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Title: A cost-effectiveness analysis of condom distribution programs for the prevention of sexually transmitted infections in England

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Competing Interest

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Structured Abstract

Background

Prevention of sexually transmitted infection (STI) incidence in England is a high priority, particularly among young people, men who have sex with men (MSM) and black ethnic minorities. An economic evaluation of condom distribution programs (CDPs) to reduce STI transmission is presented.

Methods

An economic model using a Bernoulli Process estimated the number of people acquiring an STI as a function of its prevalence, transmission rate, condom use, condom failure rate, and number of sexual contacts. Models were developed for young people (13-24 years), black ethnic minorities, MSM and the general English population. Effectiveness evidence came from a recent systematic review. For young people, a CDP was modelled (relative risk for condom use=1.23), along with an exploratory analysis of the impact on unintended pregnancies. For other populations, threshold analyses were used to identify the combination of costs and effect-size required to make a program cost-effective.

Results

The base case predicted that CDP for all young people in England could avert 5,123 STI cases per annum, with an incremental cost-effectiveness ratio of £17,411. In addition, it could avert 118 pregnancies and 82 abortions and save £333,000 in associated costs. Schemes for black ethnic minorities and MSM could also be cost-effective even with relatively high costs and small effect-sizes.

Conclusion

CDPs for young people are likely to be cost-effective or cost-saving. CDPS for other high-risk populations may also be cost-effective if they can increase condom use, since high HIV prevalence in these groups imposes a considerable health and cost burden.

Thumbnail Sketch

What is already known on this subject?

435,000 sexually transmitted infections were diagnosed in England in 2015, with substantial year-on-year increases in syphilis and gonorrhoea. Incidence was particularly high in young people under the age of 25, men who have sex with men and black ethnic minorities.

Condom distribution programs provide condoms free or at reduced prices, sometimes with training or support, to try and increase condom use and prevent the spread of sexually transmitted infections.

A recent systematic literature review highlighted a paucity of relevant evidence evaluating the cost-effectiveness of condom distribution programs in the UK.

What this study adds?

An economic model to evaluate the cost-effectiveness of condom distribution programs was developed. It suggested that an intervention which provides free condoms along with some education and support to young people in England could be expected to avert 5,123 new sexually transmitted infections per annum. This would lead to improved health-related quality of life and treatment cost savings, resulting in an estimated incremental cost of £17,411 per quality-adjusted life-year gained compared with no program.

Condom distribution programs for men who have sex with men and black ethnic minorities may also be cost-effective even with small increases in condom use since these groups have higher prevalence of HIV, which has a big impact on life-expectancy, quality of life and treatment costs.

Introduction

Sexually transmitted infections (STIs) have detrimental impacts on quality of life and survival and impose a burden on the UK National Health Service (NHS). In 2015 there were 435,000 new diagnoses in England with a 20% and 11% increase observed in the incidence of syphilis and gonorrhoea respectively compared with 2014 (2). STI incidence is highest among people under the age of 25, men who have sex with men (MSM) and black ethnic minorities (2).

Condoms can protect against transmission of many STIs including gonorrhoea, chlamydia, syphilis and HIV (3). The 2014-15 increase in syphilis and gonorrhoea diagnoses is attributed to high levels of unprotected sex (2). Reasons condoms are not used or are used incorrectly include cost, lack of knowledge and social norms. Condom distribution programs (CDPS) aim to overcome these challenges by providing condoms free of charge or at reduced prices, possibly accompanied by training or support, such as the C-Card program (the multi-component program most commonly offered to young people in England) (4).

The Department of Health referred the topic “Sexually transmitted infections: condom distribution schemes” to the National Institute for Health and Care Excellence (NICE) to develop public health guidance (5). NICE considers evidence for effectiveness and cost-effectiveness in developing recommendations. A systematic literature review highlighted a paucity of evidence for the cost-effectiveness of condom distribution programs in the UK (6). Therefore, we developed an economic model to evaluate the cost-effectiveness of CDPs. This study presents our economic evaluation of CDPs for the general population and for targeted at-risk groups: young people, MSM, and black ethnic minorities.

