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ONCOGENIC HUMAN PAPILLOMAVIRUS (HPV) INFECTIONS IN 18 TO 24 YEAR OLD FEMALE ONLINE DATERS

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Abstract

Background—While risk factors for HPV infections in young women are well-defined, the risk associated with meeting male sex partners via the internet is unclear.

Methods—We analyzed cross-sectional data from 282 18-24-year old women who reported using Internet dating websites in the past year. Women were mailed vaginal self-sampling kits for PCR-based HPV genotyping (including 19 oncogenic types) and sexual behavior and health history questionnaires. Generalized linear models were used to evaluate risk factors for prevalent oncogenic HPV infections.

Results—35% of women reported having met a male sex partner via the Internet in the past 6 months, and 42% reported a history of HPV vaccination. The prevalence of oncogenic HPV infection was 37%, and 9% of women tested positive for HPV-16 or HPV-18. Having met a male sex partner via the Internet in the past 6 months was not significantly associated with oncogenic HPV infection. In multivariate analyses, variables associated with an increased likelihood of oncogenic HPV infection included male partners in the past 6 months who were reported to have 1 concurrent partnership (adjusted prevalence ratio [aPR]=1.51,95%CI:1.11-2.06) and not always using condoms with male partners in the past 6 months (aPR=1.86,95%CI:1.05-3.30). Self-reporting a history of receiving 1 dose of HPV vaccine was inversely associated with testing positive for HPV-16 or HPV-18 (aPR=0.39,95%CI:0.16–0.97).

Conclusions—While measures of recent sexual behavior were associated with prevalent oncogenic HPV infection, male partners met online were not associated with an increased likelihood of infection in this cohort of young women.

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Keywords

HPV; human papilloma virus; women; prevalence; risk factors

INTRODUCTION

Human papillomavirus (HPV) is the most common sexually transmitted infection among women,¹ with oncogenic types HPV-16 and HPV-18 accounting for an estimated 70% of all cases of cervical cancer.² The prevalence of oncogenic HPV in the 2003-2006 U.S. National Health and Nutrition Examination Survey (NHANES) was 29% in women aged 14-59, with the highest prevalence observed in women aged 20-24 and the lowest prevalence observed in women aged 50-59.³ While there is much known about the acquisition and the natural history of HPV infections in sexually active young women,⁴ the risk associated with meeting sex partners via Internet dating or social networking websites is unclear.

We previously reported that meeting recent male sex partners online was associated with an increased likelihood of prevalent oncogenic HPV infection in 25-65 year old women.⁵ There may be considerable variation in the epidemiologic profiles of HPV infections in different populations of women and varying patterns of age-specific prevalence in different populations. This analysis aims to contribute new information to potential patterns of age-specific oncogenic HPV prevalence and risk factors among women who participate in online dating (defined in this study as using the Internet to search for romantic partners, regardless of whether the result is meeting a sex partner). Understanding population-specific patterns and risk factors for HPV infection are critical to the development of public health messages and prevention strategies to reach individuals that may be at increased risk of cervical cancer. If meeting sex partners via online dating is associated with increased risk of HPV infection, it could be beneficial to incorporate education regarding prevention, screening, and vaccination within the dating sites themselves. Using a design and protocol that were similar to those used in our previous study of 25-65 year old female online daters, we recruited 18-24 year old female online daters to self-collect vaginal samples for oncogenic HPV testing and complete detailed health and sexual behavior questionnaires. In this report, we present baseline prevalence and risk factor data and discuss our findings in comparison to our similar cohort of mid-adult women.

METHODS

We used baseline data from two studies of HPV infections in 18-24 year old women who were recruited via the Internet and reported recent online dating. Women in Study 1 (N=161) were enrolled from April 2010 to January 2011⁶ into a cross-sectional study designed to compare methods for transporting at-home self-collected samples for HPV testing. Women in Study 2 (N=195) were recruited from October 2010 to May 2012 into a one-year longitudinal study designed to evaluate incidence and persistence of oncogenic HPV infections in young female online daters. Seventy-four women from Study 1 were also recruited to participate in Study 2; only their Study 1 data are included in this analysis. In total, 282 women were included in this analysis.

