ORIGINAL ARTICLE

Ongoing decline in genital warts among young heterosexuals 7 years after the Australian human papillomavirus (HPV) vaccination programme

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Received 13 August 2014
Revised 19 September 2014
Accepted 21 September 2014
Published Online First 10 October 2014

ABSTRACT

Background Australia has provided free quadrivalent human papillomavirus (HPV) vaccines to school girls since mid-2007 and a catch-up programme in the community to women aged up to 26 years in 2007–2009. We describe the temporal trend of genital warts in different populations in Melbourne.

Methods We analysed the proportion diagnosed with genital warts for all new patients attending Melbourne Sexual Health Centre from July 2004 to June 2014, stratified by different risk groups and age. Adjusted ORs were calculated to compare the annual trend in the proportion of patients with genital warts in different risk groups in the prevaccination period (before June 2007) and the vaccination period (after July 2007).

Results The proportion with genital warts decreased in women aged <21 years, from 18.4% in 2004/2005 to 1.1% in 2013/2014 (p<0.001), but increased in women aged >32 years, from 4.0% to 8.5% (p=0.037). The odds per year for diagnosis of genital warts adjusted for number of sexual partners in the vaccination period were 0.55 (95% CI 0.47 to 0.65) and 0.63 (95% CI 0.54 to 0.74) in women and heterosexual men aged <21 years, respectively. There was no change in adjusted odds of genital warts in both women and men aged >32 years. A small annual decline in genital warts was observed in men who have sex with men (aOR=0.92; 95% CI 0.88 to 0.97).

Conclusions Genital warts have now become rare in young Australian women and heterosexual men 7 years after the launch of the national HPV vaccination programme but in stark contrast, remain common in men who have sex with men.

INTRODUCTION

Australia implemented a national human papillomavirus (HPV) vaccination programme in young women in mid-2007. Since then girls aged 12–13 years have been eligible to receive the vaccine for free in schools. In addition, two catch-up programmes ran from 2007 to 2009 for women aged from 13 to 26 years.[1] Two HPV vaccines (the bivalent vaccine, Cervarix and the quadrivalent vaccine, Gardasil) have been registered for use in Australia but Gardasil is the only vaccine provided free by the National Immunisation Program. Both vaccines protect against the 'high-risk' HPV types 16 and 18, which are associated with cervical, oropharyngeal and anal cancers.[2 3] In addition, the quadrivalent vaccine Gardasil also protects against HPV types 6 and 11 which are associated with genital warts.[3]

We previously demonstrated that clinical presentations of genital warts in young women aged <21 years at the Melbourne Sexual Health Centre (MSHC) had decreased dramatically from 20.9% in 2006/2007 to 1.9% in 2010/2011 since the female HPV vaccination programme was introduced.[4] A similar decline has also been observed in eight Australian sexual health centres across the country.[5] Australia also began a universal male school-based HPV vaccination programme in boys aged 12–13 years in February 2013.[6]

Our aim was to describe trends in clinical presentation of genital warts at a large Australian sexual health centre 7 years after the implementation of the national quadrivalent HPV vaccination programme for young women.

METHODS

Data collection

A retrospective study was conducted to investigate the proportion of new patients attending MSHC who were diagnosed with genital warts between 1 July 2004 and 30 June 2014. MSHC is the largest public sexual health centre in Australia. It serves Melbourne, population four million and provides approximately 35 000 consultations per year, all free of charge.

All new patients attending MSHC are asked to complete a computer assisted self-interview (CASI) at their first visit. Demographic details (age, sex, country of birth, year of arrival in Australia) and sexual behaviours (number and gender of sexual partners in the past 12 months) of the patients were collected from CASI. Clinical diagnoses of genital wart were entered into the clinical electronic database by clinicians at each consultation. The anatomical site (penile or anal) of wart in men who have sex with men (MSM) was recorded since 2008.

Study populations

All patients who attended MSHC for the first time between 1 July 2004 and 30 June 2014 were included in this analysis. As only Australian female citizens or those with permanent residency were eligible for the national female HPV vaccination programme, women who were born outside Australia were excluded from further analyses. To determine the herd protection effect of female-only

To cite: Chow EPF, Read TRH, Wigan R, *et al*. *Sex Transm Infect* 2015;**91**:214–219.

