Population attributable risk for chlamydia infection in a cohort of young international travellers (backpackers) and residents in Australia

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ABSTRACT

Aim: To estimate the population attributable risk (PAR) for Chlamydia trachomatis infection in young men and women in Sydney, Australia.

Method: Multivariate logistic regression was used to examine the association between demographic, sexual behaviour and other potential risk factors and chlamydia positivity in young (≤30 years) heterosexual international travellers (backpackers) and Australian residents attending a sexual health clinic. Point and interval estimates of PAR were calculated to quantify the proportion of chlamydia infections that can theoretically be prevented if a combination of risk factors is eliminated from a target population.

Results: In males, the PAR associated with inconsistent condom use in the past 3 months was 65% (95% CI 56% to 71%) in backpackers compared to 50% (95% CI 41% to 56%) in non-backpackers and the PAR associated with reporting three or more female sexual partners in the past 3 months was similar between male backpackers and non-backpackers (33% (95% CI 28% to 40%) and 36% (95% CI 32% to 41%), respectively). In females, the PAR associated with inconsistent condom use in the past 3 months was 51% (95% CI 42% to 59%) in backpackers compared to 41% (95% CI 31% to 51%) in non-backpackers, and the PAR associated with reporting three or more male sexual partners in the past 3 months was 14% (95% CI 11% to 18%) in backpackers compared to 30% (95% CI 25% to 37%) in non-backpackers.

Conclusion: These findings suggest that the largest number of chlamydia infections could be avoided by increasing condom use, particularly in backpackers. Reporting multiple partners was also associated with a large proportion of infections and the risk associated with this behaviour should be considered in health promotion strategies.

INTRODUCTION

Australia remains a popular destination among young international travellers (backpackers), with 545 000 visiting Australia in 2006 with a mean length of stay of 72 days. Sydney alone hosted 407 000 backpackers. We previously reported that, compared with age-matched non-backpackers at our clinic, backpackers reported more recent sexual partners and were more likely to drink at hazardous levels. Studies also have found that 35%—40% of sexually active young travellers report multiple sexual partners in the past year and 30% inconsistent condom use with casual partners. In response, in Australia there have been numerous social marketing campaigns aimed at raising awareness about condom use and chlamydia screening among young people, including targeted campaigns for travellers.
Understanding the risk associated with various sexual behaviours and other factors is important to ensure health promotion strategies are evidence-based and appropriately targeted. Although odds ratios can quantify the association between a disease and a risk factor, they do not provide information about the potential impact on disease occurrence by reducing or eliminating various risk factors. In this paper, we use the population attributable risk (PAR), which takes account of both the odds ratio of specific risk factors and their prevalence in the population, to provide a quantitative assessment of the potential impact of reducing a risk factor on disease incidence at a population level. Instead of the using traditional method of calculating PAR, we used a novel method described by Spiegelman et al. and Wand et al. that adjusts for the effects of other variables.

**METHODS**

**Setting**

Sydney Sexual Health Clinic is a large urban public sexual health clinic in close proximity to the city and beach areas of Sydney which are popular destinations for backpackers.

From each patient, information on demographics, alcohol and drug use, sex work, sex overseas, sexual behaviour and the reason for attending the clinic are collected and entered into a computerised medical records system. All new attendees are offered a Chlamydia trachomatis nucleic acid amplification test.

**Definitions**

Heterosexual was defined as sex with the opposite sex only in the past 12 months. Backpacker was defined as having been born outside Australia, lived outside Australia for most of the last 5 years and been in Australia for less than 2 years, or self-identification as a ‘traveller’. Non-backpackers included all other attendees who were ≤30 years old. Hazardous alcohol consumption was considered to be more than 140 g per week for women and more than 280 g per week for men. Consumption was considered to be more than 140 g per week for women and more than 280 g per week for men.

