Supplementary Material

What explains anorectal chlamydia infection in women? Implications of a mathematical model for test and treatment strategies

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Text S1 Model

In the model, people can either be single (denoted by *X*) or in a pair (denoted by *P* and *Q*). The model is characterized by serial monogamy which is a reasonable assumption for young heterosexuals. There are two infection states: susceptible (denoted by *S*) and infected (denoted by *I*). We did not include immunity in the model, since it is unknown whether a period of immunity exists after natural clearance of urogenital and anorectal chlamydia infection and if clearing chlamydia at one location would provide immunity against infection at the other locations.

There are two types of partnerships in the model: one that includes anal sex as well as vaginal sex (denoted by *Q*) and one with vaginal sex only (denoted by *P*). In the model, there is a fraction of the population (denoted by *Pas*) that wants to have anal sex. If both partners want to have anal sex, they will have regular anal sex and if they both do not want anal sex, there is none. However, if one partner wants to have anal sex and the other one does not, they will form, with a probability δ, a partnership with regular anal sex. This probability (δ) and the fraction of people that wants to have anal sex (*Pas*) are chosen as such that the percentage of people in the model population that had recent (within the last 6 months) anal sex is similar to the data. The pair formation and separation processes are independent of anal sex preference or infection status.

In the notation of singles (X), the *f* denotes females and *m* males. For female singles, the first subscript describes the infection status at the urogenital location, and the second subscript the infection status at the anorectal location. For example, Xf_{IS} denotes a single women with a urogenital infection who is susceptible for an anorectal infection. In the notation of pairs (*P* and *Q*), the first subscript describes the infection status at the female urogenital location, the second subscript the infection status at the female anorectal location, and the third subscript the infection status at the male urogenital site.

For women the subscript *g* and for men the subscript *g'* denotes if someone wants anal sex next to vaginal sex. A bar denotes whether a women had recent anal sex. This distinction is needed to reflect the current standard of care in which women are only anorectally tested when having had recent anal sex.

In total the model comprises of 92 compartments: 16 for single women, 4 for single men and 48 pair compartments for vaginal sexual sex, and 24 pair compartments for both vaginal and anal sex. Table S1 describes all symbols and their meaning and Table S2 shows the how the different intervention measures were incorporated in the model.

First, the tables with parameters and their values are shown, followed by the equations. Last, we show the equations that were used to go from transmission probabilities to frequency of events (page 13).

Table S1 Symbols and their explanation of all parameters of the pair model.

Symbol	Parameter	Baseline value	Source
Infection			
$1/\gamma_{f,u}$	Female duration of untreated urogenital infection, months	12	[1,2]
$1/\gamma_{f,a}$	Female duration of untreated anorectal infection, months	12	[3]
$1/\gamma_{m,u}$	Male duration of untreated urogenital infection, months	12	[1,2]
Transmission			
β_u	Transmission probability per vaginal sex act	*Calibrated*	
β_a	Transmission probability per anal sex act	*Calibrated*	
β_x	Daily autoinoculation probability (probability of acquiring anorectal chlamydia when urogenitally infected or acquiring urogenital chlamydia when anorectally infected)	*Calibrated*	
Behaviour			
ϕ_{uu}	Frequency of vaginal sex acts in pairs with vaginal sex only, per week	2	[4]
ϕ_{ua}	Frequency of vaginal sex acts in pairs with vaginal and anal sex, per week	Assumed the same as ϕ_{uu}	
ϕ_a	Frequency of anal sex acts per week	0.5	[4*]
ρ	Pair formation rate, per year	8.8	STI Clinic data[†]
σ	Pair separation rate, per year	4.6	STI Clinic data[†]
Pas	The fraction of the population that prefers anal sex, %	40	STI Clinic data[‡]
δ	Probability of anal sex between two people where one partner does want anal sex and the other one does not want anal sex	0.15	STI Clinic data[‡]
Intervention parameters			
$\tau_{azy,u}$	Azithromycin effectiveness[¥] urogenital infection	See Table S2	
$\tau_{azy,a}$	Azithromycin effectiveness[¥] anorectal infection	See Table S2	
$\tau_{doxy,u}$	Doxycycline effectiveness[¥] urogenital infection	See Table S2	
$\tau_{doxy,a}$	Doxycycline effectiveness[¥] anorectal infection	See Table S2	
α_f	Female testing rate, per year	0.15	[5]
$1/\nu$	Period of recent anal sex to determine which treatment to provide, months	6	[6]
q	Partner notification probability	0.5	[7]
$\boldsymbol{\theta}$	Parameter to determine testing on anatomical location with or without indication ($\theta = 1$: testing on indication only, $\theta = 0$: always testing on both locations)	0 or 1	

[*] Data of heterosexuals are lacking, so value was taken from young men who having sex with other men.

[†] Routinely collected data of heterosexual STI clinic attendees (men and women) aged 15-29 years in South Limburg, the Netherlands, between 2006 to 2013. We used the reported number of partners per year and fraction of people in a partnership at any time to estimate pair formation and separation rates. Only number of partners in the last half year is routinely collected. The median number (2 partners/year) was used and transferred to partners per year by multiplying by 1.5. The fraction of people in a partnership was 66%.

[‡] STI clinic data of female STI clinic attendees aged 18-29 years in South Limburg, the Netherlands who were included in the study on routine universal anorectal testing. Of those, 18% reported recent anal sex. In the model, the percentage of people with recent anal intercourse is a combination of two parameters (*Pas* and δ) which values were taken as such that 18% of the model population had recent anal intercourse.

[¥] Effectiveness is defined in the model as the percentage of people that are susceptible again after treatment.

Table S2 Parameter values for the different intervention scenarios (Kong *et al.*[8 9])

	Standard of care	Universal routine doxycycline	Universal routine anorectal testing	Universal routine doxycycline and anorectal testing
$\boldsymbol{\theta}$	1	1	0	0
$\tau_{azy,u}$	0.943	0.971	0.943	0.971
$\tau_{azy,a}$	0.829	0.996	0.829	0.996
$\tau_{doxy,u}$	0.971	0.971	0.971	0.971
$\tau_{doxy,a}$	0.996	0.996	0.996	0.996

Equations for **single women**:

Women who do not want anal sex and had no recent anal sex

$$\frac{dXf_{SS}}{dt} = \sigma\left(P_{SSS} + P_{SSI} + P_{SSS,g'} + P_{SSI,g'}\right) + \upsilon\widehat{Xf_{SS}} + \gamma_{f,u}Xf_{IS} + \gamma_{f,a}Xf_{SI} - \rho Xf_{SS} + \alpha_f\tau_{azy,u}Xf_{IS}$$
$$+\alpha_f\begin{cases}\theta = 1 & \tau_{azy,u}\tau_{azy,a}Xf_{II}\\ \theta = 0 & \tau_{doxy,u}\tau_{doxy,a}Xf_{II} + \tau_{doxy,a}Xf_{SI}\end{cases}$$

$$\frac{dXf_{SI}}{dt} = \sigma\left(P_{SIS} + P_{SII} + P_{SIS,g'} + P_{SII,g'}\right) + \upsilon\widehat{Xf_{SI}} + \gamma_{f,u}Xf_{II} - \left(\gamma_{f,a} + \rho + \beta_x\right)Xf_{SI}$$
$$+\alpha_f\begin{cases}\theta = 1 & \tau_{azy,u}\left(1 - \tau_{azy,a}\right)Xf_{II}\\ \theta = 0 & \tau_{doxy,u}\left(1 - \tau_{doxy,a}\right)Xf_{II} - \tau_{doxy,a}Xf_{SI}\end{cases}$$

$$\frac{dXf_{IS}}{dt} = \sigma\left(P_{ISS} + P_{ISI} + P_{ISS,g} + P_{ISI,g'}\right) + \upsilon\widehat{Xf_{IS}} + \gamma_{f,a}Xf_{II} - \left(\gamma_{f,u} + \rho + \beta_x\right)Xf_{IS} - \alpha_f\tau_{azy,u}Xf_{IS}$$
$$+\alpha_f\begin{cases}\theta = 1 & \left(1 - \tau_{azy,u}\right)\tau_{azy,a}Xf_{II}\\ \theta = 0 & \left(1 - \tau_{doxy,u}\right)\tau_{doxy,a}Xf_{II}\end{cases}$$

$$\frac{dXf_{II}}{dt} = \sigma\left(P_{IIS} + P_{III} + P_{IIS,g'} + P_{III,g'}\right) + \upsilon\widehat{Xf_{II}} + \beta_x\left(Xf_{SI} + Xf_{IS}\right) - \left(\gamma_{f,a} + \gamma_{f,u} + \rho\right)Xf_{II}$$
$$-\alpha_f\begin{cases}\theta = 1 & \left(\left(1 - \tau_{azy,u}\right)\tau_{azy,a} + \tau_{azy,u}\right)Xf_{II}\\ \theta = 0 & \left(\left(1 - \tau_{doxy,u}\right)\tau_{doxy,a} + \tau_{doxy,u}\right)Xf_{II}\end{cases}$$

Women who do not want anal sex but recently had anal sex

$$\frac{d\widehat{Xf_{SS}}}{dt} = \sigma\left(\widehat{P_{SSS}} + \widehat{P_{SSI}} + \widehat{P_{SSS,g'}} + \widehat{P_{SSI,g'}} + Q_{SSS,g'} + Q_{SSI,g'}\right) + \gamma_{f,u}\widehat{Xf_{IS}} + \gamma_{f,a}\widehat{Xf_{SI}} - (\upsilon + \rho)\widehat{Xf_{SS}} + \alpha_f\tau_{doxy,a}\widehat{Xf_{SI}}$$
$$+\alpha_f\tau_{azy,u}\widehat{Xf_{IS}} + \alpha_f\tau_{doxy,u}\tau_{doxy,a}\widehat{Xf_{II}}$$

$$\frac{d\widehat{Xf_{SI}}}{dt} = \sigma\left(\widehat{P_{SIS}} + \widehat{P_{SII}} + \widehat{P_{SIS,g'}} + \widehat{P_{SII,g'}} + Q_{SIS,g'} + Q_{SII,g'}\right) + \gamma_{f,u}\widehat{Xf_{II}} - \left(\upsilon + \gamma_{f,a} + \rho + \beta_x\right)\widehat{Xf_{SI}} - \alpha_f\tau_{doxy,a}\widehat{Xf_{SI}}$$
$$+\alpha_f\tau_{doxy,u}\left(1 - \tau_{doxy,a}\right)\widehat{Xf_{II}}$$

$$\frac{d\widehat{Xf_{IS}}}{dt} = \sigma\left(\widehat{P_{ISS}} + \widehat{P_{ISI}} + \widehat{P_{ISS,g'}} + \widehat{P_{ISI,g'}} + Q_{ISS,g'} + Q_{ISI,g'}\right) + \gamma_{f,a}\widehat{Xf_{II}} - \left(\upsilon + \gamma_{f,u} + \rho + \beta_x\right)\widehat{Xf_{IS}} - \alpha_f\tau_{azy,u}\widehat{Xf_{IS}}$$
$$+\alpha_f\left(1 - \tau_{doxy,u}\right)\tau_{doxy,a}\widehat{Xf_{II}}$$

$$\frac{d\widehat{Xf_{II}}}{dt} = \sigma\left(\widehat{P_{IIS}} + \widehat{P_{III}} + \widehat{P_{IIS,g'}} + \widehat{P_{III,g'}} + Q_{IIS,g'} + Q_{III,g'}\right) + \beta_x\left(\widehat{Xf_{SI}} + \widehat{Xf_{IS}}\right) - \left(\upsilon + \gamma_{f,a} + \gamma_{f,u} + \rho\right)\widehat{Xf_{II}}$$
$$-\alpha_f\left(\left(1 - \tau_{doxy,u}\right)\tau_{doxy,a} + \tau_{doxy,u}\right)\widehat{Xf_{II}}$$