Sex Transm Infect: first published as 10.1136/sextrans-2014-051813 on 10 October 2014. Downloaded from http://sti.bmj.com/ on September 26, 2022 at Imperial College London Library. Protected by copyright.

HPV vaccination programmes, men who were born outside Australia were also excluded in this analysis as a control group for comparison.

Men who reported having sex only with women in the past 12 months were classified as heterosexual. Men who reported having any sexual contact with men in the past 12 months were defined as MSM. We divided MSM into homosexual MSM who had sex with men only and bisexual MSM who had sex with both men and women in the past 12 months. Both women and heterosexual men were further stratified into three groups according to their age on the day they attended: (1) <21 years old: all women in this age group were eligible for the free HPV vaccine at school (aged 12–13 years) since 2007, and the majority would have received the vaccine prior to onset of sexual activity; (2) 21–32 years old: all were eligible to receive the free HPV vaccine and a proportion would have been sexually active before receiving the vaccine and (3) >32 years old: none of these women were eligible for the free vaccine as they were >26 years when the vaccination programme started in 2007.

Statistical analysis

The study period was stratified according to the Australian financial year, which runs from 1 July to 30 June of the following year. In addition, we further divided the study period into the prevaccination period (from 1 July 2004 to 30 June 2007) and the vaccination period (from 1 July 2007 to 30 June 2014). The number and the proportion of new patients diagnosed with genital warts in each financial year and risk group were calculated. Changes in the proportion with genital warts for each population over a 10-year period were tested using the χ^2 trend test. The ORs and 95% CIs for a diagnosis of warts in each financial year were calculated using logistic regression after adjusting for the number of sexual partners in the past 12 months. Logistic regression was stratified by vaccination periods, different risk groups and age groups. A significance level of 0.05 was used for all statistical tests. All statistical analyses were performed using SPSS software V. 21 (SPSS, USA).

Ethical approval was obtained from the research Ethics Committee of the Alfred Hospital, Melbourne, Australia (number 90/14).

RESULTS

A total of 81 939 patients were seen for the first time at MSHC from 1 July 2004 to 30 June 2014. Of these, 41 776 (51.0%) were born in Australia. Among the Australian-born patients, 4282 (10.2%) were diagnosed with genital warts (3037 men, 1242 women and 3 transgender). Overall, the proportion of Australian-born patients diagnosed with genital warts decreased twofold from 13.1% to 5.7% ($p_{trend}<0.001$), over the 10 years (table 1).

Australian-born women

The proportion of women diagnosed with genital warts declined significantly from 11.1% in 2004/2005 to 3.4% 2013/2014 ($p_{trend}<0.001$; table 1). There was a dramatic decline in warts in women aged <21 years (from 18.4% to 1.1%; $p_{trend}<0.001$; figure 1) and in women aged 21–32 years (from 12.4% to 2.5%; $p_{trend}<0.001$). However, the diagnosis of warts among women aged >32 years doubled from 4.0% to 8.5% ($p_{trend}=0.037$) over the same period. The largest decline in genital warts occurred from the 2007/2008 to the 2008/2009 periods in women aged <21 years, with a fall from 20.6% to 6.6%. This occurred a year after the implementation of the vaccination programme. Our results showed that the percentage of Australian-born women aged <21 years reported being vaccinated for HPV ranged from 85.3% in 2009/2010 to 75.2% in 2013/2014. Two women aged <21 years with genital warts in the 2013/2014 period were diagnosed in late 2013, and no case was reported during the first half of 2014. Both women had declined to receive the HPV vaccine at high school. Notably, of the 118 women aged <21 years in 2013/2014 who reported being vaccinated, none were found to have genital warts. In addition, there was an increase in the odds per year of having genital warts in the prevaccination period among all women (aOR=1.15; 95% CI 1.03 to 1.27) after adjusting for the number of male partners (table 2). However, during the vaccine period, diagnoses of genital warts in women decreased with each year (aOR=0.78; 95% CI 0.74 to 0.82), particularly in women aged <21 years (aOR=0.55; 95% CI 0.47 to 0.65); however, no change was observed in women aged >32 years (aOR=0.98).

