



Differences in cervical cancer screening knowledge, practices, and beliefs: An examination of survey responses

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ABSTRACT

Among the identified barriers to HPV vaccination is the concern that women may compensate for their reduced susceptibility to cervical cancers by reducing cervical cancer screening. This exploratory study examined the relationship between cervical cancer screening rates and HPV vaccination. We conducted a cross-sectional survey using a convenience sample of women aged 21–35 attending a local minority health fair in July 2015. Data were analyzed in 2015–2016. Outcomes assessed were: receiving a Pap test within the last three years, awareness and comfort with current Pap test recommendations, and knowledge regarding the purpose of a Pap test. A total of 291 women were included in the analyses. Mean age was 28.5 years and 62% were non-Hispanic black. 84% had received a Pap test in the last three years and 33% had received at least one HPV vaccine. Logistic regression results showed that women who had been vaccinated did not have lower odds of having a Pap test in the past three years (OR = 1.32; 95% CI = 0.66–2.65). In an adjusted regression model controlling for age and race, vaccinated women were significantly more likely to have had a Pap test (AOR = 3.06; 95% CI = 1.37–6.83). Yet only 26% of women knew the purpose of a Pap test and the proportion who answered correctly was higher among non-Hispanic white women. Women who have been vaccinated for HPV are more likely to have been screened for cervical cancer. These results suggest areas for more robust studies examining pro-health attitudes, behaviors, and communication regarding vaccination and preventive screening.

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1. Introduction

HPV is the most common sexually transmitted infection (STI) in the U.S. (Centers for Disease Control and Prevention, 2014). Infection with HPV can cause serious health issues including genital warts and cancers of the cervix, anus, and oropharynx, among others (National Institutes of Health, 2015). At the time of this study there were three different HPV vaccines licensed by the U.S. Food and Drug Administration and at that time a series of three doses was recommended for all of the vaccines (Markowitz et al., 2014). However, the CDC recently updated their

recommendations so that a child can receive a two-dose series of the 9-valent HPV vaccine, 6–12 months apart, as long as the first dose is administered before age 15. For those who initiate the series at age 15 or older, the three-dose series is still recommended (CDC recommends only two HPV shots for younger adolescents [press release]. Atlanta, GA, October 20, 2016, 2016). Detailed information about all of the vaccines can be found in Petrosky et al. (2015). The Advisory Committee on Immunization Practices (ACIP) recommends routine HPV vaccination for boys and girls age 11 or 12 and catch up vaccination for women up through age 26, all men up through age 21, and for men who have sex with men up to age 26 (Markowitz et al., 2014).

HPV vaccination rates in the U.S. remain lower than desired (Stokley et al., 2014). In 2015, only 41.9% of all adolescent girls and 28.1% of all adolescent boys between the ages of 13 and 17 completed the three-dose series (Reagan-Steiner et al., 2016). There are several reported barriers to HPV vaccination but one that has received particular attention especially in the media is the idea that receiving the HPV vaccine will lead a person to engage in riskier behaviors. This is known as Risk Compensation Theory and has been widely studied in the context of sexual

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behaviors (Wilde, 1982; Wilde, 1998; Kasting et al., 2016). Concomitant with risk compensation is the additional concern that women who have received the HPV vaccine may compensate for their reduced susceptibility to cervical cancers by reducing their participation in cervical cancer screening (Tiro et al., 2008; Kollar and Kahn, 2008; Pollitt, 2005; Juraskova et al., 2011).

Compared to sexual risk compensation, there has been less research conducted on cervical cancer screening behavior post-HPV vaccination, particularly regarding knowledge and uptake among minority women. Studies have shown that non-Hispanic black women have higher incidence of cervical cancer (Ward et al., 2004) and are less likely to get screened (Moser et al., 2009) than their white counterparts. One study by Robb et al. in England found cervical cancer screening awareness was lower in ethnic minorities. However, the Robb study did not assess knowledge, and is not representative of minorities in the U.S. (Robb et al., 2010) Furthermore, the idea of risk compensation was developed for use in the context of seat belt laws and risky driving techniques and may not be relevant when it comes to vaccination and other health risk behaviors. For example, one study found that health-protective behaviors such as diet, exercise, and contraception use clustered together and those who engaged in one pro-health behavior were more likely to engage in another (Fortenberry et al., 1997).

