



Knowledge of human papillomavirus (HPV) and HPV vaccination: An international comparison

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ABSTRACT

Since vaccination against human papillomavirus (HPV) became available, awareness of HPV has dramatically increased. Implementation of a vaccine program varies internationally yet no studies have explored the influence this has on the public's knowledge of HPV. The present study aimed to explore differences in awareness of HPV and HPV knowledge across three countries: The US, UK and Australia.

Participants ($n = 2409$) completed a validated measure of HPV knowledge as part of an online survey. There were higher levels of HPV awareness among men and women in the US than the UK and Australia. Being male and having a lower educational level was associated with lower HPV awareness in all three countries. Awareness of HPV vaccine was higher in women from the US than the UK and Australia. Women in the US scored significantly higher on general HPV knowledge (on a 15-item scale) than women in the UK and Australia, but there were no between country differences in HPV vaccine knowledge (on a 6-item scale). When asked about country-specific vaccine availability, participants in the US were less able to identify the correct answers than participants in the UK and Australia. More than half of participants did not know: HPV can cause genital warts; most sexually active people will get HPV at some point in their life; or HPV doesn't usually need treatment.

Pharmaceutical advertising campaigns could explain why awareness of HPV and HPV vaccine is higher in the US and this has helped to get some important messages across. Significant gaps in HPV knowledge remain across all three countries.

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1. Introduction

Infection with genital high-risk types of human papillomavirus (HPV) can have a number of serious consequences, most notably cervical cancer. HPV types 16 and 18 contribute to around 74% of cervical cancers [1] as well as to cancers of the anus, penis, vulva, vagina, mouth and oropharynx [2]. HPV types 6 and 11 cause almost all cases of genital warts [3]. Prevention of HPV would therefore reduce the incidence of a number of cancers as well as genital warts, along with the morbidity, mortality and costs associated with these diseases.

Two prophylactic vaccinations against HPV have been licenced by the US Food and Drug Administration (FDA) for use with young

women (Gardasil[®], produced by Merck and approved in 2006, and Cervarix[®], produced by GlaxoSmithKline and approved in 2009). Both vaccines protect against HPV types 16 and 18 and Gardasil[®] also protects against types 6 and 11. Australia was the first country to implement a nationwide publicly-funded vaccination program (in 2007), offering HPV vaccination for free to all girls aged 12–13 years through school-based programmes, with catch-up programs targeting young women aged 14–18 in schools and 18–26 years in the community. Over the last five years most developed countries have made HPV vaccination available for young women, although the choice of vaccine, the cohorts it is offered to, the way it is administered and the cost to the consumer varies. A report published in April 2009 reviewed HPV vaccination availability across Europe [4]. At that time nine out of forty countries offered free vaccination, the UK was the only country to offer a school-based program and in most Eastern European countries HPV vaccination was only available privately. In the UK, all girls age 12–13 are offered the vaccine in a free, school-based program that was launched in 2008. A catch-up campaign for girls up to age 18 years was run in the first two

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years of the program. In the US implementation of HPV vaccination varies by state but is mostly available through physicians' offices and medical clinics [5]. The cost of vaccination is covered by most private insurance companies and through the federal Vaccines for Children program (for those who are publically insured, uninsured, or underinsured). Debate in the US about making HPV vaccination a requirement for middle school entry is on-going [6].

Knowledge and understanding of HPV infection and vaccination are important factors in insuring informed decisions. However HPV is complicated and does not fit neatly with lay understanding of cancer or other sexually transmitted infections (STIs). The infection itself is very common, yet its serious consequences (i.e. cancers) are rare. It usually clears spontaneously or becomes undetectable, yet this is not always the case. Risk of HPV can be dramatically reduced using condoms, yet they are not as protective against HPV as they are against other STIs.