**Statistical analysis**

Chlamydia positivity was calculated as the number of positive test results divided by the total number of test results. Indeterminate chlamydia results were excluded from this calculation. Univariate and multivariate logistic regression analysis was undertaken to identify factors independently associated with chlamydia positivity. The multivariate models considered all variables statistically significant (p<0.05) in the univariate analysis and used forward stepwise methods.

The following variables were included in the regression model: age group, country of birth, marital status, employment status, smoking status, hazardous alcohol consumption, history of prior chlamydia infection, condom use and number of sexual partners in the past 3 months, and sex overseas (Thailand, other countries, no sex overseas). Separate regression models were established for male backpackers, male non-backpackers, female backpackers and female non-backpackers.

**Population attributable risk**

PAR quantifies the potential impact of a risk factor on disease occurrence in the population. The PAR is formulated as a function of odds ratio (OR) and the prevalence (p) of the risk factor(s). When there is only one risk factor at two levels (1 vs 0)

\[
\text{PAR} = \frac{p(OR - 1)}{p(OR - 1) + 1} = 1 - \frac{1}{\sum_{i=1}^{2} p_i \cdot OR_i}
\]

where OR is the odds ratios, p is the prevalence of the risk factor(s). When there is more than one risk factor at multiple levels, as

\[
\text{PAR} = \frac{\sum_{i=1}^{s} p_i (OR_i - 1)}{1 + \sum_{i=1}^{s} p_i (OR_i - 1)} = 1 - \frac{1}{\sum_{i=1}^{s} p_i \cdot OR_i}
\]

where OR_i and p_i, i=1, ..., s are the odds ratios and the prevalences in the target population for the i-th combination of the risk factors. Full PAR can be estimated by using Equation 2 and interpreted as the per cent reduction expected in the number of chlamydia diagnoses if all known risk factors were eliminated from the target population.

In a multifactorial disease setting, at least some key risk factors such as age and sex are not modifiable. This limits the practical utility of the full PAR which is based on modification of all variables of interest. In an evaluation of a preventive intervention in a multifactorial disease setting, the interest is in the per cent reduction expected in the number of chlamydia diagnoses if all known risk factors were eliminated from the target population.

Therefore we derived and used the partial PAR which kept unmodifiable variable(s) unchanged.

Under the assumption of no interaction between the modifiable and non-modifiable risk factors of interest, the partial PAR is formulated as

\[
\text{PAR} = \frac{\sum_{t=1}^{T} \sum_{i=1}^{s} p_{t,i} \cdot OR_{1,t} \cdot OR_{2,t} - \sum_{i=1}^{s} \sum_{t=1}^{T} p_{t,i} \cdot OR_{1,t} \cdot OR_{2,t}}{\sum_{t=1}^{T} \sum_{i=1}^{s} p_{t,i} \cdot OR_{1,t} \cdot OR_{2,t}}
\]

where t denotes a stratum of unique combinations of levels of all background risk factors which are not modifiable and/or not under study, t=1, ..., T and OR_{2,t} is the odds ratio in combination t relative to the lowest risk level, where OR_{2,1}=1. As previously, s indicates a risk
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factor defined by each of the unique combinations of the levels of the modifiable risk factors, that is, those risk factors to which the PAR applies, \( s=1,\ldots, S \), and \( \text{OR}_1 \), is the odds ratio corresponding to combinations relative to the lowest risk combination, \( \text{OR}_{1,1} = 1 \). The joint prevalence of exposure group \( s \) and stratum \( t \) is denoted by \( p_{st} \) and \( \text{PAR} = \sum_{s=1}^{S} p_{st} \). The PAR represents the difference between the number of cases expected in the original cohort and the number of cases expected if all subsets of the cohort who were originally exposed to the modifiable risk factor(s) had eliminated their exposure(s) so that their RR compared to the unexposed was 1, divided by the number of cases expected in the original cohort.

The PAR is calculated based on the odds ratio of the association between the risk factor (sexual behaviour) and the outcome (chlamydia positivity), combined with the prevalence of the risk factor.

