Preventive Medicine 86 (2016) 92–98

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Trends and predictors of HPV vaccination among U.S. College women and men

Erika L. Thompson *, Cheryl A. Vamos, Coralia Vázquez-Otero, Rachel Logan, Stacey Griner, Ellen M. Daley

Department of Community and Family Health, College of Public Health, University of South Florida, 13201 Bruce B. Downs Blvd. MDC 56, Tampa, FL 33612, USA

ARTICLE INFO

Available online 8 February 2016

Keywords:
HPV vaccination
Trends
College

ABSTRACT

Background. HPV vaccination was recommended by the Advisory Committee on Immunization Practices for young adult females in 2006 and males in 2011 to prevent HPV-related cancers and genital warts. As this prevention mechanism continues to disseminate, it is necessary to monitor the uptake of this vaccine. College students represent an important population for HPV vaccination efforts and surveillance due to increased risk for HPV infection and representing a priority population for catch-up HPV vaccination. The purpose of this study was to assess the trends in HPV vaccination among U.S. college females and males from 2009 to 2013, and to examine whether predictors for HPV vaccination differ between males and females.

Methods. The National College Health Assessment-II (Fall 2009–2013) was used to assess trends in HPV vaccination using hierarchical logistic regression across genders and demographics. Data from 2013 were used to assess demographic variables associated with HPV vaccination for males and females, respectively. The analysis was conducted in 2015.

Results. Females had nearly double the rates of HPV vaccination compared to males over time. All demographic sub-groups had significant increases in vaccine rates over time, with select male sub-groups having more accelerated increases (e.g., gay). Young age (18–21 vs. 22–26 years) was a significant predictor for HPV vaccination among males and females, while race/ethnicity was a predictor of vaccination among females only.

Conclusions. These findings identified specific demographic sub-groups that need continued support for HPV vaccination. Campus health centers may be rational settings to facilitate clinical opportunities for HPV vaccination among unvaccinated college students.

Introduction

Human papillomavirus (HPV) is the most common sexually transmitted infection in the U.S. (Satterwhite et al., 2013). Moreover, it is a cause of genital warts and HPV-related cancers, including cervical, vaginal, vulvar, penile, anal, and oropharyngeal (Munoz et al., 2003; H., 2002; Lacey et al., 2006). In 2006, a quadrivalent HPV vaccine was approved and recommended by the Advisory Committee on Immunization Practices (ACIP) for females 9 to 26 years of age (Markowitz et al., 2007). In 2009, the vaccine was permitted for use among males and then recommended for routine vaccination for ages 9 to 21 and 22 to 26 years for high-risk populations (e.g., men who have sex with men and persons who are immune compromised) in 2011 (Centers for Disease Control and Prevention, 2011; Centers for Disease Control and Prevention, 2010). Recently, a 9-valent HPV vaccine has become available and is congruent with previous ACIP guidelines for both genders (Petrosky et al., 2015). As this prevention mechanism continues to disseminate to age-eligible sub-groups, it is necessary to monitor the uptake of this vaccine over time. According to Healthy People 2020, national priorities aim to achieve 80% completion of the three dose HPV vaccine among 13 to 15 year old males and females (Healthy People 2020, 2015). While national objectives are not developed for young adult HPV vaccine catch-up groups, theoretically, rates would need to be similar to the 13 to 15 year old population. Yet, rates of HPV vaccination among young adult males and females in the United States are suboptimal, 6% (2011–12) and 34% (2012), respectively (Pierre-Victor et al., 2014; Schmidt and Parsons, 2014).

College students represent an important population for HPV vaccination and necessitate continued vaccination surveillance due to increased risk for HPV infection. As of 2013, approximately 48% of young adults ages 18 to 24 were enrolled/completed college (Annie E Casey Foundation, 2015). College students are of prime importance since they comprise the age groups for females at highest risk for HPV; according to national data, 20–24 year old females had the highest prevalence of genital HPV (59.8%) and HPV vaccine types 6, 11, 16, and 18 (19.9%) (Markowitz et al., 2013). The prevalence of genital warts is also highest among young adult males (25 to 29 year olds) and females

* Corresponding author. Fax: +1 813 974 5172.
E-mail addresses: ethomps1@health.usf.edu (E.L. Thompson), cvamos@health.usf.edu (C.A. Vamos), cvazquez@health.usf.edu (C. Vázquez-Otero), logan23@health.usf.edu (R. Logan), staceygriner@health.usf.edu (S. Griner), edaley@health.usf.edu (E.M. Daley).

http://dx.doi.org/10.1016/j.ypmed.2016.02.003
0091-7435/

(20 to 24 year olds) (Insinga et al., 2003). Thus, this significant proportion of easily accessible and high-risk young adults presents an opportunity for catch-up vaccination for persons who did not receive the HPV vaccine as adolescents. To date, only one study has examined predictors of HPV vaccination among a *national* sample of college women; in 2009 the rate of uptake was 45% (Lindley et al., 2013). While college students may have higher uptake of the HPV vaccine compared to the general population, this is a unique group with access to health resources that would facilitate vaccination. Moreover,the extent of dissemination of the HPV vaccine among specific demographic sub-groups in college is unknown. For instance, certain sub-groups may have lower vaccine uptake that is masked by overall HPV vaccine rates, and thus require tailored intervention efforts.

The purpose of this study was to assess the trends in HPV vaccination among United States college females and males from 2009 to 2013. Moreover, this study aimed to evaluate if predictors for HPV vaccination differ between males and females utilizing 2013 data. Findings from this analysis can indicate groups among college students that have improved HPV vaccine rates and those that require more invested public health efforts to promote HPV vaccination.

