% (95%CI: 36%-59%), completed No formal education; 59% (95%CI: 47%-69%) had ever gave birth, and only 4% (95%CI: 0%-9%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.45.

Figure 22. Distribution of new HIV infections in Kano State





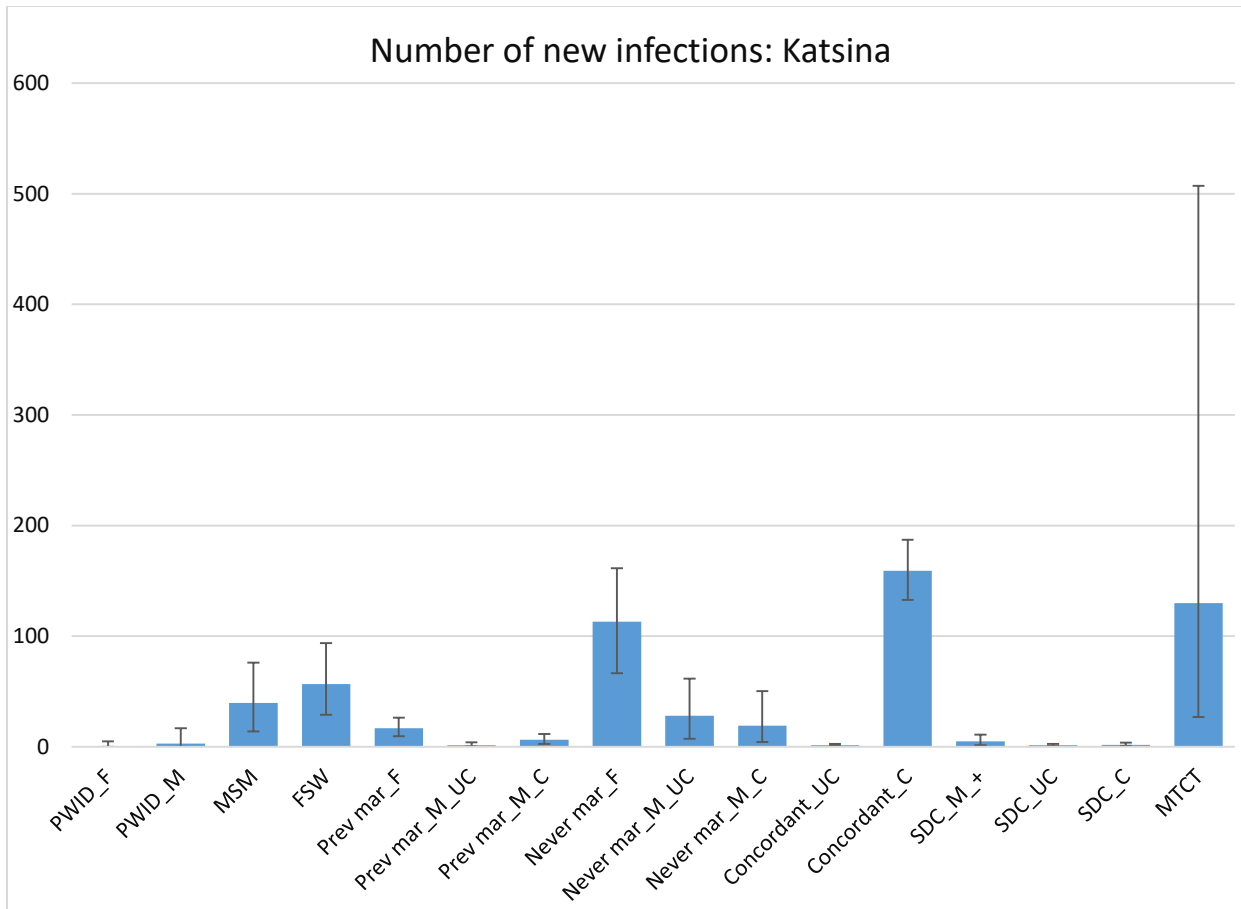
### *Katsina state*

The distribution of new infections with their 95% credible interval for Katsina state is displayed in Figure 23. Among adults: Sero-Concordant Couples, Never Married Females, Female Sex Workers, Never Married Males, and Men who have Sex with Men have the largest contribution, representing about 35.1%, 25%, 12.5%, 10.4%, and 8.76 % of new infections, respectively. This corresponds to more than 91 % of new infections. The contribution of key populations corresponds to about 22%.

About 68% of never married women were younger than 30-years during the Survey and, all of them (100%) were sexually active before 20 years. Everyone in that sub-population reported only 1 partner during the last 12 months, and 73% (95%CI: 66%-81%) were employed. The majority, 59% (95%CI: 49%-70%), completed No formal education; 57% (95%CI: 49%-66%) had ever gave birth, and only 0% (95%CI: 0%-2%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.31.

Figure 23. Distribution of new HIV infections in Katsina State



*Kebbi state*

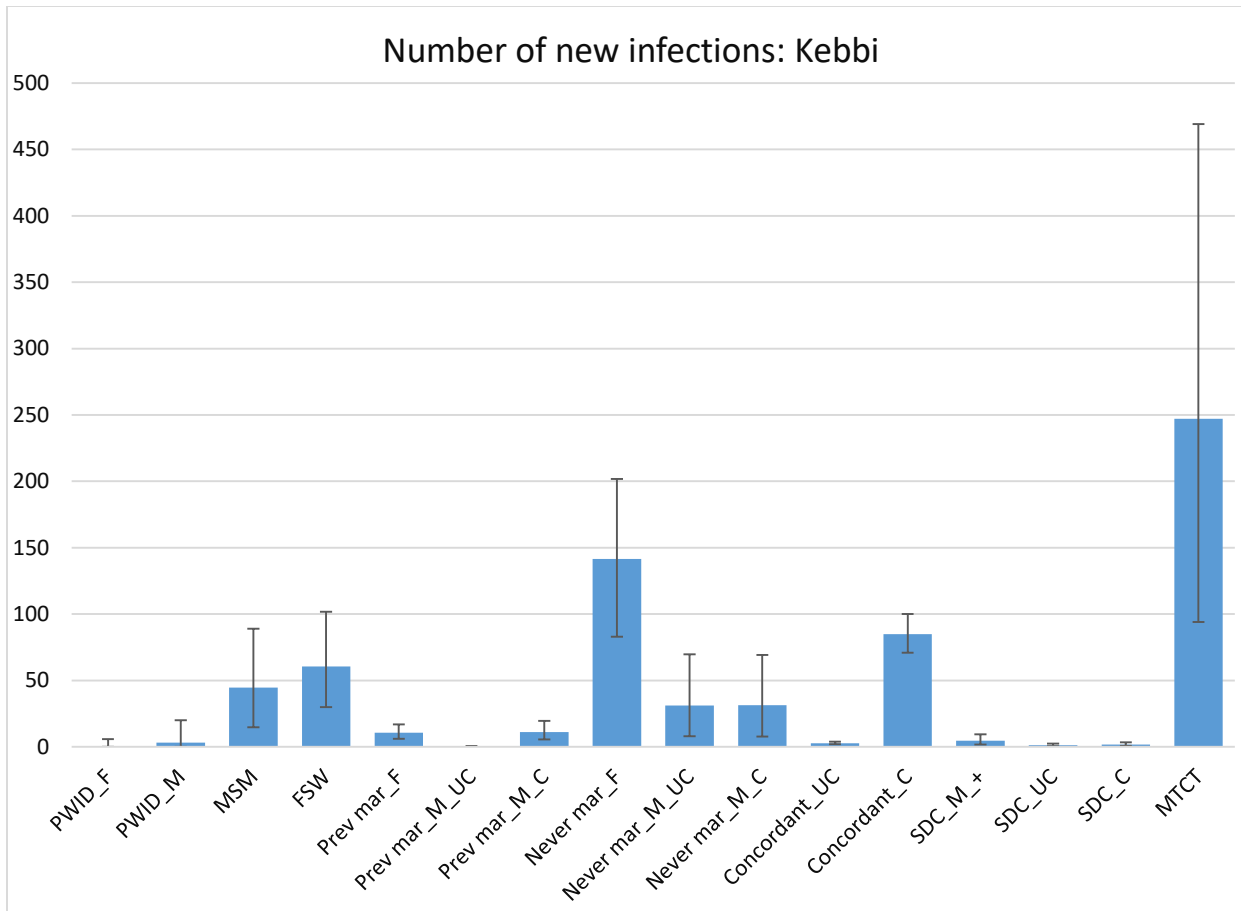
The distribution of new infections with their 95% credible interval for Kebbi state is displayed in Figure 24. Among adults: Never Married Females, Sero-Concordant Couples, Never Married Males, Female Sex Workers, and Men who have Sex with Men have the largest contribution,

representing about 32.9%, 19.7%, 14.5%, 14.1%, and 10.4 % of new infections, respectively. This corresponds to more than 91 % of new infections. The contribution of key populations corresponds to about 25.3%.

About 77% of never married women were younger than 30-years during the Survey and, among them, about 98% were sexually active before 20 years. About 98% (95%CI: 94%-100%) in that sub-population reported only 1 partner during the last 12 months, and 75% (95%CI: 66%-83%) were employed. The majority, 55% (95%CI: 44%-67%), completed No formal education; 59% (95%CI: 48%-69%) had ever gave birth, and only 4% (95%CI: 1%-8%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.61.

Figure 24. Distribution of new HIV infections in Kebbi



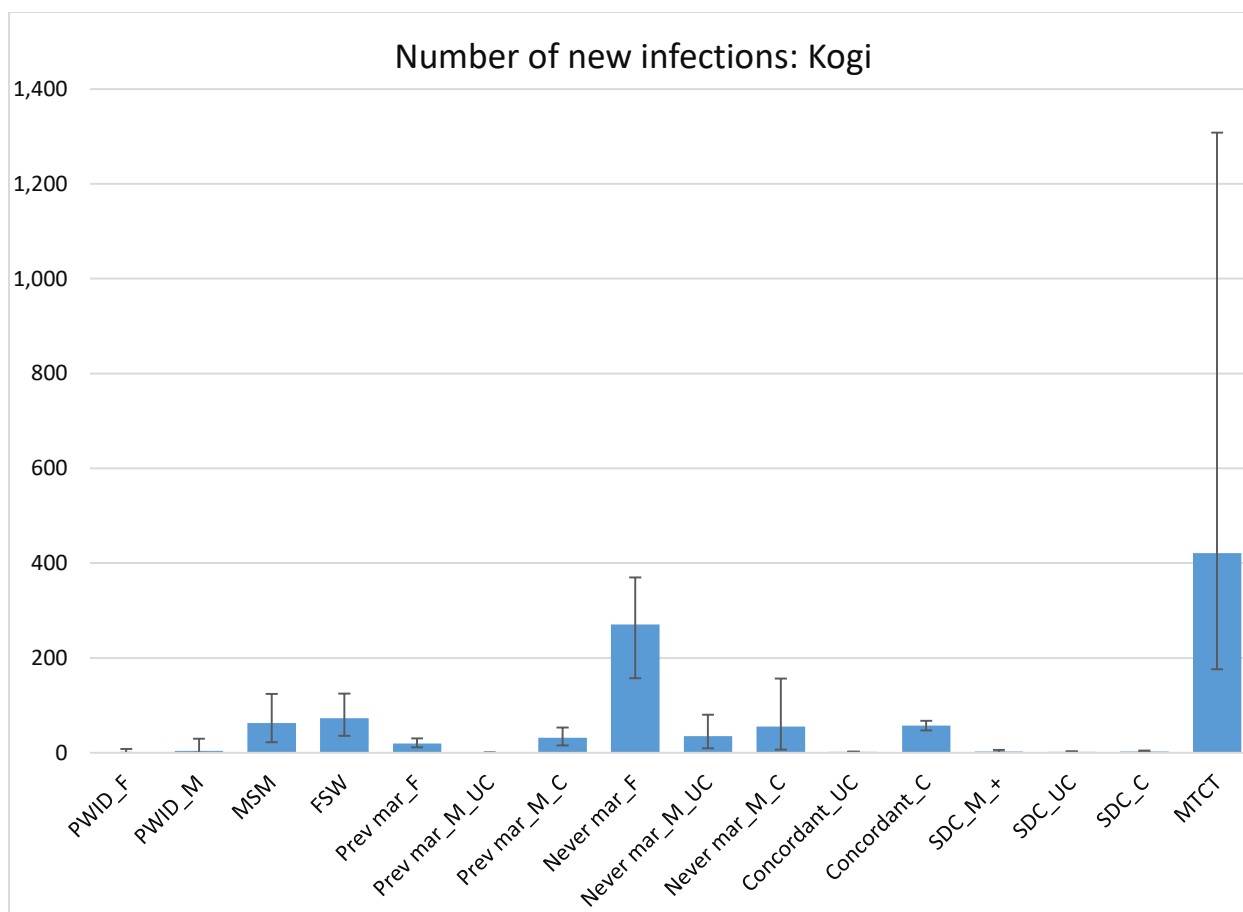
### *Kogi state*

The distribution of new infections with their 95% credible interval for Kogi state is displayed in Figure 25. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, Sero-Concordant Couples, and Previously Married Men have the largest contribution, representing about 43.7%, 14.7%, 11.8%, 10.1%, 9.24%, and 5.12 % of new infections, respectively. This corresponds to more than 94 % of new infections. The contribution of key populations corresponds to about 22.7%.

