**Table 1.** Population structure, sexual behavior, and mixing parameters.

| Parameter | Details | Symbola | Prior distributionb | Value  (mean and 95% interval) | Source |
| --- | --- | --- | --- | --- | --- |
| Total population aged 20-64 y |  | N | Fixed |  | (1) |
|  | Louisiana (LA) |  |  | 2.8x106 |  |
|  | Massachusetts (MA) |  |  | 4.2x106 |  |
| Age categories |  |  |  |  |  |
|  |  |  |  |  |  |
| Average time in each age group (y) |  | 1/μ |  |  | Assumption |
|  | 20-44 y |  | Fixed | 25 |  |
|  | 45-64 y |  | Fixed | 20 |  |
| Proportion of males in each subpopulation |  | popij |  |  | (1, 2) |
|  | Black, LA |  | Fixed | 0.310 |  |
|  | Black, MA |  | Fixed | 0.070 |  |
|  | Hispanic, LA |  | Fixed | 0.048 |  |
|  | Hispanic, MA |  | Fixed | 0.102 |  |
|  | Men who have sex with men, LA |  | Fixed | 0.025 |  |
|  | Men who have sex with men, MA |  | Fixed | 0.045 |  |
|  | Other, LA |  | Fixed | 0.616 |  |
|  | Other, MA |  | Fixed | 0.783 |  |
| Proportion of females in each subpopulation |  | popij |  |  | (1) |
|  | Black, LA |  | Fixed | 0.318 |  |
|  | Black, MA |  | Fixed | 0.073 |  |
|  | Hispanic, LA |  | Fixed | 0.050 |  |
|  | Hispanic, MA |  | Fixed | 0.107 |  |
|  | Other, LA |  | Fixed | 0.632 |  |
|  | Other, MA |  | Fixed | 0.820 |  |
| Proportion of MSM with HIV infection |  | pHIV |  |  | Louisiana Department of Public Health, Massachusetts Department of Public Health (2015) |
|  | 20-44 y, LA |  | Fixed | 0.22 |  |
|  | 20-44 y, MA |  | Fixed | 0.05 |  |
|  | 45-64 y, LA |  | Fixed | 0.28 |  |
|  | 45-64 y, MA |  | Fixed | 0.12 |  |
| Proportion ever had sex, male |  | *PS,ijkl* |  |  | (3) and assumption |
|  | Black, 20-44 y |  | Fixed | 0.98 |  |
|  | Hispanic, 20-44 y |  | Fixed | 0.94 |  |
|  | Other, 20-44 y |  | Fixed | 0.95 |  |
|  | HIV- MSM, 20-44 y |  | Fixed | 0.94 (male average) |  |
|  | HIV+ MSM, 20-44 y |  | Fixed | 1 |  |
|  | HIV+ MSM, 45-64 y |  | Fixed | 1 |  |
|  | All other males, 45-64 y |  | Fixed | 0.99 |  |
| Proportion ever had sex, female |  | *PS,ijkl* |  |  | (3) and assumption |
|  | All, 15-44 y |  | Fixed | 0.96 |  |
|  | All, 45-64 y |  | Fixed | 0.99 |  |
| Proportion of population in each sexual activity group |  | Pk |  |  | Assumption |
|  | Low |  | Fixed | 0.90 |  |
|  | High |  | Fixed | 0.10 |  |
| Minimum rate of partner acquisition (per y) |  | cmin,jl |  |  | Assumption |
|  | Male, 20-44 y |  | Gamma(5, 5) | 1 (0.32-2.0) |  |
|  | Male, 20-64 y |  | Gamma(5, 5) | 1 (0.32-2.0) |  |
|  | Female, 20-44 y |  | Gamma(5, 5) | 1 (0.32-2.0) |  |
|  | Female, 45-64 y |  | Gamma(5, 5) | 1 (0.32-2.0) |  |
|  | MSM, 20-44 y |  | Gamma(5, 5) | 1 (0.32-2.0) |  |
|  | MSM, 45-64 y |  | Gamma(5, 5) | 1 (0.32-2.0) |  |
| Relative rate of partner acquisition, males 20-44 y |  | rpijkl |  |  | (3); assumption |
|  | Black, low |  | Gamma(2.2, 0.6) | 3.7 (0.5-10.0) |  |
|  | Black, high |  | Normal(32.5, 8.9) | 32.5 (15.0-50.0) |  |
|  | Hispanic, low |  | Fixed | 1.0 |  |
|  | Hispanic, high |  | Gamma(4.3, 0.6) | 7.0 (2.0-15.0) |  |