Methods

Study sample

This secondary data analysis, conducted in 2015, utilized datasets from the American College of Health Association (ACHA). The National College Health Assessment (NCHA) II is a national survey that collects data at universities regarding health status, health behaviors, and perceptions (American College Health Association, 2014). Universities must opt-in to the survey and pay fees in order to participate. Each institution determined its targeted sample size and recruited from a randomized subset of the student population. The aggregate data were available from ACHA via a data request (American College Health Association, 2009–2013). This study was considered exempt from the Institutional Review Board.

For the purpose of this secondary data analysis, the NCHA II data were analyzed from Fall semesters of 2009 to 2013 survey collection periods. During this time period, 248 institutions and 153,276 students participated. The mean response rates for the surveys ranged between 20% and 36% (American College Health Association, 2014).

All data from the Fall 2009 to 2013 NCHA II survey were aggregated (N = 153,276). This dataset was then restricted to participants between the ages of 18–26 years since this is when the HPV vaccine is available for catch-up (N = 130,553). Because the primary outcome for this analysis was HPV vaccination status, participants were removed list-wise from the dataset if he/she were unsure of receiving the HPV vaccine (N = 110,481). Missing values for predictor variables were also removed list-wise due to the low frequency (N = 107,910): gender (0.7%; N = 883), sexual orientation (1.0%; N = 1336), relationship status (0.9%; N = 1122), and marital status (0.9%, N = 1216); note that a case may have had multiple missing values. Finally, due to the low frequency of participants identifying as transgender in this sample, (n = 194), this group was dropped from the final sample. This resulted in a final sample size of 107,716 for analysis.

Measures

The outcome for this analysis was HPV vaccination. Participants were asked if they ever received vaccinations/shots for human papillomavirus/HPV/cervical cancer vaccine (yes, no), which measured the initiation of at least one dose of the three dose vaccine. Additional variables included: gender (male, female); sexual orientation (heterosexual, gay/lesbian, bisexual, unsure); age (18 to 21 years, 22 to 26 years); relationship status (not in a relationship, in a relationship but not living together, in a relationship and living together); marital status (single, married/partnered, other); and race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic/Latino, Asian/Pacific Islander, Biracial/Multiracial, Other). The variable race/ethnicity permitted participants to self-identify with any of these categories. For the purposes of this analysis, participants who identified with more than one category were categorized as Biracial/Multiracial. Additionally, the measurement of race/ethnicity changed in 2011; therefore, comparisons of this variable were restricted to two separate time periods (i.e., 2009 to 2010, and 2011 to 2013). These variables were selected from those available in the NCHA-II survey as these represent basic demographic characteristics that remain relatively stable over time.

Statistical analyses

This study used SAS 9.4 for statistical analysis. Descriptive statistics for demographic characteristics and HPV vaccination were calculated by gender. Chi square tests assessed differences in these characteristics by gender. A p-value less than 0.05 was considered statistically significant.

To assess trends in HPV vaccination by year and demographic characteristics, logistic regression models were used to estimate the impact of time on HPV vaccination and demographic sub-groups. However, due to the sampling structure of this survey, hierarchical modeling with a binary distribution was used to account for the variability in these estimates by each individual college/university sampled (i.e., student participants are nested within colleges/universities that participated). The unconditional model for HPV vaccination (2009–2013) indicated that the proportion of variability explained by the college/university variable was approximately 9% (intraclass correlation coefficient = 0.087). These regression analyses used 2009 as the reference category to estimate the impact of year of survey on HPV vaccination for each sub-group. The only exception was for race/ethnicity where separate models were conducted for 2009–2010 and 2011–2013. This is the result of changes in measuring race/ethnicity across these survey periods, which does not permit comparison over the entire five-year period.

Finally, to compare the impact of these demographic characteristics on HPV vaccination between males and females, Fall 2013 data were used to estimate odds of HPV vaccination for each gender. The unconditional model for HPV vaccination (2013 only) indicated that there was approximately 5% of the variability attributable to college/university (intraclass correlation coefficient = 0.047). Crude odds ratios were computed to assess the independent effect of each explanatory variable on HPV vaccination. The adjusted regression model included all of these demographic predictor variables to estimate the odds of HPV vaccination, stratified by gender. Odds ratios and 95% confidence intervals are presented for these regression models, with the reference categories denoted.

Results

Sample

Among the Fall 2009 to 2013 NCHA II sample, the majority of respondents were female (71.1%). A significantly higher proportion of females received at least one dose of the HPV vaccine compared to males (59.0% females, 29.8% males; p-value < 0.01). Most participants were between the ages of 18 and 21 years (78.5% females, 73.6% males; p-value < 0.01), identified as heterosexual (92.8% females, 91.4% males; p-value < 0.01) and Non-Hispanic White (67.4% females, 65.2% males; p-value < 0.01), and reported not being in a relationship (51.2% females, 60.3% males; p-value < 0.01) and single, not married (93.2% females, 93.2% males; p-value < 0.89).

HPV vaccine trends

Rates of HPV vaccination for females were more than double the rates for males between Fall 2009 and 2011. While female rates continued to surpass male vaccination rates in years 2012 and 2013, the difference between the two groups had narrowed (Fig. 1). However, both groups experienced increases in HPV vaccination rates from 2009 to 2013. The increasing change was more rapid among males compared to females. Among females, the odds of HPV vaccination in 2013 was 2.43 (95%CI 2.01–2.94) compared to 2009 (Table 1). In contrast, for males, the odds of HPV vaccination in 2013 was 2.97 (95%CI 2.48–3.55) (Table 2).