The majority of never married women were younger than 30-years during the Survey (89%) and, among them, about 86% were sexually active before 20 years. About 89% (95%CI: 82%-95%) in that sub-population reported only 1 partner during the last 12 months, and 62% (95%CI: 53%-70%) were employed. The majority, 84% (95%CI: 78%-91%), completed High School or below; 52% (95%CI: 37%-67%) had ever gave birth, and only 25% (95%CI: 17%-33%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.70.

Figure 25. Distribution of new HIV infections in Kogi State



*Kwara state*

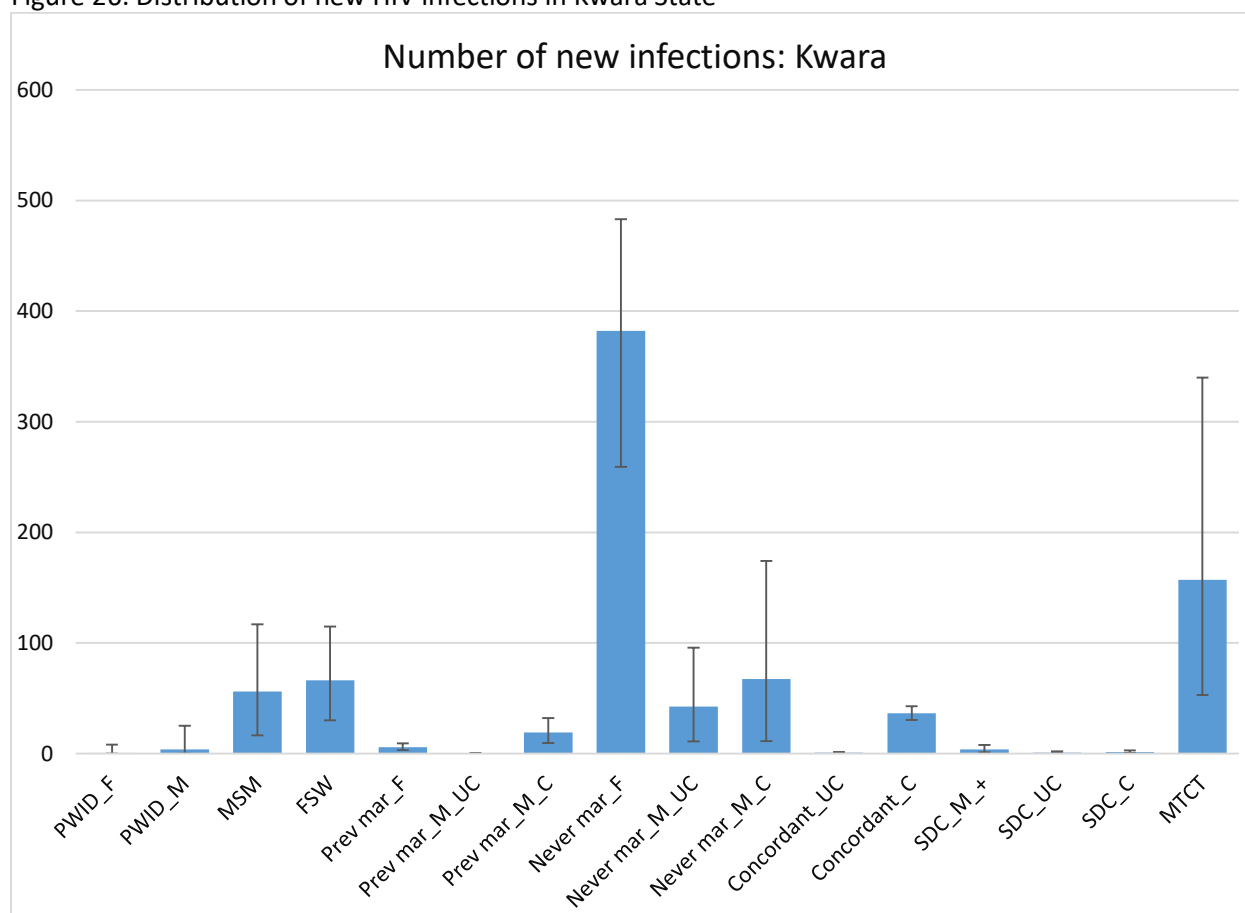
The distribution of new infections with their 95% credible interval for Kwara state is displayed in Figure 26. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, and Sero-Concordant Couples have the largest contribution, representing about 55.5%, 16%, 9.64%, 8.16%, and 5.3 % of new infections, respectively. This corresponds to more than 94 % of new infections. The contribution of key populations corresponds to about 18.5%.

Most never married women were younger than 30-years during the Survey (95%) and, among them, about 72% were sexually active before 20 years. About 86% (95%CI: 79%-92%) in that sub-population reported only 1 partner during the last 12 months, and 52% (95%CI: 43%-61%) were

employed. The majority, 74% (95%CI: 65%-82%), completed High School or below; 36% (95%CI: 20%-53%) had ever gave birth, and only 24% (95%CI: 16%-32%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.23.

Figure 26. Distribution of new HIV infections in Kwara State







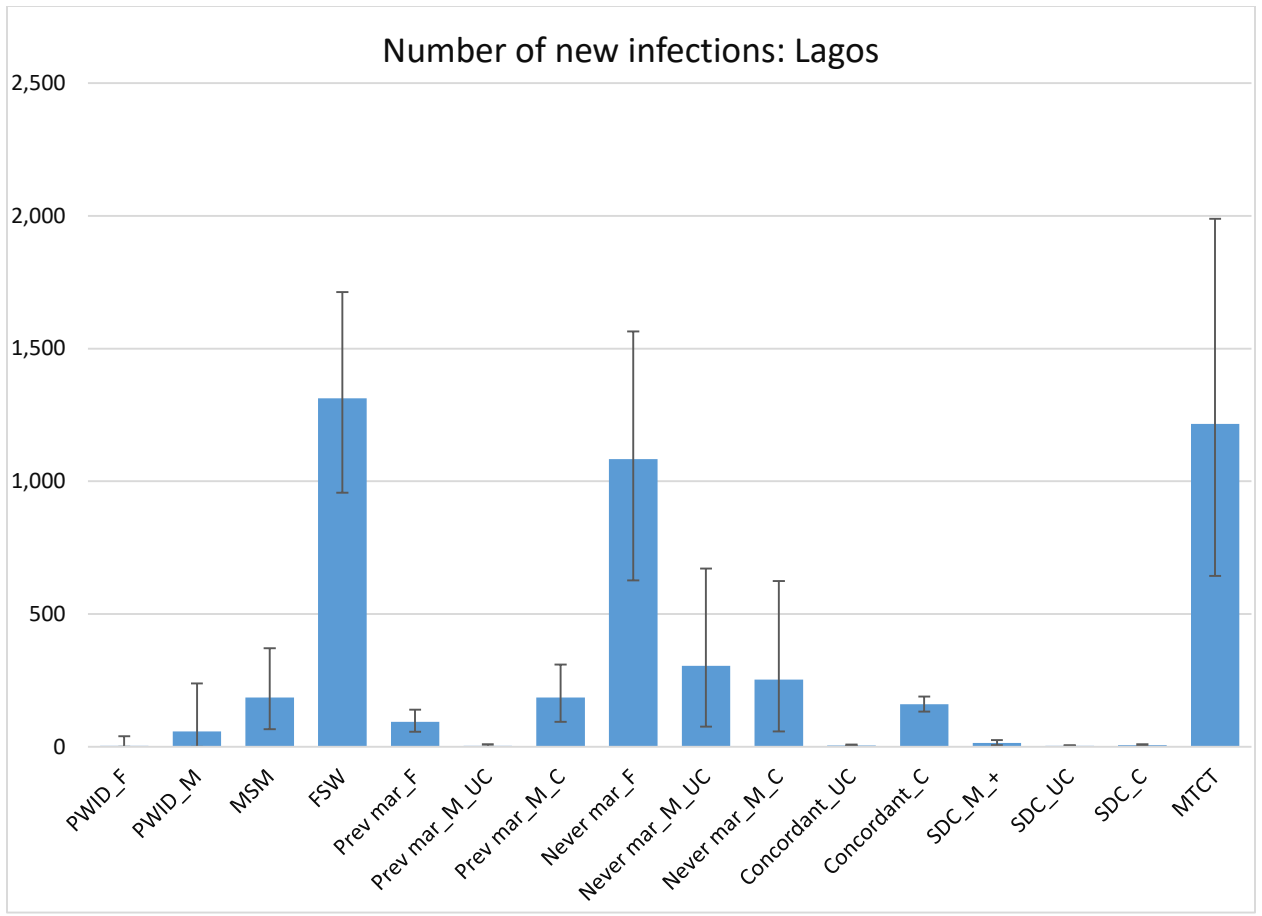
### *Lagos state*

The distribution of new infections with their 95% credible interval for Lagos state is displayed in Figure 27. Among adults: Female Sex Workers, Never Married Females, Never Married Males, Previously Married Men, and Men who have Sex with Men have the largest contribution, representing about 35.7%, 29.5%, 15.2%, 5.17%, and 5.07 % of new infections, respectively. This corresponds to more than 90 % of new infections. The contribution of key populations corresponds to about 42.5%.

Never married women were mostly younger than 30-years during the Survey (~85%) and, among them, about 77% were sexually active before 20 years. Only 22% (95%CI: 18%-26%) in that sub-population had less than 2 partners during the last 12 months, and 38% (95%CI: 33%-42%) were employed. The majority, 72% (95%CI: 68%-76%), completed High School or below; 55% (95%CI: 48%-62%) had ever gave birth, and only 31% (95%CI: 27%-35%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.33.