Women who want anal sex but did not recently had anal sex

$$\frac{dXf_{SS,g}}{dt} = \sigma\left(P_{SSS,g} + P_{SSI,g}\right) + \upsilon\widehat{Xf_{SS,g}} + \gamma_{f,u}Xf_{IS,g} + \gamma_{f,a}Xf_{SI,g} - \rho Xf_{SS,g} + \alpha_f\tau_{azy,u}Xf_{IS,g}$$
$$+\alpha_f\begin{cases}\theta = 1 & \tau_{azy,u}\tau_{azy,a}Xf_{II,g}\\ \theta = 0 & \tau_{doxy,u}\tau_{doxy,a}Xf_{II,g} + \tau_{doxy,a}Xf_{SI,g}\end{cases}$$

$$\frac{dXf_{SI,g}}{dt} = \sigma\left(P_{SIS,g} + P_{SII,g}\right) + \upsilon\widehat{Xf_{SI,g}} + \gamma_{f,u}Xf_{II,g} - \left(\gamma_{f,a} + \rho + \beta_x\right)Xf_{SI,g}$$
$$+\alpha_f\begin{cases}\theta = 1 & \tau_{azy,u}\left(1 - \tau_{azy,a}\right)Xf_{II,g}\\ \theta = 0 & \tau_{doxy,u}\left(1 - \tau_{doxy,a}\right)Xf_{II,g} - \tau_{doxy,a}Xf_{SI,g}\end{cases}$$

$$\frac{dXf_{IS,g}}{dt} = \sigma\left(P_{ISS,g} + P_{ISI,g}\right) + \upsilon\widehat{Xf_{IS,g}} + \gamma_{f,a}Xf_{II,g} - \left(\gamma_{f,u} + \rho + \beta_x\right)Xf_{IS,g} - \alpha_f\tau_{azy,u}Xf_{IS,g}$$
$$+\alpha_f\begin{cases}\theta = 1 & \left(1 - \tau_{azy,u}\right)\tau_{azy,a}Xf_{II,g}\\ \theta = 0 & \left(1 - \tau_{doxy,u}\right)\tau_{doxy,a}Xf_{II,g}\end{cases}$$

$$\frac{dXf_{II,g}}{dt} = \sigma\left(P_{IIS,g} + P_{III,g}\right) + \upsilon\widehat{Xf_{II,g}} + \beta_x\left(Xf_{SI,g} + Xf_{IS,g}\right) - \left(\gamma_{f,a} + \gamma_{f,u} + \rho\right)Xf_{II,g}$$
$$-\alpha_f\begin{cases}\theta = 1 & \left(\left(1 - \tau_{azy,u}\right)\tau_{azy,a} + \tau_{azy,u}\right)Xf_{II,g}\\ \theta = 0 & \left(\left(1 - \tau_{doxy,u}\right)\tau_{doxy,a} + \tau_{doxy,u}\right)Xf_{II,g}\end{cases}$$

Women who want anal sex and recently had anal sex

$$\frac{d\widehat{Xf_{SS,g}}}{dt} = \sigma\left(\widehat{P_{SSS,g}} + \widehat{P_{SSI,g}} + Q_{SSS,g} + Q_{SSI,g} + Q_{SSS,gg'} + Q_{SSI,gg'}\right) + \gamma_{f,u}\widehat{Xf_{IS,g}} + \gamma_{f,a}\widehat{Xf_{SI,g}} - (\upsilon + \rho)\widehat{Xf_{SS,g}} + \alpha_f\tau_{doxy,u}\widehat{Xf_{SI,g}}$$
$$+\alpha_f\tau_{doxy,u}\tau_{doxy,a}\widehat{Xf_{II,g}} + \alpha_f\tau_{azy,u}\widehat{Xf_{IS,g}}$$

$$\frac{d\widehat{Xf_{SI,g}}}{dt} = \sigma\left(\widehat{P_{SIS,g}} + \widehat{P_{SII,g}} + Q_{SIS,g} + Q_{SII,g} + Q_{SIS,gg'} + Q_{SII,gg'}\right) + \gamma_{f,u}\widehat{Xf_{II,g}} - \left(\upsilon + \gamma_{f,a} + \rho + \beta_x\right)\widehat{Xf_{SI,g}} - \alpha_f\tau_{doxy,a}\widehat{Xf_{SI,g}}$$
$$+\alpha_f\tau_{doxy,u}\left(1 - \tau_{doxy,a}\right)\widehat{Xf_{II,g}}$$

$$\frac{d\widehat{Xf_{IS,g}}}{dt} = \sigma\left(\widehat{P_{ISS,g}} + \widehat{P_{ISI,g}} + Q_{ISS,g} + Q_{ISI,g} + Q_{ISS,gg'} + Q_{ISI,gg'}\right) + \gamma_{f,a}\widehat{Xf_{II,g}} - \left(\upsilon + \gamma_{f,u} + \rho + \beta_x\right)g - \alpha_f\tau_{azy,u}\widehat{Xf_{IS,g}}$$
$$+\alpha_f\left(1 - \tau_{doxy,u}\right)\tau_{doxy,a}\widehat{Xf_{II,g}}$$

$$\frac{d\widehat{Xf_{II,g}}}{dt} = \sigma\left(\widehat{P_{IIS,g}} + \widehat{P_{III,g}} + Q_{IIS,g} + Q_{III,g} + Q_{IIS,gg'} + Q_{III,gg'}\right) - \left(\upsilon + \gamma_{f,a} + \gamma_{f,u} + \rho\right)\widehat{Xf_{II,g}} + \beta_x\left(\widehat{Xf_{SI,g}} + \widehat{Xf_{IS,g}}\right)$$
$$-\alpha_f\left(\left(1 - \tau_{doxy,u}\right)\tau_{doxy,a} + \tau_{doxy,u}\right)\widehat{Xf_{II,g}}$$

Equations for **single men**:

Men who do not want anal sex

$$\frac{dXm_S}{dt} = \sigma\left(P_{SSS} + P_{SIS} + P_{ISS} + P_{IIS} + \widehat{P_{SSS}} + \widehat{P_{SIS}} + \widehat{P_{ISS}} + \widehat{P_{IIS}} + P_{SSS,g} + P_{SIS,g} + P_{ISS,g} + P_{IIS,g} + \widehat{P_{SSS,g}} + \widehat{P_{SIS,g}} + \widehat{P_{ISS,g}} + \widehat{P_{IIS,g}}\right)$$
$$+\sigma\left(Q_{SSS,g} + Q_{SIS,g} + Q_{ISS,g} + Q_{IIS,g}\right) + \gamma_{m,u}Xm_I - \rho Xm_S$$

$$\frac{dXm_I}{dt} = \sigma\left(P_{SSI} + P_{SII} + P_{ISI} + P_{III} + \widehat{P_{SSI}} + \widehat{P_{SII}} + \widehat{P_{ISI}} + \widehat{P_{III}} + P_{SSI,g} + P_{SII,g} + P_{ISI,g} + P_{III,g} + \widehat{P_{SSI,g}} + \widehat{P_{SII,g}} + \widehat{P_{ISI,g}} + \widehat{P_{III,g}}\right)$$
$$+\sigma\left(Q_{SSI,g} + Q_{SII,g} + Q_{ISI,g} + Q_{III,g}\right) - \gamma_{m,u}Xm_I - \rho Xm_I$$

Men who want anal sex

$$\frac{dXm_{S,g'}}{dt} = \sigma\left(P_{SSS,g'} + P_{SIS,g'} + P_{ISS,g'} + P_{IIS,g'} + \widehat{P_{SSS,g'}} + \widehat{P_{SIS,g'}} + \widehat{P_{ISS,g'}} + \widehat{P_{IIS,g'}}\right) + \gamma_{m,u}Xm_{I,g'} - \rho Xm_{S,g'}$$
$$+\sigma\left(Q_{SIS,g'} + Q_{SIS,g'} + Q_{ISS,g'} + Q_{IIS,g'} + Q_{SIS,gg'} + Q_{SIS,gg'} + Q_{ISS,gg'} + Q_{IIS,gg'}\right)$$

$$\frac{dXm_{I,g'}}{dt} = \sigma\left(P_{SSI,g'} + P_{SII,g'} + P_{ISI,g'} + P_{III,g'} + \widehat{P_{SSI,g'}} + \widehat{P_{SII,g'}} + \widehat{P_{ISI,g'}} + \widehat{P_{III,g'}}\right) - \gamma_{m,u}Xm_{I,g'} - \rho Xm_{I,g'}$$
$$+\sigma\left(+Q_{SSI,g'} + Q_{SII,g'} + Q_{ISI,g'} + Q_{III,g'} + Q_{SSI,gg'} + Q_{SII,gg'} + Q_{ISI,gg'} + Q_{III,gg'}\right)$$

Equations for **pairs with vaginal sex only (P)**:

Pairs where both partners do not want anal sex

$$\frac{dP_{SSS}}{dt} = 2\rho\frac{Xf_{SS}Xm_S}{\sum X} - \sigma P_{SSS} + \upsilon\widehat{P_{SSS}} + \gamma_{f,u}P_{ISS} + \gamma_{f,a}P_{SIS} + \gamma_{m,u}P_{SSI} + \alpha_f\tau_{azy,u}q\tau_{azy,u}P_{ISI} + \alpha_f\tau_{azy,u}P_{ISS}$$
$$+\alpha_f\begin{cases}\theta = 1 & \tau_{azy,u}\tau_{azy,a}q\tau_{azy,u}P_{III} + \tau_{azy,u}\tau_{azy,a}P_{IIS}\\ \theta = 0 & \tau_{doxy,u}\tau_{doxy,a}q\tau_{azy,u}P_{III} + \tau_{doxy,u}\tau_{doxy,a}P_{IIS} + \tau_{doxy,a}P_{SIS} + \tau_{doxy,a}q\tau_{azy,u}P_{SII}\end{cases}$$

$$\frac{dP_{SSI}}{dt} = 2\rho\frac{Xf_{SS}Xm_I}{\sum X} + \upsilon\widehat{P_{SSI}} + \gamma_{f,u}P_{ISI} + \gamma_{f,a}P_{SII} - (\sigma + \gamma_{m,u} + \beta_u\phi_{uu})P_{SSI} + \alpha_f\left(\tau_{azy,u}(1-q) + \tau_{azy,u}q(1-\tau_{azy,u})\right)P_{ISI}$$
$$+\alpha_f\begin{cases}\theta = 1 & \left(\tau_{azy,u}\tau_{azy,a}(1-q) + \tau_{azy,u}\tau_{azy,a}q(1-\tau_{azy,u})\right)P_{III}\\ \theta = 0 & \left(\tau_{doxy,u}\tau_{doxy,a}(1-q) + \tau_{doxy,u}\tau_{doxy,a}q(1-\tau_{azy,u})\right)P_{III} + \left(\tau_{doxy,a}(1-q) + \tau_{doxy,a}q(1-\tau_{azy,u})\right)P_{SII}\end{cases}$$

$$\frac{dP_{SIS}}{dt} = 2\rho\frac{Xf_{SI}Xm_S}{\sum X} + \upsilon\widehat{P_{SIS}} + \gamma_{f,u}P_{IIS} + \gamma_{m,u}P_{SII} - (\sigma + \gamma_{f,a} + \beta_x)P_{SIS}$$
$$+\alpha_f\begin{cases}\theta = 1 & \tau_{azy,u}(1-\tau_{azy,a})q\tau_{azy,u}P_{III} + \tau_{azy,u}(1-\tau_{azy,a})P_{IIS}\\ \theta = 0 & \tau_{doxy,u}(1-\tau_{doxy,a})q\tau_{azy,u}P_{III} + \tau_{doxy,u}(1-\tau_{doxy,a})P_{IIS} - \tau_{doxy,a}P_{SIS} + (1-\tau_{doxy,a})q\tau_{azy,u}P_{SII}\end{cases}$$

$$\frac{dP_{SII}}{dt} = 2\rho\frac{Xf_{SI}Xm_I}{\sum X} + \upsilon\widehat{P_{SII}} + \gamma_{f,u}P_{III} - (\sigma + \gamma_{f,a} + \gamma_{m,u} + \beta_x + \beta_u\phi_{uu})P_{SII}$$
$$+\alpha_f\begin{cases}\theta = 1 & \left(\tau_{azy,u}(1-\tau_{azy,a})(1-q) + \tau_{azy,u}(1-\tau_{azy,a})q(1-\tau_{azy,u})\right)P_{III}\\ \theta = 0 & \left(\tau_{doxy,u}(1-\tau_{doxy,a})(1-q) + \tau_{doxy,u}(1-\tau_{doxy,a})q(1-\tau_{azy,u})\right)P_{III} - \left(\tau_{doxy,a} + (1-\tau_{doxy,a})q\tau_{azy,u}\right)P_{SII}\end{cases}$$

$$\frac{dP_{ISS}}{dt} = 2\rho\frac{Xf_{IS}Xm_S}{\sum X} + \upsilon\widehat{P_{ISS}} + \gamma_{f,a}P_{IIS} + \gamma_{m,u}P_{ISI} - (\sigma + \gamma_{f,u} + \beta_x + \beta_u\phi_{uu})P_{ISS} + \alpha_f(1-\tau_{azy,u})q\tau_{azy,u}P_{ISI} - \alpha_f\tau_{azy,u}P_{ISS}$$
$$+\alpha_f\begin{cases}\theta = 1 & (1-\tau_{azy,u})\tau_{azy,a}q\tau_{azy,u}P_{III} + (1-\tau_{azy,u})\tau_{azy,a}P_{IIS}\\ \theta = 0 & (1-\tau_{doxy,u})\tau_{doxy,a}q\tau_{azy,u}P_{III} + (1-\tau_{doxy,u})\tau_{doxy,a}P_{IIS}\end{cases}$$