Increases in HPV vaccination rates over the five-year time period were evident for all demographic sub-groups. For females, the greatest absolute difference in vaccination rates was for women in the 22 to 26 year old age category (26.5% to 62.2%; Δ 35.7%). When examining HPV vaccine rates by sexual orientation sub-groups for females, all

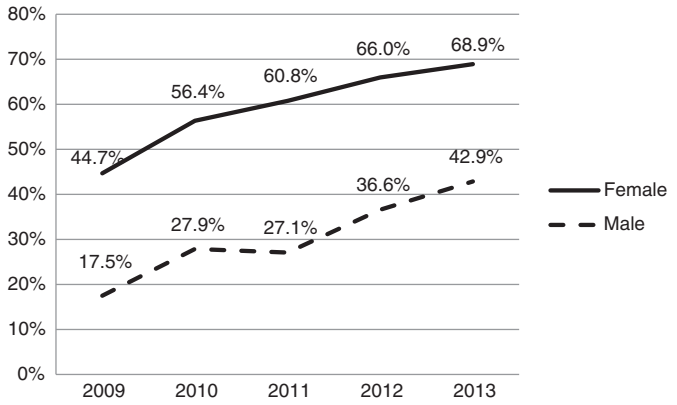

Fig. 1. Trends in HPV vaccination uptake by gender using NCHA II Fall data 2009–2013.

groups had similar rates of increase except for unsure (45.2% to 64.3%; Δ 19.1%) which was lower than the heterosexual, lesbian, and bisexual groups. Rates of HPV vaccine increase were also lower among single women (46.2% to 69.5%; Δ 23.3%) compared to married or other marital status groups. As for relationship status, the highest increase in HPV vaccination was among women living with their partners (30.4% to 62.1%; Δ 31.7%). For race/ethnicity, Asians had the highest rate of increase over time (28.0% to 61.9%; Δ 33.9%), while Non-Hispanic Blacks had the lowest rate of increase over time (49.2% to 62.0%; Δ 12.8%).

HPV vaccination rates also increased over the five-year time period for all demographic sub-groups among males. The highest increase was observed among gay males (8.2% to 41.2%; Δ 33.0%) compared to other sexual orientation groups. For age groups, 18 to 21 year olds had a higher increase in vaccination rates (19.8% to 49.5%; Δ 29.7%) compared to 22 to 26 year olds. HPV vaccination rates had the lowest increase among men in a relationship and living with their partners (11.4% to 27.2%; Δ 15.8%) compared to other relationship status groups. In contrast, HPV vaccination rates increased the most among single men (17.5% to 43.5%; Δ 26.0%) compared to the married and other marital status groups. As for race/ethnicity, Non-Hispanic Whites had the highest rate of increase over time (15.2% to 43.3%; Δ 28.1%), while Non-Hispanic Blacks had the lowest rate of increase over time (33.7% to 40.6%; Δ 6.9%).

HPV vaccine predictors

Survey data from 2013 were used to assess the association of demographic variables with HPV vaccine uptake among college females and males (Table 3). For both genders, younger age was associated with HPV vaccination. For females, 18 to 21 year olds were 1.49 (95%CI 1.37–1.63) times more likely to be vaccinated compared to 22 to 26 year olds. For males, this effect was more pronounced with 18 to 21 year olds being 2.26 (95%CI 2.00–2.57) times more likely to be vaccinated compared to 22 to 26 year olds. Sexual orientation did not have a significant effect on HPV vaccination for either gender.

Differences between genders were observed for relationship status and marital status. Relationship status did not significantly impact female vaccination; however it was significantly associated for males. Men who were living with their partner were less likely to receive the vaccine compared to men not in relationships (aOR 0.71, 95% CI 0.56–0.92). In contrast, marital status was not a significant predictor for males and was significantly associated among females. Women who were married or partnered were less likely to receive the HPV vaccine compared to single women (aOR 0.78, 95%CI 0.65–0.95).

When examining race/ethnicity, there were no significant effects on HPV vaccination among males. However, differences were observed for race/ethnicity among females. Asian (aOR 0.59, 95%CI 0.52 3–0.68), Other (aOR 0.66, 95%CI 0.51–0.85) race/ethnicities, and Non-Hispanic Blacks (aOR 0.72, 95%CI 0.63–0.83) were significantly less likely to have received the vaccine compared to Non-Hispanic White women. No significant differences were observed between Non-Hispanic White women with Hispanic/Latina and Biracial/Multiracial sub-groups.

Discussion

This study assessed the trends and predictors of HPV vaccination among college females and males from 2009 to 2013. While females had higher percentages of HPV vaccination throughout the survey periods, males had a larger increase in rates. As of 2013, approximately 43% of college males had received the HPV vaccine, which is a similar proportion to females in 2009 at 45%. Although these trends are reminiscent of changes in HPV vaccination guidelines over time (Markowitz et al., 2007; Centers for Disease Control and Prevention, 2011), evaluating these trajectories among sub-groups can identify areas of improvement and missed opportunity.

Among females, the largest increase in HPV vaccination rates over time were among 22 to 26 year olds. While younger age is a predictor of HPV vaccination (Lindley et al., 2013; Bendik et al., 2011; Bynum et al., 2011; Chao et al., 2010; Dempsey et al., 2011; Hirth et al., 2012; Laz et al., 2013; Tiro et al., 2012; Wei et al., 2013; Williams et al., 2015; Rahman et al., 2015), this increasing trend may be attributed to cohort effects of the vaccine program established in 2006. In contrast, males 18 to 21 years of age had higher rates of increase in HPV vaccination compared to the older age group. Additionally, younger age was a strong predictor of HPV vaccination in 2013. This is consistent with previous literature (Fontenot et al., 2014) and coincides with current guidelines for males to receive the HPV vaccination until age 21, and recommendations for males until age 26 only among specific high-risk groups (e.g., men who have sex with men and persons with compromised immune systems) (Centers for Disease Control and Prevention, 2011).

Similar increases in HPV vaccination were observed among sexual orientation groups for females, whereas males identifying as gay had the largest increase. Again, this may be attributed to HPV vaccination guidelines recommending the vaccine until age 26 for men who have sex with men compared to only age 21 for males who have sex with women (Centers for Disease Control and Prevention, 2011). Moreover, previous research indicates that gay and bisexual males may be more aware of the HPV vaccine and more willing to receive the vaccine compared to heterosexual males (Gilbert et al., 2011). Despite these differences over time, the 2013 data reveal that sexual orientation was not a significant predictor of HPV vaccination. Similarly, Bernat et al. reported the lack of association between sexual orientation and HPV vaccination among males (Bernat et al., 2013).