All analyses were conducted using SAS software, v 9 (SAS Institute). Ethics approval for the study was obtained from the South Eastern Sydney and Illawarra Area Health Service Human Research Ethics Committee.

RESULTS

A total of 12 958 heterosexuals aged 18–30 years attended SSHC for the first time during the period 1998–2006; 5702 (44%) were backpackers and this proportion increased steadily over time from 36% in 1998 to 52% in 2006.

Prevalence of risk factors

The characteristics of the study population are presented by gender in table 1.

Males

Compared to male non-backpackers, a significantly (\( p<0.001 \)) higher proportion of male backpackers were aged \( \leq 25 \) years (56% vs 42%), had never married (94% vs 85%), were unemployed (27% vs 13%), were current smokers (39% vs 34%), reported excess alcohol consumption (17% vs 5%), reported three or more sexual partners in the past 3 months (26% vs 15%), reported sex in Thailand in the past 12 months (22% vs 9%), reported a past chlamydia diagnosis (13% vs 9%) and stated that the reason for presenting to the clinic was for an STI/HIV screen (34% vs 32%) (table 1). A significantly higher proportion of female backpackers reported inconsistent condom use in the past 3 months (31%) compared to female non-backpackers (28%; \( p=0.006 \)).

Risk factors for chlamydia

Among 12 958 young heterosexuals, 731 chlamydia tests were positive, equating to an overall chlamydia positivity of 5.6% (95% CI 3.6% to 6.0%): 8% in male backpackers, 7% in male non-backpackers, 5% in female backpackers and 3% in female non-backpackers. The chlamydia positivity increased significantly over time in backpackers from 5% (95% CI 3% to 7%) in 1998 to 12% (95% CI 10% to 14%) in 2006 (\( p<0.001 \)) and also in non-backpackers from 3% (95% CI 2% to 4%) in 1998 to 8% (95% CI 6% to 10%) in 2006 (\( p<0.001 \)). Increasing trends were seen for both males and females (\( p<0.001 \)) (data not shown).

Tables 2 and 3 provide univariate and multivariate odds ratios for each factor considered in males and females, respectively.

Males

Independent predictors of chlamydia positivity in male non-backpackers were being aged \( \leq 25 \) years (adjusted odds ratio (AOR) 1.46, 95% CI 1.12 to 1.89), excess alcohol intake (AOR 1.65, 95% CI 1.04 to 2.61), inconsistent condom use (AOR 1.94, 95% CI 1.38 to 2.74), reporting two (AOR 2.11, 95% CI 1.53 to 2.91) or three or more sexual partners in the past 3 months (AOR 3.03, 95% CI 2.20 to 4.18), known STI contact (AOR 3.69, 95% CI 2.42 to 5.65) and a past chlamydia diagnosis (AOR 1.50, 95% CI 1.03 to 2.18). Male backpackers had the same independent predictors of chlamydia positivity except age, excess alcohol intake and past chlamydia diagnosis (table 2).

Females

In female non-backpackers, independent predictors of chlamydia positivity were inconsistent condom use (AOR 1.78, 95% CI 1.14 to 2.76), reporting three or more sexual partners in the past 3 months (AOR 3.00, 95% CI 1.89 to 4.77) and known STI contact (AOR 3.54, 95% CI 2.18 to 5.74). Female backpackers had the same independent predictors of chlamydia positivity as female non-backpackers (table 3).

Population attributable risk

The partial PARs by sex and backpacker status are shown in table 4. In males, inconsistent condom use was associated with the highest PAR, with 65% (95% CI 56% to 71%) of the chlamydia cases attributed to this risk factor among backpackers and 50% (95% CI 41% to 56%) of the cases in non-backpackers. In females, inconsistent condom use was associated with 51% (95% CI 42% to 59%) of the chlamydia cases among backpackers and 41% (95% CI 31% to 51%) of the cases in non-backpackers.