$$\frac{dP_{ISI}}{dt} = 2\rho\frac{Xf_{IS}Xm_I}{\sum X} + \upsilon\widehat{P_{ISS}} + \gamma_{f,a}P_{III} + \beta_u\phi_{uu}P_{ISS} + \beta_u\phi_{uu}P_{SSI} - (\sigma + \gamma_{f,u} + \gamma_{m,u} + \beta_x)P_{ISI} - \alpha_f(\tau_{azy,u} + (1-\tau_{azy,u})q\tau_{azy,u})P_{ISI}$$
$$+\alpha_f\begin{cases}\theta = 1 & \left((1-\tau_{azy,u})\tau_{azy,a}(1-q) + (1-\tau_{azy,u})\tau_{azy,a}q(1-\tau_{azy,u})\right)P_{III}\\ \theta = 0 & \left((1-\tau_{doxy,u})\tau_{doxy,a}(1-q) + (1-\tau_{doxy,u})\tau_{doxy,a}q(1-\tau_{azy,u})\right)P_{III}\end{cases}$$

$$\frac{dP_{IIS}}{dt} = 2\rho\frac{Xf_{II}Xm_S}{\sum X} + \upsilon\widehat{P_{IIS}} + \gamma_{m,u}P_{III} + \beta_x(P_{ISS} + P_{SIS}) - (\sigma + \gamma_{f,a} + \gamma_{f,u} + \beta_u\phi_{uu})P_{IIS}$$
$$+\alpha_f\begin{cases}\theta = 1 & (1-\tau_{azy,u})(1-\tau_{azy,a})q\tau_{azy,u}P_{III} - (\tau_{azy,u} + (1-\tau_{azy,u})\tau_{azy,a})P_{IIS}\\ \theta = 0 & (1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u}P_{III} - (\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a})P_{IIS}\end{cases}$$

$$\frac{dP_{III}}{dt} = 2\rho\frac{Xf_{II}Xm_I}{\sum X} + \upsilon\widehat{P_{III}} + \beta_u\phi_{uu}P_{IIS} + \beta_xP_{ISI} + (\beta_u\phi_{uu} + \beta_x)P_{SII} - (\sigma + \gamma_{f,u} + \gamma_{m,u} + \gamma_{f,a})P_{III}$$
$$-\alpha_f\begin{cases}\theta = 1 & (\tau_{azy,u} + (1-\tau_{azy,u})\tau_{azy,a} + (1-\tau_{azy,u})(1-\tau_{azy,a})q\tau_{azy,u})P_{III}\\ \theta = 0 & (\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a} + (1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u})P_{III}\end{cases}$$

Pairs where both partners do not want anal sex but the female partner had recent anal sex with a previous partner

$$\frac{d\widehat{P_{SSS}}}{dt} = 2\rho\frac{\widehat{Xf_{SS}}Xm_S}{\sum X} - (\sigma + \upsilon)\widehat{P_{SSS}} + \gamma_{f,u}\widehat{P_{ISS}} + \gamma_{f,a}\widehat{P_{SIS}} + \gamma_{m,u}\widehat{P_{SSI}} + \alpha_f\left(\tau_{azy,u}q\tau_{azy,u}\widehat{P_{ISI}} + \tau_{azy,u}\widehat{P_{ISS}} + \tau_{doxy,u}\tau_{doxy,a}q\tau_{azy,u}\widehat{P_{III}}\right)$$
$$+\alpha_f\left(\tau_{doxy,u}\tau_{doxy,a}\widehat{P_{IIS}} + \tau_{doxy,a}\widehat{P_{SIS}} + \tau_{doxy,a}q\tau_{azy,u}\widehat{P_{SII}}\right)$$

$$\frac{d\widehat{P_{SSI}}}{dt} = 2\rho\frac{\widehat{Xf_{SS}}Xm_I}{\sum X} - (\sigma + \upsilon)\widehat{P_{SSI}} + \gamma_{f,u}\widehat{P_{ISI}} + \gamma_{f,a}\widehat{P_{SII}} - (\gamma_{m,u} + \beta_u\phi_{uu})\widehat{P_{SSI}} + \alpha_f\left(\tau_{azy,u}(1-q) + \tau_{azy,u}q(1-\tau_{azy,u})\right)\widehat{P_{ISI}}$$
$$+\alpha_f\left(\tau_{doxy,u}\tau_{doxy,a}(1-q) + \tau_{doxy,u}\tau_{doxy,a}q(1-\tau_{azy,u})\right)\widehat{P_{III}} + \alpha_f\left(\tau_{doxy,a}(1-q) + \tau_{doxy,a}q(1-\tau_{azy,u})\right)\widehat{P_{SII}}$$

$$\frac{d\widehat{P_{SIS}}}{dt} = 2\rho\frac{\widehat{Xf_{SI}}Xm_S}{\sum X} - (\sigma + \upsilon)\widehat{P_{SIS}} + \gamma_{f,u}\widehat{P_{IIS}} + \gamma_{m,u}\widehat{P_{SII}} - (\gamma_{f,a} + \beta_x)\widehat{P_{SIS}} + \alpha_f\tau_{doxy,u}(1-\tau_{doxy,a})q\tau_{azy,u}\widehat{P_{III}} - \alpha_f\tau_{doxy,a}\widehat{P_{SIS}}$$
$$+\alpha_f\tau_{doxy,u}(1-\tau_{doxy,a})\widehat{P_{IIS}} + \alpha_f(1-\tau_{doxy,a})q\tau_{azy,u}\widehat{P_{SII}}$$

$$\frac{d\widehat{P_{SII}}}{dt} = 2\rho\frac{\widehat{Xf_{SI}}Xm_I}{\sum X} - (\sigma + \upsilon)\widehat{P_{SII}} + \gamma_{f,u}\widehat{P_{III}} - (\gamma_{f,a} + \gamma_{m,u} + \beta_x + \beta_u\phi_{uu})\widehat{P_{SII}} - \alpha_f\left(\tau_{doxy,a} + (1-\tau_{doxy,a})q\tau_{azy,u}\right)\widehat{P_{SII}}$$
$$+\alpha_f\left(\tau_{doxy,u}(1-\tau_{doxy,a})(1-q) + \tau_{doxy,u}(1-\tau_{doxy,a})q(1-\tau_{azy,u})\right)\widehat{P_{III}}$$

$$\frac{d\widehat{P_{ISS}}}{dt} = 2\rho\frac{\widehat{Xf_{IS}}Xm_S}{\sum X} - (\sigma+\upsilon)\widehat{P_{ISS}} + \gamma_{f,a}\widehat{P_{IIS}} + \gamma_{m,u}\widehat{P_{ISI}} - (\gamma_{f,u}+\beta_x+\beta_u\phi_{uu})\widehat{P_{ISS}} + \alpha_f(1-\tau_{azy,u})q\tau_{azy,u}\widehat{P_{ISI}} - \alpha_f\tau_{azy,u}\widehat{P_{ISS}}$$
$$+\alpha_f(1-\tau_{doxy,u})\tau_{doxy,a}q\tau_{azy,u}\widehat{P_{III}} + \alpha_f(1-\tau_{doxy,u})\tau_{doxy,a}\widehat{P_{IIS}}$$

$$\frac{d\widehat{P_{ISI}}}{dt} = 2\rho\frac{\widehat{Xf_{IS}}Xm_I}{\sum X} - (\sigma+\upsilon)\widehat{P_{ISS}} + \gamma_{f,a}\widehat{P_{III}} + \beta_u\phi_{uu}\widehat{P_{ISS}} + \beta_u\phi_{uu}\widehat{P_{SSI}} - (\gamma_{f,u}+\gamma_{m,u}+\beta_x)\widehat{P_{ISI}}$$
$$+\alpha_f\left((1-\tau_{doxy,u})\tau_{doxy,a}(1-q) + (1-\tau_{doxy,u})\tau_{doxy,a}q(1-\tau_{azy,u})\right)\widehat{P_{III}} - \alpha_f(\tau_{azy,u}+(1-\tau_{azy,u})q\tau_{azy,u})\widehat{P_{ISI}}$$

$$\frac{d\widehat{P_{IIS}}}{dt} = 2\rho\frac{\widehat{Xf_{II}}Xm_S}{\sum X} - (\sigma+\upsilon)\widehat{P_{IIS}} + \gamma_{m,u}\widehat{P_{III}} + \beta_x(\widehat{P_{ISS}}+\widehat{P_{SIS}}) - (\gamma_{f,a}+\gamma_{f,u}+\beta_u\phi_{uu})\widehat{P_{IIS}} + \alpha_f(1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u}\widehat{P_{III}}$$
$$-\alpha_f(\tau_{doxy,u}+(1-\tau_{doxy,u})\tau_{doxy,a})\widehat{P_{IIS}}$$

$$\frac{d\widehat{P_{III}}}{dt} = 2\rho\frac{\widehat{Xf_{II}}Xm_I}{\sum X} - (\sigma+\upsilon)\widehat{P_{III}} + \beta_u\phi_{uu}\widehat{P_{IIS}} + \beta_x\widehat{P_{ISI}} + (\beta_u\phi_{uu}+\beta_x)\widehat{P_{SII}} - (\gamma_{f,u}+\gamma_{m,u}+\gamma_{f,a})\widehat{P_{III}}$$
$$-\alpha_f(\tau_{doxy,u}+(1-\tau_{doxy,u})\tau_{doxy,a}+(1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u})\widehat{P_{III}}$$

Pairs where the female partner wants anal sex but it does not happen in this partnership

$$\frac{dP_{SSS,g}}{dt} = 2\rho(1-\delta)\frac{Xf_{SS,g}Xm_S}{\sum X} - \sigma P_{SSS,g} + \upsilon\widehat{P_{SSS,g}} + \gamma_{f,u}P_{ISS,g} + \gamma_{f,a}P_{SIS,g} + \gamma_{m,u}P_{SSI,g} + \alpha_f\tau_{azy,u}q\tau_{azy,u}P_{ISI,g} + \alpha_f\tau_{azy,u}P_{ISS,g}$$
$$+\alpha_f\begin{cases}\theta=1 & \tau_{azy,u}\tau_{azy,a}q\tau_{azy,u}P_{III,g} + \tau_{azy,u}\tau_{azy,a}P_{IIS,g}\\ \theta=0 & \tau_{doxy,u}\tau_{doxy,a}q\tau_{azy,u}P_{III,g} + \tau_{doxy,u}\tau_{doxy,a}P_{IIS,g} + \tau_{doxy,a}P_{SIS,g} + \tau_{doxy,a}q\tau_{azy,u}P_{SII,g}\end{cases}$$

$$\frac{dP_{SSI,g}}{dt} = 2\rho(1-\delta)\frac{Xf_{SS,g}Xm_I}{\sum X} + \upsilon\widehat{P_{SSI,g}} + \gamma_{f,u}P_{ISI,g} + \gamma_{f,a}P_{SII,g} - (\sigma+\gamma_{m,u}+\beta_u\phi_{uu})P_{SSI,g}$$
$$+\alpha_f\left(\tau_{azy,u}(1-q)+\tau_{azy,u}q(1-\tau_{azy,u})\right)P_{ISI,g}$$
$$+\alpha_f\begin{cases}\theta=1 & \left(\tau_{azy,u}\tau_{azy,a}(1-q)+\tau_{azy,u}\tau_{azy,a}q(1-\tau_{azy,u})\right)P_{III,g}\\ \theta=0 & \left(\tau_{doxy,u}\tau_{doxy,a}(1-q)+\tau_{doxy,u}\tau_{doxy,a}q(1-\tau_{azy,u})\right)P_{III,g} + \left(\tau_{doxy,a}(1-q)+\tau_{doxy,a}q(1-\tau_{azy,u})\right)P_{SII,g}\end{cases}$$

$$\frac{dP_{SIS,g}}{dt} = 2\rho(1-\delta)\frac{Xf_{SI,g}Xm_S}{\sum X} + \upsilon\widehat{P_{SIS,g}} + \gamma_{f,u}P_{IIS,g} + \gamma_{m,u}P_{SII,g} - (\sigma+\gamma_{f,a}+\beta_x)P_{SIS,g}$$
$$+\alpha_f\begin{cases}\theta=1 & \tau_{azy,u}(1-\tau_{azy,a})q\tau_{azy,u}P_{III,g} + \tau_{azy,u}(1-\tau_{azy,a})P_{IIS,g}\\ \theta=0 & \tau_{doxy,u}(1-\tau_{doxy,a})q\tau_{azy,u}P_{III,g} + \tau_{doxy,u}(1-\tau_{doxy,a})P_{IIS,g} - \tau_{doxy,a}P_{SIS,g} + (1-\tau_{doxy,a})q\tau_{azy,u}P_{SII,g}\end{cases}$$