Figure 27. Distribution of new HIV infections in Lagos State



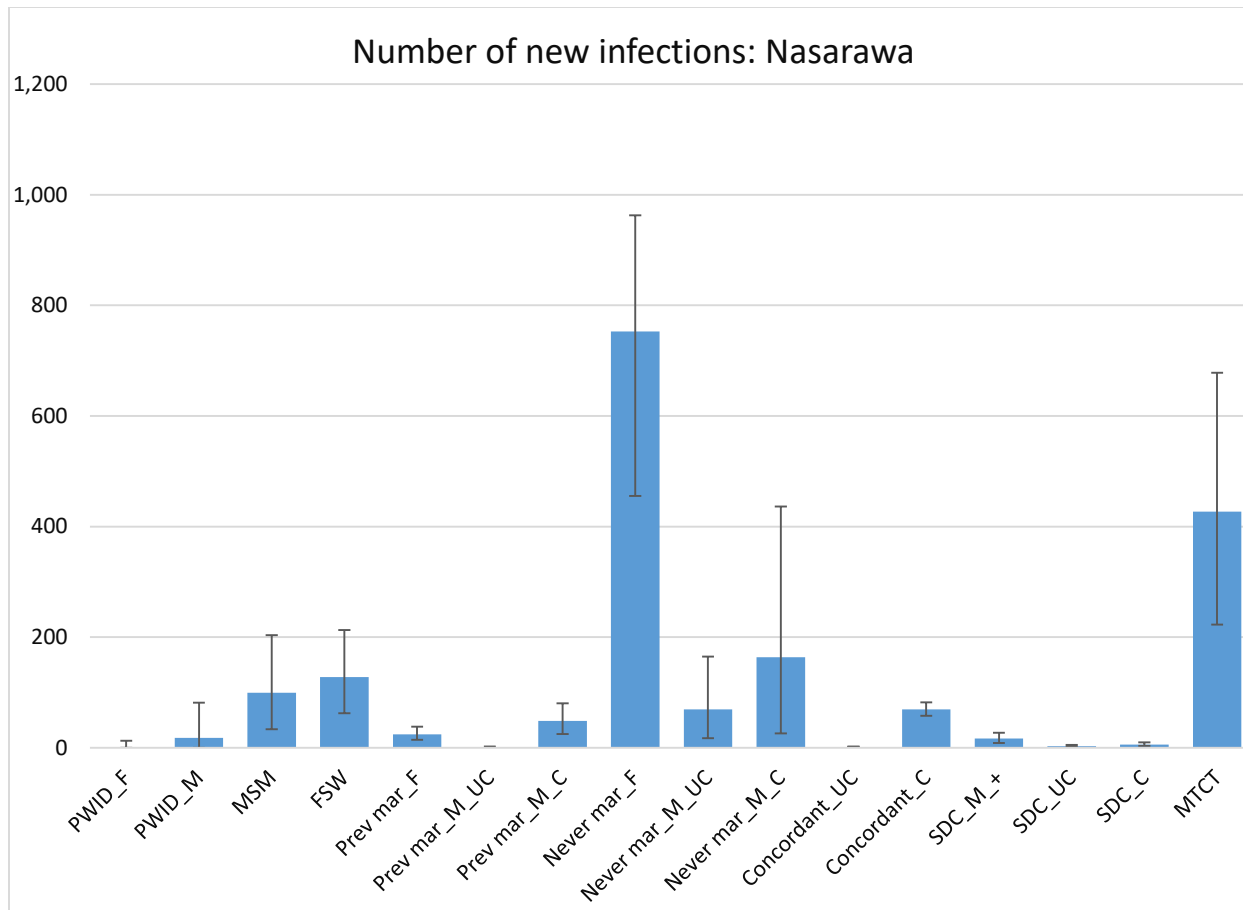
### *Nasarawa state*

The distribution of new infections with their 95% credible interval for Nasarawa state is displayed in Figure 28. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, and Sero-Concordant Couples have the largest contribution, representing about 53.6%, 16.6%, 9.12%, 7.11%, and 4.95 % of new infections, respectively. This corresponds to more than 91 % of new infections. The contribution of key populations corresponds to about 17.6%.

Most (~92%) never married women were younger than 30-years during the Survey and, among them, about 82% were sexually active before 20 years. Only 22% (95%CI: 16%-29%) in that sub-population had less than 2 partners during the last 12 months, and 68% (95%CI: 61%-75%) were employed. The majority, 74% (95%CI: 67%-80%), completed High School or below; 40% (95%CI: 26%-55%) had ever gave birth, and only 38% (95%CI: 31%-46%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.31.

Figure 28. Distribution of new HIV infections in Nasarawa State



*Niger state*

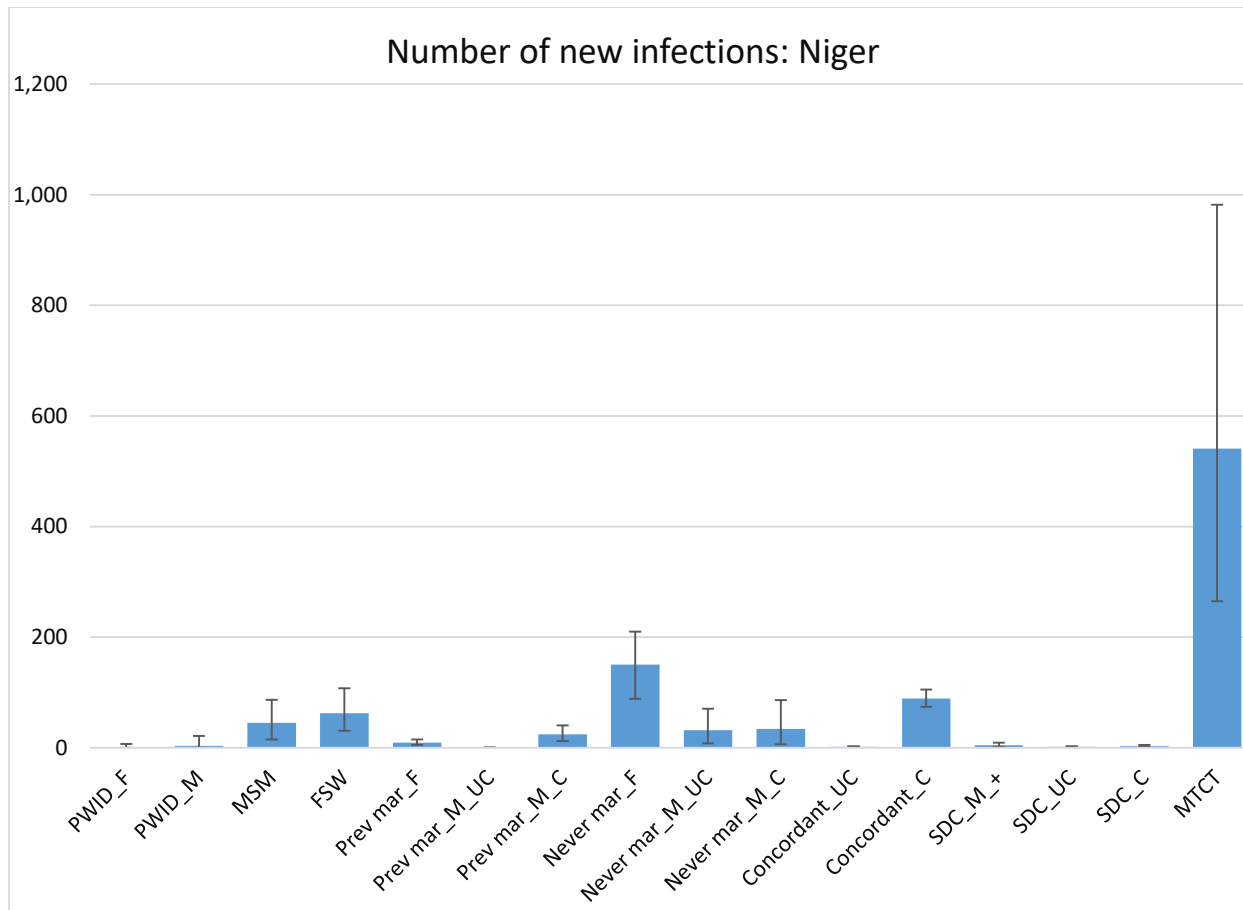
The distribution of new infections with their 95% credible interval for Niger state is displayed in Figure 29. Among adults: Never Married Females, Sero-Concordant Couples, Never Married Males, Female Sex Workers, Men who have Sex with Men, and Previously Married Men have

the largest contribution, representing about 32.5%, 19.3%, 14.3%, 13.5%, 9.73%, and 5.33 % of new infections, respectively. This corresponds to more than 94 % of new infections. The contribution of key populations corresponds to about 24.1%.

About 85% of never married women were younger than 30-years during the Survey and, among them, about 84% were sexually active before 20 years. About 96% (95%CI: 89%-100%) in that sub-population reported only 1 partner during the last 12 months, and 66% (95%CI: 53%-78%) were employed. The majority, 75% (95%CI: 61%-87%), completed High School or below; 52% (95%CI: 33%-71%) had ever gave birth, and only 18% (95%CI: 9%-29%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 1.2.

Figure 29. Distribution of new HIV infections in Niger State



*Ogun state*

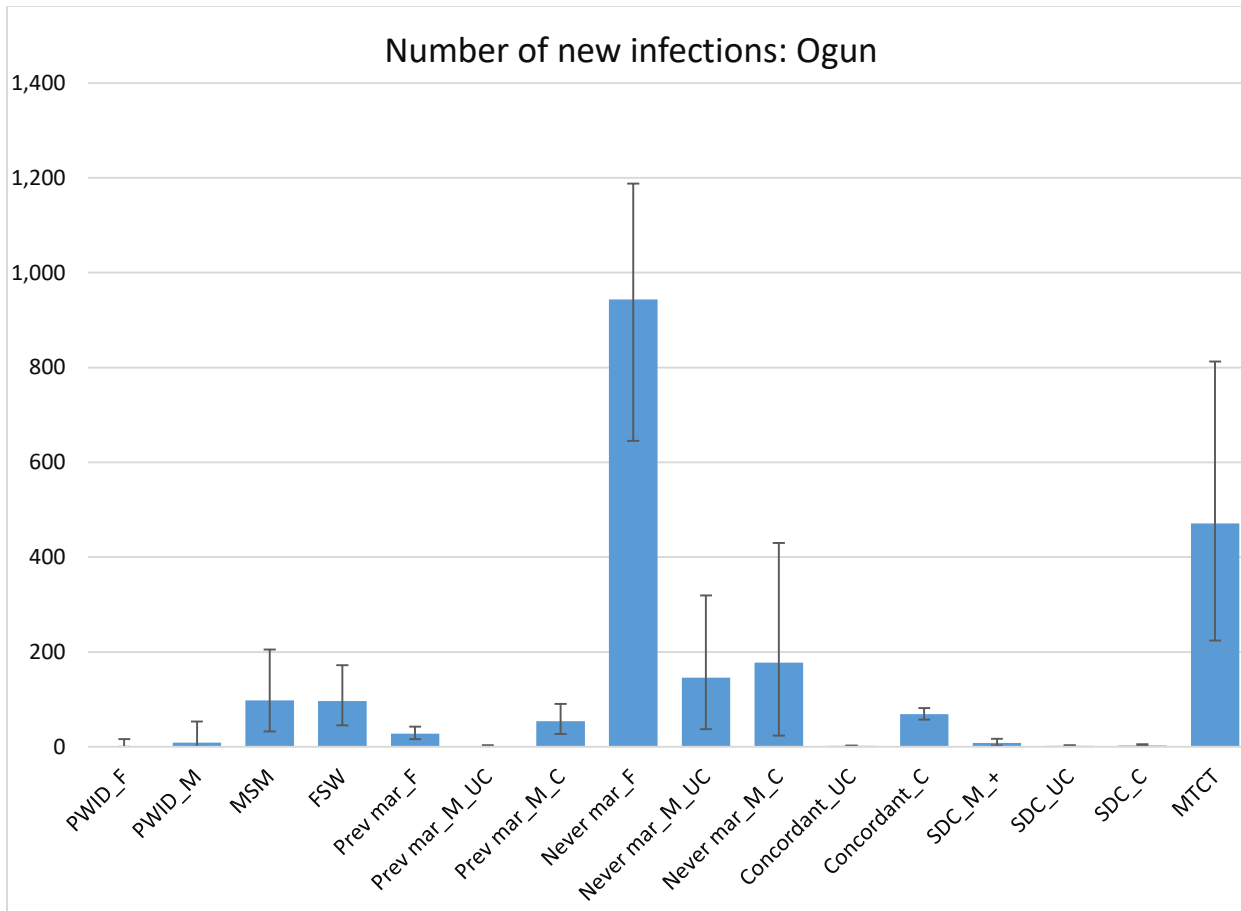
The distribution of new infections with their 95% credible interval for Ogun state is displayed in Figure 30. Among adults: Never Married Females, Never Married Males, Men who have Sex with Men, Female Sex Workers, and Sero-Concordant Couples have the largest contribution, representing about 57.6%, 19.8%, 5.97%, 5.91%, and 4.21 % of new infections, respectively. This corresponds to more than 93 % of new infections. The contribution of key populations corresponds to about 12.5%.