|  | Other, low |  | Gamma(2.2, 0.6) | 3.7 (0.5-10.0) |  |
|  | Other, high |  | Normal(27.5, 11.5) | 27.5 (5.0-50.0) |  |
|  | HIV- MSM, low |  | Fixed | 1 |  |
|  | HIV- MSM, high |  | Normal(45, 15.3) | 45.0 (15.0-75.0) |  |
|  | HIV+ MSM, low |  |  |  |  |
|  | HIV+ MSM, high |  |  |  |  |
| Relative rate of partner acquisition, males 45-64 y |  | rpijkl |  |  | Assumption |
|  | Black, low |  | Gamma(3.4, 1.6) | 2.2 (0.5-5.0) |  |
|  | Black, high |  | Normal(45, 15.3) | 45.0 (15.0-75.0) |  |
|  | Hispanic, low |  | Fixed | 1 |  |
|  | Hispanic, high |  | Gamma(5.3,0.4) | 7.0 (5.0, 30.0) |  |
|  | Other, low |  | Gamma(3.4, 1.6) | 2.2 (0.5-5.0) |  |
|  | Other, high |  | Normal(45, 15.3) | 45.0 (15.0-75.0) |  |
|  | HIV- MSM, low |  | Fixed | 1 |  |
|  | HIV- MSM, high |  | Normal(45.0, 15.3) | 45.0 (15.0-75.0) |  |
|  | HIV+ MSM, low |  |  |  |  |
|  | HIV+ MSM, high |  |  |  |  |
| Relative rate of partner acquisition, females 20-44 y |  | rpijkl |  |  | (3); assumption |
|  | Black, low |  | Gamma(2.2, 0.6) | 3.7 (0.5-10.0) |  |
|  | Black, high |  | Gamma(1.9, 0.1) | 17.7 (2.0-50.0) |  |
|  | Hispanic, low |  | Fixed | 1 |  |
|  | Hispanic, high |  | Gamma(4.3, 0.6) | 7.0 (2.0, 15.0) |  |
|  | Other, low |  | Gamma(2.2, 0.6) | 3.7 (0.5-10.0) |  |
|  | Other, high |  | Gamma(5.3, 0.4) | 14.9 (5.0-30.0) |  |
| Relative rate of partner acquisition, females 45-64 y |  | rpijkl |  |  | Assumption |
|  | Black, low |  | Gamma(3.4, 1.6) | 2.2 (0.5-5.0) |  |
|  | Black, high |  | Gamma(8.5, 0.8) | 11.3 (5.0-20.0) |  |
|  | Hispanic, low |  | Fixed | 1 |  |
|  | Hispanic, high |  | Gamma(5.3,0.4) | 14.9 (5.0, 30.0) |  |
|  | Other, low |  | Gamma(3.4,1.6) | 2.2 (0.5-5.0) |  |
|  | Other, high |  | Gamma(5.3,0.4) | 14.9 (5.0-30.0) |  |
| Mixing between sexual activity groups |  | ε1,i |  |  | Assumption |
|  | Black |  | Beta(1.1, 1.1) | 0.5 (0.032-0.97) |  |
|  | Hispanic |  | Beta(1.1, 1.1) | 0.5 (0.032-0.97) |  |
|  | Other |  | Beta(1.1, 1.1) | 0.5 (0.032-0.97) |  |
|  | HIV- MSM |  | Beta(1.1, 1.1) | 0.5 (0.032-0.97) |  |
|  | HIV+ MSM |  | Beta(1.1, 1.1) | 0.5 (0.032-0.97) |  |
| Mixing with same age group |  | ε2,ijl |  |  | (3); assumption |
|  | Male 20-44 y and  Female 45-64 y |  | Beta(9, 2.7) | 0.86 (0.5-0.95) |  |
|  | Male 45-65 y y and  Female 20-44 y |  | Beta(6.1, 2.3) | 0.81 (0.4-0.95) |  |
|  | MSM |  | Beta(8.0, 3.8) | 0.68 (0.40-0.90) |  |
| Mixing within subpopulation |  | ε3,ij |  |  | (3, 4); assumption |
|  | Black male |  | Beta(172.7, 52.4) | 0.77 (0.71-0.82) |  |
|  | Hispanic male |  | Beta(183.7, 72.6) | 0.72 (0.66-0.77) |  |
|  | Other male |  | Beta(547.2, 70.3) | 0.89 (0.86-0.91) |  |
|  | HIV- MSM |  | Beta(47.5, 2.5) | 0.95 (0.88-0.99) |  |
|  | HIV+ MSM |  | Beta(47.5, 2.5) | 0.95 (0.88-0.99) |  |
|  | Black female |  | Beta(217.0, 28.8) | 0.88 (0.84-0.92) |  |
|  | Hispanic female |  | Beta(99.1, 59.1) | 0.63 (0.55-0.70) |  |
|  | Other female |  | Beta(437.1, 70.4) | 0.86 (0.83-0.89) |  |
| Mixing with MSM of same HIV status |  | θHIV | Beta(9.0, 2.7) | 0.77 (0.50-0.95) | (5) |