Partnership status was measured by two similar, yet distinct variables: marital status and relationship status. While these two variables represent similar phenomenon, these independent variables measure distinct attributes, such as legal partnership and living or not living with a partner. For example, a person may select “single” as a marital status, but this could still vary by not being in a relationship, in a relationship and not living together, and in a relationship and living together. Traditionally measured married or not-married categories limit the true heterogeneity of partnerships. These types of distinctions may have a role in HPV vaccination as demonstrated by a study conducted among college women that found relationship status impacted HPV vaccine decision-making. Specifically, women who were in a long-term monogamous relationship (married, living with a partner, or not living with a partner) perceived a lower need for the HPV vaccine compared to women who were single and dating (Thompson, 2015). This study found that HPV vaccination rates increased for all relationship status groups and marital status groups across genders. Notably, higher increases were found among women either living with a partner or married compared to other relationship status or marital groups. In contrast, the greater increases were detected for males who were single.

Table 1
Trends in HPV vaccine uptake in college females, NCHA II 2009–2013.

	2009			2010			2011			2012			2013		
	N	%	OR (95%CI)	N	%	OR (95%CI)	N	%	OR (95%CI)	N	%	OR (95%CI)	N	%	OR (95%CI)
% HPV vacc	7547	44.68	1.00 (ref)	8662	56.35	1.38 (1.12–1.70)	8678	60.77	1.84 (1.52–2.22)	9495	65.96	2.20 (1.82–2.66)	10,769	68.93	2.43 (2.01–2.94)
Age															
18–21 years	6532	50.03	1.00 (ref)	7662	60.11	1.40 (1.14–1.71)	7223	64.36	1.78 (1.48–2.14)	7895	69.16	2.18 (1.82–2.62)	8320	71.20	2.30 (1.92–2.76)
22–26 years	1015	26.47	1.00 (ref)	1000	38.1	1.43 (1.13–1.82)	1455	47.56	2.24 (1.80–2.78)	1600	53.71	2.93 (2.36–3.64)	2449	62.19	3.67 (2.97–4.55)
Sexual orient.															
Heterosexual	7079	44.59	1.00 (ref)	8179	56.45	1.40 (1.13–1.73)	8056	60.80	1.87 (1.54–2.26)	8728	65.95	2.23 (1.84–2.71)	9782	68.91	2.45 (2.02–2.98)
Lesbian	76	43.18	1.00 (ref)	91	50.84	1.29 (0.80–2.09)	110	58.82	1.80 (1.13–2.88)	144	62.88	2.32 (1.48–3.65)	190	68.59	2.79 (1.79–4.34)
Bisexual	275	47.50	1.00 (ref)	281	55.98	1.38 (1.04–1.84)	356	61.17	1.64 (1.25–2.16)	422	66.25	2.10 (1.60–2.76)	557	71.59	2.69 (2.06–3.51)
Unsure	117	45.17	1.00 (ref)	111	55.22	1.43 (0.93–2.21)	156	59.54	1.71 (1.16–2.53)	201	68.14	2.44 (1.66–3.60)	240	64.34	2.05 (1.42–2.96)
Relationship															
No	3683	44.97	1.00 (ref)	4633	57.50	1.46 (1.17–1.82)	4442	61.25	1.89 (1.55–2.30)	5015	66.06	2.20 (1.81–2.69)	5626	69.47	2.52 (2.07–3.07)
Yes, not living together	3253	48.62	1.00 (ref)	3493	58.30	1.34 (1.08–1.66)	3374	62.88	1.74 (1.42–2.12)	3750	67.92	2.19 (1.79–2.67)	4149	70.03	2.26 (1.85–2.75)
Yes, living together	611	30.37	1.00 (ref)	536	40.51	1.38 (1.09–1.75)	862	51.83	2.29 (1.84–2.86)	730	56.94	2.61 (2.08–3.28)	994	62.09	3.12 (2.50–3.89)
Marital status															
Single	7080	46.16	1.00 (ref)	8240	57.26	1.37 (1.11–1.69)	8153	61.66	1.82 (1.51–2.19)	9086	66.59	2.17 (1.80–2.62)	10,226	69.45	2.39 (1.99–2.89)
Married	278	26.13	1.00 (ref)	229	36.58	1.49 (1.11–2.01)	333	44.94	2.15 (1.62–2.85)	246	48.91	2.43 (1.80–3.27)	353	57.03	3.19 (2.40–4.23)
Other	189	38.65	1.00 (ref)	193	54.37	1.60 (1.09–2.36)	192	60.57	2.35 (1.58–3.49)	163	65.73	2.83 (1.86–4.28)	190	67.86	2.92 (1.94–4.39)
Race/Ethnicity[a]															
White	5432	46.88	1.00 (ref)	5717	58.04	1.43 (1.09–1.88)	6430	62.90	1.00 (ref)	6608	67.75	1.89 (1.11–1.27)	7195	70.58	1.37 (1.28–1.47)
Black	597	49.22	1.00 (ref)	614	53.48	1.30 (0.98–1.72)	319	51.87	1.00 (ref)	402	57.51	1.27 (1.01–1.60)	659	61.99	1.51 (1.21–1.88)
Hispanic	409	48.52	1.00 (ref)	677	58.46	1.47 (1.06–2.04)	523	56.54	1.00 (ref)	686	64.84	1.40 (1.12–1.73)	902	67.06	1.46 (1.20–1.79)
Asian	486	27.95	1.00 (ref)	808	48.35	1.34 (0.86–2.10)	497	50.10	1.00 (ref)	665	58.18	1.40 (1.14–1.71)	712	61.86	1.42 (1.15–1.76)
Multiracial	489	42.89	1.00 (ref)	680	56.15	1.52 (1.14–2.02)	763	59.70	1.00 (ref)	967	66.69	1.28 (1.07–1.52)	1136	70.78	1.57 (1.32–1.87)
Other	134	36.31	1.00 (ref)	166	49.85	1.60 (1.02–2.49)	146	58.63	1.00 (ref)	167	57.39	0.96 (0.67–1.39)	165	62.03	1.11 (0.76–1.62)

[a] Reference categories for Race/Ethnicity are 2009 and 2011, respectively. This is due to changes in the measurement of these categories between survey years.