Introduction of HPV vaccination has been accompanied with varying levels of publicity in the media and materials produced by charities, government organisations, and pharmaceutical companies, distributed via visual and print media and the internet. Before the introduction of the HPV vaccine, population-representative surveys suggested that around 25%–50% of women had heard of HPV [7–9]. Other studies with specific sub-groups of the population suggested a wide range of HPV awareness, with levels as low as 13% among adolescents [10] and as high as 93% in clinic-based samples [11]. Studies suggested that awareness of HPV was highest among women and those from high socio-economic backgrounds [7,8,12,13]. Since the introduction of the HPV vaccination awareness of HPV seems to have increased, particularly among parents [14]. In particular, the sexually transmitted nature of the virus and its potential to cause cervical cancer are the most widely known facts [15,16].

In 2008, a systematic review of all HPV knowledge studies concluded that there were no differences between countries [12], but because only small numbers of studies were included no statistical analyses were run. In addition this review only included studies carried out before HPV vaccination was introduced. Comparing knowledge across countries is of particular interest in the case of HPV vaccination. Despite many similarities between the US, UK and Australia there were distinct differences in the way HPV vaccination was introduced (see Box 1). Most notably, the introduction of Gardasil in the US was accompanied by a million dollar advertising campaign launched by Merck, to encourage young women to be vaccinated. In the UK and Australia direct-to-consumer (DTC) advertising is not permitted, limiting TV advertising to government sponsored campaigns which were on a much smaller scale. Other advertising in the UK and Australia was more targeted, focussing on information leaflets aimed at those eligible for the vaccine.

We explored awareness and knowledge of HPV and HPV vaccination among men and women in the US, UK and Australia, using a validated measure [17]. The study aimed to (i) explore differences in awareness of HPV and knowledge of HPV between the US, UK and Australia, (ii) consider whether socio-demographic predictors of knowledge are similar across the three countries, and (iii) identify gaps in knowledge.

2. Methods

2.1. Participants

Participants were recruited through international online panels managed by Survey Sampling International (SSI). Panel members are individuals who have signed up to take part in online research studies in return for small rewards (e.g. airmiles). At the time of the present survey there were 236,088 (UK), 1,790,981 (US) and

Box 1: The context of HPV vaccination in the US, UK and Australia

	US	UK	Australia
Vaccination used	Gardasil/Cervarix	Cervarix (Gardasil from 2012)	Gardasil
Date of introduction	2006–2007 (Gardasil) and 2009 (Cervarix), varies by state	September 2008	July 2007
Eligibility	9–26 years	All girls in school year 8 (12–13 years) along with a catch-up campaign for girls up to 18 years old.	Girls aged 12–13 years (school year 7–8 depending on area) along with an initial catch-up campaign for women aged 14–26. Also available to boys age 12–13 years with a catch up program for boys aged 14 years from 2013.
Administration	Predominantly through health care providers	Predominantly through schools	Predominantly through schools
Cost	The cost of the vaccine is covered by most insurance providers or is free for those that qualify for the vaccines for children program	Free to all eligible girls	Free to all eligible girls (and boys from 2013)
Information available	- Advertises from pharmaceutical companies - Information provided by schools (varies by state) - Additional information available on various websites, including CDC	- Department of Health funded website, TV and radio campaign at the time the vaccine was launched - Leaflets distributed through schools with the invitation letter - Additional information available on various websites	Commonwealth Department of Health and Aging funded website, TV and radio campaign at the time the vaccine was launched - Leaflets distributed through schools with the invitation letter - Additional information available on various websites

80,249 (Australian) members on the panels associated with those three countries. Samples of participants were invited to take part in the present study. The samples were structured to reflect the demographic characteristics of the country in terms of gender, age and location. Participants were sent a generic recruitment email (Subject: We want your opinion; email text: exciting new survey opportunity! We appreciate your participation. Please click below). When participants clicked on the link in the email they were directed to an online survey titled 'what do you know about HPV?' The target sample was 800 participants from each country in the age range 18–70 years. Quotas were set to ensure equal numbers of men/women completed the survey. Participants were invited in waves until the recruitment target was met.

2.2. Measures

Participants were given information about the purpose of the study, reassurance of confidentiality and anonymity, and contact details for researchers in each country. Participants then reported their age, gender and country of residence and if eligible to take part (i.e. their quota was not full) were asked "before today, had you ever

Table 1
Sample characteristics.