About 91% of never married women were younger than 30-years during the Survey and, among them, about 73% were sexually active before 20 years. Only 19% (95%CI: 13%-25%) in that sub-population had less than 2 partners during the last 12 months, and 48% (95%CI: 40%-56%) were employed. The majority, 63% (95%CI: 55%-70%), completed High School or below; 36% (95%CI: 25%-48%) had ever gave birth, and only 31% (95%CI: 23%-38%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.29.

Figure 30. Distribution of new HIV infections in Ogun State





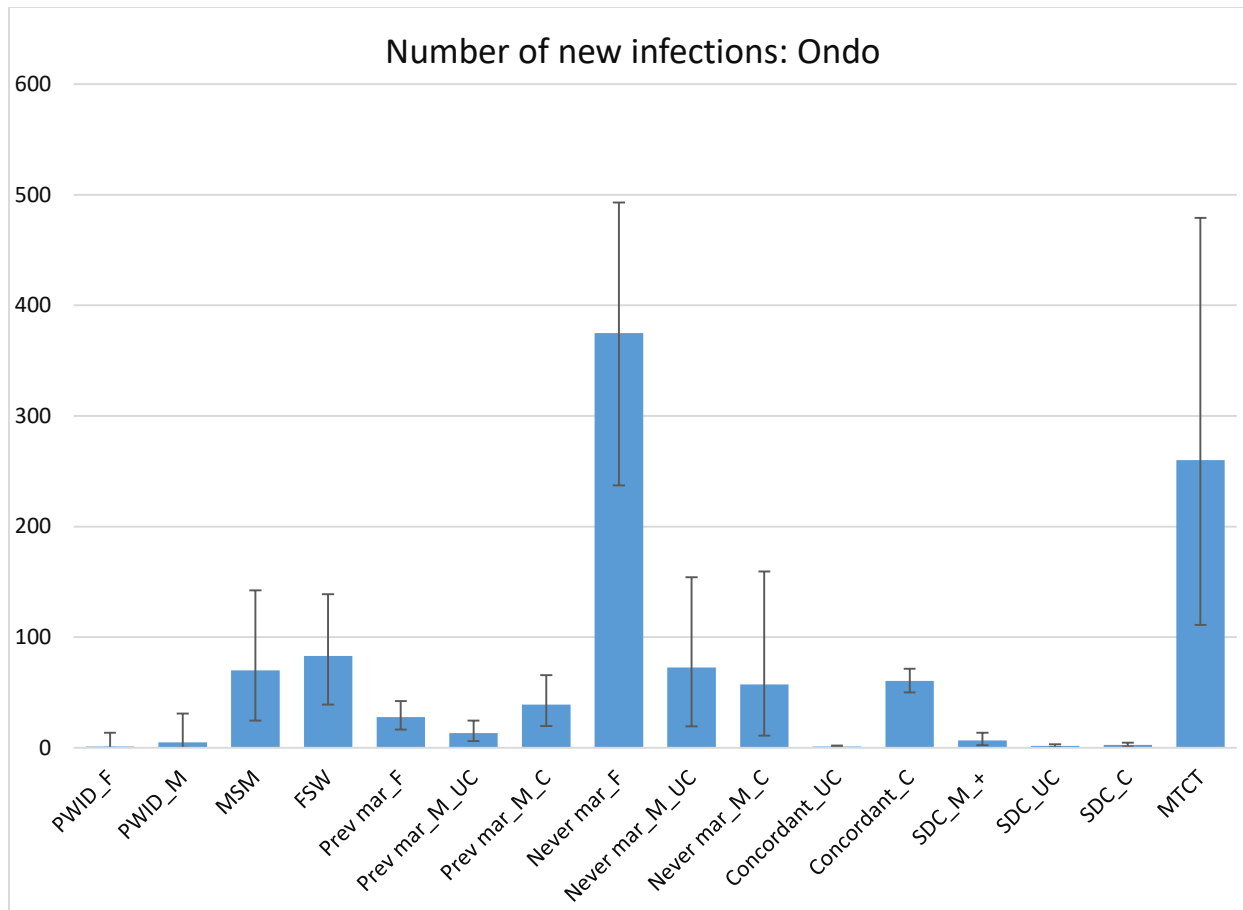
### *Ondo state*

The distribution of new infections with their 95% credible interval for Ondo state is displayed in Figure 31. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, Sero-Concordant Couples, and Previously Married Men have the largest contribution, representing about 45.9%, 15.9%, 10.2%, 8.58%, 7.39%, and 6.42 % of new infections, respectively. This corresponds to more than 94 % of new infections. The contribution of key populations corresponds to about 19.5%.

About 96% of never married women were younger than 30-years during the Survey and, among them, about 85% were sexually active before 20 years. Only 16% (95%CI: 11%-22%) in that sub-population had less than 2 partners during the last 12 months, and 67% (95%CI: 61%-73%) were employed. The majority, 85% (95%CI: 80%-89%), completed High School or below; 41% (95%CI: 29%-53%) had ever gave birth, and only 25% (95%CI: 19%-31%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.32.

Figure 31. Distribution of new HIV infections in Ondo State



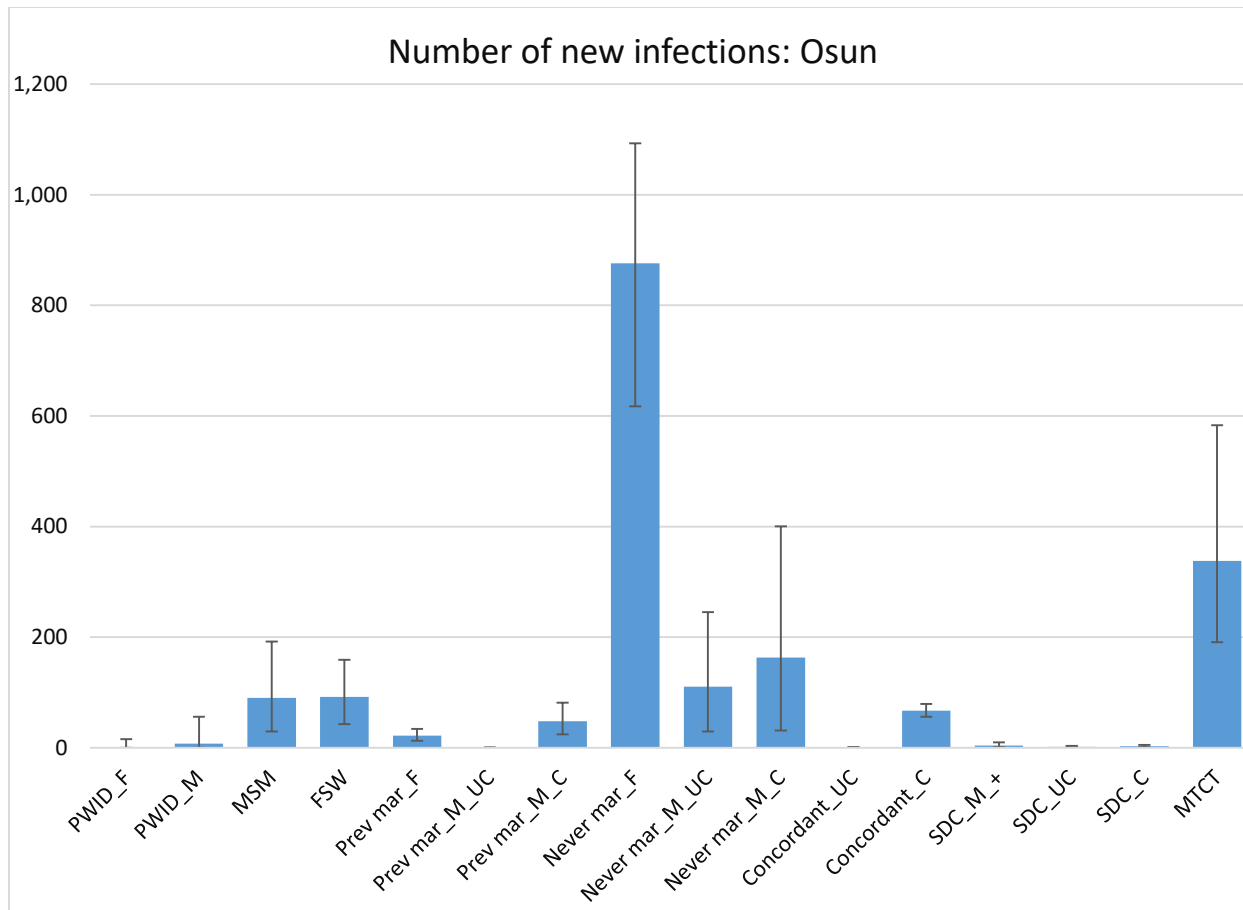
*Osun state*

The distribution of new infections with their 95% credible interval for Osun state is displayed in Figure 32. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, and Sero-Concordant Couples have the largest contribution, representing about 58.9%, 18.4%, 6.18%, 6.06%, and 4.53 % of new infections, respectively. This corresponds to more than 94 % of new infections. The contribution of key populations corresponds to about 12.9%.

Almost all never married women were younger than 30-years during the Survey (99%). In that subpopulation, about 86% were sexually active before 20 years. Only 16% (95%CI: 11%-22%) in that sub-population had less than 2 partners during the last 12 months, and 54% (95%CI: 45%-62%) were employed. The majority, 77% (95%CI: 69%-83%), completed High School or below; 41% (95%CI: 25%-58%) had ever gave birth, and only 34% (95%CI: 26%-42%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.23.

