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Factors related to vaccine uptake by young adult women in the catch-up phase of the National HPV Vaccination Program in Australia: Results from an observational study

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ABSTRACT

Background: Australia commenced a publically-funded, National Human Papillomavirus (HPV) Vaccination Program in 2007 with a two year catch-up phase for females aged 12–26 years.
Objective: To identify the factors associated with the uptake of the HPV vaccine (which has a recommended 3-dose schedule in Australia) by young adult women vaccinated by general practitioners and community-based programs within the catch-up phase.
Methods: 1139 women who were eligible to receive the free HPV vaccine during the catch-up period were recruited in 2008–2009 (age 20–29 years at recruitment), in New South Wales, after having a normal (negative) cervical smear result recorded on the NSW Pap Test Register. Participants completed a self-administered questionnaire providing information on vaccination status, and sociodemographic and other factors.
Results: Overall, 880 (77%) women reported receiving ≥1 dose of the vaccine and 777 women (68%) reported receiving ≥2 doses. In multivariable analysis (adjusting for the period for which each woman was eligible for free HPV vaccination), uptake of ≥1 dose of the vaccine was significantly associated with being born in Australia ($p < 0.01$), being single ($p = 0.02$), being nulliparous ($p < 0.01$), living in a higher socioeconomic status area (p-trend = 0.03), living in more remote areas ($p = 0.03$), drinking alcohol ($p < 0.01$) and using hormonal contraceptives ($p < 0.01$). Although vaccinated women were more likely to have fewer sexual partners than unvaccinated women (p-trend = 0.02), they were also more likely to report a prior sexually transmitted infection (STI) ($p = 0.03$). Similar factors were associated with receiving ≥2 doses.
Conclusions: In this group, women living in higher socioeconomic status areas were more likely to be vaccinated against HPV in the catch-up phase of the national program. Although vaccinated women tended to have fewer sexual partners, they also reported prior STIs, which may be a marker of increased risk of prior exposure to HPV. The findings of this study reinforce the continuing need to prioritise equitable delivery of vaccination to various population subgroups.

1. Introduction

Australia was one of the first countries to implement a national publically-funded human papillomavirus (HPV) vaccination program. The program has involved the recommended administration over 6 months of 3 doses of Gardasil quadrivalent vaccine (bioCSL Australia/Merck Inc. Whitehouse Station, NJ, USA), which protects against infection with the oncogenic HPV types 16 and 18, as well

Abbreviations: GP, general practitioner; PTR, Pap Test Register; SES, socioeconomic status; STI, sexually transmitted infections.

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as infection with types 6 and 11, which are implicated in the development of anogenital warts. School-based routine vaccination of 12–13 year old girls commenced in April 2007, and a school and general practitioner (GP)-based catch-up program involved offering free vaccination to females aged 12–26 years. Vaccination for women who had finished school was carried out by GP practices and community-based programs from July 2007 until December 2009. In 2013, the program was also extended to 12–13 year old boys, with a two-year catch-up in males to 14–15 years. The catch-up provides the opportunity for older individuals to be vaccinated, although population-level effectiveness in older age cohorts is expected to be lower if more individuals have been previously exposed to vaccine-included HPV types. Vaccination status is recorded at an individual level on the National HPV Vaccination Program Register (NHVPR) in Australia. The national coverage rates recorded on the NHVPR for those aged 18–26 years in 2007 were 55% for ≥1 dose and 32% for 3 doses (using 2007 population data as the denominator) [1]. However, a 2011 survey of women in this age cohort (22–30 years in 2011) suggested under-notification of vaccine doses to the National HPV Vaccination Program Register by providers, with 64% of surveyed women reporting ≥1 and 53% reporting receiving 3 doses [1].