Wand H, Guy R, Donovan B, et al. BMJ Open 2011;1:e000004. doi:10.1136/bmjopen-2010-000004
| Variable                        | Young heterosexual males | Non-backpackers (n=3880), % | Backpackers (n=2765), % | p Value | Young heterosexual females | Non-backpackers (n=3376), % | Backpackers (n=2937), % | p Value |
|--------------------------------|--------------------------|-----------------------------|-------------------------|---------|---------------------------|-----------------------------|-----------------------------|---------|
| Age group (years)              |                          |                             |                         |         |                           |                             |                             |         |
| 26–30 years                    |                          | 58                          | 44                      | <0.001  | 48                        | 37                          | 37                          | <0.001  |
| ≤25 years                      |                          | 42                          | 56                      |         | 52                        | 63                          |                             |         |
| Country of birth               |                          |                             |                         |         |                           |                             |                             |         |
| Australia                      |                          | 62                          | —                       |         | 61                        | —                           | —                           |         |
| England                        |                          | 5                           | 47                      |         | 4                         | 45                          | —                           |         |
| Other                          |                          | 33                          | 55                      |         | 34                        | 55                          |                             |         |
| Marital status                 |                          |                             |                         |         |                           |                             |                             |         |
| Married/partner                |                          | 9                           | 4                       | <0.001  | 12                        | 5                           | <0.001                      |         |
| Never married                  |                          | 85                          | 94                      | <0.001  | 81                        | 92                          |                             |         |
| Other                          |                          | 5                           | 2                       |         | 4                         | 1                           |                             |         |
| Employment status              |                          |                             |                         |         |                           |                             |                             |         |
| Employed                       |                          | 80                          | 59                      | <0.001  | 78                        | 61                          | <0.001                      |         |
| Unemployed                     |                          | 13                          | 27                      |         | 13                        | 26                          |                             |         |
| Other                          |                          | 7                           | 14                      |         | 10                        | 13                          |                             |         |
| Reason for presentation        |                          |                             |                         |         |                           |                             |                             |         |
| STI/HIV screen                 |                          | 36                          | 41                      | <0.001  | 32                        | 34                          | 0.043                       |         |
| Known STI contact              |                          | 5                           | 4                       | 0.105   | 5                         | 5                           | 0.680                       |         |
| Ano-genital symptoms           |                          | 51                          | 49                      | 0.104   | 42                        | 42                          | 0.997                       |         |
| Genital herpes or warts        |                          | 3                           | 3                       | 0.974   | 3                         | 3                           | 0.311                       |         |
| Cigarette smoking status       |                          |                             |                         |         |                           |                             |                             |         |
| Not/past smoker                |                          | 66                          | 61                      | <0.001  | 64                        | 58                          | <0.001                      |         |
| Current smoker                 |                          | 34                          | 39                      |          | 36                        | 42                          |                             |         |
| Hazardous alcohol use*         |                          |                             |                         |         |                           |                             |                             |         |
| Yes                            |                          | 5                           | 17                      | <0.001  | 14                        | 27                          | <0.001                      |         |
| No                             |                          | 95                          | 83                      |          | 86                        | 73                          | <0.001                      |         |
| Consistent condom use (past 3 months) |                  |                             |                         |         |                           |                             |                             |         |
| Yes                            |                          | 69                          | 69                      | 0.889   | 72                        | 69                          | 0.006                       |         |
| No                             |                          | 31                          | 31                      |          | 28                        | 31                          |                             |         |
| Number of sex partners (past 3 months) |                |                             |                         |         |                           |                             |                             |         |
| 0                              |                          | 13                          | 10                      | <0.001  | 13                        | 10                          | <0.001                      |         |
| 1                              |                          | 51                          | 41                      |          | 65                        | 59                          |                             |         |
| 2                              |                          | 20                          | 23                      |          | 15                        | 20                          |                             |         |
| 3+                             |                          | 15                          | 26                      |          | 7                         | 11                          |                             |         |
| Sex overseas in last (and country) |                        |                             |                         |         |                           |                             |                             |         |
| Thailand                       |                          | 9                           | 22                      | <0.001  | 4                         | 7                           | <0.001                      |         |
| 12 months (and country)        |                          |                             |                         |         |                           |                             |                             |         |
| Sex in another country         |                          | 17                          | 41                      |          | 17                        | 45                          |                             |         |
| No sex overseas                |                          | 74                          | 38                      |          | 79                        | 48                          |                             |         |
| Past chlamydia diagnosis       |                          |                             |                         |         |                           |                             |                             |         |
| Yes (self-report)              |                          | 10                          | 15                      | <0.001  | 9                         | 13                          | <0.001                      |         |
| No                             |                          | 90                          | 85                      |          | 91                        | 87                          |                             |         |