Methods

Population

We based the population on English 2011 census data by gender and five-year age-group (7). Cohorts of the appropriate age-range and gender were selected to model each of the target groups.

Model

We developed an economic model which estimated 'steady state' STI acquisition and associated cost-effectiveness. The model uses an established Bernoulli Process which estimates the number of STIs in a cohort of people (8) and has been used in other economic evaluations, including NICE Public Health guidelines (10, 11). The model predicts the proportion of people acquiring an STI in a given gender- and age-specific group (W) as a function of the STI prevalence (v), the proportion of sexually active people using condoms (g), the STI transmission rate (t), the condom failure rate (k), and the annual number of sexual contacts in that subgroup (s):

$$W = v(\Big(g\big(1 - ((1 - tk)^s)\big)\Big) + \Big((1 - g)\big(1 - ((1 - t)^s)\big)\Big))$$

The impact of a CDP was captured by changing the proportion of people using condoms (g) according to the effectiveness of the intervention while all other parameters were held constant. Outputs were total STI cases averted, quality-adjusted life years (QALYs)gained, costs and cost-effectiveness (cost per QALY gained).

Effectiveness

NICE's systematic review searched for evidence of effectiveness, in terms of changing condom use, of single-component programs (free provision of condoms), multi-component

programs (provision of condoms along with some sort of education or advice element) and cost-price condom provision programs between 1996 and 2015 (6) and identified 20 studies. Three studies were of multi-component programs in young people. These reported relative risks of 1.11 (95% CI=0.94-1.32) for condom use at last intercourse (Furstenberg *et al*. (12)), 1.13 (1.04-1.22) for condom use at last intercourse (Guttmacher *et al.* (13)) and 1.23 (1.10-1.38) for ever having used a condom (Larsson *et al*. (14)). Evidence quality varied, with Furstenberg *et al.* and Guttmacher *et al.* reporting quasi-experimental and pre-and post-intervention evaluations, whereas Larsson *et al.* reported a controlled trial. The studies were located in the US (Furstenberg, Guttmacher) and Sweden (Larsson). No studies evaluated interventions in the UK. The review concluded that there was some limited evidence to show that multi-component programs in high schools can increase condom use. The highest quality study (14) was chosen to give the estimated effectiveness in the base case (also the study with the largest effect size). It is worth noting that the population (students aged 17) and intervention (school-based) used in this trial was not a perfect match for the C-card program, which targets a broader age-range (typically ages 13-24) and in a wider range of settings (including sexual health, genito-urinary medicine clinics, youth services and schools). The base case uses an age range of 13-24 to replicate C-card. However, since the evidence is taken from a younger population, a scenario for ages 13-18 years is also presented.

The review identified one study targeting black ethnic minorities (15). This study was located in the USA and targeted those with high levels of syphilis. It reported that condom use increased, although study quality was poor and data were not presented.

The review identified one single component program targeting MSM. However, this study did not ask about condom use at last anal intercourse and despite improvements in condom possession rate, a small increase in men saying they ‘had anal intercourse without a condom simply because there was no condom available’ was reported (16).

The review identified only one study looking at reduced-price condom provision (17). Although this study showed increased condom purchasing, no data were collected on condom use.

Due to the lack of effectiveness evidence for programs for black ethnic minorities, MSM and the general population via discounted provision, a threshold analysis was carried out for these groups assessing a range of effectiveness and cost levels, to identify the combination of costs and effectiveness required to make a program cost effective at a threshold of £20,000 per QALY gained, or dominant (QALY-improving and cost-saving). £20,000 per QALY is the notional threshold used by NICE to assess whether interventions are considered cost-effective if funded by the NHS.

