What Do Women in the U.S. Know about Human Papillomavirus and Cervical Cancer?

Jasmin A. Tiro,[1,2] Helen I. Meissner,[2] Sarah Kobrin,[2] and Veronica Chollette[2]

[1]Cancer Prevention Fellowship Program, Division of Cancer Prevention and [2]Applied Cancer Screening Research Branch, Division of Cancer Control and Population Sciences, National Cancer Institute, Bethesda, Maryland

Abstract

Background: **Women need to understand the link between human papillomavirus (HPV) and cervical cancer in order to make appropriate, evidence-based choices among existing prevention strategies (Pap test, HPV DNA test, and HPV vaccine). Assessment of the public's knowledge in nationally representative samples is a high priority for cervical cancer control.**
Objectives: **To assess factors associated with U.S. women's awareness of HPV and knowledge about its link to cervical cancer.**
Methods: **Analyzed cross-sectional data from women ages 18 to 75 years old responding to the 2005 Health Information National Trends Survey (n = 3,076).**
Results: **Among the 40% of women who had ever heard about HPV, <50% knew it caused cervical cancer; knowledge that HPV was sexually transmitted and caused abnormal Pap tests was higher (64% and 79%, respectively). Factors associated with having heard about HPV included: younger age, being non–Hispanic White, higher educational attainment, exposure to multiple health information sources, trusting health information, regular Pap tests, awareness of changes in cervical cancer screening guidelines, and having tested positive for HPV. Accurate knowledge of the HPV-cervical cancer link was associated with abnormal Pap and positive HPV test results.**
Conclusions: **Awareness about HPV among U.S. women is low. Having heard about HPV did not ensure accurate knowledge. Strategies for communicating accurate information about HPV transmission, prevention, and detection as well as risk and treatment of cervical cancer are needed.** (Cancer Epidemiol Biomarkers Prev 2007;16(2):288–94)

Introduction

Cervical cancer screening with the Pap test is well integrated into the U.S. health care system and is widely accepted by women. However, advances in our understanding of cervical cancer etiology, specifically, the identification of human papillomavirus (HPV) as a necessary cause (1), have led to the development, evaluation, and recommendation of HPV-based technologies for cervical cancer prevention and control. Current clinical guidelines recommend using the HPV DNA test in women ages 30 and older for primary screening (2, 3) and in all ages for follow-up to abnormal cytology (4). More recent recommendations include administering the HPV vaccine in adolescent and young adult females (ages 9-26) to prevent the transmission of certain carcinogenic HPV types (5).

The changing landscape of technologies to prevent and detect cervical cancer offers new options to women and health care providers. Accurate knowledge about HPV and its link to cervical cancer are therefore critical in order to make appropriate, evidence-based health care choices. Limited available data suggest that women know little about HPV (6). As HPV-based technologies diffuse into the general population, tracking which groups of women remain unfamiliar with HPV and would, therefore, benefit from educational messages will be essential. Health communication researchers have an important window of opportunity to ensure that misinformation does not occur and women understand the state-of-the-science. Although knowledge is not a direct predictor of health behavior (7), health behavior theories hypothesize that it is a distal factor mediated by attitudes, risk perceptions, social influence, and self efficacy (8). Thus, acquiring knowledge is a key first step to the success of any health education intervention.

Most research in the U.S. on knowledge of HPV and its link to cervical cancer have been conducted in special populations such as adolescent and young adults (9-17) or individuals attending sexually transmitted infection (STI) and primary care clinics (18-23). These studies suggest that HPV awareness is low. Information about recruitment methods for the sole national survey of women living in the U.S. is limited; therefore, its generalizability is unclear; ref. 32. Thus, little is known about HPV awareness among adult women and those at average risk for developing cervical cancer (6). Furthermore, few studies have examined factors associated with HPV knowledge (23, 25, 26). Assessment of the public's knowledge of HPV in nationally representative samples was identified as a high-priority research aim in 1999 by the Centers for Disease Control and Prevention, but has yet to be achieved (6).

Disparities in cervical cancer screening persist in the U.S. (27). To prevent further disparities in cervical cancer outcomes, identifying women who are most likely to benefit from educational messages about the dangers of persistent HPV infections is necessary. Clear and consistent information will help women make decisions about the usefulness of new technologies like the HPV DNA test and the HPV vaccine.

