1,000 male condoms sold in Zambia avert 5.19 DALYs

The sale of 1,000 male condoms in Zambia gains 5.19 years of healthy life that would have been lost without PSI’s intervention.

Where does the 5.19 DALY figure come from?

One DALY (Disability Adjusted Life Year) represents one year of healthy life. The PSI DALY calculator estimates how many DALYs (years of healthy life) are gained due to PSI interventions.

PSI interventions prevent illness and death. People that benefit from these interventions live years of healthy life that would otherwise have been lost; these years of healthy life are expressed as DALYs averted.

PSI condom distribution promotes the use of condoms to prevent HIV-related morbidity and mortality in sexually active person. Due to the heterogeneity of sexual behaviors which are associated with HIV heterosexual transmission, sexually active people are divided into five risk groups (i.e., population categories) as defined by total number of partners. Those who reported having only one sexual partner in the past year are categorized as low risk group (accounting for 77.3%). Those with two sexual partners in the past year are under medium risk group (11.2%); those with 3 or 4 sexual partners high risk group (5.3%), those with 5 to 9 sexual partners very high risk group (3.7%) and those with 10 and more sexual partners the highest risk group (2.5%). On average, individuals in the low risk group have 0.854 regular partner (59 sexual contacts with each regular partner in the last year), 0.139 casual partner (43 sexual contacts with each casual partner in the last year), and 0.0072 commercial partner (near zero sexual contacts with each commercial partner in the last year). People in the medium risk group have 0.958 regular partner (70 sexual contacts with each), 0.391 casual (41 contacts with each), and 0.112 commercial partner (24 contacts with each). People in the high risk group have 0.997 regular (70 contacts with each), 1.763 casual (25 contacts with each), and 0.502 commercial partner (24 contacts with each). People in the very high risk group have 1.05 regular (56 contacts with each), 2.77 casual (22 contacts with each), and 2.27 commercial partner (25 contacts with each). People in the highest risk group have 4.09 regular (32 contacts with each), 4.74 casual (19 contacts with each) and 9.32 commercial
partner (36 contacts with each). Condom usage is estimated to be 10% with regular partner, 40% with casual and 60% with commercial partner across all five risk groups. Market share of PSI condoms is about 20%.

Based on the sexual behavior in each group and population proportion in each group, PSI estimates that the proportion of PSI condoms consumed by each group is 31% for low, 14% for medium, 9% for high, 13% for very high, and 33% for highest risk group.

For individual in each risk group, PSI estimates the risk of infection in the past year for two scenarios: when there are no PSI condoms and when PSI condoms are available on the market. Risk of infection is a function of the following parameters:

- HIV prevalence among general adults
- HIV prevalence among FSWs
- STD rate among general adults
- STD rate among FSWs
- Male circumcision rate
- Per-act infectivity when there is no STD infection and the HIV infected partner is not in acute infection stage
- Per-act infectivity when there is no STD infection and the HIV infection partner is in the acute infection stage
- STD effect on HIV transmission rate
- Protective efficacy of male condoms
- Protective efficacy of male circumcision
- Acute period of HIV infection
- Duration of HIV/AIDS infection
- Average number of sexual partners by type
- Average number of sexual contacts with each partner by type
- Percent of sex protected by a condom or PSI condom

With the estimate of risk of infection from the two scenarios, PSI then estimates the reduction in risk for infection in the past year by using PSI condoms for individuals in each risk group. With the sexual behavior related parameters, PSI estimates the number of PSI condoms consumed by individuals in each risk group. Dividing the amount of reduction in risk for infection by the number PSI condoms consumed, PSI gets the estimate of number of new infection averted per condom. After adjusting for a 10% condom wastage rate, PSI estimates the number of new infection averted per condom are 0.000106 for low, 0.000141 for medium, 0.000222 for high, 0.000373 for very high, and 0.000436 for the highest risk group.