Figure 32. Distribution of new HIV infections in Osun State



### Oyo state

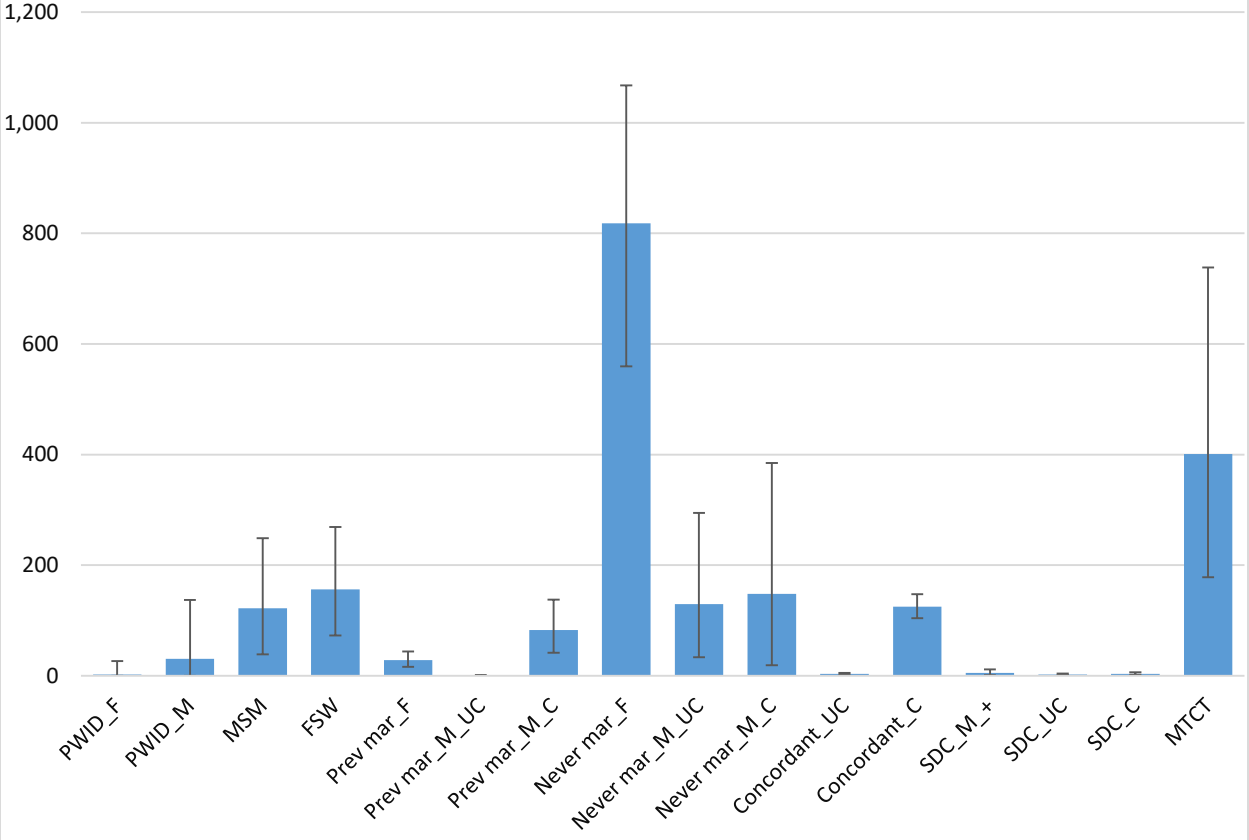
The distribution of new infections with their 95% credible interval for Oyo state is displayed in Figure 33. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Sero-Concordant Couples, and Men who have Sex with Men have the largest contribution, representing about 49.4%, 16.8%, 9.42%, 7.55%, and 7.38% of new infections, respectively. This corresponds to more than 90% of new infections. The contribution of key populations corresponds to about 18.8%.

Most never married women were younger than 30-years during the Survey (94%) and, among them, about 79% were sexually active before 20 years. About 88% (95%CI: 83%-93%) in that sub-population reported only 1 partner during the last 12 months, and 53% (95%CI: 43%-62%) were employed. The majority, 80% (95%CI: 72%-87%), completed High School or below; 47% (95%CI: 28%-66%) had ever gave birth, and only 30% (95%CI: 21%-39%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.24.

Figure 33. Distribution of new HIV infections in Oyo State

Number of new infections: Oyo



### *Plateau state*

The distribution of new infections with their 95% credible interval for Plateau state is displayed in Figure 34. Among adults: Never Married Females, Never Married Males, Female Sex Workers, Men who have Sex with Men, and Sero-Concordant Couples have the largest contribution, representing about 50.7%, 14.1%, 10.1%, 9.16%, and 7.25 % of new infections, respectively. This corresponds to more than 91 % of new infections. The contribution of key populations corresponds to about 20.1%.

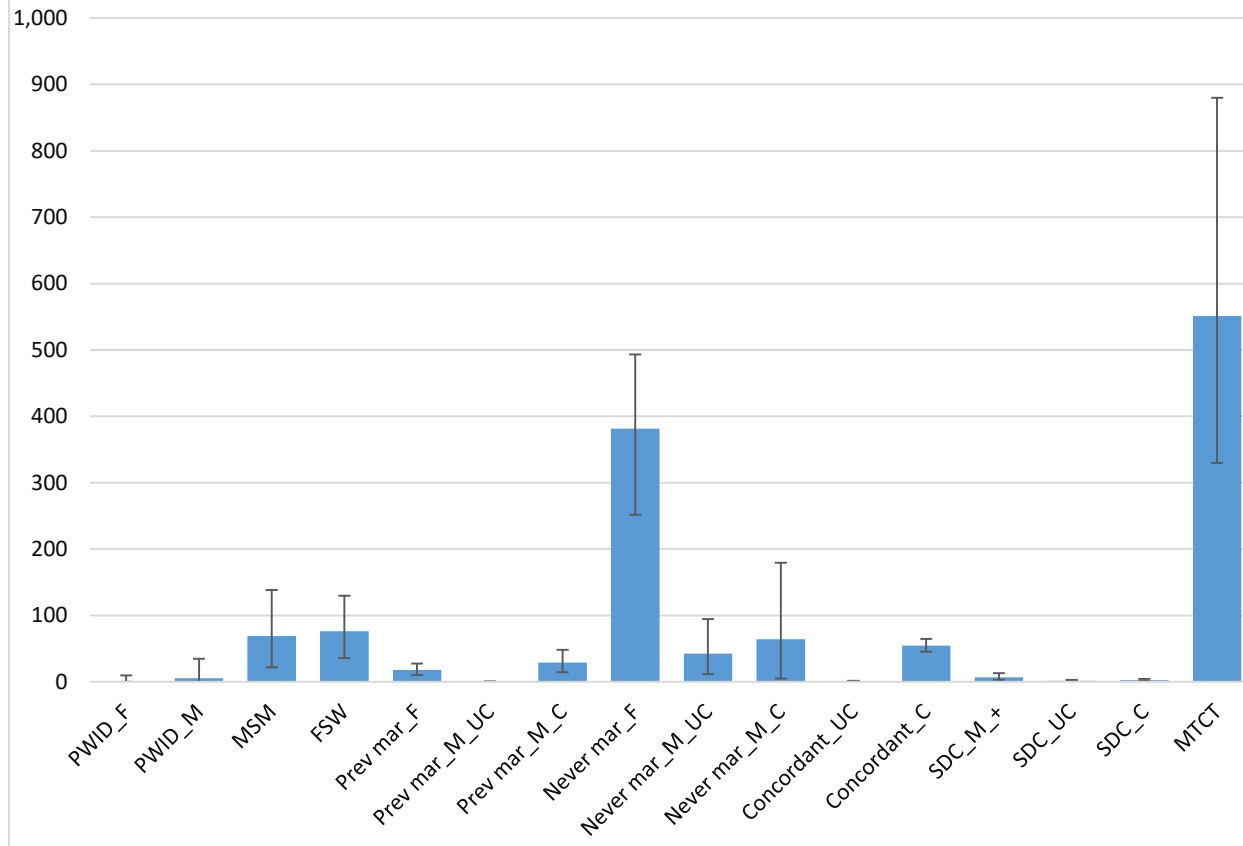
About 90% of never married women were younger than 30-years during the Survey and, among them, about 81% were sexually active before 20 years. Only 15% (95%CI: 10%-22%) in that sub-population had less than 2 partners during the last 12 months, and 57% (95%CI: 49%-65%) were employed. The majority, 81% (95%CI: 75%-87%), completed High School or below; 48% (95%CI: 32%-66%) had ever gave birth, and only 37% (95%CI: 28%-45%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.74.

Figure 34. Distribution of new HIV infections in Plateau State



Number of new infections: Plateau



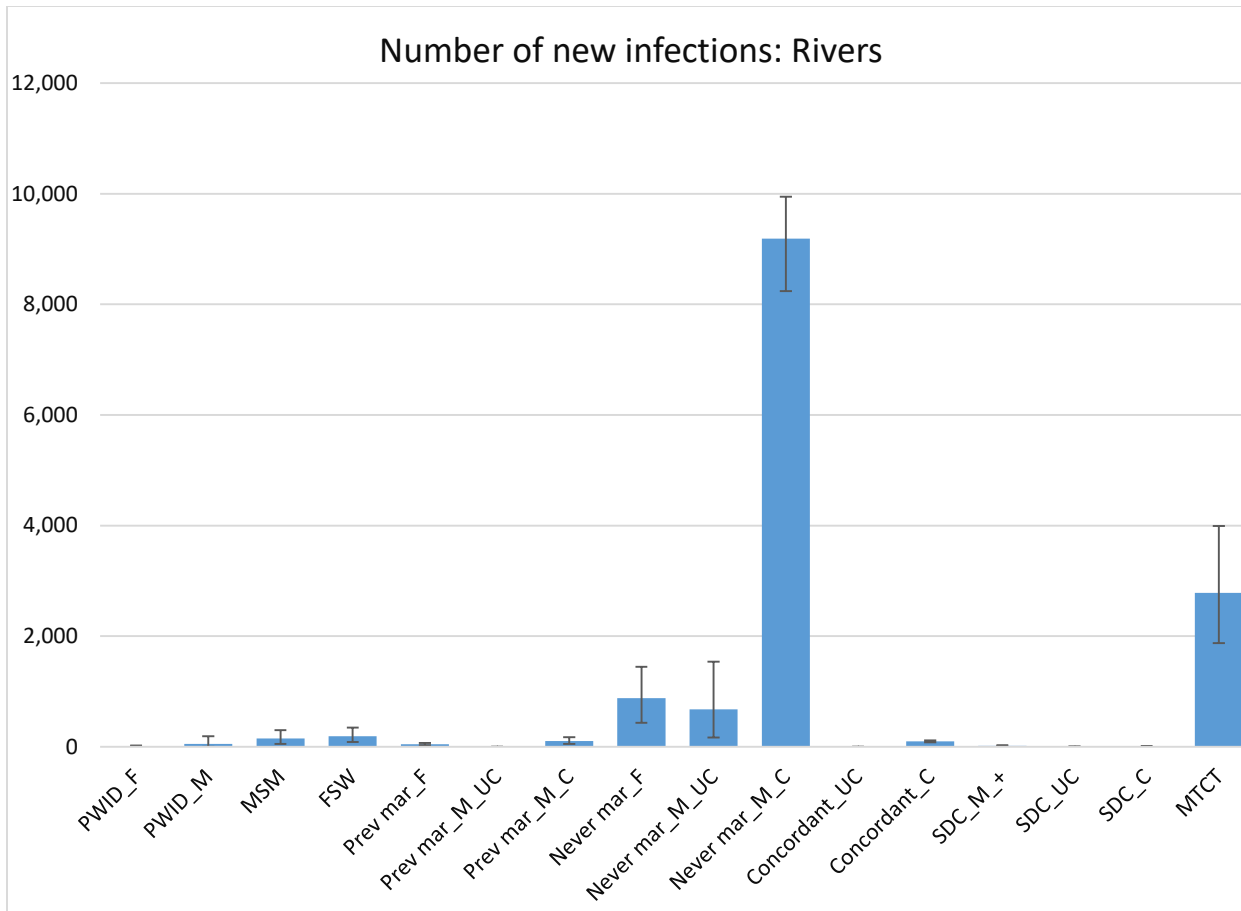
### *Rivers state*

The distribution of new infections with their 95% credible interval for Rivers state is displayed in Figure 35. Among adults: Never Married Males, and Never Married Females have the largest contribution, representing about 86.4%, and 7.72 % of new infections, respectively. This corresponds to more than 94 % of new infections. The contribution of key populations corresponds to about 3.47%.

About 81% of never married women were younger than 30-years during the Survey and, among them, about 90% were sexually active before 20 years. Only 25% (95%CI: 21%-30%) in that sub-population had less than 2 partners during the last 12 months, and 52% (95%CI: 47%-58%) were employed. The majority, 85% (95%CI: 81%-89%), completed High School or below; 48% (95%CI: 41%-55%) had ever gave birth, and only 24% (95%CI: 20%-29%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.24.