*Average alcohol intake of 280 g for men and 140 g for women. STI, sexually transmissible infection.
| Predictor                                      | Young male heterosexual backpackers, n = 2765 | Young male heterosexual non-backpackers, n = 3880 |
|------------------------------------------------|-----------------------------------------------|--------------------------------------------------|
| Age group (years)                              |                                               |                                                  |
| ≤25 years                                      | OR (95% CI) 1.12 (0.87 to 1.46) p Value 0.375 | OR (95% CI) 1.40 (1.09 to 1.81) p Value 0.009    |
| >25 years                                      |                                               |                                                  |
| Marital status                                 |                                               |                                                  |
| Never married                                  | OR (95% CI) 1.45 (0.75 to 2.80) p Value 0.264 | OR (95% CI) 1.37 (0.92 to 2.04) p Value 0.118    |
| Current cigarette smoker                       |                                               |                                                  |
| No                                             | OR (95% CI) 1.13 (0.88 to 1.47) p Value 0.346 | OR (95% CI) 1.53 (1.18 to 1.97) p Value 0.001    |
| Yes                                            |                                               |                                                  |
| Excess alcohol*                                |                                               |                                                  |
| No                                             | OR (95% CI) 1.35 (0.98 to 1.85) p Value 0.063 | OR (95% CI) 2.03 (1.31 to 3.15) p Value 0.002    |
| Yes                                            |                                               |                                                  |
| Reason for presentation                        |                                               |                                                  |
| Other reasons                                  | OR (95% CI) 0.95 (0.68 to 1.32) p Value 0.760 | OR (95% CI) 0.67 (0.48 to 0.92) p Value 0.014    |
| STI/HIV test                                   | OR (95% CI) 1.03 (0.74 to 1.43) p Value 0.854 | OR (95% CI) 0.99 (0.73 to 1.33) p Value 0.923    |
| Ano-genital symptoms                           | OR (95% CI) 3.10 (1.92 to 4.93) p Value <0.001 | OR (95% CI) 3.24 (2.16 to 4.87) p Value <0.001   |
| Known STI contact                              | OR (95% CI) 2.95 (1.82 to 4.77) p Value <0.001 | OR (95% CI) 3.69 (2.42 to 5.65) p Value <0.001   |
| Number of sex partners (past 3 months)         |                                               |                                                  |
| 0 or 1                                         | OR (95% CI) 1.81 (1.31 to 2.51) p Value <0.001 | OR (95% CI) 2.09 (1.53 to 2.85) p Value <0.001   |
| 2                                              | OR (95% CI) 2.21 (1.63 to 3.00) p Value <0.001 | OR (95% CI) 3.18 (2.34 to 4.31) p Value <0.001   |
| 3 or more                                      | OR (95% CI) 3.17 (2.20 to 4.57) p Value <0.001 | OR (95% CI) 3.03 (2.20 to 4.18) p Value <0.001   |
| Consistent condom use (past 3 months)          |                                               |                                                  |
| Yes                                            | OR (95% CI) 1.37 (2.20 to 4.57) p Value <0.001 | OR (95% CI) 2.37 (1.70 to 3.31) p Value <0.001   |
| No                                             | OR (95% CI) 3.17 (2.20 to 4.57) p Value <0.001 | OR (95% CI) 1.94 (1.38 to 2.74) p Value <0.001   |
| Past chlamydia diagnosis                       |                                               |                                                  |
| No                                             | OR (95% CI) 1.37 (2.20 to 4.57) p Value <0.001 | OR (95% CI) 2.37 (1.70 to 3.31) p Value <0.001   |
| Yes                                            | OR (95% CI) 1.37 (2.20 to 4.57) p Value <0.001 | OR (95% CI) 1.94 (1.38 to 2.74) p Value <0.001   |