QALYs

QALY loss was modelled either using an absolute QALY reduction per STI obtained from the literature or a disutility per STI multiplied by time affected. For HIV Farnham *et al.* (18) was used, assuming people were diagnosed when their CD4 count was above 500, and including QALYs lost due to infections and reduced life-expectancy, with a 3% annual discounted rate, this being a US study. All QALY decrements are shown in Table 1.

[INSERT TABLE 1]

STIs

The STIs modelled are chlamydia, gonorrhoea, syphilis, human immunodeficiency virus (HIV) and pelvic inflammatory disease (PID), which can follow chlamydia or gonorrhoea in women. Prevalence of chlamydia, gonorrhoea and syphilis by risk group, age and gender were taken from Public Health England (PHE) cases in 2014 (19). HIV prevalence was based on new cases from PHE (20). Prevalence estimates are shown in Table 1.

[INSERT TABLE 2]

Other parameters

Table 1 contains all the parameters of the STI model. Age and gender-specific proportions of people who are sexually active and rates of sexual contact were taken from Mercer et al. (21), with under-13s assumed not to be sexually active. The percentage of men who are MSM (2.8%) was taken from the National Survey of Sexual Attitudes and Lifestyles (22).

Age-specific rates of routine condom use for young people, black ethnic minorities and the general population were reported by the Office of National Statistics (20), with under-16s assumed the same as 16-19 year-olds. MSM condom use was taken from the 2008 UK Gay Men's Sex Survey (23) and applied across all ages. Condom failure rate was based on Macaluso et al. (24).

Evidence on the probability of transmission per unprotected sexual contact is old and limited by the ethical implications of this research. Rates and sources are presented in Table 1.

Rates of PID as a function of the number of cases of chlamydia and gonorrhoea were based on two studies (25, 26).

Costs

We used an NHS and personal social services perspective, a cost year of 2015 and a 3.5% annual discount rate. All costs are shown in Table 1. We include in STI treatment costs the appropriate number of consultations, tests and treatments using the British National Formulary (BNF) (27) and unit costs of health and social care (28). Costs of PID were taken from a previously published report. (11). The UK lifetime HIV treatment cost was taken from Nakagawa et al, (29) using the more conservative of their two estimates (based on the assumption of switching to generic drugs once pharmaceutical patents expire, and assuming

generic drugs cost 20% of the branded versions). It was thought important to use the more conservative estimate here to avoid potentially overestimating the costs.

A rapid search identified intervention costs for five local C-card programs in England and Wales (30-34). Using published population statistics for ages 13-24 for each area (7), we calculated that four of the five programs gave costs between £0.33 and £0.68 per head of teenage population per annum (the other had higher costs of £1.21 per head). An estimated cost of £0.48 (95% CI=£0.19-£0.76) per head of teenage population was chosen as the average of the four lowest-cost published programs. This cost was validated using a bottom-up costing exercise informed by experts with experience of running programs.

Uncertainty

A probabilistic sensitivity analysis (PSA) of 5,000 runs was conducted to assess the impact of parameter uncertainty on the model output. All results presented are probabilistic.

The systematic review identified three studies of multicomponent programs in young people. In our base case we used the highest-quality study, but this also had the largest effect size (RR=1.23). As a sensitivity analysis we calculated the incremental cost effectiveness ratio (ICER) associated with a condom use relative risk of 1.11 (the lower effect size from the three studies).

There is reasonable evidence in the literature that condom failure rates reduce with experience (35). A scenario was modelled for young people which assumed reduced condom breakage (odds ratio of 0.8) based on Macaluso *et al*. (24).

Base-case HIV prevalence estimates are from diagnosis rates and may underestimate the true prevalence of HIV. Therefore, higher HIV prevalence scenarios were modelled using estimated HIV prevalence by risk group from the 2015 HIV Situation Report (36) and in

addition using updated figures for MSM in London (20). In the general population a scenario used rates from the NICE HIV testing guideline (10).

To validate our model we compared our results for young people, with and without a CDP, to the 2014-2015 PHE data for STI prevalence (37).