$$\frac{dP_{SII,g}}{dt} = 2\rho(1-\delta)\frac{Xf_{SI,g}Xm_I}{\sum X} + \upsilon\widehat{P_{SII,g}} + \gamma_{f,u}P_{III,g} - (\sigma+\gamma_{f,a}+\gamma_{m,u}+\beta_x+\beta_u\phi_{uu})P_{SII,g}$$
$$+\alpha_f\begin{cases}\theta=1 & \left(\tau_{azy,u}(1-\tau_{azy,a})(1-q)+\tau_{azy,u}(1-\tau_{azy,a})q(1-\tau_{azy,u})\right)P_{III,g}\\ \theta=0 & \left(\tau_{doxy,u}(1-\tau_{doxy,a})(1-q)+\tau_{doxy,u}(1-\tau_{doxy,a})q(1-\tau_{azy,u})\right)P_{III,g} - \left(\tau_{doxy,a}+(1-\tau_{doxy,a})q\tau_{azy,u}\right)P_{SII,g}\end{cases}$$

$$\frac{dP_{ISS,g}}{dt} = 2\rho(1-\delta)\frac{Xf_{IS,g}Xm_S}{\sum X} + \upsilon\widehat{P_{ISS,g}} + \gamma_{f,a}P_{IIS,g} + \gamma_{m,u}P_{ISI,g} - (\sigma+\gamma_{f,u}+\beta_x+\beta_u\phi_{uu})P_{ISS,g} + \alpha_f(1-\tau_{azy,u})q\tau_{azy,u}P_{ISI,g}$$
$$-\alpha_f\tau_{azy,u}P_{ISS,g}$$
$$+\alpha_f\begin{cases}\theta=1 & (1-\tau_{azy,u})\tau_{azy,a}q\tau_{azy,u}P_{III,g} + (1-\tau_{azy,u})\tau_{azy,a}P_{IIS,g}\\ \theta=0 & (1-\tau_{doxy,u})\tau_{doxy,a}q\tau_{azy,u}P_{III,g} + (1-\tau_{doxy,u})\tau_{doxy,a}P_{IIS,g}\end{cases}$$

$$\frac{dP_{ISI,g}}{dt} = 2\rho(1-\delta)\frac{Xf_{IS,g}Xm_I}{\sum X} + \upsilon\widehat{P_{ISS,g}} + \gamma_{f,a}P_{III,g} + \beta_u\phi_{uu}P_{ISS,g} + \beta_u\phi_{uu}P_{SSI,g} - (\sigma+\gamma_{f,u}+\gamma_{m,u}+\beta_x)P_{ISI,g}$$
$$-\alpha_f(\tau_{azy,u}+(1-\tau_{azy,u})q\tau_{azy,u})P_{ISI,g}$$
$$+\alpha_f\begin{cases}\theta=1 & \left((1-\tau_{azy,u})\tau_{azy,a}(1-q)+(1-\tau_{azy,u})\tau_{azy,a}q(1-\tau_{azy,u})\right)P_{III,g}\\ \theta=0 & \left((1-\tau_{doxy,u})\tau_{doxy,a}(1-q)+(1-\tau_{doxy,u})\tau_{doxy,a}q(1-\tau_{azy,u})\right)P_{III,g}\end{cases}$$

$$\frac{dP_{IIS,g}}{dt} = 2\rho(1-\delta)\frac{Xf_{II,g}Xm_S}{\sum X} + \upsilon\widehat{P_{IIS,g}} + \gamma_{m,u}P_{III,g} + \beta_x(P_{ISS,g}+P_{SIS,g}) - (\sigma+\gamma_{f,a}+\gamma_{f,u}+\beta_u\phi_{uu})P_{IIS,g}$$
$$+\alpha_f\begin{cases}\theta=1 & (1-\tau_{azy,u})(1-\tau_{azy,a})q\tau_{azy,u}P_{III,g} - (\tau_{azy,u}+(1-\tau_{azy,u})\tau_{azy,a})P_{IIS,g}\\ \theta=0 & (1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u}P_{III,g} - (\tau_{doxy,u}+(1-\tau_{doxy,u})\tau_{doxy,a})P_{IIS,g}\end{cases}$$

$$\frac{dP_{III,g}}{dt} = 2\rho(1-\delta)\frac{Xf_{II,g}Xm_I}{\sum X} + \upsilon\widehat{P_{III,g}} + \beta_u\phi_{uu}P_{IIS,g} + \beta_xP_{ISI,g} + (\beta_u\phi_{uu}+\beta_x)P_{SII,g} - (\sigma+\gamma_{f,u}+\gamma_{m,u}+\gamma_{f,a})P_{III,g}$$
$$-\alpha_f\begin{cases}\theta=1 & (\tau_{azy,u}+(1-\tau_{azy,u})\tau_{azy,a}+(1-\tau_{azy,u})(1-\tau_{azy,a})q\tau_{azy,u})P_{III,g}\\ \theta=0 & (\tau_{doxy,u}+(1-\tau_{doxy,u})\tau_{doxy,a}+(1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u})P_{III,g}\end{cases}$$

Pairs where the female partner wants anal sex but it does not happen in this partnership, but she had recent anal sex with a previous partner

$$\frac{d\widehat{P_{SSS,g}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{SS,g}}Xm_S}{\sum X} - (\sigma+\upsilon)\widehat{P_{SSS,g}} + \gamma_{f,u}\widehat{P_{ISS,g}} + \gamma_{f,a}\widehat{P_{SIS,g}} + \gamma_{m,u}\widehat{P_{SSI,g}} + \alpha_f\left(\tau_{azy,u}q\tau_{azy,u}\widehat{P_{ISI,g}} + \tau_{azy,u}\widehat{P_{ISS,g}}\right)$$
$$+\alpha_f\left(\tau_{doxy,u}\tau_{doxy,a}q\tau_{azy,u}\widehat{P_{III,g}} + \tau_{doxy,u}\tau_{doxy,a}\widehat{P_{IIS,g}} + \tau_{doxy,a}\widehat{P_{SIS,g}} + \tau_{doxy,a}q\tau_{azy,u}\widehat{P_{SII,g}}\right)$$

$$\frac{d\widehat{P_{SSI,g}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{SS,g}}Xm_I}{\sum X} - (\sigma+\upsilon)\widehat{P_{SSI,g}} + \gamma_{f,u}\widehat{P_{ISI,g}} + \gamma_{f,a}\widehat{P_{SII,g}} - \left(\gamma_{m,u}+\beta_u\phi_{uu}\right)\widehat{P_{SSI,g}}$$
$$+\alpha_f\left(\tau_{azy,u}(1-q)+\tau_{azy,u}q\left(1-\tau_{azy,u}\right)\right)\widehat{P_{ISI,g}} + \alpha_f\left(\tau_{doxy,u}\tau_{doxy,a}(1-q)+\tau_{doxy,u}\tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)\widehat{P_{III,g}}$$
$$+\alpha_f\left(\tau_{doxy,a}(1-q)+\tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)\widehat{P_{SII,g}}$$

$$\frac{d\widehat{P_{SIS,g}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{SI,g}}Xm_S}{\sum X} - (\sigma+\upsilon)\widehat{P_{SIS,g}} + \gamma_{f,u}\widehat{P_{IIS,g}} + \gamma_{m,u}\widehat{P_{SII,g}} - \left(\gamma_{f,a}+\beta_x\right)\widehat{P_{SIS,g}} + \alpha_f\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}\widehat{P_{III,g}}$$
$$-\alpha_f\tau_{doxy,a}\widehat{P_{SIS,g}} + \alpha_f\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)\widehat{P_{IIS,g}} + \alpha_f\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}\widehat{P_{SII,g}}$$

$$\frac{d\widehat{P_{SII,g}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{SI,g}}Xm_I}{\sum X} - (\sigma+\upsilon)\widehat{P_{SII,g}} + \gamma_{f,u}\widehat{P_{III,g}} - \left(\gamma_{f,a}+\gamma_{m,u}+\beta_x+\beta_u\phi_{uu}\right)\widehat{P_{SII,g}}$$
$$-\alpha_f\left(\tau_{doxy,a}+\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}\right)\widehat{P_{SII,g}} + \alpha_f\left(\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)(1-q)+\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)q\left(1-\tau_{azy,u}\right)\right)\widehat{P_{III,g}}$$

$$\frac{d\widehat{P_{ISS,g}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{IS,g}}Xm_S}{\sum X} - (\sigma+\upsilon)\widehat{P_{ISS,g}} + \gamma_{f,a}\widehat{P_{IIS,g}} + \gamma_{m,u}\widehat{P_{ISI,g}} - \left(\gamma_{f,u}+\beta_x+\beta_u\phi_{uu}\right)\widehat{P_{ISS,g}} + \alpha_f\left(1-\tau_{azy,u}\right)q\tau_{azy,u}\widehat{P_{ISI,g}}$$
$$-\alpha_f\tau_{azy,u}\widehat{P_{ISS,g}} + \alpha_f\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}q\tau_{azy,u}\widehat{P_{III,g}} + \alpha_f\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}\widehat{P_{IIS,g}}$$

$$\frac{d\widehat{P_{ISI,g}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{IS,g}}Xm_I}{\sum X} - (\sigma+\upsilon)\widehat{P_{ISS,g}} + \gamma_{f,a}\widehat{P_{III,g}} + \beta_u\phi_{uu}\widehat{P_{ISS,g}} + \beta_u\phi_{uu}\widehat{P_{SSI,g}} - \left(\gamma_{f,u}+\gamma_{m,u}+\beta_x\right)\widehat{P_{ISI,g}}$$
$$+\alpha_f\left(\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}(1-q)+\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)\widehat{P_{III,g}} - \alpha_f\left(\tau_{azy,u}+\left(1-\tau_{azy,u}\right)q\tau_{azy,u}\right)\widehat{P_{ISI,g}}$$

$$\frac{d\widehat{P_{IIS,g}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{II,g}}Xm_S}{\sum X} - (\sigma+\upsilon)\widehat{P_{IIS,g}} + \gamma_{m,u}\widehat{P_{III,g}} + \beta_x\left(\widehat{P_{ISS,g}}+\widehat{P_{SIS,g}}\right) - \left(\gamma_{f,a}+\gamma_{f,u}+\beta_u\phi_{uu}\right)\widehat{P_{IIS,g}}$$
$$+\alpha_f\left(1-\tau_{doxy,u}\right)\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}\widehat{P_{III,g}} - \alpha_f\left(\tau_{doxy,u}+\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}\right)\widehat{P_{IIS,g}}$$

$$\frac{d\widehat{P_{III,g}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{II,g}}Xm_I}{\sum X} - (\sigma+\upsilon)\widehat{P_{III,g}} + \beta_u\phi_{uu}\widehat{P_{IIS,g}} + \beta_x\widehat{P_{ISI,g}} + \left(\beta_u\phi_{uu}+\beta_x\right)\widehat{P_{SII,g}} - \left(\gamma_{f,u}+\gamma_{m,u}+\gamma_{f,a}\right)\widehat{P_{III,g}}$$
$$-\alpha_f\left(\tau_{doxy,u}+\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}+\left(1-\tau_{doxy,u}\right)\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}\right)\widehat{P_{III,g}}$$

Pairs where the male partner wants anal sex but it does not happen in this partnership

$$\frac{dP_{SSS,g'}}{dt} = 2\rho(1-\delta)\frac{Xf_{SS}Xm_{S,g'}}{\sum X} - \sigma P_{SSS,g'} + \upsilon\widehat{P_{SSS,g'}} + \gamma_{f,u}P_{ISS,g'} + \gamma_{f,a}P_{SIS,g'} + \gamma_{m,u}P_{SSI,g'} + \alpha_f\tau_{azy,u}q\tau_{azy,u}P_{ISI,g'}$$
$$+\alpha_f\tau_{azy,u}P_{ISS,g'}$$
$$+\alpha_f\begin{cases}\theta=1 & \tau_{azy,u}\tau_{azy,a}q\tau_{azy,u}P_{III,g'} + \tau_{azy,u}\tau_{azy,a}P_{IIS,g'}\\ \theta=0 & \tau_{doxy,u}\tau_{doxy,a}q\tau_{azy,u}P_{III,g'} + \tau_{doxy,u}\tau_{doxy,a}P_{IIS,g'} + \tau_{doxy,a}P_{SIS,g'} + \tau_{doxy,a}q\tau_{azy,u}P_{SII,g'}\end{cases}$$

$$\frac{dP_{SSI,g'}}{dt} = 2\rho(1-\delta)\frac{Xf_{SS}Xm_{I,g'}}{\sum X} + \upsilon\widehat{P_{SSI,g'}} + \gamma_{f,u}P_{ISI,g'} + \gamma_{f,a}P_{SII,g'} - \left(\sigma+\gamma_{m,u}+\beta_u\phi_{uu}\right)P_{SSI,g'}$$
$$+\alpha_f\left(\tau_{azy,u}(1-q)+\tau_{azy,u}q\left(1-\tau_{azy,u}\right)\right)P_{ISI},g'$$
$$+\alpha_f\begin{cases}\theta=1 & \left(\tau_{azy,u}\tau_{azy,a}(1-q)+\tau_{azy,u}\tau_{azy,a}q\left(1-\tau_{azy,u}\right)\right)P_{III,g'}\\ \theta=0 & \left(\tau_{doxy,u}\tau_{doxy,a}(1-q)+\tau_{doxy,u}\tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)P_{III,g'} + \left(\tau_{doxy,a}(1-q)+\tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)P_{SII,g'}\end{cases}$$