	US (n = 813)	UK (n = 799)	Australia (n = 797)	Significance
Age [mean (standard deviation)]	46.03 (15.38)	41.84 (14.85)	48.07 (15.05)	$F = 35.35, p < 0.001$
Sex [n (%)]				NS
Male	398 (49.0)	395 (49.4)	396 (49.7)	
Female	415 (51.0)	404 (50.6)	401 (50.3)	
Relationship status [n (%)]				$\chi^2(6) = 50.15, < 0.001$
Single	293 (36.0)	281 (35.2)	220 (27.6)	
Dating	59 (7.3)	83 (10.4)	67 (8.4)	
Cohabiting	55 (6.8)	114 (14.3)	101 (12.7)	
Married	406 (49.9)	321 (40.2)	409 (51.3)	
Ethnicity ^a [n (%)]				$\chi^2(2) = 20.29, < 0.001$
Majority	680 (83.7)	666 (83.4)	605 (75.9)	
Minority	132 (16.3)	133 (16.6)	192 (24.1)	
Education ^c [n (%)]				$\chi^2(4) = 85.15, < 0.001$
High	297 (36.5)	273 (34.3)	177 (22.2)	
Medium	307 (37.8)	312 (39.2)	272 (34.1)	
Low	209 (25.7)	211 (26.5)	348 (43.7)	
Have a daughter 9–17 years [n(%)]	101 (12.4)	115 (14.4)	107 (13.4)	NS
Had HPV vaccine ^b [n(%)]	44 (10.6)	29 (7.2)	50 (12.5)	$\chi^2(2) = 6.40, 0.041$

NS: Not significant i.e. $p > 0.05$.

^a Majority in US = White non-Hispanic, UK = White British, AUS = Australian.

^b Women only.

^c Education was coded as follows:

High: College graduate/graduate school (US), Degree/post-graduate degree (UK), any university education (AUS).

Medium: Some college/Associate degree (US), Vocational/A-levels/other qualification < degree (UK), Vocational qualification (AUS).

Low: High school, CED or below (US), no formal education/GCSEs (UK), No formal education/high school (AUS).

heard of human papillomavirus (HPV)?” Those who had heard of HPV responded to 15-items assessing knowledge of HPV (including transmission, consequences, risk factors) and the item “before today, had you ever heard of HPV vaccination?”. Those who had heard of HPV vaccination responded to 7-items about the procedure and protection offered by HPV vaccines and 6-items (5-items for Australian participants) about the availability of HPV vaccination in their country. These policy items differed between countries to take account of the different healthcare systems through which the vaccine is offered (see Supplementary material). The response options for all items were true/false/don’t know. Development and validation of the HPV knowledge items is described elsewhere [17]. Participants also reported demographics, whether they had received HPV vaccination and if they had a daughter in the HPV vaccination age range (9–17 years).

2.3. Analyses

Chi-square tests were used to evaluate whether there were differences in HPV awareness, HPV vaccine awareness and individual item-level knowledge across the three countries. ANOVAs were used to explore differences in mean knowledge scores across countries, and post hoc Tukey’s tests were used to establish where significant differences lay. Because there were differences in some demographic characteristics between the three countries (see Table 1) we ran a series of additional analyses controlling for these potential confounders (age, relationship status, ethnicity, education and, for women, vaccine status). As adjusting for these variables did not alter the significance of any findings and in the interest of parsimony, we have reported the unadjusted results. Logistic regression analyses were used to explore demographic correlates of HPV awareness within each country. Only variables that were significant at the $p < 0.05$ level in univariate analyses were entered into the multivariate models. Analyses of the individual knowledge items used Bonferroni corrections to adjust for multiple testing. Significance values of $p < 0.003$ were used for general HPV knowledge items and $p < 0.007$ for HPV vaccine items. Analyses were carried out using SPSS version 18.

3. Results

Overall 12,259 men and women were directed to the HPV knowledge survey, of whom 3959 were eligible and invited to take part. The survey was completed by 2442 participants (62% response rate). Thirty-three cases were excluded due to anomalies in the data, leaving 2409 cases for analyses: USA ($n = 813$), UK ($n = 799$) and Australia ($n = 797$) (see Fig. 1). Sample characteristics are shown in Table 1.