The focus of NICE's guideline was STIs. However, an exploratory analysis was undertaken, to understand the impact of the interventions in young people aged of 14–18 years upon pregnancy, using an existing model of contraceptive interventions (38) and assuming that all pregnancies within this age group were unintended. It was assumed that 50% of the unintended teenage pregnancies would be prevented and 50% delayed until age 19-24. The probability of becoming pregnant and of having an abortion by age were updated using the latest national statistics (39). The model was updated to use the same condom failure rate as the STI model. Costs were expressed in 2014/15 prices (40).

Results

Results for young people aged 13-24 are summarised in Table 3. The analysis predicts that an intervention with effectiveness taken from Larsson et al. (14) and with costs in the region of a typical C-card program would be expected to avert 5,123 cases of STIs (95% CI=439-12,441), of which over 4,200 (30,655-85,406) are chlamydia. The program is estimated to lead to a gain of 55 (14-136) QALYs and a positive net cost (program cost minus healthcare savings) of £957,622 (-£2,723,496-£2,947,501), giving an incremental cost per QALY gained of £17,411 compared with no CDP.

The evidence for effectiveness was for a younger age group, however. With age 13-18 years only, the program was not cost-effective at NICE's £20,000 level (ICER = £45,856).

The result was sensitive to reducing the effectiveness estimate. With a reduced change in condom use (R=1.11), the ICER in the 13-24 age group increased to £88,979. The results of the scenario analysis where condom breakage was reduced led to an ICER of £14,469. In the scenario with higher HIV prevalence the increase in HIV cases averted makes the program cost-saving overall (£10m healthcare savings compared with £3.5m program costs across England in the target population).

[INSERT TABLE 3]

In an additional exploratory analysis of pregnancy outcomes, an England-wide program with base case costs and effectiveness is predicted to avoid approximately 118 pregnancies, 82 abortions and save £333,000 across England in associated costs (not included in our presented results). This would increase to £12m if government funded benefits were included.

Figure 1 illustrates the results of threshold analyses for the base case in each population. The result show that CDPs are much more likely to be cost-effective in populations with high prevalence of HIV (MSM and black ethnic minorities), and that even programs with relatively

small effect sizes and high costs can be cost-saving in these groups. Meanwhile, programs for young people can be cost-effective or cost-saving as long as costs can be controlled to around 40-60p per person, depending on effectiveness. Untargeted programs for the general population are only likely to be cost-effective at very low cost.

[INSERT FIGURE 1]

Results of model validation are shown in Figure 2. The model correctly shows a decrease in chlamydia diagnoses, although it overestimates this decrease by approximately 40%. Similarly the model overestimates the decrease in gonorrhoea diagnoses, which actually increased among 20-24 year old males. Syphilis remains fairly constant in both the model and PHE data, except the model shows a small decrease in cases for 20-24 year old males and PHE data shows an increase.

[INSERT FIGURE 2]

Discussion

The cost-effectiveness of CDPs is heavily influenced by the underlying STI prevalence and sexual activity levels of the population.

We found that the ICER for CDP targeted at young people, such as the C-Card program was likely to be cost-effective at NICE's £20,000/QALY threshold. Threshold analyses suggest that CDPs for MSM and black ethnic minorities can also be cost-effective even if the program cost per person is fairly high, whereas for the general population in which prevalence and risk of transmission are lower, costs have to be very low in order for programs to be cost-effective.

HIV prevalence is particularly important in determining cost-effectiveness. This is because although HIV is relatively less prevalent than other STIs, the cost and QALY loss per case is much higher. Our study confirms findings (41, 42) that CDPs for populations with high HIV prevalence can be cost-effective when condom usage is increased by as little as 2% (RR=1.02).

Although the focus of NICE's guidance was STI prevention, our analysis suggests that including the potential impact on reduced conception rates makes it very likely that a CDP would be cost-saving. This analysis was somewhat speculative, especially in terms of government-funded benefit costs, since the benefits landscape has changed considerably since the original model was developed in 2010.