$$\frac{dP_{SIS,g'}}{dt} = 2\rho(1-\delta)\frac{Xf_{SI}Xm_{S,g'}}{\sum X} + \upsilon\widehat{P_{SIS,g'}} + \gamma_{f,u}P_{IIS,g'} + \gamma_{m,u}P_{SII,g'} - \left(\sigma+\gamma_{f,a}+\beta_x\right)P_{SIS,g'}$$
$$+\alpha_f\begin{cases}\theta=1 & \tau_{azy,u}\left(1-\tau_{azy,a}\right)q\tau_{azy,u}P_{III,g'} + \tau_{azy,u}\left(1-\tau_{azy,a}\right)P_{IIS,g'}\\ \theta=0 & \tau_{doxy,u}\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}P_{III,g'} + \tau_{doxy,u}\left(1-\tau_{doxy,a}\right)P_{IIS,g'} - \tau_{doxy,a}P_{SIS,g'} + \left(1-\tau_{doxy,a}\right)q\tau_{azy,u}P_{SII,g'}\end{cases}$$

$$\frac{dP_{SII,g'}}{dt} = 2\rho(1-\delta)\frac{Xf_{SI}Xm_{I,g'}}{\sum X} + \upsilon\widehat{P_{SII,g'}} + \gamma_{f,u}P_{III,g'} - \left(\sigma+\gamma_{f,a}+\gamma_{m,u}+\beta_x+\beta_u\phi_{uu}\right)P_{SII,g'}$$
$$+\alpha_f\begin{cases}\theta=1 & \left(\tau_{azy,u}\left(1-\tau_{azy,a}\right)(1-q)+\tau_{azy,u}\left(1-\tau_{azy,a}\right)q\left(1-\tau_{azy,u}\right)\right)P_{III,g'}\\ \theta=0 & \left(\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)(1-q)+\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)q\left(1-\tau_{azy,u}\right)\right)P_{III,g'} - \left(\tau_{doxy,a}+\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}\right)P_{SII,g'}\end{cases}$$

$$\frac{dP_{ISS,g'}}{dt} = 2\rho(1-\delta)\frac{Xf_{IS}Xm_{S,g'}}{\sum X} + \upsilon\widehat{P_{ISS,g'}} + \gamma_{f,a}P_{IIS,g'} + \gamma_{m,u}P_{ISI,g'} - (\sigma + \gamma_{f,u} + \beta_x + \beta_u\phi_{uu})P_{ISS,g'} + \alpha_f(1-\tau_{azy,u})q\tau_{azy,u}P_{ISI,g'}$$
$$-\alpha_f\tau_{azy,u}P_{ISS,g'}$$
$$+\alpha_f\begin{cases}\theta = 1 & (1-\tau_{azy,u})\tau_{azy,a}q\tau_{azy,u}P_{III,g'} + (1-\tau_{azy,u})\tau_{azy,a}P_{IIS,g'}\\ \theta = 0 & (1-\tau_{doxy,u})\tau_{doxy,a}q\tau_{azy,u}P_{III,g'} + (1-\tau_{doxy,u})\tau_{doxy,a}P_{IIS,g'}\end{cases}$$

$$\frac{dP_{ISI,g'}}{dt} = 2\rho(1-\delta)\frac{Xf_{IS}Xm_{I,g'}}{\sum X} + \upsilon\widehat{P_{ISS,g'}} + \gamma_{f,a}P_{III,g'} + \beta_u\phi_{uu}P_{ISS,g'} + \beta_u\phi_{uu}P_{SSI,g'} - (\sigma + \gamma_{f,u} + \gamma_{m,u} + \beta_x)P_{ISI,g'}$$
$$-\alpha_f(\tau_{azy,u} + (1-\tau_{azy,u})q\tau_{azy,u})P_{ISI,g'}$$
$$+\alpha_f\begin{cases}\theta = 1 & \left((1-\tau_{azy,u})\tau_{azy,a}(1-q) + (1-\tau_{azy,u})\tau_{azy,a}q(1-\tau_{azy,u})\right)P_{III,g'}\\ \theta = 0 & \left((1-\tau_{doxy,u})\tau_{doxy,a}(1-q) + (1-\tau_{doxy,u})\tau_{doxy,a}q(1-\tau_{azy,u})\right)P_{III,g'}\end{cases}$$

$$\frac{dP_{IIS,g'}}{dt} = 2\rho(1-\delta)\frac{Xf_{II}Xm_{S,g'}}{\sum X} + \upsilon\widehat{P_{IIS,g'}} + \gamma_{m,u}P_{III,g'} + \beta_x(P_{ISS,g'} + P_{SIS,g'}) - (\sigma + \gamma_{f,a} + \gamma_{f,u} + \beta_u\phi_{uu})P_{IIS,g'}$$
$$+\alpha_f\begin{cases}\theta = 1 & (1-\tau_{azy,u})(1-\tau_{azy,a})q\tau_{azy,u}P_{III,g'} - (\tau_{azy,u} + (1-\tau_{azy,u})\tau_{azy,a})P_{IIS,g'}\\ \theta = 0 & (1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u}P_{III,g'} - (\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a})P_{IIS,g'}\end{cases}$$

$$\frac{dP_{III,g'}}{dt} = 2\rho(1-\delta)\frac{Xf_{II}Xm_{I,g'}}{\sum X} + \upsilon\widehat{P_{III,g'}} + \beta_u\phi_{uu}P_{IIS,g'} + \beta_xP_{ISI,g'} + (\beta_u\phi_{uu} + \beta_x)P_{SII,g'} - (\sigma + \gamma_{f,u} + \gamma_{m,u} + \gamma_{f,a})P_{III,g'}$$
$$-\alpha_f\begin{cases}\theta = 1 & (\tau_{azy,u} + (1-\tau_{azy,u})\tau_{azy,a} + (1-\tau_{azy,u})(1-\tau_{azy,a})q\tau_{azy,u})P_{III,g'}\\ \theta = 0 & (\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a} + (1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u})P_{III,g'}\end{cases}$$

Pairs where the male partner wants anal sex but it does not happen in this partnership, and the female partner had recent anal sex with a previous partner

$$\frac{d\widehat{P_{SSS,g'}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{SS}}Xm_{S,g'}}{\sum X} - (\sigma + \upsilon)\widehat{P_{SSS,g'}} + \gamma_{f,u}\widehat{P_{ISS,g'}} + \gamma_{f,a}\widehat{P_{SIS,g'}} + \gamma_{m,u}\widehat{P_{SSI,g'}}$$
$$+\alpha_f(\tau_{azy,u}q\tau_{azy,u}\widehat{P_{ISI,g'}} + \tau_{azy,u}\widehat{P_{ISS,g'}} + \tau_{doxy,u}\tau_{doxy,a}q\tau_{azy,u}\widehat{P_{III,g'}})$$
$$+\alpha_f(\tau_{doxy,u}\tau_{doxy,a}\widehat{P_{IIS,g'}} + \tau_{doxy,a}\widehat{P_{SIS,g'}} + \tau_{doxy,a}q\tau_{azy,u}\widehat{P_{SII,g'}})$$

$$\frac{d\widehat{P_{SSI,g'}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{SS}}Xm_{I,g'}}{\sum X} - (\sigma + \upsilon)\widehat{P_{SSI,g'}} + \gamma_{f,u}\widehat{P_{ISI,g'}} + \gamma_{f,a}\widehat{P_{SII,g'}} - (\gamma_{m,u} + \beta_u\phi_{uu})\widehat{P_{SSI,g'}}$$
$$+\alpha_f\left(\tau_{azy,u}(1-q) + \tau_{azy,u}q(1-\tau_{azy,u})\right)\widehat{P_{ISI,g'}}$$
$$+\alpha_f\left(\tau_{doxy,u}\tau_{doxy,a}(1-q) + \tau_{doxy,u}\tau_{doxy,a}q(1-\tau_{azy,u})\right)\widehat{P_{III,g'}} + \alpha_f\left(\tau_{doxy,a}(1-q) + \tau_{doxy,a}q(1-\tau_{azy,u})\right)\widehat{P_{SII,g'}}$$

$$\frac{d\widehat{P_{SIS,g'}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{SI}}Xm_{S,g'}}{\sum X} - (\sigma + \upsilon)\widehat{P_{SIS,g'}} + \gamma_{f,u}\widehat{P_{IIS,g'}} + \gamma_{m,u}\widehat{P_{SII,g'}} - (\gamma_{f,a} + \beta_x)\widehat{P_{SIS,g'}} + \alpha_f\tau_{doxy,u}(1-\tau_{doxy,a})q\tau_{azy,u}\widehat{P_{III,g'}}$$
$$-\alpha_f\tau_{doxy,a}\widehat{P_{SIS,g'}} + \alpha_f\tau_{doxy,u}(1-\tau_{doxy,a})\widehat{P_{IIS,g'}} + \alpha_f(1-\tau_{doxy,a})q\tau_{azy,u}\widehat{P_{SII,g'}}$$

$$\frac{d\widehat{P_{SII,g'}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{SI}}Xm_{I,g'}}{\sum X} - (\sigma + \upsilon)\widehat{P_{SII,g'}} + \gamma_{f,u}\widehat{P_{III,g'}} - (\gamma_{f,a} + \gamma_{m,u} + \beta_x + \beta_u\phi_{uu})\widehat{P_{SII,g'}}$$
$$-\alpha_f\left(\tau_{doxy,a} + (1-\tau_{doxy,a})q\tau_{azy,u}\right)\widehat{P_{SII,g'}} + \alpha_f\left(\tau_{doxy,u}(1-\tau_{doxy,a})(1-q) + \tau_{doxy,u}(1-\tau_{doxy,a})q(1-\tau_{azy,u})\right)\widehat{P_{III,g'}}$$

$$\frac{d\widehat{P_{ISS,g'}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{IS}}Xm_{S,g'}}{\sum X} - (\sigma + \upsilon)\widehat{P_{ISS,g'}} + \gamma_{f,a}\widehat{P_{IIS,g'}} + \gamma_{m,u}\widehat{P_{ISI,g'}} - (\gamma_{f,u} + \beta_x + \beta_u\phi_{uu})\widehat{P_{ISS,g'}} - \alpha_f\tau_{azy,u}\widehat{P_{ISS,g'}}$$
$$+\alpha_f(1-\tau_{azy,u})q\tau_{azy,u}\widehat{P_{ISI,g'}} + \alpha_f(1-\tau_{doxy,u})\tau_{doxy,a}q\tau_{azy,u}\widehat{P_{III,g'}} + \alpha_f(1-\tau_{doxy,u})\tau_{doxy,a}\widehat{P_{IIS,g'}}$$

$$\frac{d\widehat{P_{ISI,g'}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{IS,l}}Xm_{I,g'}}{\sum X} - (\sigma + \upsilon)\widehat{P_{ISS,g'}} + \gamma_{f,a}\widehat{P_{III,g'}} + \beta_u\phi_{uu}\widehat{P_{ISS,g'}} + \beta_u\phi_{uu}\widehat{P_{SSI,g'}} - (\gamma_{f,u} + \gamma_{m,u} + \beta_x)\widehat{P_{ISI,g'}}$$
$$+\alpha_f\left((1-\tau_{doxy,u})\tau_{doxy,a}(1-q) + (1-\tau_{doxy,u})\tau_{doxy,a}q(1-\tau_{azy,u})\right)\widehat{P_{III,g'}} - \alpha_f(\tau_{azy,u} + (1-\tau_{azy,u})q\tau_{azy,u})\widehat{P_{ISI,g'}}$$

$$\frac{d\widehat{P_{IIS,g'}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{II}}Xm_{S,g'}}{\sum X} - (\sigma + \upsilon)\widehat{P_{IIS,g'}} + \gamma_{m,u}\widehat{P_{III,g'}} + \beta_x(\widehat{P_{ISS,g'}} + \widehat{P_{SIS,g'}}) - (\gamma_{f,a} + \gamma_{f,u} + \beta_u\phi_{uu})\widehat{P_{IIS,g'}}$$
$$+\alpha_f(1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u}\widehat{P_{III,g'}} - \alpha_f(\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a})\widehat{P_{IIS,g'}}$$

$$\frac{d\widehat{P_{III,g'}}}{dt} = 2\rho(1-\delta)\frac{\widehat{Xf_{II}}Xm_{I,g'}}{\sum X} - (\sigma + \upsilon)\widehat{P_{III,g'}} + \beta_u\phi_{uu}\widehat{P_{IIS,g'}} + \beta_x\widehat{P_{ISI,g'}} + (\beta_u\phi_{uu} + \beta_x)\widehat{P_{SII,g'}} - (\gamma_{f,u} + \gamma_{m,u} + \gamma_{f,a})\widehat{P_{III,g'}}$$
$$-\alpha_f(\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a} + (1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u})\widehat{P_{III,g'}}$$