Recruitment methods and eligibility criteria were identical for both studies. Women from the United States who reported online dating within the past twelve months were recruited primarily via [Craigslist.org](https://www.craigslist.org) and other free online volunteer posting websites; recruitment methods were identical to those used in our previous study of 25-to-65 year old female online daters and have been described previously.⁵ Briefly, ads targeted 18- to 24-year old women who reported using the Internet to search for romantic partners within the past 12 months, and instructed those interested to contact the study coordinator for phone-based eligibility screening. Women were specifically asked: “Have you used an internet dating website in the past year [e.g. posted or responded to an ad on an online dating website or social networking website]?” Women were excluded from participation if they were pregnant, breastfeeding, or planning a pregnancy in the next 6 months; hysterectomized; immunocompromised; or reported no history of sex with men. The study coordinator maintained a screening database with names and detailed contact information. To avoid duplicate enrollment, all potential subjects were matched with a list of previously screened and enrolled subjects. Eligible women were mailed a consent form, and enrolled after returning the signed consent form. The protocol for each study was reviewed and approved by the University of Washington Institutional Review Board.

Women in study 1 were asked to self-collect samples for HPV testing once, whereas women in study 2 were asked to self-collect samples for HPV testing triannually for one year. Women in both studies were also asked to complete detailed questionnaires on demographics, sexual behavior, and health history (including HPV vaccination status) at the time of each self-collection. Women in study 1 received a \$20 incentive for participating. Women in study 2 received a \$15 incentive for each self-collected sample returned (up to \$60 for four samples). All self-samples and questionnaires were completed at home and mailed to the study coordinator; no in-person visits were conducted. Only the baseline data from each study were used in this analysis.

Each mailed self-collection kit contained two Dacron-tipped swabs, nitrile gloves, packing and shipping materials, a prepaid standard overnight Federal Express envelope, illustrated self-collection instructions, and written instructions to refrain from douching, vaginal intercourse, and the use of vaginal medications or preparations for 48 hours before collecting the vaginal samples. Women were instructed to collect the samples at least 2 days after the end of last menses and to collect and ship their sample on the same day in the return mailing materials provided. Study 1 kits contained two covered tubes (one containing 1 ml of Specimen Transport Medium (STM) (Qiagen, Gaithersburg, MD) and one containing no liquid medium), and study 2 kits contained one covered tube containing 1.5 ml of STM. As the primary aim of Study 1 was to evaluate concordance between paired samples transported in liquid medium versus no liquid, women were instructed to place one swab into each tube. In Study 2, women were instructed to place both swabs into the same tube.

Vaginal samples were tested for HPV DNA using polymerase chain reaction (PCR) based methods described previously.⁵ HPV DNA and β -globin were amplified simultaneously using the HPV L1 consensus primers MY09, MY11 and HMB01 and β -globin primers PC04 and GH2. Specimens determined to be HPV positive by genetic probe or that were β -globin negative by dot blot were typed using the Roche Linear Array HPV genotyping test (Roche

Molecular Systems, Inc. Alameda, CA) for 37 HPV types, including 19 types classified as carcinogenic, probably carcinogenic, or possibly carcinogenic: 16/18/26/31/33/35/39/45/51/52/53/56/58/59/66/68/73/82/IS39.^{7, 8} Paired wet and dry samples from study 1 were tested separately; because almost perfect agreement for detecting HPV was observed⁶ the wet and dry swab HPV results were combined and treated as a single result for this analysis.

We calculated prevalence estimates with 95% confidence intervals for any oncogenic HPV, HPV types 16 or 18, multiple oncogenic types, and each individual oncogenic type. In addition, separate estimates were constructed among women who did and did not report a history of prophylactic HPV vaccination (1 dose).