Figure 35. Distribution of new HIV infections in Rivers State



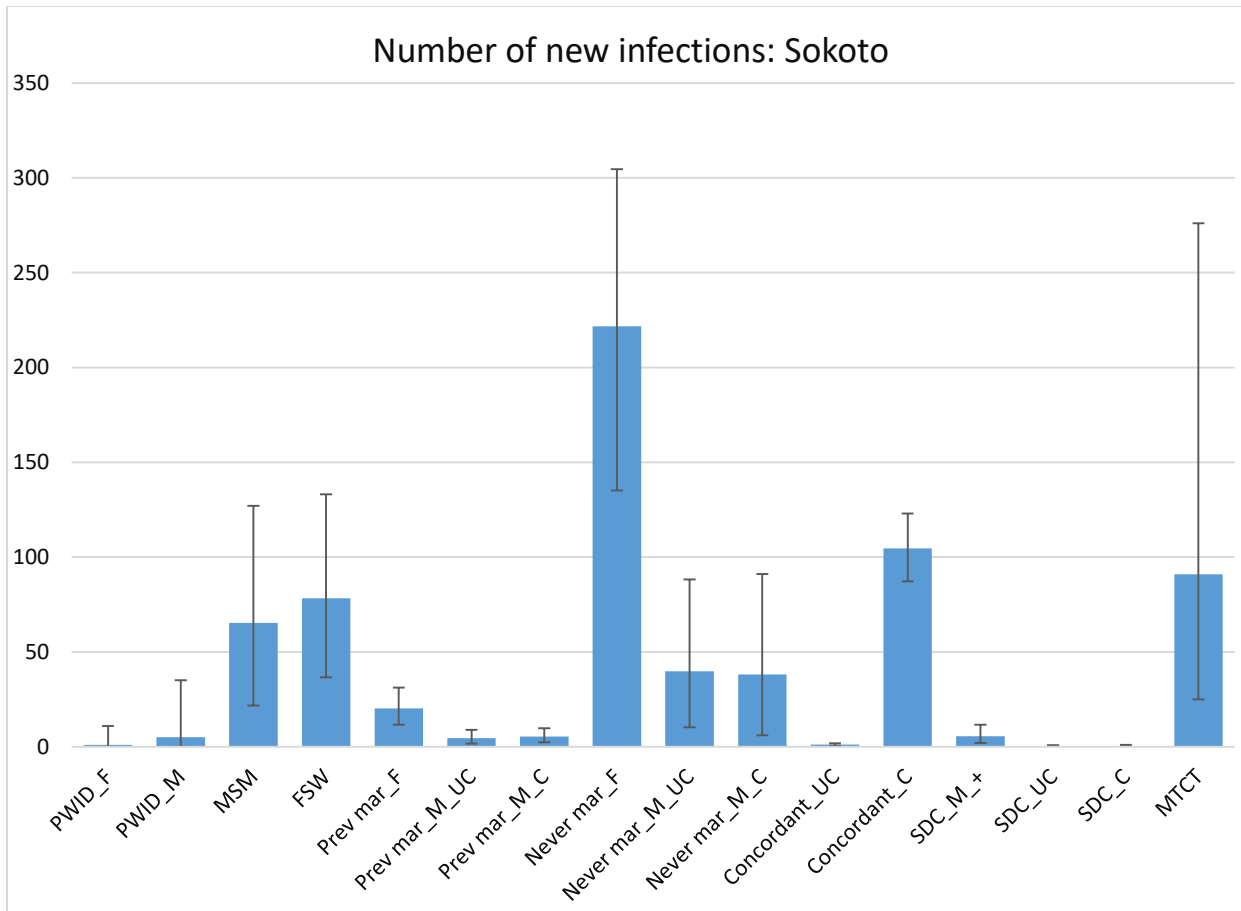
### *Sokoto state*

The distribution of new infections with their 95% credible interval for Sokoto state is displayed in Figure 36. Among adults: Never Married Females, Sero-Concordant Couples, Female Sex Workers, Never Married Males, and Men who have Sex with Men have the largest contribution, representing about 37.5%, 17.7%, 13.3%, 13.2%, and 11 % of new infections, respectively. This corresponds to more than 92 % of new infections. The contribution of key populations corresponds to about 25.3%.

Compared to other states, fewer (72%) never married women were younger than 30-years during the Survey and, among them, about 99% were sexually active before 20 years. About 97% (95%CI: 94%-100%) in that sub-population reported only 1 partner during the last 12 months, and 95% (95%CI: 90%-98%) were employed. The majority, 64% (95%CI: 49%-78%), completed No formal education; 42% (95%CI: 33%-52%) had ever gave birth, and none (0%) consistently used condom in the last twelve months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.16.

Figure 36. Distribution of new HIV infections in Sokoto State



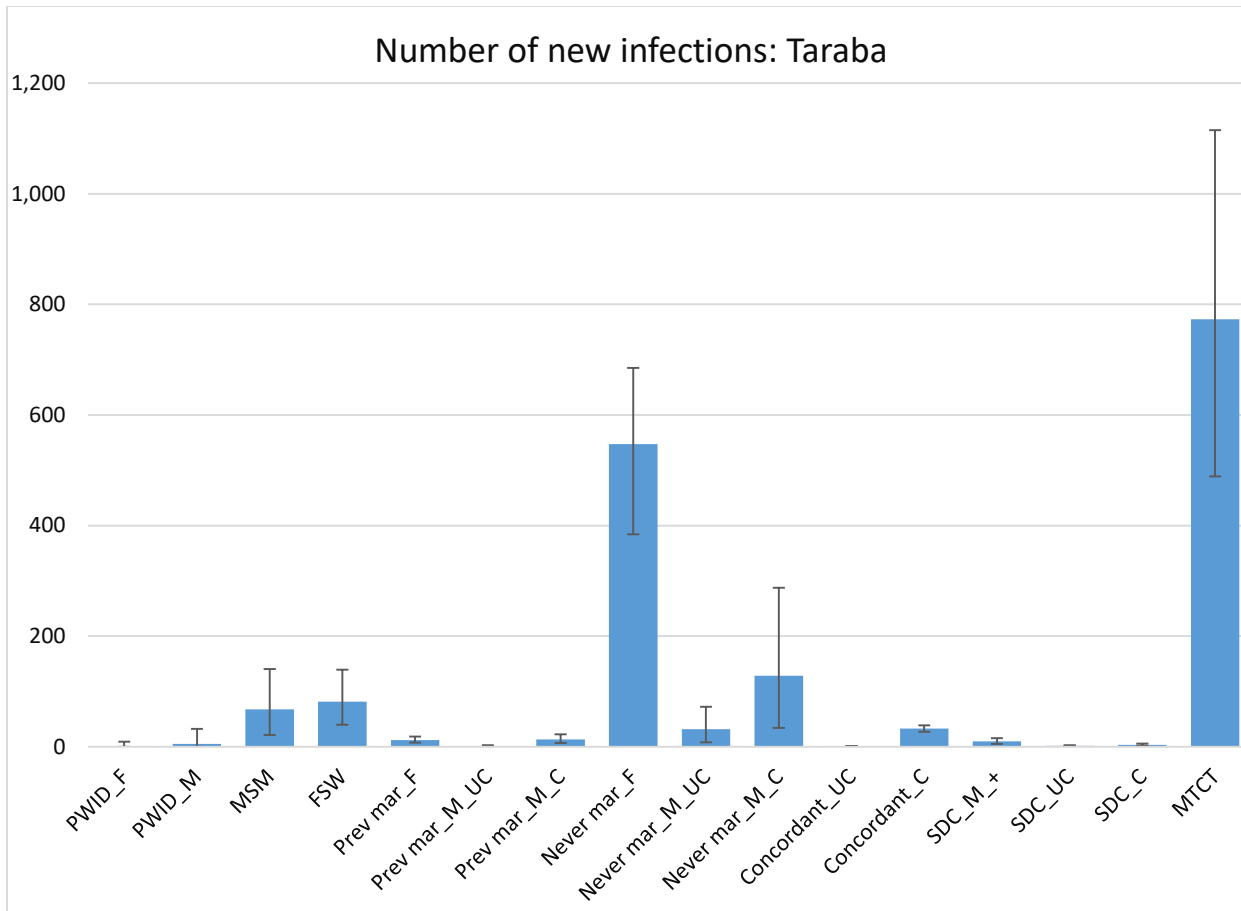
### *Taraba state*

The distribution of new infections with their 95% credible interval for Taraba state is displayed in Figure 37. Among adults: Never Married Females, Never Married Males, Female Sex Workers, and Men who have Sex with Men have the largest contribution, representing about 58.3%, 17.1%, 8.69%, and 7.24 % of new infections, respectively. This corresponds to more than 91 % of new infections. The contribution of key populations corresponds to about 16.6%.

Most never married women were younger than 30-years during the Survey (85%) and, among them, about 93% were sexually active before 20 years. Only 15% (95%CI: 11%-19%) in that sub-population had less than 2 partners during the last 12 months, and 60% (95%CI: 54%-66%) were employed. The majority, 94% (95%CI: 90%-97%), completed High School or below; 78% (95%CI: 72%-84%) had ever gave birth, and only 11% (95%CI: 8%-15%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.82.

Figure 37. Distribution of new HIV infections in Taraba State



### *Yobe state*

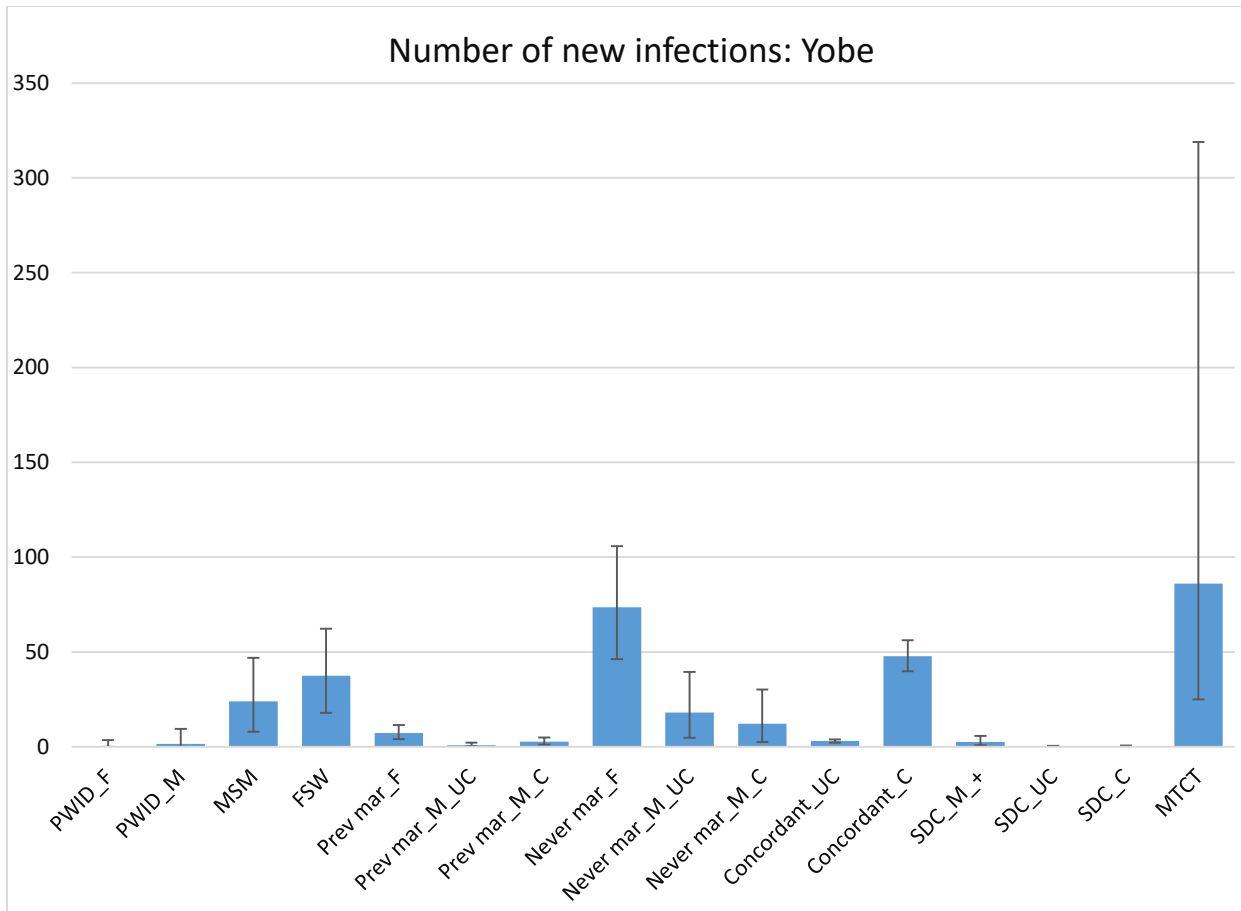
The distribution of new infections with their 95% credible interval for Yobe state is displayed in Figure 38. Among adults: Never Married Females, Sero-Concordant Couples, Female Sex Workers, Never Married Males, and Men who have Sex with Men have the largest contribution, representing about 31.8%, 20.6%, 16.1%, 13.1%, and 10.4 % of new infections, respectively. This corresponds to more than 91 % of new infections. The contribution of key populations corresponds to about 27.3%.

