**Table S1. Prior parameter values**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Time** | **Estimate/ functional form** | **Source** | **Standard deviation of prior distribution** |
| Transmission rates (A composite of number of sexual encounters and rate of transmission per encounter) – transmission rates are modeled as a joint distribution (multivariate lognormal distribution) of rates at 1990, 1997, 2008, 2018, and 2030 | | | | |
| Transmission rate prior to/in 1990 | Constant 1975-1990, interpolates to trate.1 from 1990-1997 | Ratio of trate.0 to trate.1 = 8  Joint lognormal | (Calibrated) | SD of r0:r1 ratio = log(2)/2 |
| Transmission rate in 1997 | Arrives at this value in 1997, interpolates to trate.2 from 1997-2008 | Ratio of trate.1 to trate.2 = 1  Joint lognormal | (Calibrated) | SD of r1:r2 ratio = log(2)/2 |
| Transmission rate in 2008 | Arrives at this value in 2008, interpolates to trate.3 from 2008-2018 | 0.25  Joint lognormal | (Calibrated) | log(4)/2 |
| Transmission rate in 2018 | Arrives at this value in 2018, interpolates to trate.4 from 2018-2030 | Ratio of trate.3 to trate.2 = 1  Joint lognormal | (Calibrated) | SD of r3:r2 ratio = log(2)/2 |
| Transmission rate in/after 2030 | Arrives at this value in 2030, constant after | Ratio of trate.4 to trate.3 = 1  Joint lognormal | (Calibrated) | SD of r4:r3 ratio = log(2)/2 |
| Sex transmission multipliers | | | | |
| Relative risk of transmission for female to male vs male to female | Constant | 1  Lognormal | (Calibrated) | log(4)/2 |
| Age transmission multipliers (A composite of probability of being sexually active, number of encounters, and rate of transmission per encounter) | | | | |
| Relative risk of transmission among women in all age groups other than 30-39 vs 30-39  Calculated using (proportion with multiple partners or proportion high risk sex)\* (proportion of condomless sex); relative to 30-39 value | Splines at 2003, 2008, 2014; linear interpolation | Varies by age; linear interpolation between spline points | Ages <50: Kenya DHS 2003 (Table 12.12)1, 2008 (Table 13.7.1)2, 2014 (Table 13.9.1)3  Ages 50-80: Mojola et al, 20154 | Not sampled |
| Relative risk of transmission among men in all age groups other than 30-39 vs 30-39  Calculated using (proportion with multiple partners or proportion high risk sex)\* (proportion of condomless sex); relative to 30-39 value | Splines at 2003, 2008, 2014 | Varies by age; linear interpolation between spline points | Ages <50: Kenya DHS 2003 (Table 12.12)1, 2008 (Table 13.7.2)2, 2014 (Table 13.9.2)3  Ages 50-80: Mojola et al, 20154 | Not sampled |
| Additional multiplier of transmission among age 15-19 vs age 30-39; multiplies female and male age multipliers above | 4 separate multipliers at trate times: 1990, 1997, 2008, 2018 | 1  Lognormal | (Calibrated) | log(4)/2 |
| Additional multiplier of transmission among age 20-29 vs age 30-39; multiplies female and male age multipliers above | 4 separate multipliers at trate times: 1990, 1997, 2008, 2018 | 1  Lognormal | (Calibrated) | log(4)/2 |
| Additional multiplier of transmission among age 40-49 vs age 30-39; multiplies female and male age multipliers above | 4 separate multipliers at trate times: 1990, 1997, 2008, 2018 | 1  Lognormal | (Calibrated) | log(4)/2 |
| Additional multiplier of transmission among age 50+ vs age 30-39 prior to/in 1990; multiplies female and male age multipliers above | 4 separate multipliers at trate times: 1990, 1997, 2008, 2018 | 1  Lognormal | (Calibrated) | log(4)/2 |
| Other transmission multipliers | | | | |
| Relative risk of transmission for diagnosed vs undiagnosed HIV | Constant | 0.33 | Marks et al 20055, Marks et al 20066 | Not sampled |