Among the 1000 male condoms distributed, 307 were consumed by people at low risk, 141 by people at medium risk, 91 by people at high risk, 127 by people at very high risk and 334 by people at highest risk. With the estimates of new infection averted (NIA) per condom, PSI calculates that 0.03 NIA from the low risk group, 0.02 from the medium, 0.02 from the high, 0.05 from the very high, and 0.15 from the highest risk group. All together, 0.27 new infections are averted from the 1000 male condoms.

PSI assumes all HIV infected individuals will die after 10 years of HIV infection and two years of AIDS. The DALYs gained for averting one new infection is 19.3 DALYs for the lower three risk groups, 19.5 DALYs for the very high risk group, and 19.7 DALYs for the highest risk group (see next page for details). The DALYs averted per condom is therefore 0.0020 DALYs for the low, 0.0027 DALYs for the medium, 0.0043 DALYs for the high, 0.0073

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1 Three PSI TRaC surveys (2007) among general population from Angola, Zambia and Zimbabwe
DALYs for the very high, and 0.0086 for the highest risk group. The distribution of 1000 male condoms in Zambia thus averts a total of 5.19 DALYs (i.e., sum(1000 * proportion of condom consumed by each risk group * DALY coefficient)).
Details for Number Crunchers

:: Targeting: Proportion of PSI condoms consumed by each risk group is calculated as follow: (% individuals who are sexually active in group, * number of PSI condoms consumed per person per year in group)/ \( \sum_{i=1}^{5} (\text{numerator}) \), where, number of PSI condoms consumed per person per year in group, is calculated as follow: number of sexual partners by type * number of sexual contacts with each partner by type * % sexual contacts protected by a PSI condom

Let’s use the low risk group as an example,

:: 77.3% of individuals in the low risk group are sexually active
:: An average of 0.85 regular partner, 0.14 casual partner, and 0.0072 commercial partner in a year
:: An average of 59 sexual contacts with each regular partner, 43 sexual contacts with each casual partner and 0 contacts with each commercial partner in a year
:: % of sexual contacts protected by a PSI condom is 2% with regular partner, 8% with casual and 12% with commercial partner

Proportion of PSI condoms consumed by people falling in the low risk group:

\[
77.3\% \times (0.85 \times 59 \times 2\% + 0.14 \times 43 \times 8\% + 0.0072 \times 0 \times 12\%) / \sum_{i=1}^{5} (\text{numerator}) = 31\%
\]

:: Probability of infection through heterosexual activities of individuals from each risk group is calculated as follows:

\[
I = \prod_{j=\text{reg, casual, FSWs}} (1 - p_{hiv}) \times (1 - \left[p_{std} \times \gamma_{std, win} \times \frac{P_{hiv}}{Dur} \times \frac{54}{365} + p_{std} \times \gamma_{std, nonwin} \times \left(1 - \frac{p_{hiv}}{Dur} \times \frac{54}{365}\right) \right] + (1 - p_{std}) \times \gamma_{nastd, win} \times \frac{p_{hiv}}{Dur} \times \frac{54}{365})
\]

\[
+ (1 - p_{std}) \times \gamma_{nastd, nonwin} \times \left(1 - \frac{p_{hiv}}{Dur} \times \frac{54}{365}\right) \times \left(1 - p_{cir} \times PE_{cir} \times (1 - f) \right) \times \left(1 - PE_{cdm}\right) \times 365 \times 54 \times \frac{1}{365}
\]