3.1. Awareness of HPV and general HPV knowledge

Overall 61.1% had heard of HPV before. In each of the three countries women were more likely to have heard of HPV than men (in the US unadjusted OR = 4.09, CI: 2.86–5.85; in the UK unadjusted OR = 2.49, CI: 1.87–3.31; in Australia unadjusted OR = 3.61, CI: 2.68–4.85). There were higher levels of HPV awareness among men in the US (64%) than the UK (39%) and Australia (41%). Among women, the highest awareness was in the US (88%), lowest awareness in the UK (62%) with Australia falling between the two (72%) [see Table 2].

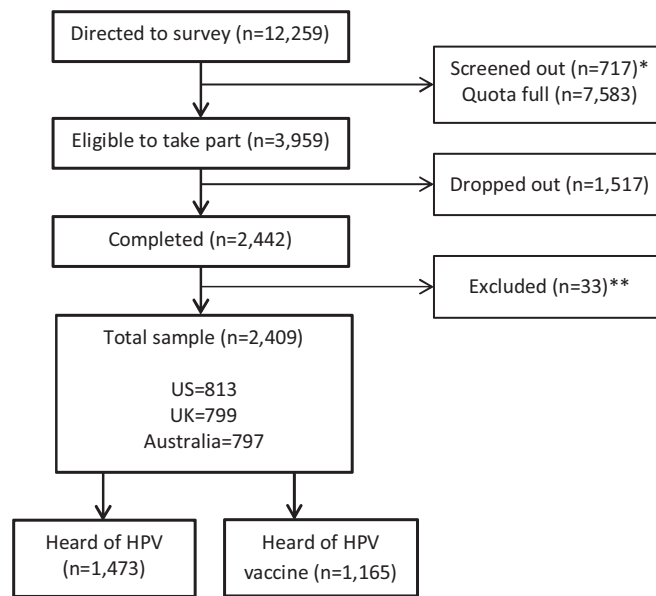
For all three countries lower educational level was associated with lower HPV awareness in men and women [see Table 3]. In addition, relationship status was associated with awareness in US men, age was associated with awareness in UK men and having a daughter aged 9–17 years old was associated with awareness in Australian men. For women, age was associated with awareness in the US, having a daughter aged 9–17 years was associated with awareness in the UK and having had the vaccine was associated with awareness in Australia [see Table 3].

Those who had heard of HPV completed a 15-item HPV knowledge scale and the mean number of items correctly identified as true or false was 8.44 (SD = 3.92). In the US and the UK women had higher mean knowledge scores than men (US: 9.22 compared with 8.00, $t(615) = 3.57, p < 0.001$; UK: 8.53 compared with 7.74, $t(402) = 1.99, p = 0.048$). Overall the mean HPV knowledge score for men was 7.97 (SD = 4.20) with no significant differences across the three countries. For women the mean HPV knowledge score was

Table 2
Awareness and mean knowledge scores by country.

	Men				Women			
	US	UK	Aus.	χ^2 or F (p-value)	US	UK	Aus.	χ^2 or F (p-value)
Heard of HPV (%)	63.6 ^a	39.2 ^b	41.4 ^b	57.65 (<0.001)	87.7 ^a	61.6 ^b	71.8 ^c	73.37 (<0.001)
Heard of HPV vaccine (%)	69.2	67.1	71.3	0.68 (0.714)	91.8 ^a	80.7 ^b	81.3 ^b	20.09 (<0.001)
HPV knowledge score (mean)	8.00	7.74	8.16	0.40 (0.672)	9.22 ^a	8.53 ^{ab}	8.31 ^b	5.48 (0.004)
HPV vaccine knowledge score (mean)	3.62	3.59	3.94	1.52 (0.220)	4.15	4.08	4.15	0.15 (.865)
HPV vaccine availability score (mean)	2.17	3.36	2.36	N/A	2.21	4.08	2.60	N/A

^{a,b,c} Different superscript letters represent significant differences at $p < 0.05$ in post hoc Tukey's tests or 2×2 chi-square analyses. Where superscript letters are the same, between-group differences are not significant.