| For each age/sex stratum, proportion of sexual partners in each other age/sex stratum | Constant | Varies by age/sex | De Oliveira et al 20177 | Not sampled |
| Dispersion of age of sexual partnerships  Inverse multiplier for standard deviation of age mixing proportion matrix by age, i.e., higher age assortativity 🡪 smaller standard deviation allowed (mean partner age difference more tightly enforced) | Constant | 1  Lognormal | (Calibrated) | log(1.5)/2 |
| Maternal-fetal transmission risk in 1990 (proportion of babies born to **unsuppressed** mothers living with HIV who become infected) | Begins at this value in 1990, interpolates to birth.transmission.risk.1 from 1990-2020 | 0.42  Logitnormal | Dabis et al, 19958 | log(3)/2 |
| Maternal-fetal transmission risk in 2020 (again, among unsuppressed) | Arrives at this value in 2020, constant after | 0.3  Logitnormal | Kenya eMTCT Framework 2016-20219 | log(3)/2 |
| Continuum parameters | | | | |
| Annual testing rate; calculated using proportion receiving a test in the past 12 months  Forecasted for all years and older age groups based on regressing on age and year  (e.g., rate of 2 means people tested twice a year; rate of 0.5 means tested every two years) | Logistic regression providing estimates for all years based on values from 2003, 2008, and 2014 | Varies by age, sex, and year | KDHS 20031, 20082, and 20143 | Not sampled |
| Log odds ratio for the intercept of the regression model fit to forecast testing rates for all ages; added on the log scale | Constant | 0  Normal | (Calibrated) | log(4)/2 |
| Log odds ratio for the slope of the regression model fit to forecast testing rates for all ages; added on the log scale | Constant | 0  Normal | (Calibrated) | log(4)/2 |
| Annual engagement rate; calculated using the number of individuals starting ART/those off of ART based on data from AIDS info  Forecasted for all years; with spline points at 2016 and 2017 to allow for increased engagement rate at the start of universal treatment era  (e.g., rate of 2 means people take 6 months to start ART (0.5 year); rate of 0.5 means people take two years) | Logistic regression providing estimates for all years | Varies by year | AIDSinfo10 | Not sampled |
| Log odds ratio for the intercept of the regression model fit to forecast engagement rates for all ages; added on the log scale | Constant | 0  Normal | (Calibrated) | log(4)/2 |
| Log odds ratio for the pre-2016 slope of the regression model fit to forecast engagement rates for all ages; added on the log scale | -2016 | 0  Normal | (Calibrated) | log(4)/2 |
| Log odds ratio for the 2016-2017 slope of the regression model fit to forecast engagement rates for all ages; added on the log scale | 2016-2017 | 0  Normal | (Calibrated) | log(4)/2 |
| Log odds ratio for the post-2017 slope of the regression model fit to forecast engagement rates for all ages; added on the log scale | 2017- | 0  Normal | (Calibrated) | log(4)/2 |
| Annual rate of disengagement for unsuppressed individuals (e.g., rate of 0.2 means people disengage after 5 years [1/0.2 = 5]) | Constant | 0.1392621  Lognormal | Lee et al11 | log(4)/2 |
| Annual rate of disengagement for suppressed individuals | Constant | 0.1025866  Lognormal | Lee et al11 | log(4)/2 |
| Annual suppression rate in 1993 (probability of achieving viral suppression) | Begins at this value in 1993, interpolates to suppression.rate.1 from 1993-2003 | 0.6732885  Lognormal | Njuguna et al12 | log(4)/2 |
| Annual suppression rate in/after 2003 | Arrives at this value in 2003, constant after | 0.6732885  Lognormal | Njuguna et al12 | log(4)/2 |
| Annual unsuppression rate | Constant | 0.1971601  Lognormal | Maina et al13 | log(4)/2 |
| Reduction multiplier for male testing rates | Constant | 1  Lognormal | (Calibrated) | log(4)/2 |