Women are generally unaware of screening guidelines (Mather et al., 2012) which have changed four times in the last 30 years (American Cancer Society, 2014). The current CDC recommendations for average risk women state that women should be screened with a Papanicolaou (Pap) test every three years from age 21 to 29. That screening period can be extended to five years from age 30 to 65 if the woman has an HPV DNA co-test along with the Pap test and both are negative. Screening is not recommended after age 65 (Centers for Disease Control and Prevention, 2012). Some studies have found that Pap screening was either positively associated with vaccination or no association was found (Williams et al., 2013; Anhang Price et al., 2011; Caskey et al., 2009). Using a national dataset, one of these studies found that a lower percentage of women who were not vaccinated reported having a recent Pap test as compared to vaccinated women (81.0% vs. 90.5%) (Sauer et al., 2015). The findings of the limited research to date suggest that HPV vaccination may not have a negative effect on women's participation in cervical cancer screening. However, this relationship is not yet fully understood, particularly within minority populations. There also is a need for ongoing research regarding women's knowledge and beliefs about screening, particularly given the potential for future changes in screening guidelines to HPV DNA testing only, such as those being implemented in 2017 in Australia and 2018 in New Zealand (Smith et al., 2016; Lew et al., 2016). One recent study examining a largely minority population did also find positive associations between HPV vaccination and cervical cancer screening (Boone et al., 2016). However, these results, obtained from medical records, were not able to examine women's knowledge and beliefs regarding vaccination and screening in order to illuminate the relationship between the two.

The present study examined the relationship between HPV vaccination and Pap testing using responses to an exploratory cross-sectional survey of mostly minority women. We used both quantitative and qualitative methodology to: 1) examine if cervical cancer screening rates differed between those who had and had not been vaccinated and 2) assess if women understood the purpose of, and current recommendations for, Pap testing.

2. Methods

2.1. Participants

All study procedures were approved by the Indiana University IRB. The research was conducted in July 2015, analyzed in 2015 and 2016, and targeted women ages 21 to 35 years who attended the 46th Annual

Indiana Black Expo Health Fair in Indianapolis. This age range was chosen because these women are eligible for screening and were all 26 years of age or younger when the first HPV vaccine was licensed in 2006. The Annual Indiana Black Expo is one of the nation's largest cultural events for African-Americans and draws an estimated 40,000 attendees from across Indiana and surrounding states. The minority health fair is a component offered at this event.

Exclusion criteria included women with a hysterectomy and women who received the vaccine less than three years prior to the survey because there would not be sufficient time to assess their post-vaccination screening behaviors. A total of 317 women started the survey; 291 of them were included in analysis after excluding those with a history of hysterectomy ($n = 8$), those who were vaccinated for HPV less than three years ago ($n = 13$), and those who started but did not complete the survey ($n = 5$). It was not possible to determine the declination rate due to the nature of the study setting.

2.2. Measures

The web-based survey was computer-administered. Questions were modeled after relevant items from the National Health Interview Survey (NHIS), a population survey administered by the CDC. The questions assessed if participants received the HPV vaccine, how many shots they received, and at what age. We also assessed when participants had their last Pap test. We then expanded on the NHIS questions by asking if participants were aware of the new cervical cancer screening recommendations and how comfortable they were with the frequency of the screenings in the new recommendations. Comfort with screening recommendations was assessed with a Likert-type variable. Participants were told current screening recommendations and then asked "How comfortable are you with this new screening recommendation?" Responses were on a five-point scale ranging from very uncomfortable to very comfortable. We also asked open-ended questions to assess if participants knew the purpose of a Pap test by asking, "What is the purpose of a Pap smear or Pap test?"