Equations for **pairs with vaginal sex and anal sex (Q)**:

Pairs where the female partner wants anal sex

$$\frac{dQ_{SSS,g}}{dt} = 2\rho\delta\frac{Xf_{SS,g}Xm_S}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{SS,g}}Xm_S}{\sum X} - \sigma Q_{SSS,g} + \gamma_{f,u}Q_{ISS,g} + \gamma_{f,a}Q_{SIS,g} + \gamma_{m,u}Q_{SSI,g} + \alpha_f\tau_{azy,u}q\tau_{azy,u}Q_{ISI,g} + \alpha_f\tau_{azy,u}Q_{ISS,g}$$
$$+\alpha_f\left(\tau_{doxy,u}\tau_{doxy,a}q\tau_{azy,u}Q_{III,g} + \tau_{doxy,u}\tau_{doxy,a}Q_{IIS,g} + \tau_{doxy,a}Q_{SIS,g} + \tau_{doxy,a}q\tau_{azy,u}Q_{SII,g}\right)$$

$$\frac{dQ_{SSI,g}}{dt} = 2\rho\delta\frac{Xf_{SS,g}Xm_I}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{SS,g}}Xm_I}{\sum X} + \gamma_{f,u}Q_{ISI,g} + \gamma_{f,a}Q_{SII,g} - \left(\sigma + \gamma_{m,u} + \beta_u\phi_{ua} + \beta_a\phi_a\right)Q_{SSI,g}$$
$$+\alpha_f\left(\tau_{azy,u}(1-q) + \tau_{azy,u}q\left(1-\tau_{azy,u}\right)\right)Q_{ISI,g} + \alpha_f\left(\tau_{doxy,u}\tau_{doxy,a}(1-q) + \tau_{doxy,u}\tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)Q_{III,g}$$
$$+\alpha_f\left(\tau_{doxy,a}(1-q) + \tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)Q_{SII,g}$$

$$\frac{dQ_{SIS,g}}{dt} = 2\rho\delta\frac{Xf_{SI,g}Xm_S}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{SI,g}}Xm_S}{\sum X} + \gamma_{f,u}Q_{IIS,g} + \gamma_{m,u}Q_{SII,g} - \left(\sigma + \gamma_{f,a} + \beta_x + \beta_a\phi_a\right)Q_{SIS,g} + \alpha_f\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)Q_{IIS,g}$$
$$+\alpha_f\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}Q_{III,g} - \alpha_f\tau_{doxy,a}Q_{SIS,g} + \alpha_f\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}Q_{SII,g}$$

$$\frac{dQ_{SII,g}}{dt} = 2\rho\delta\frac{Xf_{SI,g}Xm_I}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{SI,g}}Xm_I}{\sum X} + \gamma_{f,u}Q_{III,g} - \left(\sigma + \gamma_{f,a} + \gamma_{m,u} + \beta_x + \beta_u\phi_{ua}\right)Q_{SII,g} + \beta_a\phi_aQ_{SIS,g} + \beta_a\phi_aQ_{SSI,g}$$
$$+\alpha_f\left(\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)(1-q) + \tau_{doxy,u}\left(1-\tau_{doxy,a}\right)q\left(1-\tau_{azy,u}\right)\right)Q_{III,g} - \alpha_f\left(\tau_{doxy,a} + \left(1-\tau_{doxy,a}\right)q\tau_{azy,u}\right)Q_{SII,g}$$

$$\frac{dQ_{ISS,g}}{dt} = 2\rho\delta\frac{Xf_{IS,g}Xm_S}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{IS,g}}Xm_S}{\sum X} + \gamma_{f,a}Q_{IIS,g} + \gamma_{m,u}Q_{ISI,g} - \left(\sigma + \gamma_{f,u} + \beta_x + \beta_u\phi_{ua}\right)Q_{ISS,g} + \alpha_f\left(1-\tau_{azy,u}\right)q\tau_{azy,u}Q_{ISI,g}$$
$$-\alpha_f\tau_{azy,u}Q_{ISS,g} + \alpha_f\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}q\tau_{azy,u}Q_{III,g} + \alpha_f\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}Q_{IIS,g}$$

$$\frac{dQ_{ISI,g}}{dt} = 2\rho\delta\frac{Xf_{IS,g}Xm_I}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{IS,g}}Xm_I}{\sum X} + \gamma_{f,a}Q_{III,g} + \beta_u\phi_{ua}Q_{ISS,g} + \beta_u\phi_{ua}Q_{SSI,g} - \left(\sigma + \gamma_{f,u} + \gamma_{m,u} + \beta_x + \beta_a\phi_a\right)Q_{ISI,g}$$
$$-\alpha_f\left(\tau_{azy,u} + \left(1-\tau_{azy,u}\right)q\tau_{azy,u}\right)Q_{ISI,g} + \alpha_f\left(\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}(1-q) + \left(1-\tau_{doxy,u}\right)\tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)Q_{III,g}$$

$$\frac{dQ_{IIS,g}}{dt} = 2\rho\delta\frac{Xf_{II,g}Xm_S}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{II,g}}Xm_S}{\sum X} + \gamma_{m,u}Q_{III,g} + \beta_x\left(Q_{ISS,g} + Q_{SIS,g}\right) - \left(\sigma + \gamma_{f,a} + \gamma_{f,u} + \beta_u\phi_{ua} + \beta_a\phi_a\right)Q_{IIS,g}$$
$$+\alpha_f\left(1-\tau_{doxy,u}\right)\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}Q_{III,g} - \alpha_f\left(\tau_{doxy,u} + \left(1-\tau_{doxy,u}\right)\tau_{doxy,a}\right)Q_{IIS,g}$$

$$\frac{dQ_{III,g}}{dt} = 2\rho\delta\frac{Xf_{II,g}Xm_I}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{II,g}}Xm_I}{\sum X} + \beta_u\phi_{ua}Q_{IIS,g} + \beta_a\phi_aQ_{IIS,g} + \beta_a\phi_aQ_{ISI,g} + \beta_xQ_{ISI,g} + \left(\beta_u\phi_{ua} + \beta_x\right)Q_{SII,g}$$
$$-\left(\sigma + \gamma_{f,u} + \gamma_{m,u} + \gamma_{f,a}\right)Q_{III,g} - \alpha_f\left(\tau_{doxy,u} + \left(1-\tau_{doxy,u}\right)\tau_{doxy,a} + \left(1-\tau_{doxy,u}\right)\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}\right)Q_{III,g}$$

Pairs where the male partner wants anal sex

$$\frac{dQ_{SSS,g'}}{dt} = 2\rho\delta\frac{Xf_{SS}Xm_{S,g'}}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{SS}}Xm_{S,g'}}{\sum X} - \sigma Q_{SSS,g'} + \gamma_{f,u}Q_{ISS,g'} + \gamma_{f,a}Q_{SIS,g'} + \gamma_{m,u}Q_{SSI,g'} + \alpha_f\tau_{azy,u}q\tau_{azy,u}Q_{ISI,g'}$$
$$+\alpha_f\left(\tau_{azy,u}Q_{ISS,g'} + \tau_{doxy,u}\tau_{doxy,a}q\tau_{azy,u}Q_{III,g'} + \tau_{doxy,u}\tau_{doxy,a}Q_{IIS,g'} + \tau_{doxy,a}Q_{SIS,g'} + \tau_{doxy,a}q\tau_{azy,u}Q_{SII,g'}\right)$$

$$\frac{dQ_{SSI,g'}}{dt} = 2\rho\delta\frac{Xf_{SS}Xm_{I,g'}}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{SS}}Xm_{I,g'}}{\sum X} + \gamma_{f,u}Q_{ISI,g'} + \gamma_{f,a}Q_{SII,g'} - \left(\sigma + \gamma_{m,u} + \beta_u\phi_{ua} + \beta_a\phi_a\right)Q_{SSI,g'}$$
$$+\alpha_f\left(\tau_{azy,u}(1-q) + \tau_{azy,u}q\left(1-\tau_{azy,u}\right)\right)Q_{ISI,g'} + \alpha_f\left(\tau_{doxy,u}\tau_{doxy,a}(1-q) + \tau_{doxy,u}\tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)Q_{III,g'}$$
$$+\alpha_f\left(\tau_{doxy,a}(1-q) + \tau_{doxy,a}q\left(1-\tau_{azy,u}\right)\right)Q_{SII,g'}$$

$$\frac{dQ_{SIS,g'}}{dt} = 2\rho\delta\frac{Xf_{SI}Xm_{S,g'}}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{SI}}Xm_{S,g'}}{\sum X} + \gamma_{f,u}Q_{IIS,g'} + \gamma_{m,u}Q_{SII,g'} - \left(\sigma + \gamma_{f,a} + \beta_x + \beta_a\phi_a\right)Q_{SIS,g'} - \alpha_f\tau_{doxy,a}Q_{SIS,g'}$$
$$+\alpha_f\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)Q_{IIS,g'} + \alpha_f\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}Q_{III,g'} + \alpha_f\left(1-\tau_{doxy,a}\right)q\tau_{azy,u}Q_{SII,g'}$$

$$\frac{dQ_{SII,g'}}{dt} = 2\rho\delta\frac{Xf_{SI}Xm_{I,g'}}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{SI}}Xm_{I,g'}}{\sum X} + \gamma_{f,u}Q_{III,g'} - \left(\sigma + \gamma_{f,a} + \gamma_{m,u} + \beta_x + \beta_u\phi_{ua}\right)Q_{SII,g'} + \beta_a\phi_aQ_{SIS,g'} + \beta_a\phi_aQ_{SSI,g'}$$
$$+\alpha_f\left(\tau_{doxy,u}\left(1-\tau_{doxy,a}\right)(1-q) + \tau_{doxy,u}\left(1-\tau_{doxy,a}\right)q\left(1-\tau_{azy,u}\right)\right)Q_{III,g'} - \alpha_f\left(\tau_{doxy,a} + \left(1-\tau_{doxy,a}\right)q\tau_{azy,u}\right)Q_{SII,g'}$$

$$\frac{dQ_{ISS,g'}}{dt} = 2\rho\delta\frac{Xf_{IS}Xm_{S,g'}}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{IS}}Xm_{S,g'}}{\sum X} + \gamma_{f,a}Q_{IIS,g'} + \gamma_{m,u}Q_{ISI,g'} - \left(\sigma + \gamma_{f,u} + \beta_x + \beta_u\phi_{ua}\right)Q_{ISS,g'}$$
$$+\alpha_f\left(1-\tau_{azy,u}\right)q\tau_{azy,u}Q_{ISI,g'} - \alpha_f\tau_{azy,u}Q_{ISS,g'} + \alpha_f\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}q\tau_{azy,u}Q_{III,g'} + \alpha_f\left(1-\tau_{doxy,u}\right)\tau_{doxy,a}Q_{IIS,g'}$$

$$\frac{dQ_{ISI,g'}}{dt} = 2\rho\delta\frac{Xf_{IS}Xm_{I,g'}}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{IS}}Xm_{I,g'}}{\sum X} + \gamma_{f,a}Q_{III,g'} + \beta_u\phi_{ua}Q_{ISS,g'} + \beta_u\phi_{ua}Q_{SSI,g'} - (\sigma + \gamma_{f,u} + \gamma_{m,u} + \beta_x + \beta_a\phi_a)Q_{ISI,g'}$$
$$-\alpha_f(\tau_{azy,u} + (1-\tau_{azy,u})q\tau_{azy,u})Q_{ISI,g'} + \alpha_f\left((1-\tau_{doxy,u})\tau_{doxy,a}(1-q) + (1-\tau_{doxy,u})\tau_{doxy,a}q(1-\tau_{azy,u})\right)Q_{III,g'}$$

$$\frac{dQ_{IIS,g'}}{dt} = 2\rho\delta\frac{Xf_{II}Xm_{S,g'}}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{II}}Xm_{S,g'}}{\sum X} + \gamma_{m,u}Q_{III,g'} + \beta_x(Q_{ISS,g'} + Q_{SIS,g'}) - (\sigma + \gamma_{f,a} + \gamma_{f,u} + \beta_u\phi_{ua} + \beta_a\phi_a)Q_{IIS,g'}$$
$$+\alpha_f(1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u}Q_{III,g'} - \alpha_f(\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a})Q_{IIS,g'}$$

$$\frac{dQ_{III,g'}}{dt} = 2\rho\delta\frac{Xf_{II}Xm_{I,g'}}{\sum X} + 2\rho\delta\frac{\widehat{Xf_{II}}Xm_{I,g'}}{\sum X} + \beta_u\phi_{ua}Q_{IIS,g'} + \beta_a\phi_aQ_{IIS,g'} + \beta_a\phi_aQ_{ISI,g'} + \beta_xQ_{ISI,g'} + (\beta_u\phi_{ua} + \beta_x)Q_{SII,g'}$$
$$-(\sigma + \gamma_{f,u} + \gamma_{m,u} + \gamma_{f,a})Q_{III,g'} - \alpha_f(\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a} + (1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u})Q_{III,g'}$$