It is plausible that a number of socio-demographic factors may have been associated with vaccine uptake even within the free public program. The population of women who were vaccinated in the catch-up phase has yet to be fully characterised in terms of their demographic profiles, sexual behaviour and lifestyle characteristics; however a prior survey has identified that vaccinated young adult women were more likely to be Australian born, a permanent resident in 2007, English speaking at home, and unmarried [1]. There are also indications that adolescent and young women's degree of knowledge towards vaccination and the availability of free vaccination during the catch-up period was limited or variable [2,3]. It is also pertinent to assess vaccine uptake in relation to behavioural factors relevant to the risk of prior HPV exposure (including the number of sexual partners and related measures), because these have the potential to alter the overall effectiveness of vaccination in the population. In clinical trials, prophylactic vaccination with quadrivalent vaccine was 98% effective in preventing cervical high grade precancerous disease (CIN2/3), adenocarcinoma in situ or cervical cancer related to HPV 16 and 18 in 16–26 year old women previously naive for these vaccine-included types, but 44% effective in prevention of this outcome in the trial population overall (and 17% effective in prevention of all cervical high grade lesions regardless of causal HPV type) [4]. Women reporting more than four prior sexual partners were excluded [4], and so the overall effectiveness of the vaccine in "real world" catch-up programs has the potential to be lower than reported in the trial.

Taking into account the above issues, the objectives of the current study were to assess whether socio-demographic, clinical and/or behavioural factors were associated with vaccine uptake in a population of women who were 20–29 years old in 2008–2009, and were eligible to receive free vaccine at the time of the delivery of catch-up HPV vaccination in Australia.

2. Methods

2.1. Study population and recruitment

This cross-sectional analysis was performed in a group of women who recently had a cervical screening test with a normal (negative) cytology result and were eligible for vaccination in the catch-up phase. These women were recruited as controls for a case-control study of the role of exogenous hormonal co-factors in the development of cervical precancerous lesions (the "Cervical Health Study"). Recruitment for the Cervical Health Study was performed in women aged 20–64 years via invitation letters sent from the centralised Pap Test Register (PTR) in New South Wales (NSW). Recruitment of 20–29 year old subjects began in March 2008. Cases for the Cervical Health Study were recruited as women on the PTR with a record of a low or high grade cytological or histological abnormality. Controls matched to cases by age and local area were recruited from the PTR with a record of a normal cytological result in the same week as the abnormal smear for the matched case. All participants gave informed consent before taking part. Exclusion criteria included hysterectomy, current pregnancy, morbidity or impairment preventing participation and prior treatment for a cervical abnormality in the three months prior to recruitment. Complete history of cervical cytology and histology dates and results from the PTR were obtained for all participants. The current analysis was restricted to participants recruited between March 2008 and November 2009, who had returned a completed questionnaire by 1 January 2010 and on the date of completing the questionnaire had been eligible for the free vaccination catch-up program for at least one day (i.e. those aged ≤26 years on 1 July 2007 and thus ≤29 years of age at the time of recruitment). The time for which individual women had been eligible for vaccination was taken into account in the analysis.

Ethical approval for the release of PTR data was originally obtained in 2006 (Ref 2004/05/073) from the Human Research Ethics Committee of the Cancer Institute NSW. Following the implementation of the National HPV Vaccination Program, a protocol amendment to collect information on HPV vaccination status through the study questionnaire was approved in 2007, under the same reference number, by the NSW Population and Health Services Research Ethics committee.

Participants were sent a detailed self-administered questionnaire which requested demographic, lifestyle and medical details as well as reproductive and sexual history. Women were asked to indicate whether they had ever been vaccinated against HPV (additionally described on the questionnaire as "vaccinated against cervical cancer"), the year of vaccination and the number of doses received. Because study recruitment was ongoing during the catch-up program (rather than being performed after its completion), the reported number of doses at the time of questionnaire completion did not necessarily reflect the final number of doses received. Therefore, for the current analysis the factors influencing 3-dose uptake could not be directly assessed. In order to increase statistical power, we analysed factors associated with uptake of ≥1 doses of vaccine. We also performed a secondary analysis on factors associated with receiving two or more doses. The time for which the vaccine was available free of charge for each participant was taken into account in the analysis.

2.2. Socio-demographic factors

Socio-demographic factors that were assessed included age at questionnaire completion; the highest educational qualification completed; marital status, country of birth; and the number of full term pregnancies. We also used the Socio-Economic Indexes for Areas (SEIFA) [5] quintiles [1 = lowest socioeconomic status (SES) to 5 = highest] and the Accessibility-Remoteness Index of Australia Plus (ARIA+) [6], which is a standard Australian Bureau of Statistics-endorsed measure of geographical remoteness.