2.3. Analyses

2.3.1. Quantitative analysis

The main outcome assessed was whether the women were up-to-date on cervical cancer screenings. Women who indicated they had been screened within the last three years were considered current; women who indicated their last screening was over three years ago or had never been screened were considered not current. We compared the demographic characteristics of women who were current with women who were not current using bivariate analyses. Multivariable logistic regression assessed the association of HPV vaccination status and screening, adjusting for the effects of the demographic variables that were found to be independently significantly associated with screening such as age and race. In order to explain the interaction between age and vaccination status, stratified logistic regression models were conducted separately for each age group in five-year increments. Additionally, we assessed women's knowledge and comfort with cervical cancer screening guidelines using frequency tables and regression analyses. All quantitative analyses were performed using SPSS v. 22.0 (IBM Corp., Armonk, NY, USA). $P < 0.05$ was considered statistically significant.

2.3.2. Qualitative analysis

The survey included an open-ended question ("What is the purpose of a Pap smear or Pap test?") which was analyzed using inductive content analysis (Elo and Kyngäs, 2008). Responses to questions were coded independently by two investigators (MLK & SW) and assessed to identify meaningful themes. The coded responses were reviewed and areas of disagreement were resolved through discussion. Participants were also assessed on whether they correctly answered the question. In order to consider the response to the question correct, the

participant had to indicate that a Pap test checks for cancer or abnormal cells of the cervix. If a participant did not mention the cervix, or she indicated the test also checks for STIs, she was marked as answering the question partially correct. All other answers were considered incorrect. In order to assess racial disparities in knowledge regarding cervical cancer screening, we examined differences in answers between non-Hispanic blacks and non-Hispanic whites. For these questions only, we excluded women who indicated that their race was “Hispanic” ($n = 14$), “Asian” ($n = 14$), “other” ($n = 4$), and “multiracial” ($n = 11$) because the number of respondents were relatively small and heterogeneous.

3. Results

3.1. Sample description

A full description of the respondents, including differences by screening status, is shown in Table 1. The respondents' ages ranged from 21 to 35 ($m = 28.5$, $SD = 4.7$). Race was assessed by self-report and nearly two-thirds of the respondents (62.5%, $n = 182$) were non-Hispanic black, 22.7% ($n = 66$) were non-Hispanic white, and 14.8% ($n = 43$) were Hispanic, other, or multiracial. A majority of the women in the study received a Pap test in the last three years (84.2%, $n = 245$), and 33% ($n = 97$) had received at least one HPV vaccination. There were demographic differences in the bivariate comparisons

Table 1
Sample description by cervical cancer screening status (current vs. not current).

	Total sample ($n = 291$)	Current ($n = 245$)	Not current ($n = 46$)	<i>p</i> -value
Mean age (continuous)	28.5	29.1	25.3	<0.001
Age (categorical) <i>n</i> (%)				<0.001
21–25 years old	99 (34.0)	69 (28.2)	30 (65.2)	
26–30 years old	82 (28.2)	73 (29.8)	9 (19.6)	
31–35 years old	110 (37.8)	103 (42.0)	7 (15.2)	
Race <i>n</i> (%)				0.004
Non-Hispanic white	66 (22.7)	56 (22.9)	10 (21.7)	
Non-Hispanic black	182 (62.5)	160 (65.3)	22 (47.8)	
Other ^a	43 (14.8)	29 (11.8)	14 (30.4)	
Education <i>n</i> (%)				0.112
Some high school/high school graduate/GED	35 (12.0)	27 (11.0)	8 (17.4)	
Some college/trade school/4-year degree	154 (52.9)	136 (55.5)	18 (39.1)	
Some post-grad/graduate degree	102 (35.1)	82 (33.5)	20 (43.5)	
HPV vaccine status <i>n</i> (%)				0.497
Received > = 1 dose	97 (33.3)	84 (34.3)	13 (28.3)	
Never received HPV vaccine or unsure	194 (66.7)	161 (65.7)	33 (71.7)	
Purpose of a Pap test <i>n</i> (%)				0.317
Incorrect	104 (35.7)	84 (34.3)	20 (43.5)	
Partially correct	110 (37.8)	97 (39.6)	13 (28.3)	
Correct	77 (26.5)	64 (26.1)	13 (28.3)	
Pap recommendation awareness <i>n</i> (%)				<0.001
Aware	132 (45.5)	122 (50.0)	10 (21.7)	
Unaware	158 (54.5)	122 (50.0)	36 (78.3)	
Guideline comfort <i>n</i> (%)				0.005
Very uncomfortable	63 (21.8)	59 (24.2)	4 (8.9)	
Somewhat uncomfortable	61 (21.1)	52 (21.3)	9 (20.0)	
Neither comfortable nor uncomfortable	51 (17.6)	39 (16.0)	12 (26.7)	
Somewhat comfortable	39 (13.5)	27 (11.1)	12 (26.7)	
Very comfortable	75 (26.0)	67 (27.5)	8 (17.8)	