*Average alcohol intake of 280 g for men and 140 g for women.

STI, sexually transmissible infection.
### Table 3: Predictors of chlamydia in young heterosexual female backpackers and non-backpackers

| Predictor                          | Young female heterosexual backpackers, n = 2937 | Young female heterosexual non-backpackers, n = 3376 |
|-----------------------------------|-------------------------------------------------|---------------------------------------------------|
|                                   | Univariate                                      | Multivariate                                      | Univariate                                      | Multivariate                                      |
| Age group (years)                 | OR (95% CI)                                     | p Value                                           | OR (95% CI)                                     | p Value                                           |
| 26–30                             | 1                                                | 0.106                                             | 1                                              | 0.065                                             |
| <25                               | 1.30 (0.95 to 1.79)                             | –                                                 | 1.37 (0.98 to 1.91)                             | –                                                 |
| Marital status                    |                                                 |                                                   | 1                                              | 0.104                                             |
| Other                             | 1                                                | 0.434                                             | 1.48 (0.92 to 2.36)                             | –                                                 |
| Never married                     | 1.27 (0.70 to 2.32)                             | –                                                 | 1.39 (0.99 to 1.93)                             | –                                                 |
| Current cigarette smoker          |                                                 |                                                   | 1                                              | 0.0504                                            |
| No                                | 1                                                | 0.304                                             | 1.17 (0.87 to 1.58)                             | –                                                 |
| Yes                               | 1.17 (0.87 to 1.58)                             | –                                                 | 1.39 (0.99 to 1.93)                             | –                                                 |
| Excess alcohol*                   |                                                 |                                                   | 1                                              | 0.043                                             |
| No                                | 1                                                | 0.331                                             | 1                                              | 1.54 (1.01 to 2.34)                              | 0.043                                             |
| Yes                               | 1.17 (0.85 to 1.62)                             | –                                                 | 1.54 (1.01 to 2.34)                             | –                                                 |
| Reason for presentation           |                                                 |                                                   | 1                                              | 1                                                 |
| Other                             | <0.001                                          | <0.001                                            | 3.54 (2.18 to 5.74)                             | <0.001                                            |
| Known STI contact                 | 2.54 (1.58 to 4.08)                             | 2.37 (1.47 to 3.82)                              |                                                 |                                                   |
| Number of sex partners (past 3 months) |                                                 |                                                   |                                                 |                                                   |
| 0 or 1                            | 1                                                | 1                                                 | 1                                              | 1                                                 |
| 2                                 | 1.25 (0.86 to 1.81)                             | 0.243                                             | 1.57 (1.02 to 2.42)                             | 0.004                                             |
| 3 or more                         | 2.07 (1.38 to 3.11)                             | <0.001                                           | 3.05 (1.93 to 4.80)                             | <0.001                                            |
| Consistent condom use (past 3 months) |                                                 |                                                   |                                                 |                                                   |
| Yes                               | <0.001                                          | 1                                                 | 0.002                                          | 1                                                 |
| No                                | 2.50 (1.68 to 3.72)                             | 2.33 (1.56 to 3.48)                              | 2.00 (1.30 to 3.10)                             | 1.78 (1.14 to 2.76)                              | 0.011                                             |
| Past chlamydia diagnosis          |                                                 |                                                   | 1                                              | 0.362                                             |
| No                                | 1                                                | 0.192                                             | 1                                              | 1.28 (0.75 to 2.18)                              | 0.362                                             |
| Yes                               | 1.32 (0.87 to 1.99)                             | –                                                 | 1                                              | –                                                 |