2.3. Clinical and behavioural characteristics

Clinical characteristics that were assessed were: the number of cytological smear tests prior to the year of vaccination in vaccinated participants or prior to the normal index cytological test in unvaccinated women, the number of previous high grade

Table 1
Year of first dose of HPV vaccine by number of doses received for women aged 20–29 years at study recruitment (2008–2009), in NSW, Australia (self-reported vaccination uptake).

Year of first dose	Number of doses received, *n* (row %)			
	One	Two	Three	Total *n*
Same calendar year as questionnaire response	77(40%)	64(33%)	53(27%)	194
One calendar year before questionnaire response	18(3%)	74(14%)	433(82%)	525
Two calendar years before questionnaire response	8(5%)	6(4%)	147(91%)	161

cytological and histological lesions and low grade lesions, and the number of detected precancerous lesions overall. Behavioural characteristics that were assessed included history of any sexually transmitted infection (STI), lifetime number of sexual partners, alcohol consumption, use of tobacco and use of hormonal contraceptives.

2.4. Statistical methods

Multivariable logistic regression modelling was used to identify the factors associated with vaccination status. Independent variables included all socio-demographic, clinical and behavioural factors described previously, with the exception of the variables representing the numbers of prior low grade and high grade lesions. These variables were excluded from the full model because of their collinear relationship with the variable representing prior number of total lesions (i.e. high grade and low grade combined). Estimated coefficients for the excluded variables were obtained by fitting a separate full model that excluded prior number of total lesions. A reduced multivariable logistic regression model was then obtained by sequential exclusion of statistically non-significant factors (in decreasing order of *p*-values) that were not observed confounders of other effects (using a 10% change-in-estimate criterion for confounding). However, since the reduced model provided no appreciable reduction in the standard errors of effect estimates, only the results of the full multivariable analysis are reported here. Linear trend tests were performed by sequentially substituting the binary indicator variables of inherently ordinal determinants with their ordinal counterparts into the full logistic regression model. The ordinal values for each level of each factor was taken to be the median value of the data for that level for interval data or consecutive integers for ordered categories.

A complete case approach was adopted for all analyses, thus participants with missing/unknown information on vaccination status and/or any one of the factors of interest were excluded from all analyses. The exception to this rule was the inclusion of the category "prefer not to answer" for lifetime number of sexual partners since this was offered as a legitimate response option on the questionnaire. We analysed factors associated with vaccine uptake of ≥1 doses in women with normal cervical smears. We also performed a secondary analysis on factors associated with receiving two or more doses of vaccine. All analyses were performed using Stata 11.0 software (StataCorp, College Station, TX, USA).

3. Results

A total of 1925 controls were invited to participate in the Cervical Health Study between March 2008 and November 2009 who were eligible for the catch-up vaccination program for at least one day (Fig. 1). Of these, 1222 (64%) consented to participate in the Cervical Health Study and returned a completed questionnaire by 1 January 2010. A total of 7% (*n* = 83) of those who consented to participate had missing or non-valid data on HPV vaccination and/or at least one potential factor related to vaccination. These participants were excluded from all further analyses thus providing an overall participation rate of ~59%. All analyses were performed on

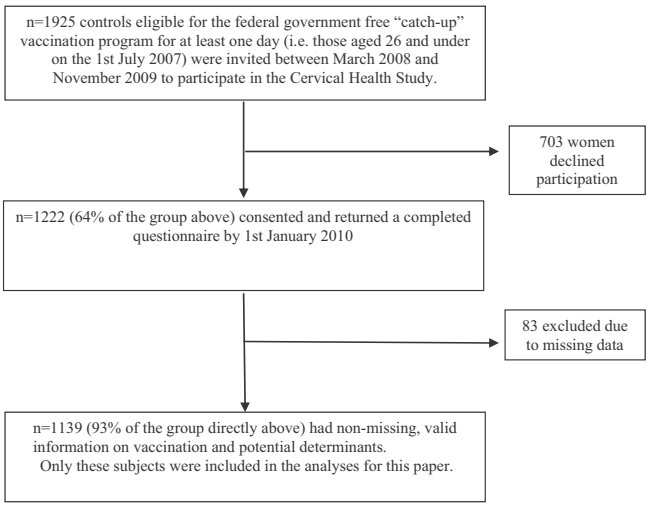

Fig. 1. Flowchart showing overall study recruitment process and subjects included in the current analysis.