Table 2
Trends in HPV vaccine uptake in college males, NCHA II 2009–2013.

	2009			2010			2011			2012			2013		
	N	%	OR (95%CI)	N	%	OR (95%CI)	N	%	OR (95%CI)	N	%	OR (95%CI)	N	%	OR (95%CI)
% HPV vacc	1310	17.49	1.00 (ref)	1802	27.87	1.49 (1.22–1.82)	1488	27.07	1.67 (1.39–2.00)	1997	36.59	2.47 (2.06–2.96)	2677	42.87	2.97 (2.48–3.55)
Age															
18–21 years	1069	19.84	1.00 (ref)	1547	30.20	1.46 (1.20–1.78)	1231	30.31	1.64 (1.67–1.97)	1696	41.47	2.61 (2.18–3.12)	2111	49.53	3.33 (2.78–3.98)
22–26 years	241	11.47	1.00 (ref)	255	18.99	1.76 (1.34–2.31)	257	17.92	1.72 (1.32–2.23)	301	22.00	2.20 (1.62–2.72)	566	28.56	2.92 (2.29–3.71)
Sexual orient.															
Heterosexual	1240	17.88	1.00 (ref)	1699	28.38	1.49 (1.22–1.83)	1359	27.14	1.64 (1.36–1.98)	1827	36.89	2.44 (2.03–2.93)	2399	43.03	2.96 (2.47–3.55)
Gay	22	8.21	1.00 (ref)	40	20.51	2.91 (1.65–5.15)	61	24.21	3.56 (2.09–6.07)	79	31.60	5.22 (3.09–8.79)	145	41.19	7.82 (4.77–12.83)
Bisexual	27	16.56	1.00 (ref)	37	22.56	1.47 (0.83–2.61)	45	32.85	2.44 (1.39–4.29)	56	39.16	3.23 (1.87–5.60)	74	44.05	3.86 (2.25–6.61)
Unsure	21	17.07	1.00 (ref)	26	21.67	1.17 (0.54–2.54)	23	23.23	1.54 (0.72–3.32)	35	31.25	2.12 (1.03–4.37)	59	39.60	3.01 (1.53–5.93)
Relationship															
No	795	18.16	1.00 (ref)	1174	29.74	1.60 (1.29–1.98)	948	28.37	1.64 (1.35–2.00)	1252	37.23	2.40 (1.97–2.92)	1702	45.45	3.05 (2.51–3.70)
Yes, not living together	437	18.00	1.00 (ref)	563	26.54	1.37 (1.07–1.74)	447	26.33	1.64 (1.31–2.05)	656	37.70	2.64 (2.12–3.29)	844	41.82	3.06 (2.47–3.80)
Yes, living together	78	11.37	1.00 (ref)	65	16.37	1.50 (1.00–2.26)	93	20.39	2.02 (1.39–2.95)	89	25.07	2.65 (1.80–3.89)	131	27.23	2.92 (2.04–4.18)
Marital status															
Single	1192	17.51	1.00 (ref)	1693	28.04	1.51 (1.23–1.85)	1403	27.29	1.67 (1.39–2.01)	1908	37.01	2.49 (2.07–2.99)	2568	43.53	3.01 (2.51–3.62)
Married	67	13.96	1.00 (ref)	65	23.64	1.66 (1.03–2.70)	55	23.21	1.95 (1.20–3.15)	55	26.70	2.37 (1.45–3.88)	65	26.75	2.27 (1.43–3.61)
Other	51	24.88	1.00 (ref)	44	28.95	1.14 (0.67–1.94)	30	25.42	1.04 (0.59–1.81)	34	35.42	1.69 (0.96–2.96)	44	43.14	2.33 (1.36–3.99)
Race/Ethnicity[a]															
White	765	15.23	1.00 (ref)	1007	25.40	1.77 (1.43–2.18)	950	24.92	1.00 (ref)	1250	34.61	1.48 (1.32–1.66)	1692	43.27	2.11 (1.88–2.36)
Black	169	36.66	1.00 (ref)	144	37.02	1.18 (0.74–1.87)	54	30.34	1.00 (ref)	89	44.72	2.05 (1.29–3.26)	139	40.64	1.71 (1.12–2.59)
Hispanic/Latino	81	26.21	1.00 (ref)	182	35.07	1.29 (0.86–1.94)	120	35.71	1.00 (ref)	159	42.40	1.30 (0.93–1.81)	217	42.80	1.33 (0.97–1.81)
Asian	160	15.97	1.00 (ref)	268	29.04	1.50 (0.96–2.35)	166	30.91	1.00 (ref)	227	37.40	1.28 (0.96–1.72)	299	41.41	1.28 (0.94–1.73)
Bi/Multiracial	94	18.58	1.00 (ref)	148	29.08	1.63 (1.10–2.43)	158	30.80	1.00 (ref)	229	42.72	1.65 (1.24–2.20)	288	44.65	1.73 (1.31–2.28)
Other	41	21.47	1.00 (ref)	53	32.92	1.80 (1.11–2.90)	40	33.33	1.00 (ref)	43	33.33	1.01 (0.59–1.75)	42	35.59	1.15 (0.66–2.02)

[a] Reference categories for Race/Ethnicity are 2009 and 2011, respectively. This is due to changes in the measurement of these categories between survey years.