Australian-born heterosexual men

The proportion of heterosexual men diagnosed with genital warts also declined significantly from 17.3% in 2004/2005 to 7.6% in 2013/2014 ($p_{trend}<0.001$; table 1). There was a large reduction of warts in men aged <21 years (from 11.3% to 2.8%; $p_{trend}<0.001$) and 21–32 years (from 19.1% to 5.9%; $p_{trend}<0.001$), and a small decrease in men aged >32 years from 15.7% to 11.4% ($p_{trend}<0.001$) over the same period. Significant reductions in genital warts in men aged <21 years occurred from 2007/2008 (25.5%) to 2008/2009 (13.7%) to 2009/2010 (2.2%), consistent with the declines observed in women. Furthermore, the odds per year of having genital warts among heterosexual men in the prevaccination period were stable, but decreased in the vaccination period (aOR=0.87; 95% CI 0.84 to 0.89). There was a notable decrease in men aged <21 years (aOR=0.63; 95% CI 0.54 to 0.74) compared with no change in men aged >32 years (aOR=0.99) in the vaccination period.

Australian-born MSM

Interestingly, we also observed an overall decline in genital warts in MSM, from 7.8% to 5.2% over the study period ($p_{trend}<0.001$). The adjusted odds per year of having genital warts among all MSM in the vaccination period were 0.92 (95% CI 0.88 to 0.97) in all MSM and 0.92 (95% CI 0.87 to 0.97) in homosexual MSM. There was no particular downward trend found in bisexual MSM between the prevaccination and vaccination periods (table 2). Importantly, we found that the proportion of MSM with anal warts did not change over time ($p_{trend}=0.239$), whereas penile warts decreased among all MSM in the vaccination period (from 2.4% to 1.3%; $p_{trend}=0.040$).

DISCUSSION

Seven years after the introduction of the HPV vaccine that achieved a three-dose coverage approaching 70% in girls, genital warts have virtually disappeared in women who were likely to have received the vaccine before commencing sexual activity. There were no cases of genital warts in Australian-born women <21 years of age in 2014. Large declines were seen in younger heterosexual men but cases continue to occur among the older unvaccinated men, presumably from sexual contact with older women or women from overseas. Our findings support the concept that the current vaccination programme is sufficient for the near elimination of genital warts from the Australian-born population.

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Table 1 Number (N) and percentage of new patients diagnosed with genital warts at Melbourne Sexual Health Centre, by financial year and risk group, from 1 July 2004 to 30 June 2014