About 76% of never married women were younger than 30-years during the Survey and, among them, about 100% were sexually active before 20 years. All participants falling in that sub-population reported only 1 partner during the last 12 months, and 63% (95%CI: 34%-86%) were employed. All of them completed High School or below; 73% (95%CI: 41%-100%) had ever gave birth, and only 9% (95%CI: 7%-31%) consistently used condom during the last 12 months.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.42.

Figure 38. Distribution of new HIV infections in Yobe State





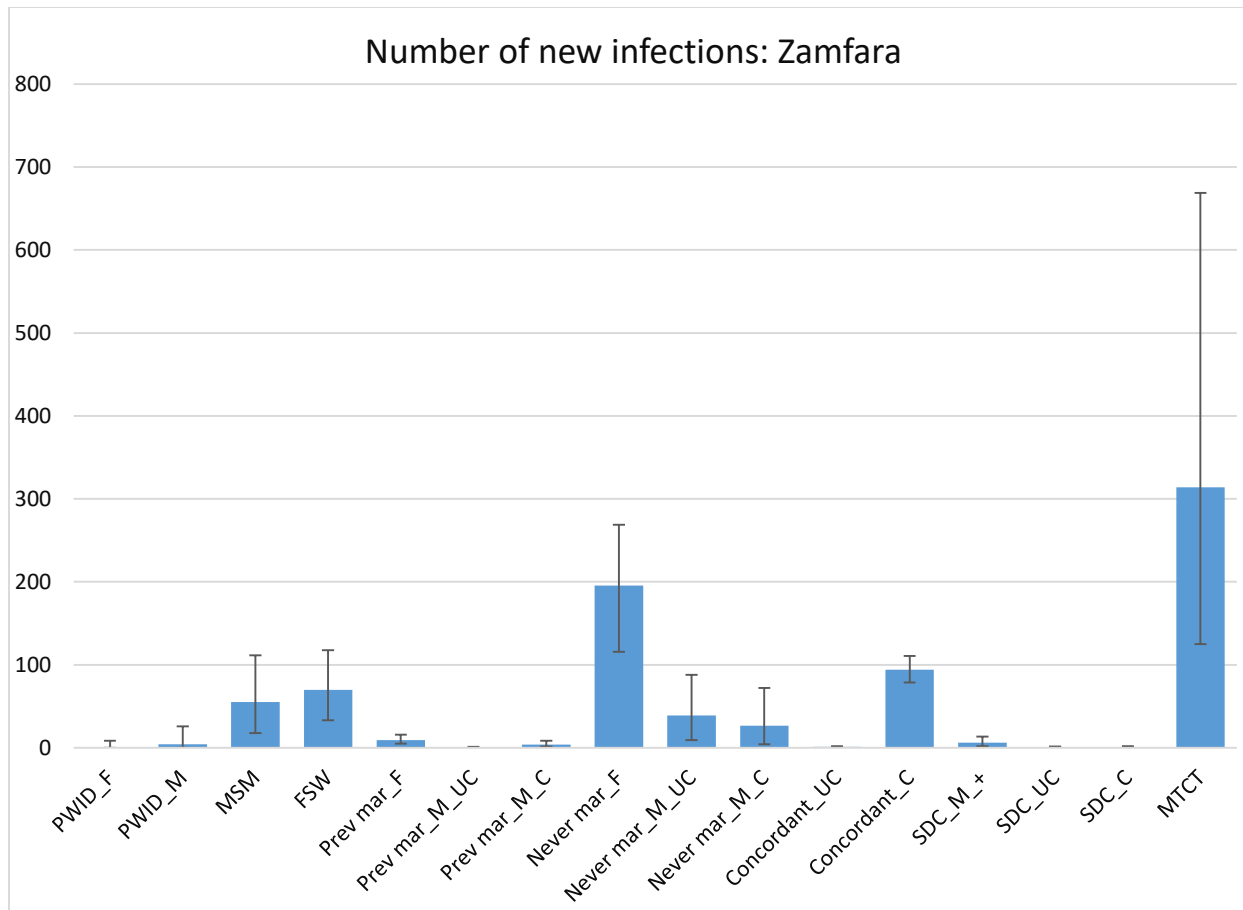
### *Zamfara state*

The distribution of new infections with their 95% credible interval for Zamfara state is displayed in Figure 39. Among adults: Never Married Females, Sero-Concordant Couples, Female Sex Workers, Never Married Males, and Men who have Sex with Men have the largest contribution, representing about 38.5%, 18.5%, 13.7%, 12.9%, and 10.8 % of new infections, respectively. This corresponds to more than 94 % of new infections. The contribution of key populations corresponds to about 25.6%.

Only about 68% of never married women were younger than 30-years during the Survey and, among them, about 98% were sexually active before 20 years. All women in that sub-population reported only 1 partner during the last 12 months, and 86% (95%CI: 76%-95%) were employed. The majority, 66% (95%CI: 51%-80%), completed No formal education; 46% (95%CI: 32%-60%) had ever gave birth.

The ratio of the number of new infections among children aged 0-to-14 to the number of new infections among adult aged 15-to-49 was about 0.64.

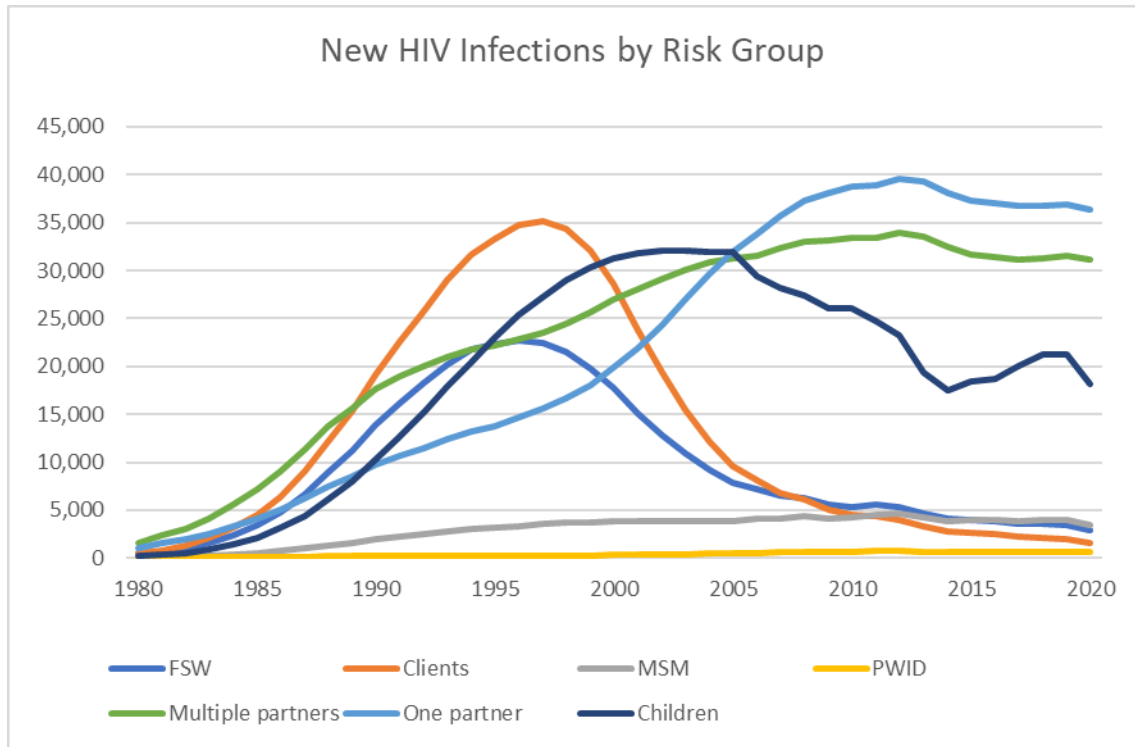
Figure 39. Distribution of new HIV infections in Zamfara



*Time trends*

Figure 40 below shows the trends over time in new infections by risk group as estimated with the Goals model. Key populations (female sex workers, male clients of female sex workers, men who have sex with men, people who inject drugs) accounted for 50% of all new adult infections in 2000 but by 2020 that has dropped to 11%. Due to the rising prevalence among reproductive age women and a lack of options to prevent mother-to-child transmission, children became the leading group for new infections shortly after 2000. But the expansion of programs to prevent mother-to-child transmission have reduced new child infections by half since the peak.

Figure 40. New infections over time as estimated with the Goals model



## Discussion

These results suggest that most new infections are occurring among never married uncircumcised and circumcised men, never married women, Female Sex Workers and Men who have Sex with Men and children.

The distribution of new infections varies by state. However, the larger proportion of new infections generally occur among never married individuals or in Sero-concordant negative couples. Overall, young people and Female Sex Workers appear to be playing an important role in the dynamics of the infection. A study of formation and dissolution of partnerships among these groups may help understanding this dynamic.

Mother-to-child transmission represents a large source of new infections nationally and is the largest source in several states. This happens when new adult infections have been dropping in recent years, but adult prevalence remains high due to high ART coverage. When this is coupled with low coverage of PMTCT services, the number of new child infections can be very high. In Ebonyi state, where new child infections are the major source of new infections, the low coverage of PMTCT is due to low utilization of ANC services. Most of those women who do attend ANC get tested for HIV but over 60% of pregnant women do not attend ANC. Increasing ANC attendance would have benefits not only for reducing HIV transmission but also for the overall health of the child and the mother.

Estimates of the effects of male circumcision appeared to be unreliable. In fact, less than 4% of men in the 2018 NAHS are uncircumcised and, the observed HIV prevalence was zero among those of them who were not married or living in unions, certainly due to their small number.

The credible intervals for these estimates are large. They depend on several factors, but the most important is probably the uncertainty around the prior. The prior is the first guess at incidence in each population group. It is based on published studies and estimates derived from fitting the model to data from cohort studies. Different studies find different incidence rates and this difference contributes to the confidence intervals around the prior. Then the model adjusts these prior values to make the model fit the overall number of new infections as estimated by Spectrum. This produces the final result, but the uncertainty range is largely reflecting the range from published studies.

There are several sources of limitation in the IPM: the model structure, the incidence estimation method and the data used. In terms of model structure, several simplifications were needed. The model does not include partners of key populations such as clients of FSW or female stable partners of MSM. The results of the model strongly depend on assumptions regarding mixing patterns in the population. Country or state specific information on sexual networks as well as phylogenetic data providing insights into transmission patterns could be used to refine the mixing matrix definition, leading to more robust results. The model does not incorporate the role of acute infection. This may lead to underestimation of the risk of infection in stable unions. Lastly, the short time scale of the model implies that longer-term epidemic dynamics

are not captured. The essential feature of the model is applicability on cross section of countries, and therefore a long perspective would not be appropriate.