the remaining 1139 women. Of these, 880 (77%) reported receiving ≥1 doses and 777 (68%) women reported receiving ≥2 doses of vaccine. The timing of the reported number of doses in relation to study recruitment is shown in Table 1. Women who received fewer than 3 doses of vaccine and who were vaccinated in the same year as recruitment, or the year immediately before recruitment, could still potentially complete the remainder of their doses within the recommended time frame after completing the study questionnaire (hence these women cannot contribute to an estimate of actual dose completion rates in the study group). However, an estimate of the vaccination completion rate was obtained for those women who reported receiving their first dose of vaccine 2 years before recruitment; amongst this subgroup of women, 91% reported receiving all 3 doses of vaccine.

As expected, women were less likely to report being vaccinated as the time for which they had been eligible for free vaccination decreased (Table 2). Table 2 also presents the odds ratios for socio-demographic characteristics potentially associated with vaccination uptake (≥1 dose). Women who were single (never married) had higher odds of being vaccinated compared to married/partnered women. Women with children were significantly less likely to be vaccinated than nulliparous women and those born overseas were less likely to report being vaccinated than women born in Australia. In addition, although there was no significant association between educational attainment and vaccination status, the likelihood of reporting being vaccinated decreased with decreasing socio-economic status of the place of residence. The adjusted odds of women living in areas in the second lowest and lowest socio-economic quintiles being vaccinated were around half those of women living in areas in the highest quintile. Women in outer regional/remote/very remote areas were more likely to report being vaccinated.

Table 3 presents clinical and behavioural characteristics by vaccination status. Women reporting a higher number of sexual

Table 2
Socio-demographic characteristics by self-reported HPV vaccination status, based on ≥1 doses, in women aged 20–29 years at study recruitment (2008–2009) in NSW, Australia.

Characteristic	Unvaccinated *n* = 259 (23%)	Vaccinated *n* = 880 (77%)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)♦	Overall *p*-value and *p*-trend♦,*
Age					
20–21	30 (17%)	148 (83%)	Ref.	Ref.	
22	25 (16%)	135 (84%)	1.09 (0.61–1.95)	1.33 (0.69–2.53)	
23	28 (21%)	103 (79%)	0.75 (0.42–1.32)	0.79 (0.41–1.51)	0.59
24	31 (17%)	147 (83%)	0.96 (0.55–1.67)	1.36 (0.72–2.59)	0.73
25	30 (21%)	114 (79%)	0.77 (0.44–1.35)	1.39 (0.7–2.73)	
26	41 (27%)	111 (73%)	0.55 (0.32–0.93)	0.94 (0.49–1.81)	
27	48 (36%)	86 (64%)	0.36 (0.21–0.62)	1.18 (0.58–2.38)	
28–29	26 (42%)	36 (58%)	0.28 (0.15–0.53)	1.35 (0.5–3.32)	
Time vaccine was available free of charge to woman					
24+ to 30 months	16 (13%)	105 (87%)	Ref.	Ref.	
18+ to 24 months	67 (20%)	274 (80%)	0.62 (0.35–1.12)	0.61 (0.32–1.16)	<0.01
12+ to 18 months	66 (22%)	236 (78%)	0.54 (0.3–0.99)	0.51 (0.27–0.98)	<0.01
6+ to 12 months	73 (24%)	235 (76%)	0.49 (0.27–0.88)	0.44 (0.23–0.85)	
1 day to 6 months	37 (55%)	30 (45%)	0.12 (0.06–0.25)	0.12 (0.05–0.31)	
Highest qualification completed					
University degree or higher	101 (22%)	356 (78%)	Ref.	Ref.	
Certificate/diploma	67 (23%)	221 (77%)	0.94 (0.6–1.33)	1.07 (0.69–1.64)	0.84
Trade/apprenticeship	8 (19%)	35 (81%)	1.24 (0.56–2.76)	1.50 (0.5–3.83)	n/a
HSC or leaving certificate	52 (20%)	204 (80%)	1.11 (0.76–1.62)	1.22 (0.76–1.96)	
School certificate or less	31 (33%)	64 (67%)	0.59 (0.36–0.95)	0.97 (0.5–1.85)	
SEIFA quintile					
5—Highest SES	106 (20%)	422 (80%)	Ref.	Ref.	
4	57 (23%)	194 (77%)	0.85 (0.59–1.23)	0.94 (0.59–1.50)	0.17
3	56 (25%)	167 (75%)	0.75 (0.52–1.08)	0.83 (0.51–1.35)	0.03
2	28 (32%)	60 (68%)	0.54 (0.33–0.88)	0.46 (0.23–0.91)	
1—Lowest SES	12 (24%)	37 (76%)	0.77 (0.39–1.54)	0.56 (0.25–1.26)	
ARIA plus					
Major City	174 (22%)	630 (78%)	Ref.	Ref.	
Inner Regional	68 (29%)	170 (71%)	0.69 (0.50–0.96)	0.68 (0.45–1.04)	0.03
Outer regional/remote/very remote	17 (18%)	80 (82%)	1.30 (0.75–2.25)	1.62 (0.83–3.18)	n/a
Marital status					
Married or partnered	181 (29%)	445 (71%)	Ref.	Ref.	
Single—never married	74 (15%)	419 (85%)	2.30 (1.70–3.11)	1.58 (1.09–2.27)	0.02
Single- divorced, separated or Widowed	4 (20%)	16 (80%)	1.63 (0.54–4.93)	2.7 (0.79–9.22)	n/a
Country of birth					
Australia	195 (20%)	782 (80%)	Ref.	Ref.	
Overseas-English speaking country	28 (37%)	48 (63%)	0.43 (0.26–0.70)	0.43 (0.24–0.76)	<0.01
Overseas-non English speaking country	36 (42%)	50 (58%)	0.35 (0.22–0.55)	0.31 (0.18–0.54)	n/a
Number of births					
None	160 (18%)	740 (82%)	Ref.	Ref.	