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	Trend†	p Value
All patients*	750 (11.0)	804 (11.8)	818 (11.7)	696 (9.8)	660 (8.3)	662 (7.9)	622 (7.3)	556 (6.3)	601 (6.0)	582 (5.5)	↓	<0.001
All, Australian-born	550 (13.1)	562 (13.9)	572 (14.0)	454 (12.8)	389 (10.6)	372 (9.7)	314 (8.0)	262 (7.0)	279 (6.6)	240 (5.7)	↓	<0.001
All, non-Australian born*	200 (7.7)	242 (8.8)	246 (8.5)	242 (6.9)	271 (6.3)	290 (6.4)	308 (6.7)	294 (5.9)	322 (5.5)	342 (5.4)	↓	<0.001
All Australian-born women	181 (11.1)	191 (12.6)	225 (14.1)	156 (12.1)	96 (7.8)	95 (7.4)	65 (5.0)	45 (3.7)	48 (3.5)	48 (3.4)	↓	<0.001
Australian-born women, <21 years	44 (18.4)	53 (20.4)	62 (21.5)	39 (20.6)	12 (6.6)	9 (4.3)	4 (2.2)	2 (1.1)	6 (2.8)	2 (1.1)	↓	<0.001
Australian-born women, 21–32 years	120 (12.4)	118 (13.4)	140 (14.7)	88 (11.3)	63 (8.4)	66 (8.3)	36 (4.4)	26 (3.4)	21 (2.4)	22 (2.5)	↓	<0.001
Australian-born women, >32 years	17 (4.0)	20 (5.4)	23 (6.4)	29 (9.1)	21 (7.2)	20 (7.1)	25 (8.3)	17 (6.1)	21 (7.0)	24 (8.5)	↑	0.037
Non-Australian-born women*	189 (7.8)	218 (8.7)	214 (8.2)	210 (6.7)	233 (6.3)	265 (6.4)	287 (6.7)	268 (5.8)	306 (5.6)	327 (5.5)	↓	<0.001
Non-Australian-born women, <21 years*	14 (7.0)	22 (10.1)	20 (9.6)	14 (5.1)	16 (5.9)	12 (4.9)	6 (2.4)	11 (3.9)	8 (2.4)	16 (4.0)	↓	<0.001
Non-Australian-born women, 21–32 years*	130 (8.7)	152 (9.3)	149 (8.8)	160 (7.6)	174 (6.6)	196 (6.4)	215 (6.8)	202 (5.8)	235 (5.7)	255 (5.6)	↓	<0.001
Non-Australian-born women, >32 years*	45 (6.3)	44 (6.7)	45 (6.6)	36 (4.8)	43 (5.3)	57 (6.8)	66 (7.3)	55 (6.4)	63 (6.2)	56 (5.6)	→	0.916
All Australian-born heterosexual men	306 (17.3)	293 (17.0)	260 (16.2)	228 (16.3)	232 (15.0)	205 (13.0)	185 (11.2)	157 (9.2)	176 (9.4)	143 (7.6)	↓	<0.001
Australian-born heterosexual men, <21 years	12 (11.3)	13 (11.8)	24 (17.9)	25 (25.5)	13 (13.7)	2 (2.2)	4 (3.0)	6 (4.5)	5 (3.7)	4 (2.8)	↓	<0.001
Australian-born heterosexual men, 21–32 years	185 (19.1)	179 (19.5)	156 (18.6)	140 (18.5)	146 (17.1)	140 (16.0)	111 (12.0)	92 (9.1)	96 (9.3)	64 (5.9)	↓	<0.001
Australian-born heterosexual men, >32 years	109 (15.7)	101 (14.5)	80 (12.7)	63 (11.5)	73 (12.3)	63 (10.4)	70 (11.7)	59 (10.3)	75 (10.6)	75 (11.4)	↓	<0.001