Poisson regression models with robust variance estimates were constructed to estimate associations between selected risk factors and any oncogenic HPV (prevalence ratios). Variables found to be statistically significant ($p < .10$) in univariate analyses were entered into a multivariate model; forward stepwise regression was used to construct the final multivariate model, with $p < 0.10$ as the criterion for entering and removing variables. Potential risk factors evaluated included demographics, women's health history, and cumulative and recent sexual behaviors. Demographic variables included age (continuous), race (White, African American, other), Hispanic ethnicity (yes, no), smoking history (never, former, current), and current marital status (married or living with a partner, separated or unmarried). Women's health history variables included hormonal contraceptive use (never, former, current), history of an abnormal Pap test (yes, no), history of genital warts (yes, no), and history of HPV vaccination (yes, no). Cumulative sexual behavior variables included age at 1st sexual intercourse (15, 16-17, 18) and lifetime number of male sex partners (1-2, 3), while recent sexual behavior variables included characteristics of male sex partners and partnerships in the past six months. If male partners were reported in the past six months, characteristics of male partners were summarized across partnerships as follows:

1 new male partner (yes, no), 1 casual (versus regular) male partner (yes, no), 1 male partner with 1 concurrent partnership (yes, no or unknown), 1 male sex partner whom the subject met online (yes, no), and condom use with male sex partners (always, not always).

Similar methods were used to evaluate the association between self-reported history of prophylactic HPV vaccination (1 dose versus 0 doses) and HPV-16 or HPV-18 infection. All variables from the main analysis were evaluated univariately with HPV-16/HPV-18 infection as the outcome. Variables found to be statistically significant ($p < .10$) in univariate analyses were entered into a multivariate model; forward stepwise regression was used to construct the final multivariate model, with $p < 0.10$ as the criterion for entering and removing variables.

RESULTS

The mean age of the 282 subjects was 22.0 (standard deviation [SD]: 1.8) years. Women reported a median lifetime number of male sex partners of 6 (range: 3-12) and a mean age at first intercourse of 16.6 (SD: 2.4) years. Forty two percent reported receiving 1 dose of prophylactic HPV vaccine, 35% reported having met a recent male sex partner (in the past 6

months) via the Internet (Table 1), and 80% reported always using condoms with male sex partners in the past 6 months.

The prevalence of oncogenic HPV infection was 36.5% (95% CI: 30.9-42.1). Multiple oncogenic types were detected in 18.4% (95% CI: 13.9-23.0) of all women tested and 9.2% (95% CI: 5.8-12.6) of all women tested positive for HPV-16 or HPV-18. The most common oncogenic types detected were HPV-16 (8.2%), HPV-51 (8.2%), and HPV-53 (6.4%) (Figure 1).

In univariate analyses, self-reporting a history of genital warts, a lifetime number of male sex partners ≥ 3 , and sex with ≥ 1 male partner in the past 6 months were each positively associated with oncogenic HPV infection (Table 2). Among those who were sexually active with ≥ 1 male partner in the past 6 months, male partner characteristics associated with an increased likelihood of positivity included new partners, casual partners, partners reported to have ≥ 1 concurrent partnership, and inconsistent condom use. Meeting recent male sex partners via the Internet was not statistically significantly associated with oncogenic HPV infection. In multivariate analysis (restricted to women who reported sexual activity with male partners in the past 6 months), variables that remained independently associated with an increased likelihood of oncogenic HPV infection included reporting a lifetime number of male partners ≥ 3 (adjusted prevalence ratio [aPR] versus 1-2 partners = 1.71, 95% CI: 0.90-3.23), recent male partners reported to have ≥ 1 concurrent partnership (aPR = 1.51, 95% CI: 1.11-2.06) and not always using condoms with recent male partners (aPR=1.86, 95% CI: 1.05-3.30).

Self-reporting a history of receiving ≥ 1 dose of HPV vaccine was inversely associated with testing positive for vaccine-types HPV-16 or HPV-18. The prevalence of HPV-16 or HPV-18 infection was 4.7% (95% CI: 0.85-9.15) in vaccinated women versus 13.4% (95% CI: 7.60-18.40) in unvaccinated women (aPR=0.39, 95% CI: 0.16-0.97, adjusting for lifetime number of male partners, smoking history, and reporting a male partner with other concurrent partners) (Figure 1 and Table 2).