* Refers to those who were outside the age range 18–70 years

** Due to inconsistencies in the data which led us to believe the survey was not being completed properly

Fig. 1. Recruitment overview.**Table 3**
Socio-demographic correlates of HPV awareness for each country for men and women (multivariate models).

	Men			Women		
	USA (n = 398)	UK (n = 393)	AUS (n = 395)	USA (n = 415)	UK (n = 403)	AUS (n = 401)
Education ^a						
High	1.00	1.00	1.00	1.00	1.00	1.00
Medium	0.66 [0.41–1.07]	0.50 [0.31–0.80]**	0.59 [0.35–1.00]	0.30 [0.12–0.77]*	0.37 [0.22–0.62]***	0.89 [0.44–1.82]
Low	0.49 [0.28–0.85] [†]	0.34 [0.19–0.59]***	0.29 [0.17–0.49]***	0.18 [0.07–0.46]***	0.22 [0.13–0.98]***	0.51 [0.26–0.98] [†]
Relationship						
Married	1.00	–	–	1.00	–	–
In a relationship/cohabiting	2.01 [0.96–4.21]	–	–	4.17 [0.95–18.25]	–	–
Single	0.62 [0.40–0.97] [†]	–	–	1.00 [0.53–1.91]	–	–
Age	–	0.98 [0.97–0.99]**	–	0.98 [0.96–1.00]*	–	–
Have a daughter 9–17 years	–	–	2.29 [1.22–4.31] [†]	–	2.23 [1.18–4.24]**	–
Had HPV vaccine	N/A	N/A	N/A	–	–	0.39 [0.17–0.91] [†]

Note: Variables that were not significantly associated with HPV awareness in univariate logistic regression analyses were not included in the multivariate model.

^a Education was coded as follows: High: College graduate/graduate school (US), Degree/post-graduate degree (UK), Any university education (AUS), Medium: some college/Associate degree (US), Vocational/A-levels/other qualification < degree (UK), Vocational qualification (AUS), Low: high school, CED or below (US), no formal education/GCSEs (UK), No formal education/high school (AUS).

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

Table 4
Individual item level differences in general HPV knowledge and HPV vaccination knowledge by country.

	Men				Women			
	US	UK	AUS	χ^2	US	UK	AUS	χ^2
General HPV knowledge in those aware of HPV (men, $n = 572$; women, $n = 901$)								
HPV can cause cervical cancer	76.9	79.4	77.4	NS	92.6 ^a	86.3 ^b	85.1 ^b	10.39 (0.006)
A person could have HPV for many years without knowing it	65.6	67.1	65.9	NS	82.7	78.3	79.2	NS
Having many sexual partners increases the risk of getting HPV	70.0	71.6	74.4	NS	76.1	74.7	72.9	NS
HPV is very rare (F)	64.0	54.2	69.5	NS	76.9 ^a	67.1 ^b	78.1 ^a	10.38 (0.006)
HPV can be passed on during sexual intercourse	66.8	70.3	71.3	NS	74.2	67.1	66.7	NS
HPV always has visible signs or symptoms (F)	58.5	56.8	55.5	NS	78.0	71.1	76.7	NS
Using condoms reduces the risk of getting HPV	55.7	60.0	68.9	NS	60.7	68.3	61.6	NS
HPV can cause HIV/Aids (F)	52.6	52.3	53.7	NS	60.4	65.9	58.0	NS
HPV can be passed on by genital skin-to-skin contact	56.1	52.9	60.4	NS	51.9	51.0	54.9	NS
Men cannot get HPV (F)	55.7	50.3	49.4	NS	61.0 ^a	55.0 ^b	45.8 ^c	14.93 (.001)
Having sex at an early age increases the risk of getting HPV	51.4	45.2	48.2	NS	62.1 ^a	58.2 ^a	43.8 ^b	23.17 (<0.001)
There are many types of HPV	53.4	48.4	49.4	NS	57.7 ^a	45.8 ^b	46.2 ^b	11.88 (0.003)
HPV can cause genital warts	45.8	48.4	56.1	NS	49.5	48.2	51.4	NS
HPV can be cured with antibiotics (F)	40.3	35.5	33.5	NS	54.4	48.2	45.1	NS
Most sexually active people will get HPV at some point in their lives	29.6	21.9	23.8	NS	31.9 ^a	24.9 ^{ab}	19.4 ^b	13.11 (0.001)
HPV usually doesn't need any treatment	9.9	12.3	12.3	NS	9.3	8.4	4.5	NS
HPV vaccine knowledge in those aware of HPV vaccine (men, $n = 396$; women, $n = 769$)								
Girls who have had an HPV vaccine do not need a Pap test when they are older (F)	74.3	61.5	77.8	NS	88.0	82.6	92.3	NS
One of the HPV vaccines offers protection against genital warts	76.6	69.2	71.8	NS	84.4	82.1	80.3	NS
HPV vaccines offer protection against all sexually transmitted infections (F)	76.6	69.2	71.8	NS	84.4	82.1	80.3	NS
Someone who has an HPV vaccine cannot develop cervical cancer (F)	74.3	60.6	66.7	NS	80.8 ^a	71.6 ^b	66.2 ^b	16.02 (<0.001)
HPV vaccines offer protection against most cervical cancers	44.0	53.8	62.4	NS	53.9	61.2	62.8	NS
The HPV vaccine requires three doses	29.7	39.4	40.2	NS	47.9 ^a	39.3 ^a	59.0 ^b	17.04 (<0.001)
HPV vaccines are most effective if given to people who have never had sex	37.1	49.0	41.0	NS	41.0 ^a	50.7 ^b	35.5 ^a	10.54 (0.005)