| Reduction multiplier for male engagement rates | Constant | 1  Lognormal | (Calibrated) | log(4)/2 |
| Reduction multiplier for male suppression rates | Constant | 1  Lognormal | (Calibrated) | log(4)/2 |
| Mortality/fertility multipliers | | | | |
| Multiplier for the intercept of the regression model fit to smooth/forecast mortality (until year 2040) for age 45-65 | Constant | 1  Lognormal | (Calibrated) | log(4)/2 |
| Multiplier for the slope of the regression model fit to smooth/forecast mortality (until year 2040) for age 45-65 | Constant | 1  Lognormal | (Calibrated) | log(4)/2 |
| Multiplier for the intercept of the regression model fit to smooth/forecast mortality (until year 2040) for age 65+ | Constant | 1  Lognormal | (Calibrated) | log(4)/2 |
| Multiplier for the slope of the regression model fit to smooth/forecast mortality (until year 2040) for age 65+ | Constant | 1  Lognormal | (Calibrated) | log(4)/2 |
| Annual HIV-specific mortality rate in 1990 (excess mortality rate among PWH with unsuppressed HIV)  (e.g., rate of 0.02 means 2/100 people die per year) | Begins at this value in 1990, interpolates to hiv.specific.mortality.rates.1 from 1990-2005 | 0.04 | AIDSinfo (global values)10 | log(4)/2 |
| Annual HIV-specific mortality rate in 2005 | Arrives at this value in 2005, interpolates to hiv.specific.mortality.rates.2 from 2005-2020 | 0.07 | AIDSinfo10 | log(4)/2 |
| Annual HIV-specific mortality rate in/after 2020 | Arrives at this value in 2020, constant after | 0.018 | AIDSinfo10 | log(4)/2 |
| Multiplier of HIV-specific mortality for age 0-14 | 3 separate multipliers at HIV mortality times: 1990, 2005, 2030 | 1  Lognormal | (Calibrated) | log(4)/2 |
| Multiplier of HIV-specific mortality for age 15-24 | 3 separate multipliers at HIV mortality times: 1990, 2005, 2030 | 1  Lognormal | (Calibrated) | log(4)/2 |
| Multiplier of HIV-specific mortality for age 50+ | 3 separate multipliers at HIV mortality times: 1990, 2005, 2030 | 1  Lognormal | (Calibrated) | log(4)/2 |
| Multiplier of fertility rates | Constant | 1 | (Calibrated) | log(4)/2 |
| Aging parameters | | | | |
| Rate at which individuals age out of each age bracket. As a default, this is set to the inverse of the number of years in the age bracket, meaning that individuals are equally distributed throughout the age bracket (e.g., we would expect that 1/5 of the individuals in the 15-19 age bracket are 19-year-olds and therefore 1/5 will age out each year). We allow this to vary for certain age groups in acknowledgement that some age brackets are not evenly distributed. | Constant | 1/(age range in bracket) | N/A | Not sampled |
| Rate at which individuals age out of the 15-19 age bracket  (I.e., rate of 0.25 means the 15-19 bracket has more individuals clustered on the older end and are therefore aging out more quickly. We also allow these rates to change over time as these clusters of individuals move through each age category – this is done using the aging factors below to either multiply or divide the aging rate.) | Constant | 0.25  Lognormal | (Calibrated) | log(4)/2 |
| Rate at which individuals age out of the 20-24 age bracket | Constant | 0.25  Lognormal | (Calibrated) | log(4)/2 |
| Age 15-19 aging rate multiplier\* | Low time: 1992  High time: (low time + age span) | 2  Lognormal | (Calibrated) | log(4)/2 |
| Age 20-24 aging rate multiplier\* | Low time: 1996  High time: (low time + age span) | 2  Lognormal | (Calibrated) | log(4)/2 |
| Age 25-50 aging rate multiplier\* | Low time: 2000  High time: (low time + age span) | 2  Lognormal | (Calibrated) | log(4)/2 |
| Over age 50 aging rate multiplier\* | Low time: 2020  High time: (low time + age span) | 2  Lognormal | (Calibrated) | log(4)/2 |