Table 3
Stratified gender comparison of predictors for HPV vaccination among college students, NCHA II Fall 2013.

	Women		Men	
Characteristic	Crude OR (95%CI)	Adjusted OR (95%CI)	Crude OR (95%CI)	Adjusted OR (95%CI)
Age				
18–21 years	**1.53 (1.41–1.67)**[a]	**1.49 (1.37–1.63)**	**2.41 (2.13–2.73)**	**2.26 (2.00–2.57)**
22–26 years	(ref)	(ref)	(ref)	(ref)
Sexual orientation				
Heterosexual	(ref)	(ref)	(ref)	(ref)
Gay/Lesbian	1.01 (0.78–1.32)	1.06 (0.82–1.38)	0.94 (0.75–1.17)	0.91 (0.73–1.15)
Bisexual	1.14 (0.97–1.34)	1.15 (0.97–1.35)	1.05 (0.76–1.44)	1.02 (0.74–1.41)
Unsure	0.81 (0.65–1.01)	0.84 (0.67–1.05)	0.86 (0.61–1.20)	0.82 (0.58–1.16)
Relationship status				
No	(ref)	(ref)	(ref)	(ref)
Yes, not living together	1.06 (0.99–1.15)	1.06 (0.98–1.14)	**0.88 (0.79–0.99)**	0.91 (0.81–1.02)
Yes, living together	**0.81 (0.72–0.91)**	0.95 (0.83–1.09)	**0.50 (0.40–0.62)**	**0.71 (0.56–0.92)**
Marital status				
Single	(ref)	(ref)	(ref)	(ref)
Married/partnered	**0.66 (0.56–0.78)**	**0.78 (0.65–0.95)**	**0.51 (0.38–0.69)**	0.84 (0.60–1.18)
Other	1.06 (0.82–1.37)	1.07 (0.82–1.39)	1.03 (0.69–1.55)	1.11 (0.73–1.68)
Race/ethnicity				
White	(ref)	(ref)	(ref)	(ref)
Black	**0.73 (0.64–0.84)**	**0.72 (0.63–0.83)**	0.98 (0.77–1.24)	0.92 (0.72–1.17)
Hispanic/Latino	0.97 (0.95–1.12)	0.96 (0.83–1.10)	1.17 (0.94–1.45)	1.12 (0.90–1.39)
Asian	**0.59 (0.52–0.68)**	**0.60 (0.52–0.68)**	0.86 (0.73–1.03)	0.89 (0.74–1.05)
Biracial/Multiracial	1.02 (0.90–1.15)	0.99 (0.88–1.12)	1.05 (0.88–1.25)	1.03 (0.86–1.23)
Other	**0.66 (0.51–0.85)**	**0.67 (0.52–0.87)**	0.69 (0.47–1.02)	0.69 (0.46–1.03)

[a] Bold indicates statistically significant $p < 0.05$.

Moreover, differences were observed between genders for these two variables as predictors for HPV vaccination. Marital status was a significant predictor of HPV vaccination for females, while insignificant for males in the adjusted model. This is consistent with previous literature which reported that married women were less likely to receive the HPV vaccine (Laz et al., 2013; Wei et al., 2013; Anhang Price et al., 2011; Williams et al., 2013), whereas this was not the case for males (Bernat et al., 2013; Newman et al., 2013). In contrast, living with a partner was a significant predictor for males only. It is unclear why these HPV vaccination differences exist across relationship status groups for college students. Additional research elucidating the decision-making process for HPV vaccination and its connection to relationship and marital statuses by gender is needed to provide insight on these inconsistencies.

Among race and ethnic groups, similar rates of increased HPV vaccination were identified. As of 2013 for both genders, biracial and multiracial college students had the highest rates of HPV vaccination, slightly greater than Non-Hispanic White students. For females, Asian, Non-Hispanic Black, and Other race/ethnicities had similarly low rates of HPV vaccination compared to Non-Hispanic White females. The literature is mixed regarding the influence of race/ethnicity on HPV vaccine uptake among young adult women; some indicate that racial and ethnic minorities are less likely to be HPV vaccinated, (Chao et al., 2010; Bednarczyk et al., 2011; Ford, 2011; Kharbanda et al., 2013; Liddon et al., 2012) while others report no differences among minorities when compared to White women (Dempsey et al., 2011; Laz et al., 2013; Williams et al., 2013). However, no differences in race/ethnicity were found for males when predicting HPV vaccination, which is comparable with national survey data (Pierre-Victor et al., 2014. One explanation for the observed racial/ethnic HPV vaccine differences among females may be due to the prolonged period of the vaccine availability, which has provided additional times for disparities to emerge.

These findings must be considered in context with limitations. First, these data were cross-sectional, which limit the ability to establish temporality between the time of HPV vaccination and certain modifiable variables (e.g., relationship and marital status). Moreover, these data do not specify how many of the recommended three doses of the HPV vaccine participants received. Additionally, the measurement of race/ethnicity changed between study periods, which prohibited the comparison of vaccination continuously across all study periods. Also, the measurement of these variables was based on self-report. As a result, this relied on the recall of young adults to report their HPV vaccination status, which may result in non-differential misclassification. Moreover, variables selected for this analysis only included demographic characteristics of college students, as the main goal of the study was to assess trends in HPV vaccination among these factors and to explore potential differences in these predictors by gender. Future research should examine additional individual-level predictors of HPV vaccination over time, such as sexual behavior, as well as family, social and religious factors that may provide additional context and expand identification of important sub-groups for intervention. For example, previous research among a national sample of young adult women found HPV vaccination rates increased similarly among economic and healthcare utilization sub-groups (Schmidt and Parsons, 2014). Finally, the generalizability of these data is limited to the population of United States college students between the ages of 18 to 26 from similar institutions of those participating in the NCHA II. Trends among the general population of 18 to 26 year old males and females may differ from this specific group, as well as non-participating NCHA college and university institutions.