Note 1: Making Bonferroni corrections for each gender means overall χ^2 were considered significant at $p < 0.003$ for general HPV knowledge items and at $p < 0.007$ for HPV vaccine items (NS means Not significant).

^{a,b,c} Different superscript letters represent significant differences in 2×2 chi-square analyses at $p < 0.05$.

F = correct answer is 'false.'

8.74 (SD = 3.70), with women in the US scoring significantly higher than women in Australia (9.22 compared to 8.31, $p = 0.005$) and slightly higher than women in the UK (8.53, $p = 0.058$ – bordering on significant). Looking at item level differences between the three countries showed no differences for men, however more women in the US responded correctly to a number of items than women in the UK and/or Australia. These items related to cervical cancer as a consequence of HPV, the prevalence of HPV, that there are different types of HPV, that men can get HPV and that having sex at an early age increases the risk of getting HPV (see Table 4).

3.2. Awareness of HPV vaccination and HPV vaccination knowledge

Of the 1473 participants who had heard of HPV, 79.1% had heard of HPV vaccination. In each country, women were more likely to be aware of HPV vaccination than men (in the US OR = 4.96, CI: 3.14–7.85; in the UK OR = 2.05, CI: 1.30–3.25; in Australia OR = 1.74, CI: 1.11–2.73). Awareness of HPV vaccination was similar for men in all three countries. Among women awareness was higher in the US (92%) than in the UK and Australia (both 81%) [Table 2]. Very few of the socio-demographic factors showed associations with awareness of HPV vaccine. Lower educational level was associated with lower HPV vaccine awareness in US men and having a daughter aged 9–17 years was associated with higher awareness in UK women and Australian men.

Participants completed a 7-item scale assessing their knowledge of HPV vaccination. Mean scores were 3.71 (SD = 1.73) for men and 4.13 (SD = 1.59) for women. Women had higher HPV vaccination knowledge scores than men in the US (4.15 compared to 3.62; $t(507) = 3.36$, $p = 0.001$) and the UK (4.08 compared to 3.59, $t(303) = 2.48$, $p = 0.014$), but not in Australia. There were no differences in mean HPV vaccine knowledge scores between the three countries for men or women. Table 4 shows item level differences between the three countries. While there were no between country

differences for men, there were for women. Women in the US were more aware that HPV vaccine does not protect against all cervical cancers; women in Australia were more likely to know that the vaccine requires 3 doses; and women in the UK were more likely to know that HPV vaccine is most effective if given to people who have never had sex.