This is the first study to estimate the cost-effectiveness of CDPs in the UK. It combines data from several different sources, and gives an indication of the potential economic impact of C-Card programs which has not previously been reported. However, the analysis is limited by the quality and availability of evidence. It assumes that all sexually active people within one age band behave in the same way, with an average number of sexual contacts and the same probability of condom use without a CDP. In reality there will be some people who are

more sexually active than others, some people in monogamous relationships and some with higher numbers of sexual partners, and condom usage rates will differ according to these (and other) factors.

Validating the binomial model of disease prevalence is challenging because the current distribution and uptake of CDPs in England are unknown, and because CDPs are often linked to other services such as STI testing which impact diagnosis rates and confound prevalence estimates. We expected the model results without CDP to show more STIs than the PHE 2015 data, and the model results with CDP to show fewer STIs than the PHE 2015, since in reality a number of CDPs programs are already in operation. We saw that for all STIs, the model results with and without STIs were lower than the PHE data. The binomial model of steady state disease prevalence appears therefore to underestimate STI transmission and therefore potentially underestimates the effect of increased condom usage on STI reduction, which suggests that the estimates of CDP cost-effectiveness are likely to be conservative.

We used a static model for estimating the transmission of STIs, assuming a constant underlying prevalence of each STI. In reality, for STIs with long recovery periods or no recovery, the underlying prevalence will increase. This may partly explain why our model under-predicts STI prevalence. This effect may be particularly important in the case of HIV, for which both costs and quality of life effects are high. In addition, our model does not take account of the potential transmission of infections such as HIV and syphilis from mother to baby, where condom use before and during pregnancy may have the additional impact of reducing infection or other severe health impacts on foetuses or new-borns.

Our model was not able to account for any effects of increased condom use on undiagnosed STIs. There may also be variability around CDP costs. We used the average from four C-Card programs with similar costs as these closely corresponded to a bottom-up costing exercise, and excluded one program that had higher costs.

Our model considers STI transmission over a one-year period, which may underestimate the benefit of CDPs for two reasons. Firstly, since new STI diagnoses are a function of initial prevalence, the rates of new diagnoses for CDP and a comparator without CDP, diagnoses would be expected to diverge over time and the incremental effectiveness would increase. Secondly, there may be longer term benefits of engaging people with CDPs and sexual health services, potentially resulting in fewer STIs at little or no extra cost.

More research of better quality is needed on the effectiveness of CDPs. Research that investigates change in condom usage would also allow the economic models to be updated, while research investigating the relationship between CDP implementation and STI incidence would remove the need for an epidemiological model. Evaluations of C-Card programs are particularly important to understand both their effectiveness and cost-effectiveness. Furthermore, comparative evaluation of different modes of implementation of C-Card programs and different population subgroups or age groups would allow policy makers to understand how these programs may be optimally delivered and targeted.

We conclude that CDPs for young people are likely to be good value for money at currently accepted cost-effectiveness thresholds, and that CDPs for other high-risk populations may also be economically attractive. Given the substantial public health burden associated with STIs, it is important that efforts are made to reduce their transmission and this suggests that CDPs are likely to be a cost-effective approach.

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371 **Tables/Illustrations:**

372 *Table 1 Costs (£), QALYs and STI transmission parameters and distributions used in the*
373 *model*