aSubscripts *i, j, k,* and *l* indicate subpopulation, sex, sexual activity group, and age group, respectively.

bGamma distributions are described by shape (α) and rate (β) parameters; beta distributions are described by shape parameters (α and β).

**Table 2.** Syphilis natural history, screening, and treatment parameters

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | Details | Symbola | Prior distributionb | Value (mean and 95% interval) | Source |
| Probability of transmission |  | *β*ji |  |  | (6) |
|  | Female to male |  | Beta(14.3, 9.7) | 0.60 (0.40-0.78) |  |
|  | Male to female |  | Beta(14.3, 9.7) | 0.60 (0.40-0.78) |  |
|  | Male to male |  | Beta(14.3, 9.7) | 0.60 (0.40-0.78) |  |
| Average duration of infection stage (d) |  |  |  |  | (6) |
|  | Incubating | 1/ δ | Uniform(20, 30) | 25.0 (20.3-29.8) |  |
|  | Primary | 1/ γp | Uniform(30, 60) | 45.0 (30.8-59.3) |  |
|  | Secondary | 1/ γs | Uniform(78, 138) | 108.0 (79.5-136.5) |  |
|  | Early latent | 1/ γe |  | 365 – (duration primary + duration secondary) |  |
| Average duration of protection from re-infection following treatment (d)c |  |  |  |  | (6, 7) |
|  | Primary and secondary syphilis | 1/**ξps** | Normal(14.0, 3.6) | 14.0 (7.0-21.0) |  |
|  | Late latent syphilis | 1/**ξe** | Normal(927.5, 457.9) | 927.5 (30.0-1825.0) |  |
| Multiplier for duration of protection from re-infection if treated during early latent stage | Relative to primary and secondary infection | rrimm | Uniform(1,10) | 5.5 (1.2, 9.8) | (6); assumption |
| Background antibiotic treatment rate (per y) |  | Φ |  |  | Assumption |
|  | For 35 y period ending 25 y before calibration start |  | 0.1 |  |  |
|  | For remainder of model time |  | 0.01 |  |  |
| Symptomatic treatment rate, primary syphilis (per y) |  | **τp** |  |  | Assumption |
|  | Male |  | Beta(3.4,14.2) | 0.19(0.05, 0.40) |  |
|  | HIV- MSM |  | Beta(3.4,14.2) | 0.19(0.05, 0.40) |  |
|  | HIV+ MSM |  | Beta(3.4,14.2) | 0.19(0.05, 0.40) |  |
|  | Female |  | Beta(3.4,14.2) | 0.19(0.05, 0.40) |  |
| Symptomatic treatment rate, secondary syphilis (per y) |  | **τs** |  |  | Assumption |
|  | Male |  | Beta(9.2,13.6) | 0.40(0.22, 0.61) |  |
|  | HIV- MSM |  | Beta(9.2,13.6) | 0.40(0.22, 0.61) |  |
|  | HIV+ MSM |  | Beta(9.2,13.6) | 0.40(0.22, 0.61) |  |
|  | Female |  | Beta(9.2,13.6) | 0.40(0.22, 0.61) |  |
| Symptomatic treatment rate, early latent syphilis (per y) |  | **τe** |  |  | Assumption |
|  | Male |  | Beta(3.4,14.2) | 0.19(0.05, 0.40) |  |
|  | HIV- MSM |  | Beta(3.4,14.2) | 0.19(0.05, 0.40) |  |
|  | HIV+ MSM |  | Beta(3.4,14.2) | 0.19(0.05, 0.40) |  |
|  | Female |  | Beta(3.4,14.2) | 0.19(0.05, 0.40) |  |
| Symptomatic treatment rate, late latent syphilis (per y) |  | **τl** |  |  | Assumption |
|  | Male |  | Beta(1.9, 21.5) | 0.08(0.01, 0.22) |  |