All Australian-born MSM	51 (7.8)	71 (10.6)	69 (9.7)	61 (9.2)	49 (6.9)	66 (8.0)	56 (7.1)	57 (7.3)	55 (6.1)	47 (5.2)	↓	<0.001
Australian-born MSM, <21 years	5 (7.8)	4 (7.0)	4 (6.7)	6 (7.4)	8 (10.1)	9 (10.6)	9 (9.3)	9 (8.7)	7 (6.1)	5 (3.5)	→	0.289
Australian-born MSM, 21–32 years	31 (10.3)	37 (12.3)	38 (11.7)	33 (9.4)	30 (8.7)	40 (9.5)	31 (7.2)	38 (8.6)	34 (6.9)	31 (6.3)	↓	<0.001
Australian-born MSM, >32 years	15 (5.2)	30 (9.6)	27 (8.3)	22 (9.4)	11 (3.8)	17 (5.4)	16 (6.2)	10 (4.1)	14 (4.9)	11 (4.0)	↓	0.004
All Australian-born MSM, homosexual	39 (7.6)	59 (10.9)	58 (10.3)	52 (9.7)	40 (6.9)	59 (8.7)	50 (7.8)	50 (7.7)	44 (5.8)	43 (5.6)	↓	<0.001
All Australian-born MSM bisexual	12 (9.0)	12 (9.0)	11 (7.9)	9 (7.3)	8 (6.6)	5 (4.2)	6 (4.3)	7 (5.2)	11 (7.9)	4 (3.0)	↓	0.023
All Australian-born MSM, anal wart‡	–	–	–	–	32 (4.5%)	47 (5.7%)	44 (5.6%)	46 (5.9%)	41 (4.6%)	35 (3.8%)	→	0.239
All Australian-born MSM, <21 years, anal wart‡	–	–	–	–	5 (6.3)	9 (10.6)	8 (8.2)	7 (6.7)	7 (6.1)	5 (3.5)	→	0.105
All Australian-born MSM, 21–32 years, anal wart‡	–	–	–	–	18 (5.2)	31 (7.4)	25 (5.8)	31 (7.0)	23 (4.6)	25 (5.8)	→	0.338
All Australian-born MSM, >32 years, anal wart‡	–	–	–	–	9 (3.1)	7 (2.2)	11 (4.2)	8 (3.3)	11 (3.8)	5 (1.8)	→	0.800
All Australian-born MSM, penile wart‡	–	–	–	–	17 (2.4%)	19 (2.3%)	17 (2.2%)	13 (1.7%)	14 (1.6%)	12 (1.3%)	↓	0.040
All Australian-born MSM, <21 years, penile wart‡	–	–	–	–	3 (3.8)	0 (0)	1 (1.0)	2 (1.9)	0 (0)	0 (0)	↓	0.031
All Australian-born MSM, 21–32 years, penile wart‡	–	–	–	–	12 (3.5)	9 (2.1)	10 (2.3)	8 (1.8)	11 (2.2)	6 (1.2)	→	0.062
All Australian-born MSM, >32 years, penile wart‡	–	–	–	–	2 (0.7)	10 (3.2)	6 (2.3)	3 (1.2)	3 (1.0)	6 (2.2)	→	0.951
Women with prior HPV vaccination	–	–	–	–	–	20 (6.1)	8 (1.9)	10 (1.8)	9 (1.3)	10 (1.5)	↓	0.001
Total number of Australian-born new patient	4197	4043	4081	3545	3685	3829	3905	3765	4199	4241	–	–
Total number of non-Australian born new patients*	2599	2749	2891	3529	4269	4508	4624	5024	5866	6390	–	–
Total number of all new patients*	6796	6792	6972	7074	7954	8337	8529	8789	10 065	10 631	–	–