	Mean	Range		Source
COSTS (£) DIAGNOSIS AND TREATMENT				
Chlamydia	121.92	Max = 75.76	Min = 166.58	(28) (44) (45)
Gonorrhoea	206.17	Max = 129.24	Min = 280.61	(28) (44) (45)
Syphilis	210.59	Max = 133.66	Min = 285.03	(28) (44) (45)
HIV	103,243	95% CI = 82,594 - 123,892		(29)
PID	3,124	95% CI = 2499 - 3749		(11) (28)
COSTS (£) INTERVENTION				
C-card per head (age 13-24)	0.48	95% CI = 0.34 - 0.62		(30, 32-34)
QALYs				
Chlamydia	-0.002	-		(46)
Gonorrhoea	-0.004	-		(46)
HIV	-6.200	95% CI = -7.950 - -4.450		(18)
Syphilis	-0.006	95% CI = -0.0068 - -0.0055		(47)
PID	-0.025	-		(48)
Parameter	**Value**	**Distribution (α,β) Rounded (unless specified)**		**Source**
SEXUAL PRACTICE – CONDOM USE (By age)				
16-19	54%	None		(49)
20-24	54%			(49)
25-29	41%			(49)
30-34	46%			(49)
35-39	27%			(49)
40-44	10%			(49)
45-49	13%			(49)
MSM (All ages)	52.7%			(23)
CONDOM BREAKAGE				
Rate	3.6%	Beta (194, 9,704)		(24)
SEXUALLY ACTIVE – MEN				
13	4.4%			NATSAL-3 dataset (21)
14	11.8%			
15	26.0%			(21)
16-24	75.9%	Beta (1,007, 320)		(21)
25-34	90.1%	Beta (952, 105)		(21)
35-44	92.5%	Beta (682, 55)		(21)
45-54	86.4%	Beta (68, 11)		(21)
55-64	76.3%	Beta (533, 166)		(21)
65-	59.8%	Beta (336, 226)		(21)
SEXUALLY ACTIVE – WOMEN				
13	2.3%			NATSAL-3 dataset (21)
14	8.5%			
15	21.4%			(21)
16-24	77.0%	Beta (1,246, 372)		(21)
25-34	91.8%	Beta (1,698, 152)		(21)

35-44	90.8%	Beta (850, 86)	(21)
45-54	85.0%	Beta (990, 175)	(21)
55-64	63.7%	Beta (519, 296)	(21)
65-	42.1%	Beta (266, 365)	(21)
SEXUAL CONTACTS – MEN			
13-15	5.10	Gamma (0.50, 10.16)	assumed
16-24	5.10	Gamma (0.50, 10.16)	(21)
25-34	5.40	Gamma (0.69, 7.82)	(21)
35-44	4.10	Gamma (0.91, 4.51)	(21)
45-54	4.10	Gamma (0.45, 9.08)	(21)
55-64	3.20	Gamma (0.51, 6.33)	(21)
65-	2.30	Gamma (0.41, 5.63)	(21)
SEXUAL CONTACT – WOMEN			
13-15	5.80	Gamma (0.77, 7.51)	assumed
16-24	5.80	Gamma (0.77, 7.51)	(21)
25-34	4.90	Gamma (0.92, 5.31)	(21)
35-44	4.00	Gamma (0.76, 5.29)	(21)
45-54	3.50	Gamma (0.69, 5.04)	(21)
55-64	2.50	Gamma (0.54, 4.62)	(21)
65-	1.40	Gamma (0.37, 3.78)	(21)
PID RATES			
after chlamydia	16.0%	Beta (9, 47)	(25)
after gonorrhoea	0.9%	Beta (4, 469)	(50)
TRANSMISSION RATES			
HIV – Men	0.120%	Beta (10, 8,175)	(51)
HIV - MSM	1.400%	Beta (6, 394)	(52)
HIV – Women	0.390%	Beta (5, 1,324)	(51)
Chlamydia	45.000%	Beta (42, 52)	(53)
Gonorrhoea	53.000%	Beta (16, 14)	(53)
Syphilis	61.818%	Beta (68, 42)	(54)

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Table 2: Mean prevalence values used in the model for Chlamydia, Gonorrhoea, HIV & Syphilis