Table 2 (*Continued*)

Characteristic	Unvaccinated $n = 259$ (23%)	Vaccinated $n = 880$ (77%)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)♦	Overall p-value and p-trend♦,*
One	53 (37%)	90 (63%)	0.37 (0.25–0.54)	0.53 (0.32–0.88)	<0.01
Two or more	46 (48%)	50 (52%)	0.24 (0.15–0.36)	0.38 (0.21–0.66)	<0.01

ARIA plus: Accessibility-Remoteness Index of Australia Plus; HSC: higher school certificate; n/a: not applicable; SEIFA: Socio-Economic Indexes for Areas; SES: socioeconomic status.

♦ Adjusted for time vaccine was available to woman and socio-demographic characteristics (shown in Table 2), and clinical and behavioural characteristics (shown in Table 3).

* *P*-values are from the multivariable model.

partners were less likely to report being vaccinated. However, women who reported having a prior STI (other than oncogenic HPV infection) had higher odds of reporting being vaccinated compared to women who did not report a prior history of STIs. Reported uptake of ≥1 dose of the vaccine was also associated with drinking alcohol, with women who drank more likely to report being vaccinated. In addition, past- and never-users of hormonal contraceptives had close to half the odds of being vaccinated than those of current users. No significant associations with vaccination uptake were observed for the number of prior cervical cytology tests (Pap smears) or abnormal cytology tests.

These socio-demographic, clinical and behavioural characteristics were also evaluated for their association with uptake of ≥2 doses versus no dose, and results were found to be similar to those for ≥1 doses (detailed results not shown).

4. Discussion

To our knowledge this is the first study to investigate a comprehensive range of socio-demographic, clinical and behavioural characteristics in relation to vaccine uptake within a publically-funded HPV vaccination catch-up program for young adult women in the community. In the study group, we found vaccine uptake to be associated with being born in Australia, being single, being nulliparous, living in higher socioeconomic status areas and living in outer regional/remote/very remote areas. In the study population, women who reported receiving the vaccine also reported fewer sexual partners. However, we found an association between vaccine uptake and history of other STIs, and we also found an association with use of hormonal contraceptives, which is a documented co-factor in the development of invasive cervical cancer [7].