*Alcohol intake of average 280 g for men and 140 g for women.
STI, sexually transmissible infection.
Two or more sexual partners in the past 3 months had the second highest PAR, with an estimated 33% (95% CI 28% to 40%) of the chlamydia cases among male backpackers and 36% (95% CI 32% to 41%) in male non-backpackers attributable to this risk factor. In females, three or more sexual partners in the past 3 months was associated with an estimated 14% (95% CI 11% to 18%) of the chlamydia cases among backpackers and 30% (95% CI 25% to 37%) of cases in non-backpackers.

When two factors were combined (inconsistent condom use and having three or more partners in the past 3 months), the estimated PAR was 81% (95% CI 73% to 86%) in male backpackers and 71% (95% CI 65% and 77%) in non-backpackers. In females, the estimated PAR for these two combined risk factors was 66% (95% CI 54% to 76%) and 63% (95% CI 53% to 73%) among female backpackers and non-backpackers, respectively.

When all four factors were combined (inconsistent condom use and having three or more sexual partners in the past 3 months, known STI contact and previous history of chlamydia), the PAR was 88%, 73%, 76% and 68% among male-backpackers, female-backpackers, male non-backpackers and female non-backpackers, respectively.

### DISCUSSION

The impact of risk factors for a disease at a population level has important implications for prevention policy and practice. In this study we have shown that the majority of chlamydia cases in our clinic population were attributable to inconsistent condom use and multiple sexual partners in the past 3 months. In both males and females, inconsistent condom use was associated with a greater PAR in backpackers compared to non-backpackers. Conversely in females, reporting three or more male sexual partners in the past 3 months was associated with a greater PAR in non-backpackers.

Notably, while sexual contact with a person known to have an STI was associated with a current chlamydia diagnosis, this only contributed a PAR of 2% because it was a relatively uncommon risk factor.

The PAR findings suggest that the largest number of chlamydia infections could be avoided by increasing condom use. In Australia there have been numerous health promotion strategies involving social marketing in the past 10 years which have focused on increasing condom use, but there is little evidence that they changed behaviour, and no evidence that they have led to a reduction in chlamydia transmission. Internationally, most mass media interventions have no effect on condom use. Our analysis also showed that multiple partners in the past 3 months was a frequently reported risk behaviour and a significant risk factor for chlamydia positivity, thus netting a substantial PAR. Although not specifically measured, multiple partners in a short period is likely to reflect sex with new partners or concurrent partnerships that are established risk factors for chlamydia.

Health promotion and other prevention strategies targeting young people need to be more innovative than just social marketing and include information about the various risk factors for chlamydia, which in turn may then lead to increased testing and treatment. With widespread use of the internet and mobile phones, electronic-based health promotion may be more effective at changing sexual and healthcare seeking behaviour. Lim and colleagues recently demonstrated in a randomised trial that sending health promotion messages via SMS increased self-reported condom use and STI testing rates compared to a control group. Also websites that enable young people to assess their individual risk of STIs based on the odds ratio of a range of risk factors should be considered. Regarding travellers, approaches should be targeted and include health promotion messages displayed in selected pubs/clubs, backpacker hostels, domestic airports and backpacker publications.

If a health department is considering spending money on controlling chlamydia, calculating the PAR makes it
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possible to estimate the potential population-level impact of the strategy and weigh this up against the available budget. For example, in young male Australian residents (non-backpackers) although a past chlamydia diagnosis was significantly associated with chlamydia positivity, its impact at a population level was about 5% due to the relatively low prevalence of this risk factor compared to a PAR of 60% for inconsistent condom use. This means that strategies that target men with a history of past chlamydia infection would need to cost 12 times less to be more cost effective.