Boldface indicates statistical significance ($p < 0.05$) between those who were current and those who were not current for a Pap test.

Abbreviations: GED, General Educational Development; HPV, Human Papillomavirus; Pap, Papanicolaou.

^a “Other” category includes people who indicated “other” for their race, people who indicated multiple races, and Hispanics.

between the participants who were current on their Pap testing as compared to those who were not. Those who were current on their cervical cancer screening were more likely to be younger ($p < 0.001$) and Hispanic, other, or multiracial ($p = 0.004$).

3.2. Quantitative results

3.2.1. Association between HPV vaccination and cervical cancer screening

In bivariate logistic regression, women who indicated they had received at least one HPV vaccine dose in the series were not less likely to have received a Pap test when compared to unvaccinated women ($OR = 1.32$; 95% $CI = 0.66–2.65$). In contrast to the prediction of risk-compensation theory, multivariable logistic regression, controlling for age and race, showed that vaccinated women were actually more likely to obtain cervical cancer screening than their non-vaccinated counterparts ($AOR = 3.06$; 95% $CI = 1.37–6.83$). For all regression analyses, see Table 2.

An interaction analysis was performed to assess if age was the driver in the relationship between vaccination status and Pap testing. The interaction between age and vaccination status was then entered into the model and was statistically significant ($OR = 1.62$; 95% $CI = 1.05–2.50$; $p = 0.003$). Stratified logistic regression models indicated that the relationship between vaccination status and cervical cancer screening frequency was not significant for 21 to 25 year olds (34%; $n = 99$) while controlling for race ($OR = 2.0$; 95% $CI = 0.8–5.0$). For the 26 to 30 (28%; $n = 82$) and 31 to 35 (38%; $n = 110$) age groups, of the women who were overdue for Pap testing ($n = 9$ and 7 respectively), none had been vaccinated for HPV. We then performed a Fisher's exact test and found that the relationship between vaccination status and Pap testing was significant for the middle age group ($p = 0.03$) but was not significant for the youngest or oldest age groups ($p = 0.13$ and 0.59, respectively).

3.2.2. Beliefs about post-vaccination screening frequency

When asked if vaccinated women should get screened less frequently than unvaccinated women, 17% ($n = 50$) incorrectly said “yes,” 68% ($n = 198$) said “no,” and 15% ($n = 43$) said they did not know. Women who answered the question correctly were not more likely to have had a Pap test in the last three years than women who answered the question incorrectly ($OR = 1.18$; 95% $CI = 0.48–2.92$). However, response patterns varied by HPV vaccination status, and women who answered the question correctly were more likely to be vaccinated than women who answered it incorrectly ($OR = 2.77$; 95% $CI = 1.31–5.85$). The accuracy of the responses to the question about whether

Table 2
Regression analyses assessing the receipt of a pap test in the last three years.