DISCUSSION

The prevalence of oncogenic HPV infections was 36.5% in this population of female online daters aged 18 to 24 years. This estimate is comparable to the 43% prevalence estimate reported among 20 to 24 year old women in the NHANES general population (with an additional 4 possibly carcinogenic HPV types [64, 67, 69, and 70] classified as oncogenic)³ and the 36% estimate reported among our previous cohort of female online daters aged 25 to 65 years.⁵ Measures of recent high-risk sexual behaviors (e.g. report of recent male sex partners with concurrent partnerships and inconsistent condom use) were associated with an increased likelihood of oncogenic HPV infection. The association between report of male partners with concurrent partnerships and increased likelihood of oncogenic HPV infection is consistent with findings from our mid-adult cohort.⁵ In contrast, the observed association between inconsistent condom use and increased likelihood of oncogenic HPV positivity differs from the null association observed in our previous mid-adult cohort.⁵ We previously showed that consistent condom use effectively reduced the risk of newly acquired HPV

infection in newly sexually active young women.⁹ One explanation for the discrepant findings between our mid-adult and young online dating cohorts is that a higher proportion of prevalent HPV infections were recently acquired in the younger versus the mid-adult cohort. Characteristics of condom users may also have differed between the two age groups, potentially leading to residual confounding by unmeasured sexual behaviors. It is notable that a higher proportion of women in our young online dating cohort reported always using condoms with recent male partners than in our mid-adult online cohort (80% versus 22%) (similarly, an Australian survey of female online daters reported that older women [>40 years] were less likely to use condoms with new male partners than younger women [18-39 years]¹⁰).

The literature on the association between seeking sex partners online and risk of sexually transmitted infections (STIs) has been mixed. There is limited evidence that seeking sex partners online is associated with an increased likelihood of engaging in high risk sexual behaviors,¹¹⁻¹³ with the Internet serving as a rapid, efficient medium for arranging sexual contact, potentially resulting in more efficient STI transmission. Studies illustrating this link, however, have been equivocal.¹⁴⁻¹⁶ The broad and varying definitions of online sex partner seeking or online dating make it complicated to interpret associations with STI risk. It is possible, for example that the risk of HPV infection associated with meeting sex partners online may vary according to factors such as the mode of online partner seeking, type of dating site used, or timing of first sexual encounter in relation to initial in-person meeting (information not collected in our study). Research also suggests age-related patterns in online dating, which may complicate interpretations of potential age-specific associations between meeting sex partners online and oncogenic HPV prevalence. Younger adults tend to use a broader definition that includes chat rooms, social networking sites, and “sexting”.¹⁷ On the other hand, older adults tend to focus proportionally more of their time online looking to establish earnest relations and foster potential long-term partnerships compared to their younger counterparts.¹⁸ Therefore, we might have expected that any association between meeting sex partners online and increased likelihood of oncogenic HPV infection would be stronger in this younger cohort of women than in our previous mid-adult cohort. In fact, the opposite was true. We observed an increased likelihood of oncogenic HPV infection in the mid-adult cohort⁵ but no association in the younger cohort. However, given that young adulthood is a high-risk period for HPV acquisition,⁴ it may be challenging to determine an independent effect of a specific risk behavior such as meeting sex partners online.

Forty-two percent of women in our study reported having received 1 dose of the HPV vaccination series. This figure is comparable to U.S. national statistics from the same time period. Nationally, 43% of females between the ages of 19 and 21 years and 22% of females between the ages of 22 and 26 years self-reported having received 1 dose of HPV vaccine in 2011.¹⁹ In our study, self-reported history of receiving 1 dose of HPV vaccine was associated with a 61% decrease in the likelihood of prevalent HPV-16 or HPV-18 infection. Among 14-19 year old females participating in the 2007-2010 NHANES, self-reported history HPV vaccination (1 dose) was associated with an even stronger reduction in prevalence of HPV-16 or HPV-18 infection (82% effectiveness).²⁰ While we did not collect data on timing of vaccination in relation to sexual debut, it is not surprising that the

protective effect of vaccination was attenuated in our older cohort of 18-24 year old women compared to the younger NHANES cohort.