Additional items assessed knowledge of HPV vaccination availability, using different items for each of the three countries (6-items in the US and UK, 5-items in Australia; see Supplementary material). Mean scores on these scales were higher for women than men in the UK (4.08 compared to 3.36, $t(303) = 3.96$, $p < 0.001$), but there were no gender differences in the US and Australia. Although not directly comparable we have presented the proportion of men and women correctly answering items on different themes in Fig. 2. Participants in the US were less able to identify the correct answer to items about the cost of the vaccine, the setting where it is offered, whether it is available for males, whether it is available to older women and the protection offered by the vaccine.

4. Discussion

Women had higher awareness of HPV than men and were more likely to have heard of the vaccine, which is consistent with previous findings [12,15] and is not surprising given that current strategies mostly involve offering and marketing the vaccine to women only. Education was significantly associated with awareness of HPV, which is also consistent with previous research [7,8,13]. Other demographic variables associated with awareness varied by country and gender.

Awareness of HPV in general and HPV vaccination was higher in the US than in Australia and the UK. One possible explanation for this is the abundance of publicity about HPV produced by the pharmaceutical industry with drug company adverts being the most common source for having heard of HPV in the US [18,19]. There are no studies in the UK or Australia asking about sources

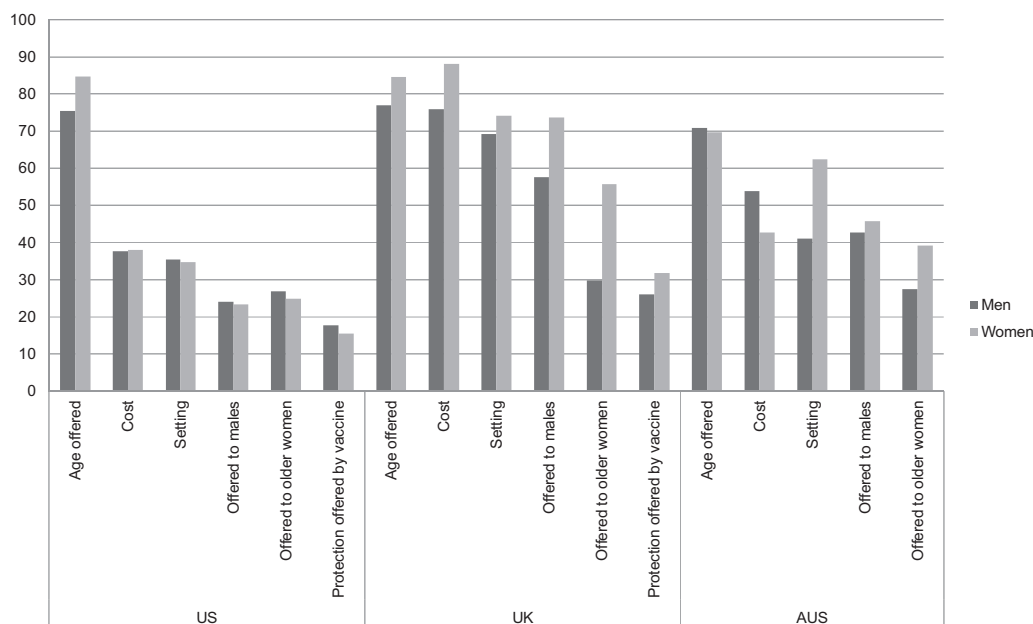


Fig. 2. The percentage of men and women in the US, UK and Australia correctly responding to HPV vaccine availability items.

of information on HPV but common sources of information on women's health and cervical cancer prevention in the UK and Australia include health professionals (particularly the GP), talking to friends and reading leaflets [20,21]. In addition controversy surrounding mandating HPV vaccination has been widely reported in the US media [22].