Note: All analyses exclude patients were not born in Australia unless '*' is shown. Anatomical site of genital wart among heterosexual was not recorded.
†↑ represents an increasing trend; ↓ represents a decreasing trend; → represents no significant trend was observed.
‡The anatomical site of diagnosed genital warts among MSM was routinely recorded from 2008. Data prior to 2008 are not available.
HPV, human papillomavirus; MSM, men who have sex with men.

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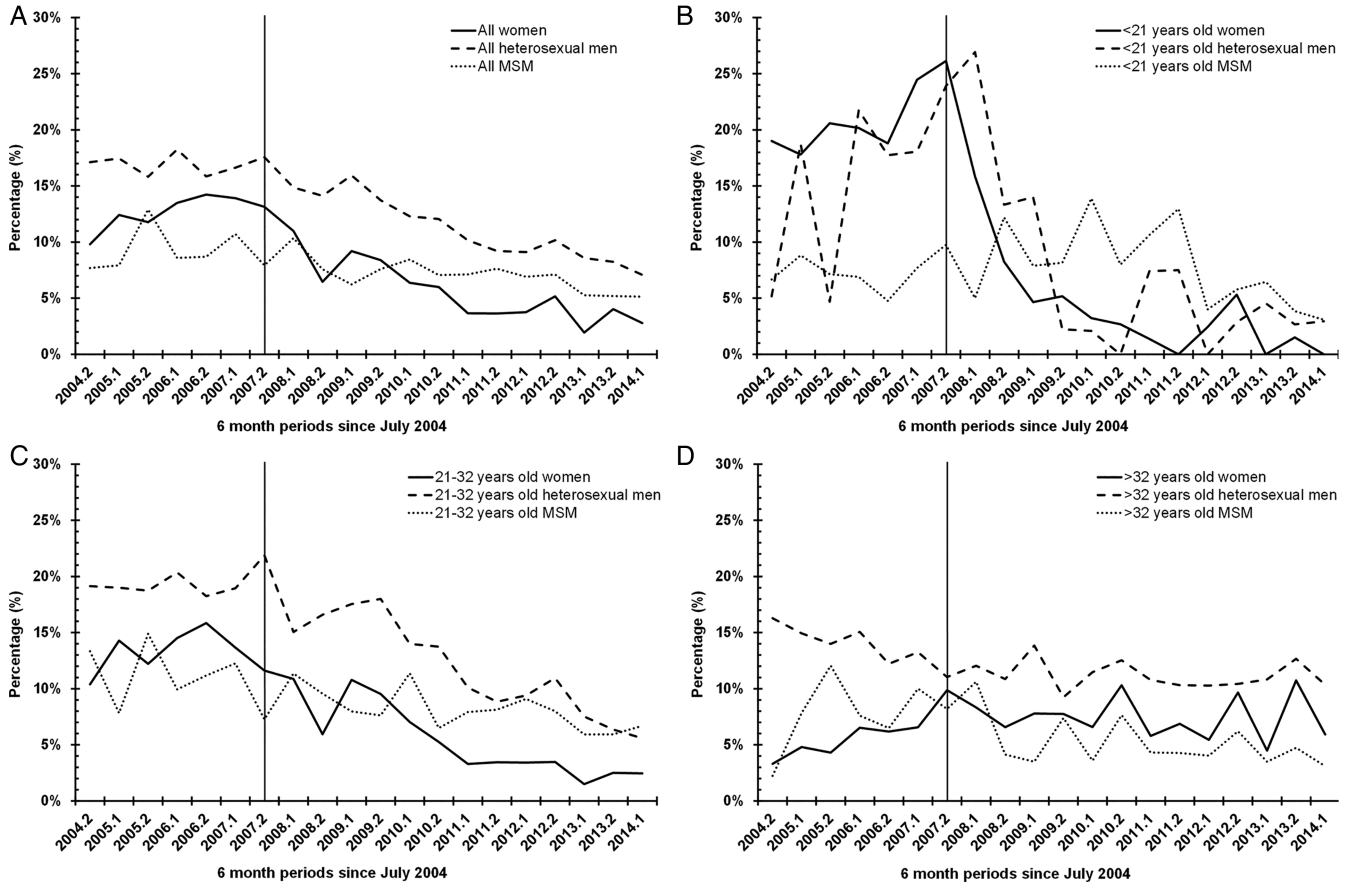

Figure 1 Proportion of Australian-born women, heterosexual men, and men who have sex with men (MSM) diagnosed as having genital warts at Melbourne Sexual Health Centre, from July 2004 to June 2014: stratified by (A) all age group, (B) <21 years, (C) 21–32 years and (D) >32 years. The vertical line represents the implementation of the national HPV vaccination programme.

Our study has several limitations. This is a retrospective analysis of records from a single urban sexual health centre and the findings may not be representative of changes in other parts of Australia, although earlier studies around Australia have found similar results.[4 5 7] MSHC primarily targets individuals at higher risk of sexually transmissible infections (STI), and so the absolute proportion with genital warts will not be the same as in the community as a whole, although the direction of the changes should be similar. Self-reporting and recall bias may have occurred in this retrospective study that requires self-reported sexual activities in the past 12 months and vaccination status against HPV. In addition, the number of doses of HPV vaccine is not reported by participants, so if a woman reports receiving the HPV vaccine this may only mean a single dose that will not provide optimal protection against HPV. We only included Australian-born individuals in the subanalyses; however, individuals born outside Australia but are also Australian citizens or permanent residents were also eligible in the national vaccination programme. We did this as we can be sure that all individuals born in Australia are eligible for the free vaccine and it is unclear what proportion of individuals born outside Australia in our data set would have been eligible.

There have been significant changes in number of individuals who attend MSHC over time. We discuss below the likely effect of increasingly numbers of MSM attending, but there have also been increases in heterosexuals attending. In 2007/2008, there were 2692 new presentations to MSHC from Australian-born heterosexuals but in 2013/2014 there were 3277, a 22% increase. We adjusted our analysis for the number of sexual partners in the previous 12 months but acknowledge that statistical adjustments are imperfect. However, the median number of female partners for men (around 2–3) and male partners for women (around 2–3) was very similar in each year since 2007 and not likely to have significantly influenced the main findings in relation to the fall in presentations of genital warts.