In summary, measures of recent high-risk sexual behavior were associated with prevalent oncogenic HPV infection in this cohort of young women. Unlike in our cohort of older women, however, meeting male partners online was not associated with an increased likelihood of oncogenic HPV infection. Self-reported history of HPV vaccination was associated with a decreased likelihood of HPV-16 and HPV-18 infection. Limitations to our study should be addressed. The results may not be generalizable to all young female online daters due to self-selection bias. In addition, the sample size was relatively small, and thus power was limited for analyses of certain risk factors. Furthermore, this was a cross-sectional analysis limited to evaluation of risk factors for prevalent oncogenic infections. Future analyses will focus on the longitudinal results from women in study 2 to explore the epidemiology of newly acquired and persistent HPV infections in young female online daters. Finally, while our goal was to enroll a comparison cohort of young women with a sexual behavior risk profile that was similar to our previous mid-adult cohort, age-related differences in online dating patterns exist, and between-age-group comparisons of meeting sex partners online as a risk factor for oncogenic HPV infections may not be valid. To better understand the risk of HPV infection associated with seeking and meeting sex partners online, future studies should collect more detailed information on the types of websites used and how respondents ultimately used the websites identified.

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Figure 1.

Prevalence of Type-Specific Oncogenic HPV in Self-Collected Vaginal Samples Obtained From Women Aged 18 to 24 Years Who Date Online. Error bars represent 95% confidence intervals for HPV prevalence. No samples tested positive for HPV types 26 or 82.

Table 1

Demographic, Health, and Sexual History Characteristics of 18-to-24 Year Old Females Who Date Online (N=282)

Characteristics	^a n (%)
Race	
White	146 (52.5)
African American	57 (20.5)
Asian	27 (9.7)
American Indian/ Native American	2 (0.7)
Native Hawaiian/ Pacific Islander	2 (0.7)
Other ^b	44 (15.8)
Hispanic Ethnicity	
Yes	31 (11.4)
No	240 (88.6)
Geographic Region	
Midwest	55 (19.6)
Northeast	76 (27.1)
South	43 (15.3)
West	107 (38.1)
Marital Status	
Unmarried	210 (76.1)
Unmarried, living with partner	51 (18.5)
Married	13 (4.7)
Separated	2 (0.7)
Smoking History	
Never	195 (69.9)
Former	32 (11.5)
Current	52 (18.6)
Hormonal Contraceptive Use	
Never	90 (32.4)
Former	109 (39.2)
Current	79 (28.4)

Characteristics	^a n (%)
History of Abnormal Pap Test^c	
No	143 (70.4)
Yes	60 (29.6)
History of Genital Warts	
No	263 (93.9)
Yes	17 (6.1)
History of HPV vaccination	
No	149 (58.4)
Yes	106 (41.6)
No. of doses^d	
1 dose	16 (16.5)
2 doses	14 (14.4)
3 doses	67 (69.1)
Age at first intercourse (years)^e	
15	92 (33.0)
16-17	96 (34.4)
18	91 (32.6)
Lifetime no. of male sex partners^f	
1-2	53 (19.3)
3-5	58 (21.1)
6-8	59 (21.5)
9-14	50 (18.2)
15	55 (20.0)
Sex with male partners in the past 6 months	
Not sexually active	22 (7.9)
1 non-new sex partner only	105 (37.6)
2 sex partners or 1 new sex partner	152 (54.5)
Met a male sex partner online in the past 6 months	
No	180 (64.8)
Yes	98 (35.3)

Characteristics	^a n (%)
Condom use with male partners in the past 9 months ^g	
Always	205 (80.1)
Not always	51 (19.9)

^aNumbers may not add up to totals due to missing data.

^bIncludes individuals reporting other race or multiple races

^cRestricted to women 21 years or older

^dNine women who self-reported a history of HPV vaccination (8.5%) did not report number of doses received.