Age group	Chlamydia		Gonorrhoea		HIV						Syphilis	
					Low (Base case)		Central		High			
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
YOUNG PEOPLE & GENERAL POPULATION												
13 – 14	0.009%	0.136%	0.001%	0.010%	0.004%	0.001%	-	-	0.054%	0.019%	0.000%	0.000%
15 – 19	0.881%	2.651%	0.101%	0.166%	0.016%	0.006%	-	-	0.229%	0.081%	0.004%	0.002%
20 – 24	1.800%	2.692%	0.330%	0.161%	0.015%	0.005%	-	-	0.209%	0.072%	0.022%	0.003%
25 – 34	0.704%	0.631%	0.292%	0.055%	0.042%	0.014%	-	-	0.586%	0.195%	0.036%	0.003%
35 – 44	0.205%	0.120%	0.143%	0.015%	0.033%	0.011%	-	-	0.471%	0.155%	0.035%	0.001%
45 – 64	0.057%	0.023%	0.041%	0.004%	0.017%	0.006%	-	-	0.243%	0.079%	0.014%	0.000%
65+	0.006%	0.001%	0.004%	0.000%	0.004%	0.001%	-	-	0.053%	0.014%	0.001%	0.000%
MSM												
13 – 14	0.026%	-	0.011%	-	0.000%	-	0.000%	-	0.000%	-	0.000%	-
15 – 19	1.705%	-	1.240%	-	0.464%	-	4.732%	-	8.605%	-	0.088%	-
20 – 24	5.911%	-	6.548%	-	0.424%	-	4.321%	-	7.859%	-	0.629%	-
25 – 34	5.595%	-	7.539%	-	1.241%	-	12.657%	-	23.019%	-	1.116%	-
35 – 44	3.443%	-	4.101%	-	0.728%	-	7.421%	-	13.496%	-	1.104%	-
45 – 64	1.125%	-	1.113%	-	0.311%	-	3.175%	-	5.774%	-	0.435%	-
65+	0.124%	-	0.081%	-	0.030%	-	0.305%	-	0.554%	-	0.026%	-
BLACK ETHNIC MINORITIES												
13 – 14	0.015%	0.231%	0.003%	0.028%	0.231%	0.641%	0.284%	0.759%	0.369%	0.881%	0.000%	0.000%
15 – 19	1.491%	4.485%	0.286%	0.469%	0.987%	2.752%	1.214%	3.261%	1.579%	3.784%	0.006%	0.003%
20 – 24	3.044%	4.554%	0.932%	0.454%	0.901%	2.457%	1.108%	2.911%	1.442%	3.378%	0.037%	0.005%
25 – 34	1.192%	1.067%	0.826%	0.157%	2.524%	6.634%	3.105%	7.861%	4.039%	9.122%	0.061%	0.005%
35 – 44	0.346%	0.203%	0.403%	0.041%	2.026%	5.297%	2.492%	6.277%	3.242%	7.283%	0.060%	0.002%
45 – 64	0.096%	0.039%	0.117%	0.010%	1.046%	2.696%	1.287%	3.195%	1.674%	3.707%	0.024%	0.001%
65+	0.010%	0.001%	0.011%	0.000%	0.228%	0.492%	0.280%	0.583%	0.364%	0.676%	0.002%	0.000%

Table 3 Results of modelling the C-card program in young people for the whole eligible population of England

Scenario	STIs averted						STI cost savings	Program cost	Net cost	QALY gain	Cost/QALY
	Chlamydia	Gonorrhoea	HIV	Syphilis	PID	Total					
Base case (age 13-24)	4272	378	6	14	454	5123	£2,587,340	£3,544,962	£957,622	55	£17,411
1: Age 13-18	1151	83	2	2	135	1373	£758,947	£1,538,499	£779,552	17	£45,856
2: Lower RR condom use	2007	178	3	7	215	2409	£1.216.794	£3,530,260	£2,313,466	26	£88,979
3: Breakage reduced	4586	407	5	15	487	5501	£2,728,775	£3,539,033	£810,258	56	£14,468
4: High HIV prevalence	4254	376	77	14	454	5174	£9,954,650	£3,541,896	-£6,412,754	496	Dominates

Figure 1 Threshold analyses showing cost per QALY gained from the base-case analysis across a range of program costs (per person per annum) and effectiveness levels (relative risk of condom use) in a) young people b) MSM c) black ethnic minorities and d) general population

Figure 2: Validation results

FIGURES SUBMITTED SEPARATELY

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