Most participants who had heard of HPV knew its association with cervical cancer (77–79% of men and 85–93% of women) and that HPV is sexually transmitted (70–74% of men and 73–76% of women). This is consistent with other studies [15,16] and suggests that information campaigns have successfully raised awareness of some aspects of HPV knowledge as pre-vaccine introduction fewer respondents were reported to know these facts [7,23]. Knowledge of other aspects regarding HPV and HPV vaccination could still be greatly improved, for example more than half of those who had heard of HPV did not know: HPV can cause genital warts; most sexually active people will get HPV at some point in their life; or HPV doesn't usually need treatment and more than half of those who had heard of HPV vaccine did not know that it requires three doses and is most effective if given to people who have never had sex. In addition more than a third of participants responded incorrectly to items about the ability for condoms to reduce the risk of HPV and about men getting HPV as well as women. Interestingly, there were no inter-country differences in correctly identifying the statement HPV can cause genital warts as true, despite the fact that both the US and Australia offer Gardasil and at the time of data collection the UK only offered Cervarix. Confusion about whether HPV is related to HIV/AIDS was also common, although this item has been found to correlate poorly with other aspects of HPV knowledge, so should perhaps be interpreted with caution [17].

Some interesting paradoxes emerged from the data, for example that fact that most women were aware that vaccination does not rule out the need for future cervical screening (83–92% across the three countries) and yet 19–34% of women were uninformed about the fact that it is possible to develop cervical cancer despite receiving the vaccine. The discrepancy was particularly marked among Australian women (see Table 4), and is consistent with findings from a survey in Victoria [24]. The finding suggests that messages about the need for future screening may need to be underpinned

with clearer information about the limitations of the vaccine—i.e. that it does not prevent all cervical cancers.

US women were more likely to know about the link between HPV and cervical cancer, that HPV is common and that there are different types of HPV than women in the UK and Australia. These were the three messages covered in the Gardasil campaigns 'tell someone' (about HPV) and 'one less' (with the message that by being vaccinated, you could be one woman less affected by cervical cancer). The campaigns included TV advertising in the US and our findings suggest that these advertisements did more than simply raise awareness. However, when asked about the availability of the vaccine in their country men and women from the US got fewer questions correct. These questions are not directly comparable so differences should be interpreted with caution, however there are several explanations for why knowledge about vaccine availability may be poor in the US. Firstly, as availability of the vaccine varies by state, this information is unlikely to be publicised on a national level and actively searching for vaccine availability information is likely to be necessary. Secondly, while pharmaceutical advertisements seem to have helped raise awareness of HPV in the US, even those who recall having seen DTC HPV adverts found it hard to understand and recall what they had seen [25] and not surprisingly those who used advertisements as their only source of information about HPV had lower knowledge than those who sought additional information [26]. While fewer men and women have heard of HPV in the UK and Australia, those who have may feasibly be those who the vaccine is most applicable to and therefore know more about its availability.

There are a number of limitations to this study. The recruitment of online panel samples and the use of quotas to ensure adequate representation of different age-groups and genders means our sample may not be representative of the US, UK and Australian populations. Although the vast majority of the population seem to have some access to the internet [27], there are still inequalities and those who opt in to internet survey panels may not be representative of those with internet access due to self-selection bias. HPV knowledge is also higher in those who use the internet [16]. Having said that, the aim of this survey was to compare HPV knowledge across three countries and online recruitment allowed

for directly comparable recruitment methods. There is no reason to suppose that recruitment biases would have differed systematically between the three countries. It is difficult to report an accurate response rate for online surveys. Of those who were directed to our survey and eligible to take part 62% completed the survey, but this denominator does not represent those who decided not to click on the survey link in the email. The study measured knowledge using closed questions which we know from previous work is likely to give higher estimates of knowledge than a more open-ended approach [12,28]. However we chose to use a validated measure that is easy to administer and code, for pragmatic reasons and to facilitate comparison with future studies.

This study explores differences in HPV knowledge and awareness between three countries that have introduced HPV vaccination in the last five years. Awareness seems to be high in all three countries although inequalities still exist, with lower awareness among those with lower educational level. We have highlighted some significant gaps in HPV knowledge which should be the target of future information campaigns. Poor knowledge in men may pose a particular challenge as and when HPV vaccination for males becomes available.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.vaccine.2012.11.083>.

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