Previous studies have shown 86%–97% of genital warts in both men and women are associated with HPV types 6 and 11[3 8 9] and the HPV vaccine has been shown to be nearly 100% effective in clinical trials against HPV type 6 and 11 among women without prior exposure to these types.[10] The dramatic falls in genital warts that we observed in this study and the absence of genital warts among vaccinated women aged <21 years in 2013/2014 suggest that virtually all genital warts are due to types 6 or 11 or other HPV types which the quadrivalent vaccine provides cross-protection against.[11 12]

Among clinic attendees there were genital warts in approximately 1% of women who self-reported receiving the HPV vaccine. The 10 cases among vaccinated women in 2013/2014 occurred in 21-year-olds to 49-year-olds, and of six who the reported year of vaccination, only two were <25 years of age at vaccination. While there is a substantial variation in the time since first detection of HPV infection and the appearance of genital warts (range 0–45 months)[9] infection often occurs rapidly after first sexual experience, therefore these women may have already infected with HPV type 6 or 11 before being vaccinated. It is also possible that HPV vaccination was inaccurately reported by some women.

As observed in women, there was a greater decline in genital warts in heterosexual men aged <21 years compared with those

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Table 2 Adjusted OR for genital warts per financial year in new patients at Melbourne sexual Health Centre

	Prevaccination period (July 2004–June 2007)		Vaccination period (July 2007–June 2014)	
Patient category/risk group	Adjusted OR† (95% CI)	p Value	Adjusted OR† (95% CI)	p Value
All patients	1.04 (0.98 to 1.09)	0.192	0.90 (0.89 to 0.91)	<0.001***
Australian born	1.04 (0.98 to 1.11)	0.236	0.86 (0.84 to 0.88)	<0.001***
Non-Australian born	1.06 (0.96 to 1.17)	0.258	0.96 (0.94 to 0.98)	<0.001***
Australian-born women	1.15 (1.03 to 1.27)	0.011*	0.78 (0.74 to 0.82)	<0.001***
<21 years	1.10 (0.89 to 1.37)	0.376	0.55 (0.47 to 0.65)	<0.001***
21–32 years	1.10 (0.97 to 1.26)	0.141	0.74 (0.70 to 0.79)	<0.001***
>32 years	1.28 (0.93 to 1.77)	0.124	0.98 (0.91 to 1.06)	0.654
Australian-born heterosexual men	0.96 (0.88 to 1.06)	0.431	0.87 (0.84 to 0.89)	<0.001***
<21 years	1.33 (0.91 to 1.94)	0.141	0.63 (0.54 to 0.74)	<0.001***
21–32 years	0.99 (0.88 to 1.11)	0.809	0.82 (0.79 to 0.85)	<0.001***
>32 years	0.88 (0.76 to 1.03)	0.113	0.99 (0.94 to 1.04)	0.686
Australian-born men who have sex with men	1.12 (0.93 to 1.34)	0.232	0.92 (0.88 to 0.97)	0.003**
Homosexual	1.16 (0.95 to 1.43)	0.144	0.92 (0.87 to 0.97)	0.003**
Bisexual	0.93 (0.61 to 1.42)	0.736	0.94 (0.82 to 1.09)	0.413

*p<0.05, **p<0.01, ***p<0.001.
†The OR was adjusted for the number of partners in the past 12 months (opposite sex partners for heterosexuals and male partners for men who have sex with men).

aged 21–32 years. Heterosexual men in general have sexual partners who are younger or of similar age to their own[13] and, therefore, younger men will receive more herd protection from the young vaccinated women.[14] It is, therefore, not surprising that we have observed a decline in older men but did not observe a decline in older women who would generally be having sex with older unvaccinated men.