Conclusion

Public health efforts should continue to target college students, especially sub-groups with the lowest HPV vaccination rates, with college and university campuses being an opportune site for intervention. For instance, Richman et al., 2012 explored the feasibility of an HPV vaccination program among college students. They found large proportions of undergraduate students who reported willingness to receive the HPV vaccine (71%) and being comfortable receiving the HPV vaccine (61%) in a university setting. Students reported convenience as the primary benefit for receiving the vaccine at the school (Richman et al., 2012). In addition to university settings, physician recommendation is integral for increasing HPV vaccine uptake among college students. A strong physician recommendation, being a student, and perceiving the

importance of the HPV vaccine were found to be predictive factors of HPV vaccine uptake among insured females between the ages of 19 to 26 (Rosenthal et al., 2011). To avoid missed clinical opportunities, catch-up vaccination can be improved by creating vaccination programs that include education by college and university-based physicians about the HPV vaccine to college students. Interventions targeting groups with continued low HPV vaccine uptake could take place at college health centers where unique resources are available, such as peer educators. Future research is warranted to explore innovative, college-centered interventions that are tailored to the needs of historically unvaccinated, yet eligible college sub-groups, such as males 22 to 26 years old and in relationships or married.

In summary, this study compared the trends and predictors for HPV vaccination among U.S. college females and males. These findings identified the demographic sub-groups that may need additional support for HPV vaccination. Campus health centers may be logical settings to facilitate clinical opportunities for HPV vaccination among unvaccinated college students.

Conflict of interest statement

EMD: participated on Merck HPV Vaccine Scientific Advisory Board. The remaining authors (ELT, CAV, SG, RL, CVO) declare that there are no conflicts of interest.

Transparency document

The Transparency document associated with this article can be found, in online version.

Acknowledgments

The authors would like to thank the American College Health Association and Mary Hoban, PhD for access to these data, which made this analysis possible. The opinions, findings, and conclusions presented/reported in this article/presentation are those of the author(s), and are in no way meant to represent the corporate opinions, views, or policies of the American College Health Association (ACHA). ACHA does not warrant nor assume any liability or responsibility for the accuracy, completeness, or usefulness of any information presented in this article/presentation. The authors would also like to acknowledge the two reviewers of this manuscript for their peer review and feedback to improve the dissemination of these findings.

References

American College Health Association, 2009–2013. American College Health Association-National College Health Assessment. American College Health Association, Hanover, MD [computer file].

American College Health Association, 2014. American College Health Association National College Health Assessment. [cited 2014 September 15]; Available from http://www.acha-ncha.org/.

Anhang Price, R., Tiro, J.A., Saraiya, M., Meissner, H., Breen, N., 2011. Use of human papillomavirus vaccines among young adult women in the United States: an analysis of the 2008 National Health Interview Survey. Cancer 117 (24), 5560–5568.

Annie E Casey Foundation, 2015. Kids count data center: young adults ages 18 to 24 enrolled in or completed college. [cited 2015 June 28]; Available from http://datacenter.kidscount.org/data/tables/77-young-adults-ages-18-to-24-enrolled-in-or-completed-college?loc=1&loct=1#detailed/1/any/false/36,868,867,133,38/any/388,389.

Bednarczyk, R.A., Birkhead, G.S., Morse, D.L., Doleyres, H., McNutt, L.A., 2011. Human papillomavirus vaccine uptake and barriers: association with perceived risk, actual risk and race/ethnicity among female students at a New York State university, 2010. Vaccine 29 (17), 3138–3143.

Bendik, M.K., Mayo, R.M., Parker, V.G., 2011. Knowledge, perceptions, and motivations related to HPV vaccination among college women. J. Cancer Educ. 26 (3), 459–464.

Bernat, D.H., Gerend, M.A., Chevallier, K., Zimmerman, M.A., Bauermeister, J.A., 2013. Characteristics associated with initiation of the human papillomavirus vaccine among a national sample of male and female young adults. J. Adolesc. Health 53 (5), 630–636.

Bynum, S.A., Brandt, H.M., Sharpe, P.A., Williams, M.S., Kerr, J.C., 2011. Working to close the gap: identifying predictors of HPV vaccine uptake among young African American women. J. Health Care Poor Underserved 22 (2), 549–561.

Centers for Disease Control and Prevention, 2010. FDA licensure of quadrivalent human papillomavirus vaccine (HPV4, Gardasil) for use in males and guidance from the Advisory Committee on Immunization Practices (ACIP). MMWR Morb. Mortal. Wkly Rep. 59 (20), 630.

Centers for Disease Control and Prevention, 2011. Recommendations on the use of quadrivalent human papillomavirus vaccine in males—Advisory Committee on Immunization Practices (ACIP). MMWR Morb. Mortal. Wkly Rep. 60 (50), 1705.

Chao, C., Velicer, C., Slezak, J.M., Jacobsen, S.J., 2010. Correlates for human papillomavirus vaccination of adolescent girls and young women in a managed care organization. Am. J. Epidemiol. 171 (3), 357–367.

Dempsey, A., Cohn, L., Dalton, V., Ruffin, M., 2011. Worsening disparities in HPV vaccine utilization among 19–26 year old women. Vaccine 29 (3), 528–534.

Fontenot, H.B., Fantasia, H.C., Charyk, A., Sutherland, M.A., 2014. Human papillomavirus (HPV) risk factors, vaccination patterns, and vaccine perceptions among a sample of male college students. J. Am. Coll. Heal. 62 (3), 186–192.

Ford, J.L., 2011. Racial and ethnic disparities in human papillomavirus awareness and vaccination among young adult women. Public Health Nurs. 28 (6), 485–493.

Gilbert, P., Brewer, N.T., Reiter, P.L., Ng, T.W., Smith, J.S., 2011. HPV vaccine acceptability in heterosexual, gay, and bisexual men. Am. J. Mens Health 5 (4), 297–305.