Pairs where both partners want anal sex

$$\frac{dQ_{SSS,gg'}}{dt} = 2\rho\frac{Xf_{SS,g}Xm_{Sg'}}{\sum X} + 2\rho\frac{\widehat{Xf_{SS,g}}Xm_{S,g'}}{\sum X} - \sigma Q_{SSS,gg'} + \gamma_{f,u}Q_{ISS,gg'} + \gamma_{f,a}Q_{SIS,gg'} + \gamma_{m,u}Q_{SSI,gg'} + \alpha_f\tau_{azy,u}q\tau_{azy,u}Q_{ISI,gg'}$$
$$+\alpha_f(\tau_{azy,u}Q_{ISS,gg'} + \tau_{doxy,u}\tau_{doxy,a}q\tau_{azy,u}Q_{III,gg'} + \tau_{doxy,u}\tau_{doxy,a}Q_{IIS,gg'} + \tau_{doxy,a}Q_{SIS,gg'} + \tau_{doxy,a}q\tau_{azy,u}Q_{SII,gg'})$$

$$\frac{dQ_{SSI,gg'}}{dt} = 2\rho\frac{Xf_{SS,g}Xm_{I,g'}}{\sum X} + 2\rho\frac{\widehat{Xf_{SS,g}}Xm_{I,g'}}{\sum X} + \gamma_{f,u}Q_{ISI,gg'} + \gamma_{f,a}Q_{SII,gg'} - (\sigma + \gamma_{m,u} + \beta_u\phi_{ua} + \beta_a\phi_a)Q_{SSI,gg'}$$
$$+\alpha_f\left(\tau_{azy,u}(1-q) + \tau_{azy,u}q(1-\tau_{azy,u})\right)Q_{ISI,gg'} + \alpha_f\left(\tau_{doxy,u}\tau_{doxy,a}(1-q) + \tau_{doxy,u}\tau_{doxy,a}q(1-\tau_{azy,u})\right)Q_{III,gg'}$$
$$+\alpha_f\left(\tau_{doxy,a}(1-q) + \tau_{doxy,a}q(1-\tau_{azy,u})\right)Q_{SII,gg'}$$

$$\frac{dQ_{SIS,gg'}}{dt} = 2\rho\frac{Xf_{SI,g}Xm_{S,g'}}{\sum X} + 2\rho\frac{\widehat{Xf_{SI,g}}Xm_{S,g'}}{\sum X} + \gamma_{f,u}Q_{IIS,gg'} + \gamma_{m,u}Q_{SII,gg'} - (\sigma + \gamma_{f,a} + \beta_x + \beta_a\phi_a)Q_{SIS,gg'} - \alpha_f\tau_{doxy,a}Q_{SIS,gg'}$$
$$+\alpha_f\tau_{doxy,u}(1-\tau_{doxy,a})Q_{IIS,gg'} + \alpha_f\tau_{doxy,u}(1-\tau_{doxy,a})q\tau_{azy,u}Q_{III,gg'} + \alpha_f(1-\tau_{doxy,a})q\tau_{azy,u}Q_{SII,gg'}$$

$$\frac{dQ_{SII,gg'}}{dt} = 2\rho\frac{Xf_{SI,g}Xm_{I,g'}}{\sum X} + 2\rho\frac{\widehat{Xf_{SI,g}}Xm_{I,g'}}{\sum X} + \gamma_{f,u}Q_{III,gg'} - (\sigma + \gamma_{f,a} + \gamma_{m,u} + \beta_x + \beta_u\phi_{ua})Q_{SII,gg'} + \beta_a\phi_aQ_{SIS,gg'} + \beta_a\phi_aQ_{SSI,gg'}$$
$$+\alpha_f\left(\tau_{doxy,u}(1-\tau_{doxy,a})(1-q) + \tau_{doxy,u}(1-\tau_{doxy,a})q(1-\tau_{azy,u})\right)Q_{III,gg'} - \alpha_f(\tau_{doxy,a} + (1-\tau_{doxy,a})q\tau_{azy,u})Q_{SII,gg'}$$

$$\frac{dQ_{ISS,gg'}}{dt} = 2\rho\frac{Xf_{IS,g}Xm_{S,g'}}{\sum X} + 2\rho\frac{\widehat{Xf_{IS,g}}Xm_{S,g'}}{\sum X} + \gamma_{f,a}Q_{IIS,gg'} + \gamma_{m,u}Q_{ISI,gg'} - (\sigma + \gamma_{f,u} + \beta_x + \beta_u\phi_{ua})Q_{ISS,gg'}$$
$$+\alpha_f(1-\tau_{azy,u})q\tau_{azy,u}Q_{ISI,gg'} - \alpha_f\tau_{azy,u}Q_{ISS,gg'} + \alpha_f(1-\tau_{doxy,u})\tau_{doxy,a}q\tau_{azy,u}Q_{III,gg'} + \alpha_f(1-\tau_{doxy,u})\tau_{doxy,a}Q_{IIS,gg'}$$

$$\frac{dQ_{ISI,gg'}}{dt} = 2\rho\frac{Xf_{IS,g}Xm_{I,g'}}{\sum X} + 2\rho\frac{\widehat{Xf_{IS,g}}Xm_{I,g'}}{\sum X} + \gamma_{f,a}Q_{III,gg'} + \beta_u\phi_{ua}Q_{ISS,gg'} + \beta_u\phi_{ua}Q_{SSI,gg'} - (\sigma + \gamma_{f,u} + \gamma_{m,u} + \beta_x + \beta_a\phi_a)Q_{ISI,gg'}$$
$$-\alpha_f(\tau_{azy,u} + (1-\tau_{azy,u})q\tau_{azy,u})Q_{ISI,gg'} + \alpha_f\left((1-\tau_{doxy,u})\tau_{doxy,a}(1-q) + (1-\tau_{doxy,u})\tau_{doxy,a}q(1-\tau_{azy,u})\right)Q_{III,gg'}$$

$$\frac{dQ_{IIS,gg'}}{dt} = 2\rho\frac{Xf_{II,g}Xm_{S,g'}}{\sum X} + 2\rho\frac{\widehat{Xf_{II,g}}Xm_{S,g'}}{\sum X} + \gamma_{m,u}Q_{III,gg'} + \beta_x(Q_{ISS,gg'} + Q_{SIS,gg'}) - (\sigma + \gamma_{f,a} + \gamma_{f,u} + \beta_u\phi_{ua} + \beta_a\phi_a)Q_{IIS,gg'}$$
$$+\alpha_f(1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u}Q_{III,gg'} - \alpha_f(\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a})Q_{IIS,gg'}$$

$$\frac{dQ_{III,gg'}}{dt} = 2\rho\frac{Xf_{II,g}Xm_{I,g'}}{\sum X} + 2\rho\frac{\widehat{Xf_{II,g}}Xm_{I,g'}}{\sum X} + \beta_u\phi_{ua}Q_{IIS,gg'} + \beta_a\phi_aQ_{IIS,gg'} + \beta_a\phi_aQ_{ISI,gg'} + \beta_xQ_{ISI,gg'} + (\beta_u\phi_{ua} + \beta_x)Q_{SII,gg'}$$
$$-(\sigma + \gamma_{f,u} + \gamma_{m,u} + \gamma_{f,a})Q_{III,gg'} - \alpha_f(\tau_{doxy,u} + (1-\tau_{doxy,u})\tau_{doxy,a} + (1-\tau_{doxy,u})(1-\tau_{doxy,a})q\tau_{azy,u})Q_{III,gg'}$$

Where $\sum X$ denotes the sum of all singles (both males and females). The initial conditions are chosen as such that the group that prefers anal sex equals *Pas*.

The distribution of female urogenital infections and anorectal infections that occur through sex or autoinoculation was calculated as follows:

Transmission on **urogenital** location:

Vaginal sex (a): $\beta_u\phi_{ua}(Q_{SSI} + Q_{SSI,g} + Q_{SSI,g'}) + \beta_u\phi_{ua}(Q_{SII} + Q_{SII,g} + Q_{SII,g'}) + \beta_u\phi_{uu}(P_{SSI} + \widehat{P_{SSI}} + P_{SSI,g} + \widehat{P_{SSI,g}} + P_{SSI,g'} + \widehat{P_{SSI,g'}}) + \beta_u\phi_{uu}(P_{SII} + \widehat{P_{SII}} + P_{SII,g} + \widehat{P_{SII,g}} + P_{SII,g'} + \widehat{P_{SII,g'}})$

Autoinoculation (b): $\beta_x(Xf_{SI} + \widehat{Xf_{SI}} + Xf_{SI,g} + \widehat{Xf_{SI,g}}) + \beta_x(Q_{SIS} + Q_{SIS,g} + Q_{SIS,g'}) + \beta_x(Q_{SIS} + Q_{SIS,g} + Q_{SIS,g'}) + \beta_x(P_{SIS} + \widehat{P_{SIS}} + P_{SIS,g} + \widehat{P_{SIS,g}} + P_{SIS,g'} + \widehat{P_{SIS,g'}}) + \beta_x(P_{SII} + \widehat{P_{SII}} + P_{SII,g} + \widehat{P_{SII,g}} + P_{SII,g'} + \widehat{P_{SII,g'}})$

where the fractions are calculated as a/(a+b) and b/(a+b) and b denotes the autoinoculation from the anorectal to the urogenital site

Transmission on **anorectal** location:

Anal sex (c): $\beta_a\phi_{ua}(Q_{SSI} + Q_{SSI,g} + Q_{SSI,g'}) + \beta_a\phi_{ua}(Q_{SSI} + Q_{SSI,g} + Q_{SSI,g'})$

Autoinoculation (d): $\beta_x(Xf_{IS} + \widehat{Xf_{IS}} + Xf_{IS,g} + \widehat{Xf_{IS,g}}) + \beta_x(Q_{ISS} + Q_{ISS,g} + Q_{ISS,g'}) + \beta_x(Q_{ISI} + Q_{ISI,g} + Q_{ISI,g'}) + \beta_x(P_{ISS} + \widehat{P_{ISS}} + P_{ISS,g} + \widehat{P_{ISS,g}} + P_{ISS,g'} + \widehat{P_{ISS,g'}}) + \beta_x(P_{ISI} + \widehat{P_{ISI}} + P_{ISI,g} + \widehat{P_{ISI,g}} + P_{ISI,g'} + \widehat{P_{ISI,g'}})$

where the fractions are calculated as c/(c+d) and d/(c+d) and d denotes the autoinoculation from the urogenital to the anorectal site

Text S2 Additional methods

Calibration procedure

The model was parameterized to reflect the chlamydia prevalence of young heterosexual STI clinic visitors in the Netherlands. Here we describe how we fitted the three unknown parameters (transmission probability per vaginal sex act and per anal sex act and the daily autoinoculation probability) to the site specific chlamydia prevalence in females and males.

For the per sex act transmission probabilities, we defined a uniform probability distribution between 0 and 0.10 and for the autoinoculation probability a uniform distribution between 0 and 0.05. The distributions were then sampled 50,000 times using Latin hypercube sampling.[10] For each parameter set, the model was solved numerically until the system reached a stable state, which is consistent with studies showing no decrease in chlamydia prevalence in young heterosexuals despite control efforts.[11 12] We then recorded the urogenital, anorectal and concurrent chlamydia prevalence in women and urogenital prevalence in men. Parameter sets were accepted when all 4 model prevalences were within the 95% confidence intervals of the data. Of the 50,000 parameter sets, 92 fell within the predefined ranges and were used in all analyses presented in the main text.

In the uncertainty analyses we changed one parameter, for example the anal infection duration, and fitted the model to the data using the same 50,000 parameter sets of transmission probabilities as in the main analyses. For each analyses, we again selected the parameters (which can be different from the main analyses) that resulted in prevalences that fell within the 95% confidence intervals of the data and calculated the impact of the intervention using those selected parameter sets.

Calculating impact of intervention measures

Figure S1 shows how we calculated the impact of intervention measures for one parameter set. Since every parameter set resulted in different chlamydia prevalences, we calculated the impact separately for every selected parameter set and report medians and inter quartile ranges over all parameter sets.