|  | HIV- MSM |  | Beta(1.9, 21.5) | 0.08(0.01, 0.22) |  |
|  | HIV+ MSM |  | Beta(1.9, 21.5) | 0.08(0.01, 0.22) |  |
|  | Female |  | Beta(1.9, 21.5) | 0.08(0.01, 0.22) |  |
| Annual asymptomatic screen and treat rate, low sexual activity groupd | Start = 2010  End = 2016 | ψij | Bezier curve |  | (3); assumption |
|  | Male |  | Start: Beta(2.6, 22.3)  End: Beta(2.6, 22.3) | 0.11 (0.02-0.25)  0.11 (0.02-0.25) |  |
|  | MSM |  | Start: Beta(5.7, 10.2)  End: Beta(7.0, 9.9) | 0.36 (0.15-0.60)  0.42 (0.20-0.65) |  |
|  | Female |  | Start: Beta(2.6, 22.3)  End: Beta(2.6, 22.3) | 0.11 (0.02-0.25)  0.11 (0.02-0.25) |  |
| Relative risk of screening, by subpopulation and sexc |  | rr\_popij |  |  | (3); assumption |
|  | Black male |  | Gamma(9.3, 5.4) | 1.7 (0.8-3.0) |  |
|  | Hispanic male |  | Gamma(8.5, 7.5) | 1.1 (0.5-2.0) |  |
|  | Other male |  | Fixed | 1 |  |
|  | HIV- MSM |  | Fixed | 1 |  |
|  | HIV+ MSM |  | Gamma(3.4, 0.5) | 6.5 (1.5-15.0) |  |
|  | Black female |  | Gamma(3.4, 1.6) | 2.2 (0.5-5) |  |
|  | Hispanic female |  | Gamma(8.5, 7.5) | 1.1 (0.5-2.0) |  |
|  | Other female |  | Fixed | 1 |  |
| Relative risk of screening, by sexual activity groupc |  | rr\_ack |  |  | Assumption |
|  | Low sexual activity group |  | Fixed | 1 |  |
|  | High sexual activity group |  | Gamma(8.5, 7.5) | 1.1 (0.5-2.0) |  |
| Relative risk of screening, by age group |  | rr\_agel |  |  | Assumption |
|  | Male 20-44 y |  | Fixed | 1 |  |
|  | Male 45-64 y |  | Gamma(3.4, 0.5) | 6.5 (1.5-15.0) |  |
|  | MSM 20-44 y |  | Fixed | 1 |  |
|  | MSM 45-64 y |  | Gamma(4.0, 4.4) | 0.9 (0.3-2.0) |  |
|  | Female 20-44 y |  | Fixed | 1 |  |
|  | Female 45-64 y |  | Gamma(8.5, 7.5) | 1.1 (0.5-2.0) |  |
| Probability case is reported |  | ω | Bezier curve |  | Assumption |
|  | Start (2010) |  | Beta(116.1, 12.1) | 0.91 (0.85-0.95) |  |
|  | End (2016) |  | Beta(109.7, 6.1) | 0.95 (0.90-0.98) |  |
| Relative risk case is reported, by method of identification |  | ηj |  |  | Assumption |
|  | Screening |  | Fixed | 1 |  |
|  | Seeking medical care, male |  | Beta(9.0, 27) | 0.77 (0.50-0.95) |  |
|  | Seeking medical care, female |  | Beta(9.0, 27) | 0.77 (0.50-0.95) |  |
| Annual increase in transmission probability (2010-2016) | MSM | crr | Beta(1.1,36.9) | 0.03 (0.001, 0.1) | Assumption |

aSubscripts *i, j, k,* and *l* indicate subpopulation, sex, sexual activity group, and age group, respectively.

bGamma distributions are described by shape (α) and rate (β) parameters; beta distributions are described by shape parameters (α and β); normal distributions are described by mean (μ) and standard deviation (σ).

cDuration of immunity for treated early latent infection calculated as: 1/(ξps x rrimm)

dAnnual screening rates (α) calculated as: ψ*jl*x *rr\_popij* x *rr\_ack*,x rr\_agei

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