Our findings are in broad agreement with those of a prior Australian study involving women aged 18–26 years in 2007 who were recruited as part of a mobile phone-based survey, which found that women reporting being vaccinated with ≥1 doses in the catch-up phase were more likely to be born in Australia and to be unmarried [1]. Our findings are also consistent with another analysis of National HPV Register data from the state of Victoria for the cohort who were 18–26 years old in 2007, which demonstrated a statistically significantly lower 3-dose HPV vaccination coverage in the most disadvantaged areas compared to the least disadvantaged areas (33.4% vs. 38.0%: $p < 0.001$) (although it should be noted that this socioeconomic gradient was less pronounced than that observed for cervical screening) [8]. This is an important issue because Australian women from lower socioeconomic status areas are less likely to attend cervical screening [8,9] and are thus at higher lifetime risk of developing cervical cancer.

Our findings that vaccination initiation was associated with living in a higher socioeconomic status area appear broadly consistent with international studies for adult women offered HPV vaccination. High neighbourhood income was positively associated with vaccination initiation in women aged 18–26 years in a US study conducted within a Managed Care Organization [10], and in other US studies in young adult women, HPV vaccination initiation and/or completion has also been associated with health insurance status [11–16]. It should be noted that the relationship between socioeconomic status and HPV vaccination may differ between young adult women and adolescent groups and may also different between populations. A recent systematic review of the international literature on inequalities in HPV vaccination in females aged 18 years or younger identified strong evidence of heterogeneity in analyses of area-level deprivation and HPV vaccination initiation - some, but not all primary studies in this age group found that those living in the most deprived areas were less likely to initiate HPV vaccination than those living in the least deprived areas [17]. In general terms, an association between area-level SES and uptake of the HPV vaccine may also indicate underlying factors such as beliefs and cultural sensitivities which may have influenced the decision to accept vaccination [18].

In the current study, we found that vaccinated women were more likely to report fewer sexual partners, however, adult women who chose to be vaccinated in the catch-up phase also reported certain other characteristics that potentially place them at an increased risk of HPV exposure prior to vaccination (i.e. prior STI exposure which may act as a marker of higher risk of past HPV exposure) or of progression of cervical HPV infection (i.e. use of hormonal contraceptives). A recent study conducted on older adolescents (16–17 year old girls) in the Netherlands found that vaccinated and unvaccinated girls were comparable with respect to most sexual risk behaviours (a slightly higher percentage of vaccinated girls were sexually active, but this group had fewer total lifetime numbers of sexual partners) and no difference was found for history of STIs in the sexually active group [19]. There have been differing results from other international studies that have assessed HPV vaccination in relation to sexual behaviour; some studies in young adult women have found a positive association between vaccination initiation or completion and a history of STIs [10–12,15] or increasing number of sexual partners [13,20], while other studies reported no association with these characteristics [14,21]. Other studies in young adult women have also found an association between vaccination status and being single, unmarried or never married (with the exact measure being study dependent) [12,14,15,22].

The relationship identified in the current study between HPV vaccine uptake and use of hormonal contraception, has not been previously documented in the Australian National HPV Vaccination Program and has only been investigated in a few other international studies of young adult women [10,11,21,23]. Hormonal contraception use may act as a proxy for accessing health services on a regular basis, thus possibly increasing the likelihood of vaccination in the catch-up phase, and/or it may indicate increased awareness of women's health issues [24].

Our study is subject to some limitations. First, study participants were recruited from a population of women attending cervical screening and therefore findings and observed vaccination rates

Table 3
Clinical and behavioural characteristics by self-reported HPV vaccination status, based on ≥1 doses, in women aged 20–29 years at study recruitment (2008–2009), in NSW, Australia.