H., zur Hausen, 2002. Papillomaviruses and cancer: from basic studies to clinical application. Nat. Rev. Cancer 2 (5), 342–350.

Healthy People 2020, 2015. Immunization and infectious diseases. [cited 2015 December 15]; Available from http://www.healthypeople.gov/2020/topics-objectives/topic/immunization-and-infectious-diseases/objectives.

Hirth, J.M., Tan, A., Wilkinson, G.S., Berenson, A.B., 2012. Completion of the human papillomavirus vaccine series among insured females between 2006 and 2009. Cancer 118 (22), 5623–5629.

Insinga, R.P., Dasbach, E.J., Myers, E.R., 2003. The health and economic burden of genital warts in a set of private health plans in the United States. Clin. Infect. Dis. 36 (11), 1397–1403.

Kharbanda, E.O., Parker, E., Nordin, J.D., Hedblom, B., Rolnick, S.J., 2013. Receipt of human papillomavirus vaccine among privately insured adult women in a U.S. Midwestern Health Maintenance Organization. Prev. Med. 57 (5), 712–714.

Lacey, C.J., Lowndes, C.M., Shah, K.V., 2006. Chapter 4: Burden and management of non-cancerous HPV-related conditions: HPV-6/11 disease. Vaccine 24 (Suppl. 3) (S3/35–41).

Laz, T.H., Rahman, M., Berenson, A.B., 2013. Human papillomavirus vaccine uptake among 18- to 26-year-old women in the United States: National Health Interview Survey, 2010. Cancer 119 (7), 1386–1392.

Liddon, N.C., Leichliter, J.S., Markowitz, L.E., 2012. Human papillomavirus vaccine and sexual behavior among adolescent and young women. Am. J. Prev. Med. 42 (1), 44–52.

Lindley, L.L., Elkind, J.S., Landi, S.N., Brandt, H.M., 2013. Receipt of the human papillomavirus vaccine among female college students in the United States, 2009. J. Am. Coll. Heal. 61 (1), 18–27.

Markowitz, L., Dunne, E., Saraiya, M., Lawson, H., Chesson, H., Unger, E., 2007. Quadrivalent human papillomavirus vaccine. MMWR Morb. Mortal. Wkly Rep. 56 (RR-2), 1–24.

Markowitz, L.E., Hariri, S., Lin, C., et al., 2013. Reduction in human papillomavirus (HPV) prevalence among young women following HPV vaccine introduction in the United States, National Health and Nutrition examination surveys, 2003–2010. J. Infect. Dis. 208 (3), 385–393.

Munoz, N., Bosch, F.X., de Sanjose, S., et al., 2003. Epidemiologic classification of human papillomavirus types associated with cervical cancer. N. Engl. J. Med. 348 (6), 518–527.

Newman, P.A., Logie, C.H., Doukas, N., Asakura, K., 2013. HPV vaccine acceptability among men: a systematic review and meta-analysis. Sex. Transm. Infect. 89 (7), 568–574.

Petrosky, E., Bocchini Jr., J.A., Hariri, S., et al., 2015. Use of 9-valent human papillomavirus (HPV) vaccine: updated HPV vaccination recommendations of the Advisory Committee on immunization practices. MMWR Morb. Mortal. Wkly Rep. 64 (11), 300–304.

Pierre-Victor, D., Mukherjee, S., Bahelah, R., Madhivanan, P., 2014. Human papillomavirus vaccine uptake among males 11–26 years in United States: findings from the National Health and Nutrition Examination Survey, 2011–2012. Vaccine 32 (49), 6655–6658.

Rahman, M., Islam, M., Berenson, A.B., 2015. Differences in HPV immunization levels among young adults in various regions of the United States. J. Community Health.

Richman, A.R., Haithcox-Dennis, M.J., Allsbrook, A.R., 2012. Feasibility of a catch-up HPV vaccination program among college students attending a large rural university in the south. Am. J. Sex Educ. 7 (3), 237–252.

Rosenthal, S.L., Weiss, T.W., Zimet, G.D., Ma, L., Good, M.B., Vichnin, M.D., 2011. Predictors of HPV vaccine uptake among women aged 19–26: importance of a physician's recommendation. Vaccine 29 (5), 890–895.

Satterwhite, C.L., Torrone, E., Meites, E., et al., 2013. Sexually transmitted infections among US women and men: prevalence and incidence estimates, 2008. Sex. Transm. Dis. 40 (3), 187–193.

Schmidt, S., Parsons, H.M., 2014. Vaccination interest and trends in human papillomavirus vaccine uptake in young adult women aged 18 to 26 years in the United States: an analysis using the 2008–2012 National Health Interview Survey. Am. J. Public Health 104 (5), 946–953.

Thompson, E.L., 2015. The Influence of Relationship Status on HPV Vaccine Decision-Making among Young Adult Women. University of South Florida, Tampa, FL.

Tiro, J.A., Tsui, J., Bauer, H.M., Yamada, E., Kobrin, S., Breen, N., 2012. Human papillomavirus vaccine use among adolescent girls and young adult women: an analysis of the 2007 California Health Interview Survey. J. Womens Health (Larchmt) 21 (6), 656–665.

Wei, F., Moore, P.C., Green, A.L., 2013. Geographic variability in human papillomavirus vaccination among U.S. young women. Am. J. Prev. Med. 44 (2), 154–157.

Williams, W.W., Lu, P.J., Saraiya, M., et al., 2013. Factors associated with human papillomavirus vaccination among young adult women in the United States. Vaccine 31 (28), 2937–2946.

Williams, W.W., Lu, P.J., O'Halloran, A., et al., 2015. Vaccination coverage among adults, excluding influenza vaccination — United States, 2013. MMWR Morb. Mortal. Wkly Rep. 64 (4), 95–102.