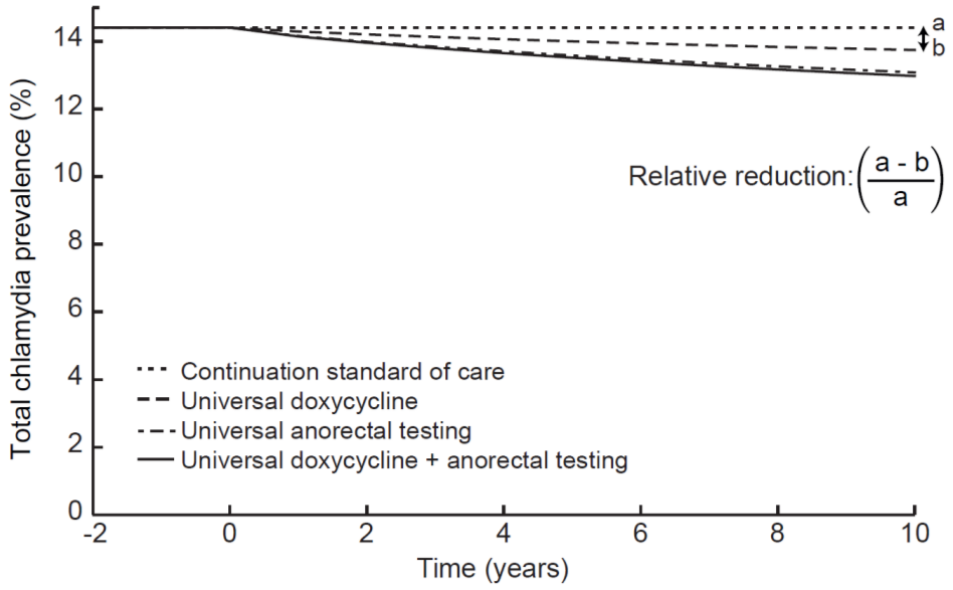

Figure S1 Example of how the relative reduction in prevalence of introducing the intervention measures is calculated. The example is for the total chlamydia prevalence (urogenital and/or anorectal infections), and for the doxycycline intervention measure, but the method is similar for anorectal and urogenital prevalence and other intervention measures. For every run the difference of the prevalence after 10 years between continuation of the standard of care (a) and universal doxycycline (b) is calculated and divided by the prevalence under the standard of care (a). In this particular example, the relative reduction of universal doxycycline would be (14.4% - 13.7%)/14.4% = 0.049, meaning that universal doxycycline would reduce the prevalence with 4.9% compared to continuation of the standard of care. This calculation is repeated for every selected parameter set since every parameter set resulted in slightly different baseline chlamydia prevalences. We report medians and inter quartile ranges over all parameter sets.

Text S3 Additional analyses

Here we show results from additional analyses. First, we show the results for the transmission probabilities and the distribution of infections that occur through sex or autoinoculation using data from the two additional data sources on universal routine anorectal testing.[13 14] We then show the results of the impact of intervention measures on urogenital (Table S3) and anorectal prevalence (Table S4), the total prevalence is given in the main document.

Two other studies on universal testing

The first study was in South-African women visiting primary care facilities.[13] The urogenital prevalence (16.0%) was slightly higher than the Dutch study, but the anorectal prevalence (7.1%) and the concurrent infections (calculated as 5.3% (32/603) from Dukers-Muijrers *et al*.[15]) were lower. The fraction of reported anal sex was much lower (5%) and the percentage of people with a steady partner was high (94%) which we accounted for in the model by changing pair formation and separation rates and the fraction of women having had recent anal sex. The second study was performed in a Danish STI clinic.[14] They found similar female urogenital prevalence (14.5%), but lower anorectal prevalence (5.6%) and concurrent infections (calculated as 4.6% (9/196) from Dukers-Muijrers *et al*.[15]) and a lower male prevalence (6.5%). Since no data on partner change rates or sex frequency were reported, it was assumed to be similar to the Dutch STI clinic visitors data from the main analyses. This is reasonable since the reported recent anal sex was also comparable between the studies (14% in the last 3 months vs 18% in the last 6 months). The results of the transmission probabilities and distribution of infections are shown in Figure S1.

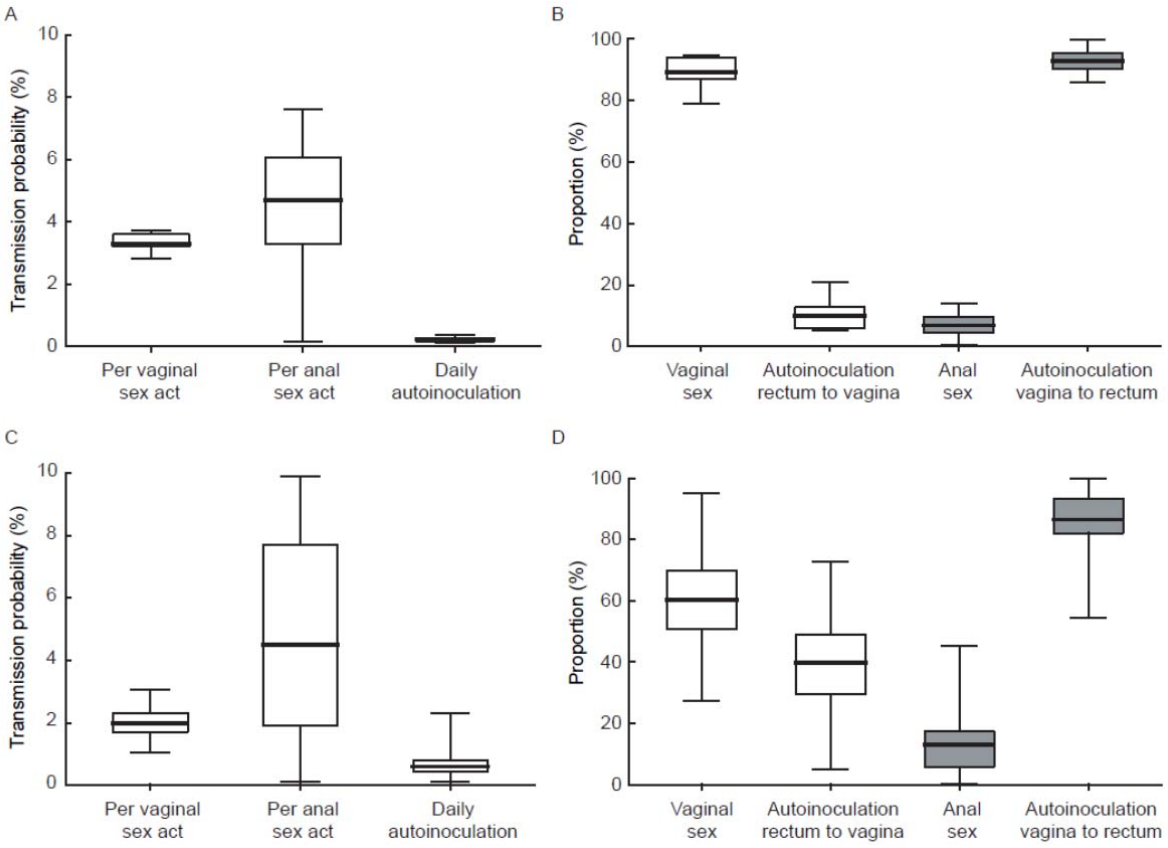

Figure S2 The calibrated transmission probabilities (A and C) and the corresponding distribution of female urogenital infections (white) and anorectal infections (grey) that occur through sex or autoinoculation (B and D) for fitting to the data from Peters *et al*.[13] (top row) or the data from Østergard *et al*.[14] (bottom row). Results are presented as medians (black line), with the boxes representing the inter quartile ranges and the bars the minimum and maximum values.

Impact of intervention measures on urogenital and anorectal prevalence

Table S3 Relative reduction of **urogenital** chlamydia prevalence of female STI clinic visitors 10 years after introducing universal routine doxycycline treatment or universal routine anorectal testing or both interventions combined compared to continuation of standard of care.

	Universal routine doxycycline % (IQR)	Universal routine anorectal testing % (IQR)	Both interventions % (IQR)
Baseline	4.1 (3.3 – 5.2)	8.2 (7.0 – 9.4)	8.8 (7.7 – 9.9)
Uncertainty analyses			
Infection parameters			
Anal infection duration is doubled (2 years)	3.9 (3.0 – 4.5)	11.2 (9.7 – 12.2)	11.8 (10.4 – 12.8)
Anal infection duration is halved (0.5 year)	4.6 (3.6 – 5.2)	6.5 (5.4 – 7.3)	7.1 (6.1 – 7.9)
Behavioural parameters			
Higher frequency of anal sex acts (once per week)	4.1 (3.2 – 4.8)	8.0 (7.1 – 8.7)	8.5 (7.7 – 9.2)
Lower vaginal sex acts in pairs that also engage in anal sex (same amount of sex acts in both partnerships)	4.3 (3.7 – 5.1)	8.4 (7.5 – 9.5)	9.1 (8.2 – 10.1)
Higher fraction of people with recent anal sex (30%)	2.7 (2.2 – 3.0)	5.0 (4.2 – 5.3)	5.6 (4.9 – 5.9)
Treatment parameters			
Lower azithromycin effectiveness for anorectal infection (56%)	8.6 (6.6 – 11.1)	12.5 (10.2 – 15.3)	13.2 (10.9 – 15.9)
Lower doxycycline effectiveness for anorectal infection (90%)	2.5 (2.0 – 2.9)	6.3 (5.4 – 6.8)	6.9 (6.1 – 7.4)
Higher azithromycin and doxycycline efficacy for urogenital infection (96.8% and 100%)[16]	4.4 (3.6 – 5.3)	8.4 (7.2 – 9.3)	9.1 (8.0 – 10.0)
Other scenarios			
Azithromycin as the standard of care for anorectal infections[17]	6.7 (5.7 – 8.3)	10.7 (9.3 – 12.4)	11.4 (10.0 – 12.9)
Higher female testing uptake (from 14% to 40% per year)	4.5 (3.7 – 5.3)	8.4 (7.5 – 9.3)	9.1 (8.2 – 9.8)
Other data source			
Peters et al (South-African primary care facility data)[13]	2.9 (2.5 – 3.3)	4.8 (3.4 – 6.2)	6.2 (4.9 – 7.5)
Østergaard et al (Danish STI clinic data)[14]	4.2 (3.4 – 4.8)	8.5 (6.9 – 9.4)	9.2 (7.7 – 10.1)

IQR, inter quartile ranges; STI, sexual transmitted infection.

Table S4 Relative reduction of **anorectal** chlamydia prevalence of female STI clinic visitors 10 years after introducing universal routine doxycycline treatment or universal routine anorectal testing or both interventions combined compared to continuation of standard of care.

	Universal routine doxycycline % (IQR)	Universal routine anorectal testing % (IQR)	Both interventions % (IQR)
Baseline	4.5 (3.7 – 5.5)	9.2 (8.2 – 10.1)	9.8 (8.9 – 10.7)
Uncertainty analyses			
Infection parameters			
Anal infection duration is doubled (2 years)	4.7 (3.0 – 5.2)	13.8 (12.8 – 14.3)	14.3 (13.3 – 14.7)
Anal infection duration is halved (0.5 year)	4.8 (3.9 – 5.4)	6.9 (6.0 – 7.6)	7.5 (6.7 – 8.2)
Behavioural parameters			
Higher frequency of anal sex acts (once per week)	4.5 (3.6 – 5.0)	8.7 (8.1 – 9.6)	9.2 (8.6 – 10.2)
Lower vaginal sex acts in pairs that also engage in anal sex (same amount of sex acts in both partnerships)	4.8 (4.2 – 5.4)	9.6 (8.9 – 10.3)	10.2 (9.6 – 10.9)
Higher fraction of people with recent anal sex (30%)	2.8 (2.5 – 3.2)	5.4 (5.0 – 5.8)	6.0 (5.6 – 6.4)
Treatment parameters			
Lower azithromycin effectiveness for anorectal infection (56%)	9.7 (7.8 – 12.1)	14.3 (12.3 – 16.5)	15.0 (12.9 – 17.1)
Lower doxycycline effectiveness for anorectal infection (90%)	2.6 (2.2 – 3.0)	7.0 (6.4 – 7.4)	7.5 (7.1 – 8.0)
Higher azithromycin and doxycycline efficacy for urogenital infection (96.8% and 100%)[16]	4.8 (4.1 – 5.6)	9.3 (8.5 – 10.2)	10.0 (9.3 – 10.9)
Other scenarios			
Azithromycin as the standard of care for anorectal infections[17]	7.4 (6.5 – 8.8)	12.2 (11.0 – 13.3)	12.9 (11.6 – 13.8)
Higher female testing uptake (from 14% to 40% per year)	5.1 (4.4 – 5.9)	10.0 (9.6 – 10.4)	10.5 (10.2 – 11.0)
Other data source			
Peters et al (South-African primary care facility data)[13]	4.0 (3.5 – 4.3)	8.6 (7.4 – 9.4)	9.9 (8.7 – 10.6)
Østergaard et al (Danish STI clinic data)[14]	4.6 (4.0 – 5.2)	9.7 (8.7 – 10.2)	10.4 (9.6 – 10.8)

IQR, inter quartile ranges; STI, sexual transmitted infection.

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