Our study has some limitations. The sample was not representative of the general community and are likely to be at higher risk of chlamydia. A community-based study of young sexually active women aged 18–25 years found a chlamydia prevalence of 3.7% (95% CI 1.2% to 8.4%), which is lower than the 6% chlamydia positivity in our clinic-based sample.19 A community-based study of British backpackers in Australia found 41% of backpackers reported inconsistent condom use, which is also lower than the 69% reported in both males and females in our clinic sample.7 Most of the risk factors examined were based on self-reported data and may be subject to recall and measurement bias, particularly regarding the high PAR associated with this behaviour. In addition, young people should be given information about the risk associated with multiple partners and new partners.

Competing interests None.

Contributors HW implemented the study, analysed the data and wrote the first draft. RG, BD and AM helped interpreting the data and finalising the manuscript. All authors saw and approved the final manuscript.

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Correction

Wand H, Guy R, Donovan B et al. Population attributable risk for chlamydia infection in a cohort of young international travellers (backpackers) and residents in Australia. BMJ Open 2011;1:e000004.

The following reference was omitted from this paper:
10. Wand H, Ramjee G. Combined impact of sexual risk behaviors for HIV seroconversion among women in Durban, South Africa: implications for prevention policy and planning. AIDS Behav 2011;15:479–86.

References in the manuscript should be re-numbered accordingly.

‘Introduction’ section, page 2, paragraph 1, lines 8-12 should have read: “In this paper, we use the population attributable risk (PAR), which takes account of both the odds ratio of specific risk factors and their prevalence in the population, to provide a quantitative assessment of the potential impact of reducing a risk factor on disease incidence at a population level.10”

The ‘Statistical analysis’ section, ‘Population attributable risk’ sub-section, page 2, paragraph 2, lines 2–5 should have read: “The PAR is formulated as a function of odds ratio (OR) (s) and the prevalence (p) (s) of the risk factor(s). When there is only one risk factor at two levels (1 versus 0).10”

The ‘Statistical analysis’ section, ‘Population attributable risk’ sub-section, page 2, paragraph 3, lines 1-3 should have read: “Where OR is the odds ratios, p is the prevalence of the risk factor in the population and s indexes the two strata determined by the value of the risk factor.”

The ‘Statistical analysis’ section, ‘Population attributable risk’ sub-section, page 2, paragraph 4, lines 1-6 should have read: “where ORs and ps, s=1,…,S, are the odds ratios and the prevalences in the target population for the sth combination of the risk factors. Full PAR can be estimated by using Equation and interpreted as the percent reduction expected in the number of HIV seroconversion if all the known risk factors were eliminated from the target population. In a multifactorial disease setting, at least some key risk factors such as age and sex are not modifiable. This limits the practical utility of the full PAR which is based on modification of all variables of interests. In an evaluation of a preventive intervention in a multifactorial disease setting, the interest is in the percent of cases associated with the exposures to be modified, when other risk factors, particularly non-modifiable, exist but do not change as a result of the intervention. Therefore we derived and used partial PAR which kept unmodifiable variable(s) unchanged.”

The ‘Statistical analysis’ section, ‘Population attributable risk’ sub-section, page 2, paragraph 5, should have read: “where t denotes a stratum of unique combinations of levels of all background risk factors which are not modifiable and/or not under study, t=1,…,T and OR2t is the odds ratio in combination t relative to the lowest risk level, where OR21=1. As previously, t indicates a risk factor defined by each of the unique combinations of the levels of the modifiable risk factors, that is, those risk factors to which the PAR applies, s=1,…,S, and ORs is the relative risk corresponding to combinations relative to the lowest risk combination, ORs.”

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