	Bivariate odds ratio (95% CI)	Multivariable odds ratio (95% CI)
Ever received HPV vaccine		
No	Ref	Ref
Yes	1.32(0.66–2.65)	3.06 (1.37–6.83)
Race		
Non-Hispanic white	Ref	Ref
Non-Hispanic black	1.30(0.58–2.91)	0.94 (0.39–2.27)
Other	0.37(0.15–0.94)	0.30 (0.11–0.82)
Age (continuous)	1.21(1.12–1.31)	1.26 (1.15–1.38)
Education ^a		
Some high school/high school graduate/GED (ref)	Ref	
Some college/trade school/4-year degree	2.24(0.88–5.67)	
Some post-grad/graduate degree	1.22(0.48–3.07)	

Boldface indicates statistical significance ($p < 0.05$).

Abbreviations: GED, General Educational Development; HPV, Human Papillomavirus; Pap, Papanicolaou.

^a These variables were not significant in the bivariate analysis and were subsequently excluded from multivariable regression model.

HPV vaccinated women should be screened for cervical cancer at a different frequency than non-vaccinated women also varied by race; participants who answered incorrectly were more likely to be non-Hispanic black than participants who answered correctly (OR = 3.19; 95% CI = 1.27–7.97).

When asked how often a woman should get a Pap test if she has never had cervical cancer or an abnormal Pap test, 64% ($n = 187$) incorrectly responded they thought she should get screened every year. There were variations by race; those who answered incorrectly had double the odds of being non-Hispanic black (OR = 2.0; 95% CI = 1.11–3.58). Women were then told the current recommendation for average risk women is every three years and were asked if they were aware of this recommendation. Almost half (45.3%, $n = 132$) indicated they were aware of the recommendation. Of the women who were aware of the current recommendation, 53% ($n = 70$) indicated that they knew the recommendation was every three years, but still stated the women should get screened every year. When asked on a five-point scale how comfortable they were with the new screening recommendations, 43% ($n = 124$) indicated they were either very or somewhat uncomfortable, 40% ($n = 114$) reported they were either very or somewhat comfortable, and 18% ($n = 51$) indicated they were neither comfortable nor uncomfortable.

3.3. Qualitative results

At the beginning of the survey, prior to defining the term “Pap smear.” respondents were asked “What is the purpose of a Pap smear or Pap test?” Almost half (49%, $n = 143$) stated that a Pap test checks for cancer, although not all participants knew it tested specifically for cervical cancer. Additionally, 20% ($n = 57$) stated it checked for abnormal or precancerous cells and 41% ($n = 119$) knew that a Pap test checked the cervix. Some (29%; $n = 85$) were vague in their answers (i.e. “to check for abnormalities”) suggesting they did not fully understand the purpose of a Pap test and 9% ($n = 25$) indicated that a Pap test checked for STIs in general and an additional 9% of women ($n = 25$) stated the Pap test checked for “disease” but did not specifically say what disease. Some participants thought a Pap test evaluated other body parts including the ovaries, uterus, breasts, and generic terms such as “organs” and “down there.”

We examined whether responses from the participants regarding the purpose of a Pap test were correct or incorrect. Just over one quarter of women (26%; $n = 77$) answered correctly, 38% of women ($n = 110$) were partially correct, and 36% ($n = 104$) answered incorrectly. Correct answers varied by race and participants who answered incorrectly had more than four times the odds of being non-Hispanic black as compared to those who answered correctly (OR = 4.20; 95% CI = 2.00–8.81; $p < 0.001$). A breakdown of answers by race/ethnicity can be found in Table 3.

Table 3
Answers to “What is the purpose of a Pap smear or Pap test?” by race/ethnicity.