Characteristic	Unvaccinated *n* = 259 (23%)	Vaccinated *n* = 880 (77%)	Unadjusted OR (95%CI)	Adjusted♦ OR (95%CI)	Overall *p*-value and *p*-trend♦
Number of pap smears#					
None	51 (20%)	199 (80%)	Ref.	Ref.	
One	89 (24%)	281 (76%)	0.81 (0.55–1.19)	0.75 (0.47–1.2)	0.70
Two	52 (22%)	185 (78%)	0.91 (0.59–1.41)	0.83 (0.49–1.4)	0.78
Three or more	67 (24%)	215 (76%)	0.82 (0.54–1.24)	0.82 (0.47–1.45)	
Number of high grade lesions#,♣					
None	238 (23%)	779 (77%)	Ref.	Ref.	
One	7 (19%)	29 (81%)	1.27 (0.55–2.93)	0.93 (0.35–2.5)	0.42
Two or more	14 (16%)	72 (84%)	1.57 (0.87–2.84)	1.59 (0.78–3.22)	0.23
Number of low grade lesions#,♣					
None	222 (24%)	698 (76%)	Ref.	Ref.	
One	21 (15%)	117 (85%)	1.77 (1.09–2.89)	1.46 (0.83–2.56)	0.33
Two or more	16 (20%)	65 (80%)	1.29 (0.73–2.28)	1.43 (0.69–2.95)	0.18
Number of high and low grade lesions#					
None	212 (24%)	656 (76%)	Ref.	Ref.	
One	19 (17%)	93 (83%)	1.58 (0.94–2.65)	1.28 (0.71–2.3)	0.13
Two or more	28 (18%)	131 (82%)	1.51 (0.98–2.34)	1.78 (1.00–3.16)	0.05
Had other STI~					
No	224 (24%)	715 (76%)	Ref.	Ref.	0.03
Yes	35 (18%)	165 (83%)	1.48 (1.00–2.19)	1.66 (1.05–2.63)	n/a
Family history of cervical cancer or precancer					
No family history	178 (24%)	579 (76%)	Ref.	Ref.	
Mother and/or sister	29 (17%)	141 (83%)	1.49 (0.97–2.31)	1.82 (1.10–3.02)	0.07
Distant family member only	23 (25%)	69 (75%)	0.92 (0.56–1.52)	1.07 (0.60–1.9)	n/a
Not aware of any cervical cancer	29 (24%)	91 (76%)	0.96 (0.61–1.51)	0.77 (0.46–1.31)	
Number of sexual partners ever					
1	52 (25%)	156 (75%)	Ref.	Ref.	
2–4	61 (20%)	248 (80%)	1.36 (0.89–2.06)	0.91 (0.55–1.51)	0.11
5–9	68 (24%)	221 (76%)	1.08 (0.72–1.64)	0.65 (0.39–1.09)	0.02*
10+	57 (25%)	167 (75%)	0.98 (0.63–1.51)	0.54 (0.31–0.96)	
Prefer not to answer	21 (19%)	88 (81%)	1.40 (0.79–2.47)	0.97 (0.48–1.95)	
How often drink alcohol					
Never/non-drinker	37 (42%)	51 (58%)	Ref.	Ref.	
Ex-drinker	19 (58%)	14 (42%)	0.53 (0.24–1.20)	0.51 (0.20–1.3)	<0.01
Less than once a month	46 (20%)	184 (80%)	2.90 (1.70–4.94)	2.43 (1.31–4.49)	n/a
A few days a month	116 (19%)	484 (81%)	3.03 (1.89–4.84)	1.66 (0.93–2.95)	
More than 8 days a month	41 (22%)	147 (78%)	2.60 (1.51–4.49)	1.66 (0.85–3.25)	
Smoking status					
Never smoked	162 (21%)	599 (79%)	Ref.	Ref.	
Ex-smoker	44 (28%)	116 (73%)	0.71 (0.48–1.05)	0.82 (0.51–1.3)	0.43
Occasional smoker	21 (20%)	83 (80%)	1.07 (0.64–1.78)	0.86 (0.48–1.54)	n/a
Regular smoker	32 (28%)	82 (72%)	0.69 (0.44–1.08)	0.65 (0.38–1.11)	

Table 3 (*Continued*)

Characteristic	Unvaccinated $n=259$ (23%)	Vaccinated $n=880$ (77%)	Unadjusted OR (95%CI)	Adjusted♦ OR (95%CI)	Overall p-value and p-trend♦
Use of hormonal contraceptives					
Current@	129 (18%)	608 (82%)	Ref.	Ref.	
Past	112 (32%)	239 (68%)	0.45 (0.34–0.61)	0.58 (0.41–0.81)	<0.01
Never used	18 (35%)	33 (65%)	0.39 (0.21–0.71)	0.54 (0.27–1.10)	n/a