Where,

- \( p_{std} \) refers to STD prevalence rate among partners;
- \( p_{hiv} \) refers to HIV prevalence rate among partners;
- \( p_{cir} \) refers to circumcision rate among males;
- \( \gamma_{std, win} \) refers to per-act infectivity when one or both partners have an STD and the HIV infected case is in the acute infection stage;
- \( \gamma_{std, nonwin} \) refers to per-act infectivity when one or both partners have an STD and the HIV infected case is not in the acute infection stage;
- \( \gamma_{nastd, win} \) refers to per-act infectivity when neither partner has an STD but the HIV infected case is in the acute infection stage;
- \( \gamma_{nastd, nonwin} \) refers to per-act infectivity when neither partner has an STD and the HIV infected case is not in the acute infection stage;
- \( Dur \) refers to the length of HIV infection;
- \( PE_{cir} \) refers to the protective efficacy of male circumcision;
- \( PE_{cdm} \) refers to the protective efficacy of male condoms;
- \( f \) refers to the fraction of sexual acts protected with a condom; and
- 54 is the length (in days) of acute HIV infection

Let’s use the low risk group as an example,
:: STD rate among regular & casual partners is 26%;
:: HIV prevalence rate among regular & casual partners is 17%;
:: Male circumcision rate is 12%;
:: Per-act infectivity when neither partner has an STD but the HIV infected case is in the acute infection stage is 0.0047;
:: Per-act infectivity when neither partner has an STD and the HIV infected case is not in the acute infection stage is 0.0005;
:: Effect of STD infection on HIV per-act infectivity is 5;
:: HIV infection lasts for 10 years and AIDS lasts for 2 years;
:: Protective efficacy of male circumcision is 60%;
:: Protective efficacy of male condoms is 90%;
:: An average of 0.85 regular partner, 0.14 casual partner, and 0.0072 commercial partner in a year
:: An average of 59 sexual contacts with each regular partner, 43 sexual contacts with each casual partner and 0 contacts with each commercial partner in a year
:: % of sexual contacts protected by a PSI condom is 2% with regular partner, 8% with casual and 12% with commercial partner
:: The length (in days) of acute HIV infection is 54 days

Plug those numbers into the formula and the probability of infection without & with PSI condoms are 0.006802 & 0.000175 for individuals in the low risk group.

:: YLL (Years of Life Lost) & YLD (Years lost due to disability/being sick) from HIV/AIDS is calculated as follows:
   Average duration of HIV * disability weight of HIV+ average duration of AIDS * disability weight of AIDS + Years of life lost due to premature death
   :: Duration of HIV is 10 years
   :: Duration of AIDS is 2 years
   :: Disability weight of HIV is 0.135^2
   :: Disability weight of AIDS is 0.505^3

   Years of life lost to death for HIV/AIDS is counted based on average age of death from HIV/AIDS in low risk group (26 years^4), discounting by 3% the future years until the age of 81.25 (internationally established potential limit for a life) totaling to 17.4 years
   YLL&YLD: 10 (discounting by 3%)*0.135 +2 (discounting by 3%)*0.505+ 17.4 = 19.3

:: New infection averted (NIA) coefficient is calculated as follows:
   (Reduction in risk of infection per person per year / number of PSI condoms consumed per person per year) * (1-wastage rate)
   :: Reduction in risk of infection per person per year for individuals in the low risk group is 0.006802-0.000175=0.000118)
   :: Number of PSI condoms consumed per person per year for individuals in the low risk group is 1.48
   :: Wastage rate of male condoms is 10%.

   New infection averted: (0.000118 /1.48) * (1-10%) = 0.000106 for low risk group.

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2 GBD&Risk Factor: Tabel 3A.6, p120.
3 GBD&Risk Factor: Tabel 3A.6, p120.
4 PSI estimates.
DALY coefficient is calculated as follows: NIA coefficient * (YLL+YLD)
DALY coefficient for the low risk group: 0.000106 * 19.3 = 0.00205

Similarly, the NIA & DALY coefficients for other four risk groups are calculated. When 1000 male condoms are distributed in Zambia, 307 used by individuals in low risk group, 141 by medium, 91 by high, 121 by very high and 334 by the highest risk group. With the NIA and DALY coefficients, the 1000 male condoms will avert 0.27 cases and 5.19 DALYs.

The approach applies to female condom except that we assume the protective efficacy is 85%.
The approach applies to free condom as well except that we assume an additional 25% wastage rate.