Purpose of a Pap	Overall ($n = 248$)	Non-Hispanic white ($n = 66$)	Non-Hispanic black ($n = 182$)	Example quotes
Correct n (%)	64 (25.8)	29 (43.9)	35 (19.2)	“For early detection of cancerous cells in the cervix.” “Screening test which detects pre-cancerous or cancerous cervical cells.” “Screening for cervical cancer.”
Partially correct n (%)	93 (37.5)	22 (33.3)	71 (39.0)	“The check for any abnormalities and to screen for cervical cancer as well as STDs.” “To ensure there are no abnormalities that may lead to ovarian or cervical cancer.”
Incorrect n (%)	91 (36.7)	15 (22.7)	76 (41.8)	“To determine if you possibly have breast cancer.” “Check for irregular uterine cells.” “To check for STDs and make sure everything is good with female organs.”

Abbreviations: Pap, Papanicolaou; STD, Sexually Transmitted Disease.

4. Discussion

4.1. Behaviors and beliefs around vaccination and cervical cancer screening

We examined a convenience sample of mostly non-Hispanic black women to compare cervical cancer screening practices between HPV vaccinated and unvaccinated women. We also explored knowledge regarding the purpose of a Pap test, current screening recommendations, and level of comfort with the current screening recommendations. In contrast to the prediction of risk-compensation theory, the results suggest no relationship between vaccination status and subsequent cervical cancer screening behaviors. Moreover, when the relationship is examined controlling for age and race of the respondent, we found that women who had been vaccinated had a three times greater odds of having been screened for cervical cancer within the last three years. This is consistent with recent research that used a national sample and found uptake of Pap testing was lower among those who had not initiated the HPV vaccination series (Sauer et al., 2015). It is also consistent with other health behavior literature that has demonstrated that pro-health behaviors cluster and a person who makes the decision to engage in one protective health behavior (e.g. getting the HPV vaccine) is more likely to engage in another (e.g. getting screened for cervical cancer) (Fortenberry et al., 1997).

Most women knew that HPV-vaccinated women are recommended to obtain cervical cancer screening at the same frequency as unvaccinated women. Results varied by vaccination status but did not vary by whether the women were current for cervical cancer screenings. The majority of women thought an average-risk woman should get screened every year, even though 45% of women claimed to know that the recommendation was every three years. This might be because current practice has not caught up with recommendations, the participants did not like admitting they were unaware of current screening recommendations, or it may be indicative of how uncomfortable women may be with the screening recommendations. More women were uncomfortable than comfortable with the current screening recommendations, suggesting that discomfort as well as lack of awareness may be a significant problem. While adherence to cervical cancer screening guidelines is important in terms of cost-effectiveness (Schiffman et al., 2011), provider communication and education is essential for patient-centered care (Levinson et al., 2010). This could be an area for a future intervention targeted at reminding physicians to educate their patients on the purpose of Pap tests and the current cervical cancer screening recommendations as well as for a broader public health campaign aimed at increasing knowledge around current cervical cancer screening guidelines.

4.2. Cervical cancer screening beliefs and understanding

Most women knew that Pap testing checked for cancer or abnormal cells but less than half knew it was checking the cervix. Additionally,

women believed they were being checked for STIs during the course of a Pap test and some thought they were also being checked for uterine or ovarian cancer. Only one-fourth of the sample correctly answered the question stating a Pap test checked for cervical cancer only.

4.3. Racial disparities in cervical cancer knowledge

There were racial disparities observed in questions concerning knowledge of cervical cancer screening. Non-Hispanic black participants were less likely to be aware of current screening recommendations. They were also less likely to correctly identify the purpose of a Pap smear which means that not only are non-Hispanic black women substantially less aware of screening recommendations, but they also lack a fundamental knowledge regarding the purpose of a Pap test. This could be due to differences in education between the two groups but also indicates there is significant room for improvement in educating particularly minority women regarding the purpose of and guidelines for cervical cancer screening. It is important for healthcare providers to know about these differences in order to target minority women for educational opportunities and tailor their education and screening messages that would be sensitive to the needs of different populations.