♦ Adjusted for time vaccine was available to woman and socio-demographic (shown in Table 2), and clinical and behavioural characteristics (shown in Table 3).
On or before reported year of vaccination in vaccinated subjects or reference test year in unvaccinated subjects.
♣ Fitted in separate model which excluded "number of high grade and low grade lesions" due to collinearity.
~ Includes warts but not cervical oncogenic HPV infection.
* Trend statistic calculated by excluding subjects who preferred not to answer.
@ Includes pill, mini pill, implants, injections or intrauterine devices with hormones.

are not representative of all young adult women at the time of the delivery of catch-up vaccination in Australia. It is possible that some 'opportunistic' vaccination occurred in young women presenting for cervical screening during the vaccination catch-up phase (and/or vice-versa i.e. that opportunistic screening may have occurred in those presenting for vaccination). Following the completion of the catch-up phase, however, participation in cervical screening appears to have declined in 20–29 year old women. A recent analysis using linked data from the National HPV Vaccination Register and the Victorian Cervical Cytology Register shows that participation in cervical screening was significantly lower in vaccinated women over the period 2009–2011 (i.e. a period subsequent to that over which recruitment to the current study was conducted) [25].

A second limitation of the current study is that because recruitment for the study ran concurrently to the catch-up program, it was not possible to assess factors associated with completion of the recommended 3-dose schedule. However, assessing uptake of ≥1 doses of the HPV vaccine is consistent with other studies which have investigated vaccine initiation, and we adjusted for the time eligible for catch-up vaccination in the analysis**.** A third limitation of our study is that we used self-reported vaccination uptake, and in our study group of women attending cervical screening who had a normal cervical cytology result, we had a high reported uptake of vaccination overall; but it is notable that the reported uptake of 77% for ≥1 doses in the current study group is broadly consistent with that of the self-reported 3-dose coverage rate of ~71% in a prior study of 18–24 year old women presenting for cervical screening in 2010–2011 (i.e. in a slightly younger birth cohort) [26]. Furthermore, a prior Australian analysis of 629 self-reported HPV vaccination doses has also shown that ~86% of self-reports agreed with register/provider records [1] and a ~90% concordance between self-reported and registry-reported vaccination status was found in a survey of women aged 18–25 years recruited in 2011–2013 [27].

Despite the above limitations, the current study has a number of strengths including the availability of a wide range of demographic, clinical and lifestyle characteristics and recruitment from a single source, the NSW Pap Test Register, which collects information on almost all women who have a Pap test, with a low opt-out rate of <1% [28]. Our findings are in broad agreement with those of other Australian studies for the outcomes assessed in those studies, however the current study provides a more detailed description of the characteristics of the women who chose to be vaccinated against HPV in the catch-up phase of the National HPV Vaccination Program.

Substantial indications of the effect of the National HPV Vaccination Program in Australia were predicted [29,30] and have already been observed in young cohorts offered vaccination; these include a substantial decline in the prevalence of vaccine-included HPV types in women aged 18–24 years [26], a decline in the incidence of anogenital warts in females under 30 years of age [31] and a decline in high grade cervical precancerous lesions in young women [32]. Linked data analysis between vaccination and cervical screening registers have also demonstrated substantial reductions in high grade precancerous abnormalities in vaccinated women in Australia [33,34]. Although this substantial and rapid effect of the catch-up vaccination program is very reassuring, the findings of the current study reinforce the continuing need to assess vaccine uptake in different groups in the HPV vaccine-eligible population and to prioritise equitable delivery of vaccination.

Authors' contributions

KC conceived the project and wrote the first full draft together with LSV. SE performed the statistical analysis for this evaluation, prepared the tables and figures and participated in drafting the manuscript. DO'C provided statistical input. JDB was responsible for the conduct of the study, recruitment of participants and coordinated the project. FS is the Principal Investigator for the Cervical Health Study. All authors had full access to all of the data, and can take responsibility for the integrity of the data and the accuracy of the data analysis. All authors contributed to the writing of the manuscript, approved the final version to be published and are in agreement with the analysis, results and interpretation of the findings. KC is the guarantor.

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Conflict of interest statement

KC, DO'C, EB and FS have received grants from the National Health and Medical Research Council. KC is co-PI of an investigator-initiated trial of HPV-based cervical screening in Australia which is conducted and funded by the Victorian Cytology Service and which has received a funding contribution from Roche Molecular Systems and Ventana Inc., USA; JBD is the project coordinator for the same trial. LSV and SE have nothing to disclose.

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