Unexpectedly, there was a small reduction in genital warts in homosexual MSM that was not evident in bisexual MSM in the vaccination period; however, this decline was not present in previous studies in 2011[4] and 2008.[7] Since homosexual MSM reported no female partners in the past 12 months, this decline may not be attributed to the herd protection as a result of the female vaccination programme. There are two plausible explanations. First, it is possible that the overall sexual risk profile of the MSM attending MSHC has declined, particularly in the vaccination period. The number of MSM attending MSHC increased moderately during the prevaccination period (from 3543 in 2004 to 5946 in 2007) but increased substantially during the vaccination period (i.e. 12 724 in 2013) as a result of increased public health programmes to increase HIV and STI testing in MSM.[15 16] This has resulted in two changes; a greater proportion of MSM seen in recent years have attended without symptoms, which would have pushed down the proportion attending with symptomatic genital warts in the absence of a true decline. Consistent with seeing more asymptomatic MSM, the average number of sexual partners in the past 12 months for MSM has also declined over time (data not shown). It is unlikely that the HPV vaccine has contributed significantly to the decline because it was only available free to boys aged 12–15 years since 2013. Few young men would have been able to purchase it as it costs AU$ 450 or US$ 422 in Australia. In addition, we found that there was a decline in penile but not anal warts in MSM. It is possible that the decline in penile wart may due to the herd protection in bisexual MSM during penile-vaginal sex. Furthermore, the majority of MSM are usually versatile (engaged in both insertive and receptive anal sex), only a small proportion (<25%) of MSM had insertive anal sex only.[17] Given that anal wart is more common than penile wart in MSM, and it is extremely rare to have both penile and anal wart among individuals, it is suggested that the anal epithelium may be more susceptible to warts than the penile epithelium.[18]

We have reported the findings for MSM by penile and anal site. While the numbers are small, the data suggest that most of the decline has occurred in penile warts rather than in anal warts. This interpretation is limited by the small numbers of cases, and no data on female sexual partners of MSM beyond a year. Most (82.8%) do not report sex with women in the past 12 months.

We also noted a gradual rise over the decade in genital warts in women >32 years. Most of the rise has occurred during the prevaccination period and is consistent with the rise seen in other heterosexual groups in this prevaccination period. We presume this trend is continuing because these women have not been eligible for the HPV vaccine, and as women tend on average to have male partners who are older, these older male partners would not have benefited significantly from herd immunity occurring in younger age groups.

There has been much debate about the cost-effectiveness of adding males to the existing female HPV vaccination programme in Australia and worldwide.[3 19] A recent Australian study has shown that an additional 7% and 12% of genital wart among female and male would be reduced, respectively, in female-and-male vaccination programme compared with female-only vaccination programme.[20] A reduction of genital wart could significantly reduce the costs of treatment and clinical management of genital warts, which is approximately AU$ 14 million (~US$ 13 million) per year in Australia.[21] In addition, it is estimated that the base case incremental cost-effectiveness ratio of female-and-male HPV vaccination programme, compared with the female-only vaccination programme, ranged between AU $15 000 and AU$ 45 000 per quality-adjusted life-year gained.[22]

Since the introduction of the male HPV vaccination programme in 2013 it is expected that genital warts in Australian-born heterosexuals will become very rare and acquired primarily in unvaccinated individuals who have had sex overseas or with unvaccinated travellers.[20] However, outcomes may differ among MSM due to the higher rate of partner

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change and a greater susceptibility of anal epithelium,[18] suggesting a higher degree of vaccine coverage in young MSM than heterosexual males may be required.

Key messages

- Australia began a free quadrivalent human papillomavirus vaccination programme in mid-2007 for school girls and women aged <27 years, with coverage of approximately 70%.
- Since July 2007, there has been an ongoing significant decline in genital warts in young women and heterosexual men but not among those aged >32 years.
- A minimal annual decline in genital warts was observed in men who have sex with men in the vaccination period.

Handling editor Jackie A Cassell

Acknowledgements The authors would like to acknowledge A. Afrizal for his assistance with data extraction.

Contributors EPFC, TRHR, BD, MYC, CSB and CKF conceived and designed the study. EPFC, RW and CKF undertook the data analysis. EPFC wrote the first draft of the manuscript. All authors critically revised the article for intellectual content and approved the final version.

Funding This work was supported by the National Health and Medical Research Council (NHMRC) programme grant (grant number 568971).

Competing interests None.

Ethics approval Ethics approval for this study was obtained by the Alfred Hospital Ethics Committee (No.: 90/14).

Provenance and peer review Not commissioned; externally peer reviewed.

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