4.4. Limitations

This study gathered survey data from a convenience sample, thus the women in the sample may not be representative of the general population. However, our survey results were consistent with those from a previous national study (Sauer et al., 2015). There may also be a selection bias, with greater participation of with pro-health attitudes. The measures for receipt of HPV vaccination and Pap screening were both self-reported and are subject to recall bias and reporting errors.

5. Conclusions

The current study found that cervical cancer screening practices between vaccinated and unvaccinated participants were not different overall. In fact, contrary to risk-compensation theory, there was a positive relationship between vaccination and screening when adjusted for age and race. Rather than supporting risk compensation, this set of findings adds credibility to the hypothesis that higher screening rates among vaccinated women may be related to access to healthcare and pro-health attitudes. The findings suggest this is an area for future research using stronger study designs in order to make stronger, causal arguments about the relationship of HPV vaccination to cervical cancer screening. Findings from this study may inform future interventions with stronger study designs aimed at tailoring messages for patients, standardizing education for providers, or both. The results of such studies may disentangle the effects of both of these approaches in order to effectively assist healthcare providers in communicating effectively with their patients about HPV vaccination and cervical cancer screening.

Conflict of interest statement

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The authors and their contributions are as follows:

Author	Contributions
Monica L. Kasting, PhD, corresponding author	Conception and design, development of methodology, acquisition of data, analysis and interpretation of data, writing of manuscript
Shannon Wilson, BA	Conception and design, acquisition of data, analysis and interpretation of data, review and revision of manuscript
Terrell W. Zollinger, DrPH	Conception and design, development of methodology, analysis and interpretation of data, review and revision of manuscript
Brian E. Dixon, MPA, PhD	Analysis and interpretation of data, review and revision of manuscript
Nathan W Stupiansky, PhD	Analysis and interpretation of data, review and revision of manuscript
Gregory D. Zimet, PhD	Conception and design, development of methodology, analysis and interpretation of data, review and revision of manuscript

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References

- American Cancer Society, 2014. Chronological History of ACS Recommendations for the Early Detection of Cancer in People Without Cancer Symptoms. (<http://www.cancer.org/healthy/findcancerearly/cancerscreeningguidelines/chronological-history-of-acr-recommendations>. Accessed 15 July 2014).
- Anhang Price, R., Koshiol, J., Kobrin, S., Tiro, J.A., 2011. Knowledge and intention to participate in cervical cancer screening after the human papillomavirus vaccine. *Vaccine* 29 (25), 4238–4243.
- Boone, S.D., Pinkston, C.M., Baumgartner, K.B., et al., 2016. Associations between prior HPV4 vaccine doses and cervical cancer screening participation. *Cancer Epidemiol.* 42, 108–114.
- Caskey, R., Lindau, S.T., Alexander, G.C., 2009. Knowledge and early adoption of the HPV vaccine among girls and young women: results of a national survey. *J. Adolesc. Health* 45 (5), 453–462.
- CDC Recommends Only Two HPV Shots for Younger Adolescents [Press Release]. Atlanta, GA, October 20, 2016.
- Centers for Disease Control and Prevention. Cervical Cancer Screening Guidelines for Average-Risk Women. In: Services UDoHaH, ed 2012.
- Centers for Disease Control and Prevention, 2014. *Genital HPV Infection—CDC Fact Sheet*. Atlanta, GA.
- Elo, S., Kyngäs, H., 2008. The qualitative content analysis process. *J. Adv. Nurs.* 62 (1), 107–115.
- Fortenberry, J.D., Costa, F.M., Jessor, R., Donovan, J.E., 1997. Contraceptive behavior and adolescent lifestyles: a structural modeling approach. *J. Res. Adolesc.* 7 (3), 307–329.