^eApproximate tertiles

^fApproximate quintiles

^gRestricted to women reporting a male sex partner in past 6 months

Table 2

Prevalence Ratios (PR) for the Associations between Selected Risk Factors and Oncogenic HPV Infections in 18-to-24-Year-Old Women Who Date Online (N=282)

Risk Factors	Total	Oncogenic HPV Positive (%)	Univariate PR (95% CI) (N=282)	Total	Oncogenic HPV Positive (%)	Multivariate^a PR (95% CI) (N=250)
Continuous Age	282	36.5	1.03 (0.94-1.12)			
Race						
White	146	39.7	1.00			
African American	57	36.8	0.93 (0.62-1.38)			
Other ^b	75	29.3	0.74 (0.49-1.10)			
Hispanic Ethnicity						
No	240	37.1	1.00			
Yes	31	35.5	0.96 (0.58-1.58)			
Current Marital Status						
Unmarried or Separated	212	35.9	1.00			
Married or Unmarried, living with partner	64	37.5	1.05 (0.73-1.51)			
Smoking History						
Never	195	35.9	1.00			
Former	32	50.0	1.39 (0.94-2.07)			
Current	52	30.8	0.86 (0.54-1.34)			
Hormonal contraceptive use						
Never	90	33.3	1.00			
Former	109	42.2	1.27 (0.88-1.83)			
Current	79	32.9	0.99 (0.64-1.52)			
History of abnormal Pap test^c						

Risk Factors	Total	Oncogenic HPV Positive (%)	Univariate PR (95% CI) (N=282)	Total	Oncogenic HPV Positive (%)	Multivariate ^a PR (95% CI) (N=250)
No	143	37.8	1.00			
Yes	60	48.3	1.28 (0.91-1.79)			
History of genital warts						
No	263	35.0	1.00			
Yes	17	58.8	1.68 (1.09-2.59)			
History of HPV vaccination ^d						
No	149	38.3	1.00			
Yes	106	36.8	0.96 (0.70-1.33)			
Restricted to HPV 16 or 18 outcomes ^e						
No	149	13.4	1.00	133	15.0	1.00
Yes	106	4.7	0.35 (0.14-0.91)	94	5.3	0.39 (0.16-0.97)
Age of first intercourse (years)						
15	92	38.0	1.00			
16-17	96	42.7	1.12 (0.79-1.59)			
18	91	29.7	0.78 (0.52-1.18)			
Lifetime no. of male sex partners						
1-2	53	15.1	1.00	40	20.0	1.00
3	222	41.9	2.78 (1.44-5.36)	210	41.9	1.71 (0.90-3.23)
Sexual behaviors in the past 6 months						
Sex with a male partner						
No	22	13.6	1.00			
Yes	257	38.9	2.85 (0.98-8.27)			

Risk Factors	Total	Oncogenic HPV Positive (%)	Univariate PR (95% CI) (N=282)	Total	Oncogenic HPV Positive (%)	Multivariate ^a PR (95% CI) (N=250)
New male sex partner^f						
No	124	32.3	1.00			
Yes	133	45.1	1.40 (1.02-1.92)			
Casual male sex partner^f						
No	138	33.3	1.00			
Yes	118	44.9	1.35 (0.99-1.84)			
Male sex partner with 1 concurrent partnership^f						
No or unknown	156	30.1	1.00	152	30.3	1.00
Yes	99	51.5	1.71 (1.26-2.32)	98	51.0	1.51 (1.11-2.06)
Met male sex partner online^f						
No	158	36.1	1.00			
Yes	98	42.9	1.19 (0.87-1.62)			
Condom Use^f						
Always	205	42.9	1.00	201	42.8	1.00
Not Always	51	21.6	1.99 (1.15-3.44)	49	20.4	1.86 (1.05-3.30)

^aRestricted to women reporting a male sex partner in past 6 months and with non-missing data for all variables included. Sex with a male partner (yes/no) was not tested in the multivariate model.

^bIncludes individuals reporting American Indian/Alaska Native, Native Hawaiian/Other Pacific Islander, other race, or multiple races.

^cRestricted to women 21 years of age or older

^dCoded "no" if self-reported no history of HPV vaccination and "yes" if self-reported 1 dose HPV vaccine.

^eThe multivariate model restricted to HPV-16 and HPV-18 outcomes was adjusted for lifetime number of male sex partners, smoking, and reporting a male partner with 1 concurrent partnership.

^fRestricted to women reporting a male sex partner in past 6 months