The trends over time estimated with the Goals model suggest that key populations played a major role in the spread of HIV early in the epidemic, but that role is much reduced today. The number of new infections among key populations has declined largely due to increases in condom use in commercial sex and among high-risk MSM. HIV prevalence is still high in these groups (15-20%) so prevention efforts need to be maintained and strengthened.

New infections among children due to mother-to-child transmission have dropped in recent years as programs to prevent transmission have expanded. However, ARV coverage among HIV+ pregnant women is still only about 55%. Increasing the coverage to the global target of 95% could reduce new child infections by another 50%.

## Supporting Information





Figure S1: Contribution of individual states to the national incidence. Proportion portion of new HIV cases (left) and ratio of proportion of new HIV cases to the proportion of sexually active population by state (right).

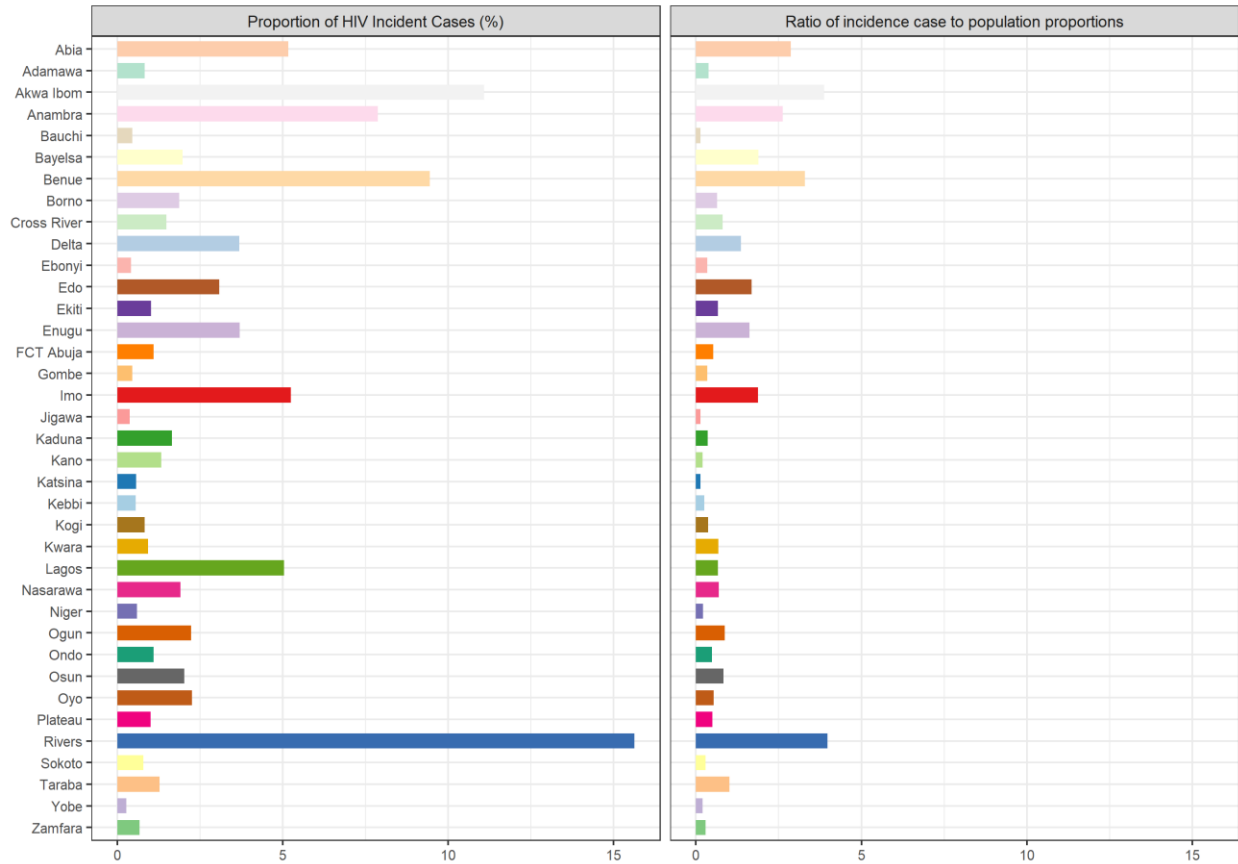


Figure S2: Proportion of adult men that are circumcised among never married (left), previously married (middle) and married in sero-discordant negative unions (right) by state.

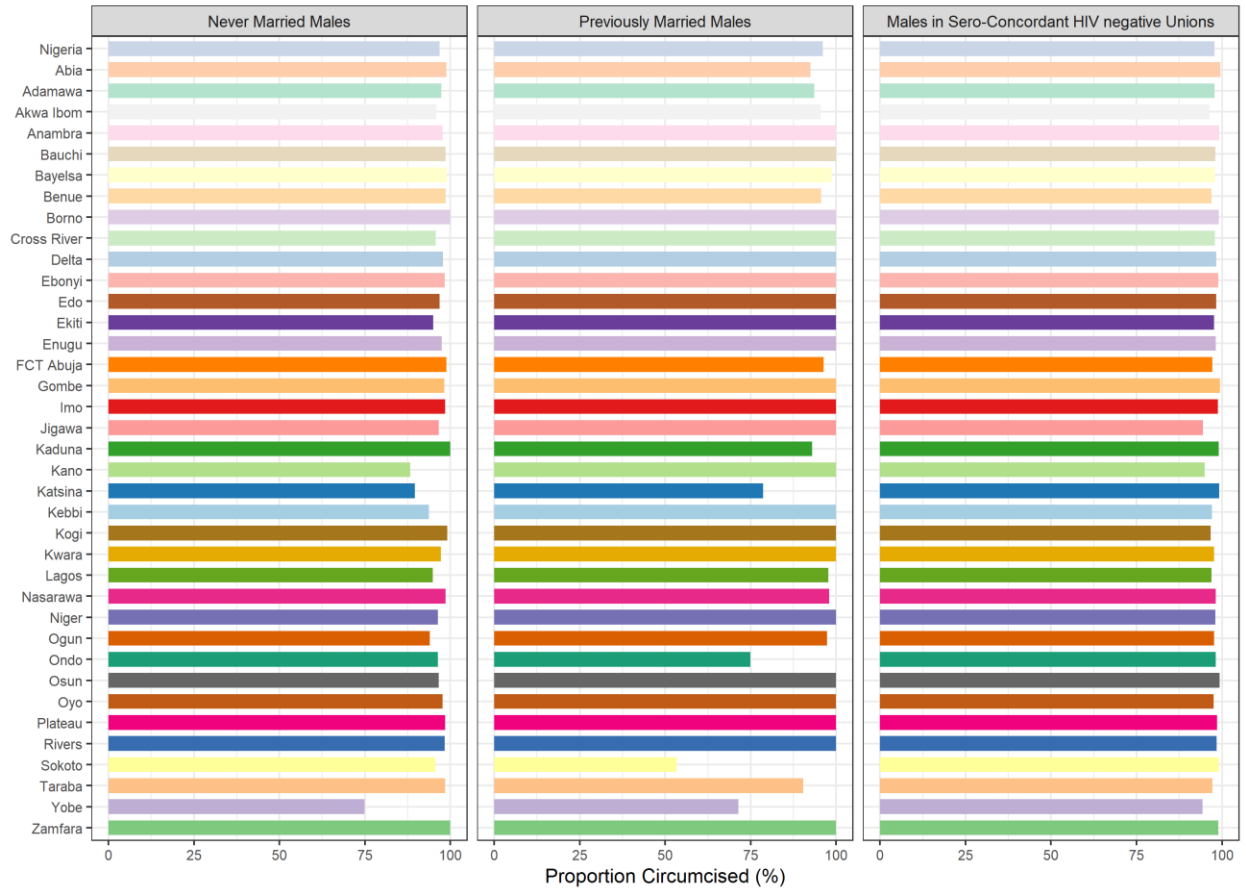


Figure S3: Age of not sexually active, never married, married, and never married men. Dots represent the mean and the horizontal bars the 95%CI in each state.

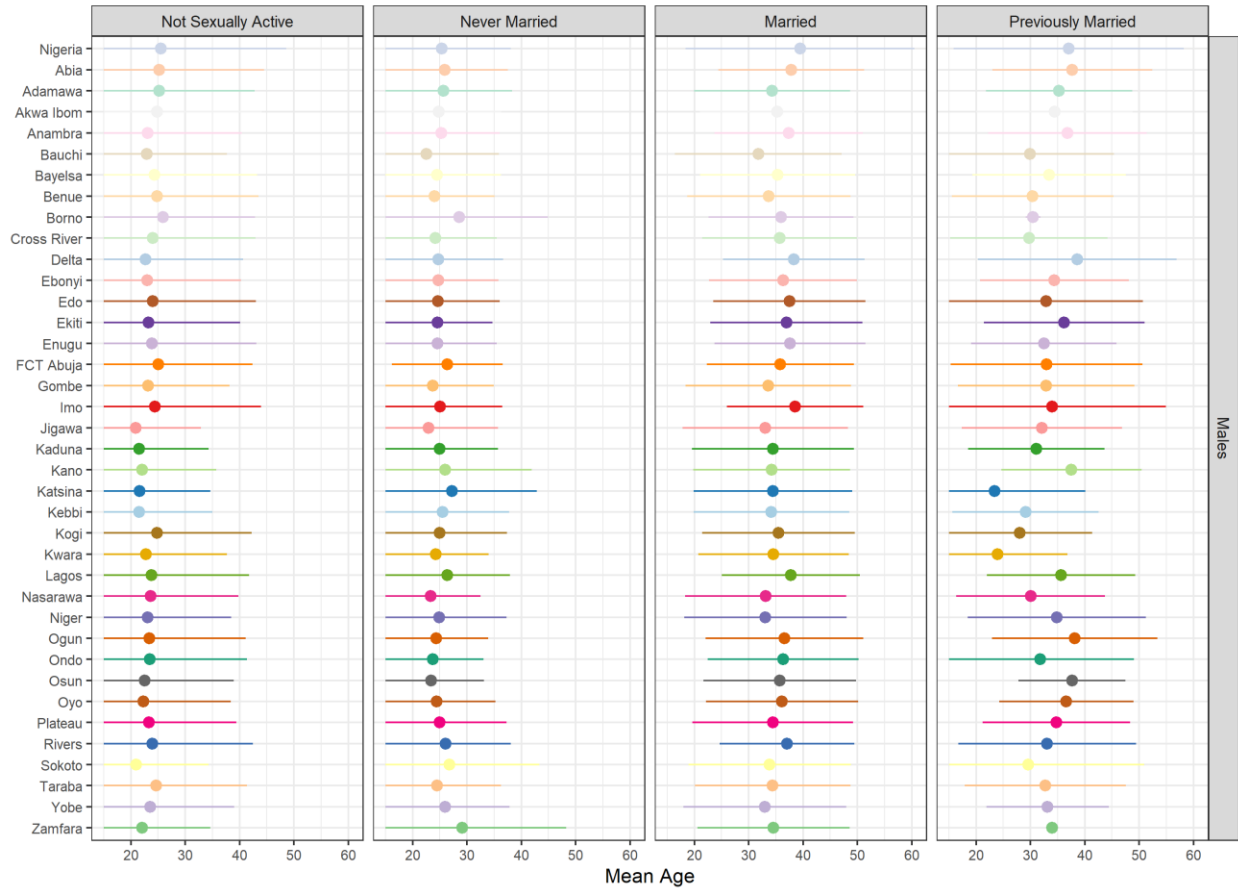


Figure S4: Age of not sexually active, never married, married, and never married women. Dots represent the mean and the horizontal bars the 95%CI in each state.