\* Factor to divide/multiply aging rate by when aging is at its lowest/highest. E.g., assumed 15-19 aging rate is at its lowest in 1992 due to a concentration of this age group in the younger ages; this aging rate is then at its highest in 1996 when this concentration of individuals moves to the upper end of the age range and subsequently ages out.

**Abbreviations**: transmission rate (trate); antiretroviral therapy (ART); elimination of mother-to-child transmission (eMTCT);

1. Central Bureau of Statistics - CBS/Kenya, Ministry of Health - MOH/Kenya, ORC Macro. *Kenya Demographic and Health Survey 2003.* Calverton, Maryland, USA: CBS, MOH, and ORC Macro;2004.

2. Kenya National Bureau of Statistics - KNBS, National AIDS Control Council/Kenya, National AIDS/STD Control Programme/Kenya, Health MoP, Sanitation/Kenya, Kenya Medical Research Institute. *Kenya Demographic and Health Survey 2008-09.* Calverton, Maryland, USA: KNBS and ICF Macro;2010.

3. Kenya National Bureau of Statistics, Ministry of Health/Kenya, National AIDS Control Council/Kenya, Kenya Medical Research Institute, Population NCf, Development/Kenya. *Kenya Demographic and Health Survey 2014.* Rockville, MD, USA2015.

4. Mojola SA, Williams J, Angotti N, Gómez-Olivé FX. HIV after 40 in rural South Africa: A life course approach to HIV vulnerability among middle aged and older adults. *Social science & medicine.* 2015;143:204-212.

5. Marks G, Crepaz N, Senterfitt JW, Janssen RS. Meta-analysis of high-risk sexual behavior in persons aware and unaware they are infected with HIV in the United States: implications for HIV prevention programs. *JAIDS Journal of Acquired Immune Deficiency Syndromes.* 2005;39(4):446-453.

6. Marks G, Crepaz N, Janssen RS. Estimating sexual transmission of HIV from persons aware and unaware that they are infected with the virus in the USA. *Aids.* 2006;20(10):1447-1450.

7. De Oliveira T, Kharsany AB, Gräf T, et al. Transmission networks and risk of HIV infection in KwaZulu-Natal, South Africa: a community-wide phylogenetic study. *The lancet HIV.* 2017;4(1):e41-e50.

8. Dabis F, Fransen L, Halsey N, et al. Rates of mother-to-child transmission of HIV-1 in Africa, America, and Europe: results from 13 perinatal studies. *Journal of acquired Immune deficiency syndromes and Human retrovirology.* 1995;8(5):506-510.

9. (NACC) NACC. Kenya Framework for Elimination of Mother-To-Child Transmission of HIV and Syphilis 2016-2021. In:2016.

10. HIV/AIDS JUNPo. AIDSInfo. <http://aidsinfo.unaids.org/>. Published 2019. Accessed August 30, 2019.

11. Lee H, Hogan JW, Genberg BL, et al. A state transition framework for patient‐level modeling of engagement and retention in HIV care using longitudinal cohort data. *Statistics in medicine.* 2018;37(2):302-319.

12. Njuguna N, Mugo N, Anzala O, et al. An empiric tool to identify Kenyans living with HIV who will have unsuppressed viremia 18 months following treatment initiation to guide differentiated care models. *PloS one.* 2022;17(7):e0271520.

13. Maina E, Mureithi H, Adan A, Muriuki J, Lwembe R, Bukusi E. Incidences and factors associated with viral suppression or rebound among HIV patients on combination antiretroviral therapy from three counties in Kenya. *International Journal of Infectious Diseases.* 2020;97:151-158.