- Juraskova, I., Bari, R.A., O'Brien, M.T., McCaffery, K.J., 2011. HPV vaccine promotion: does referring to both cervical cancer and genital warts affect intended and actual vaccination behavior? *Womens Health Issues* 21 (1), 71–79.
- Kasting, M.L., Shapiro, G.K., Rosberger, Z., Kahn, J.A., Zimet, G.D., 2016. Tempest in a teapot: a systematic review of HPV vaccination and risk compensation research. *Hum. Vaccin. Immunother.* 12 (6), 1435–1450.
- Kollar, L.M., Kahn, J.A., 2008. Education about human papillomavirus and human papillomavirus vaccines in adolescents. *Curr. Opin. Obstet. Gynecol.* 20 (5), 479–483.
- Levinson, W., Lesser, C.S., Epstein, R.M., 2010. Developing physician communication skills for patient-centered care. *Health Aff.* 29 (7), 1310–1318.
- Lew, J.-B., Simms, K., Smith, M., Lewis, H., Neal, H., Canfell, K., 2016. Effectiveness Modeling and economic evaluation of primary HPV screening for cervical cancer prevention in New Zealand. *PLoS One* 11 (5), e0151619.
- Markowitz, L.E., Dunne, E.F., Saraiya, M., et al., 2014. Human papillomavirus vaccination: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR. Recommendations and Reports: Morbidity and Mortality Weekly Report. Recommendations and Reports/Centers for Disease Control Vol. 63*, pp. 1–30.
- Mather, T., McCaffery, K., Juraskova, I., 2012. Does HPV vaccination affect women's attitudes to cervical cancer screening and safe sexual behaviour? *Vaccine* 30 (21), 3196–3201.
- Moser, K., Patnick, J., Beral, V., 2009. Inequalities in reported use of breast and cervical screening in great Britain: analysis of cross sectional survey data. *BMJ* 338.
- National Institutes of Health, 2015. HPV and Cancer. Institute NC, Bethesda, MD.
- 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.
- Pollitt, K., 2005. *Virginity or death!* The Nation. New York, NY: NATION CO INC, 33 IRVING PLACE, 8TH FLOOR, NEW YORK, NY 10003 USA.
- Reagan-Steiner, S., Yankey, D., Jeyarajah, J., et al., 2016. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years – United States, 2015. *MMWR Morb. Mortal. Wkly Rep.* 65 (33), 850–858.
- Robb, K., Wardle, J., Stubbings, S., et al., 2010. Ethnic disparities in knowledge of cancer screening programmes in the UK. *J. Med. Screen.* 17 (3), 125–131.
- Sauer, A.G., Jemal, A., Simard, E.P., Fedewa, S.A., 2015. Differential uptake of recent Papanicolaou testing by HPV vaccination status among young women in the United States, 2008–2013. *Cancer Epidemiol.* 39 (4), 650–655.
- Schiffman, M., Wentzensen, N., Wacholder, S., Kinney, W., Gage, J.C., Castle, P.E., 2011. Human papillomavirus testing in the prevention of cervical cancer. *J. Natl. Cancer Inst.* 103 (5), 368–383.
- Smith, M.A., Gertig, D., Hall, M., et al., 2016. Transitioning from cytology-based screening to HPV-based screening at longer intervals: implications for resource use. *BMC Health Serv. Res.* 16 (1), 147.
- Stokley, S., Jeyarajah, J., Yankey, D., et al., 2014. Human papillomavirus vaccination coverage among adolescents, 2007–2013, and postlicensure vaccine safety monitoring, 2006–2014 – United States. *MMWR Morb. Mortal. Wkly Rep.* 63 (29), 620–624.
- Tiro, J.A., Saraiya, M., Jain, N., et al., 2008. Human papillomavirus and cervical cancer behavioral surveillance in the US. *Cancer* 113 (S10), 3013–3030.
- Ward, E., Jemal, A., Cokkinides, V., et al., 2004. Cancer disparities by race/ethnicity and socioeconomic status. *CA Cancer J. Clin.* 54 (2), 78–93.
- Wilde, G.J., 1982. The theory of risk homeostasis: implications for safety and health. *Risk Anal.* 2 (4), 209–225.
- Wilde, G.J., 1998. Risk homeostasis theory: an overview. *Inj. Prev.* 4 (2), 89–91.
- 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.