The purposes of this report are to (*a*) assess awareness of HPV and knowledge of its link to cervical cancer in a national sample of U.S. women, and (*b*) to explore the association of accurate HPV knowledge with factors relevant to health communication. Results should aid in developing effective communication about HPV and identify opportunities to facilitate appropriate adoption of state-of-the-science technologies to reduce the burden of cervical cancer.

Received 9/7/06; revised 11/6/06; accepted 12/6/06.

Grant support: The Health Information National Trends Survey (HINTS) 2005 was funded by the National Cancer Institute, under contract N02-PC-3523, Project 7845. Westat was contracted to collect the data.

The costs of publication of this article were defrayed in part by the payment of page charges. This article must therefore be hereby marked *advertisement* in accordance with 18 U.S.C. Section 1734 solely to indicate this fact.

Requests for reprints: Jasmin A. Tiro, Division of Cancer Control and Population Sciences, National Cancer Institute, 6130 Executive Boulevard, EPN 4103A, MSC 7331 Bethesda, MD 20892-7331. Phone: 301-451-5040; Fax: 301-480-6637. E-mail: tiroj@mail.nih.gov

doi:10.1158/1055-9965.EPI-06-0756

Materials and Methods

Sample. Data were from the National Cancer Institute's 2005 Health Information National Trends Survey (HINTS) conducted between February and August 2005. HINTS collects nationally representative data on the U.S. population's knowledge of, methods of searching for, and use of cancer-related information as well as performance of behaviors that prevent cancer or detect it early. A random-digit-dial sample of all working residential telephones in the U.S. was used to recruit participants. Telephone exchanges were geographically stratified and those with higher percentages of African-Americans and Hispanics were oversampled. During the screening process, one adult aged 18 years or older from each household was randomly selected for the extended interview. Interviews were conducted in English or Spanish with 5,394 adults. The overall response rate of 20.8% and was calculated by combining the American Association for Public Opinion Research's standard definitions (28) for screening interview response rate (34%; i.e., the proportion of households in which eligibility was ascertained) and the extended interview rate (61.3%; i.e., the proportion of eligible households in which an adult completed the full survey; ref. 29). More information about the HINTS 2005 data collection procedures can be found at the National Cancer Institute web site (http://hints.cancer.gov/instrument.jsp). Only female respondents were asked questions about HPV; thus, male respondents were excluded from all analyses.

Measures. The HINTS 2005 included items that assessed sociodemographics, health status, personal and familial cancer history, general and specific-cancer knowledge, attitudes, beliefs, health communication, and cancer screening behaviors.

Outcome variables. Female respondents were asked if they had heard of human papillomavirus or HPV. If a woman responded ''no,'' she was not asked HPV knowledge questions and was not included in the analysis of the following dependent variables. Knowledge of the link between HPV and cervical cancer was assessed with a single item (''Do you think HPV causes cervical cancer?''). Knowledge of other aspects about HPV was assessed with five questions, specifically, whether HPV: is a STI, will often go away without treatment, can cause abnormal Pap tests, is rare, and affects a woman's ability to get pregnant. The latter two items were distracters and were reverse coded. A summary scale of the five items was created in which higher scores indicated more accurate knowledge.

Correlate variables. Continuous variables were grouped into ordinal categories to facilitate inclusion in the multivariate logistic regression analysis. Sociodemographic variables examined included age (18-29, 30-64, 65-75), race/ethnicity (non–Hispanic White, Hispanic, Black, other), education (less than high school, high school degree, some college, college degree), income (<\$15,000, \$15,000-34,999, \$35,000 – 49,999, \$50,000+), and marital status (married/living with partner versus single/divorced/widowed).

Access to health care was measured with three variables: insurance status (yes, no), visit health care provider in past year (yes, no), and comfortable speaking English (a little/not at all/does not speak versus somewhat/very/completely/English is native language).

Attention to and trust in health information was assessed with two composite variables. Respondents were asked whether they paid attention to information about health issues from three sources (newspapers/magazines, television news programs, and the Internet). Then, they were asked—on a four-point Likert scale—how often they paid attention. For print and television media, responses were dichotomized as once or more per week and less than once per week. For the Internet, responses were coded as 1+ or 0 per month. A summary scale was created (range, 0-3) with higher scores indicating more exposure.

Participants were also asked how much they would trust information about health issues from seven sources (doctor, family or friends, newspapers, magazines, radio, the Internet, and television). Based on a coding scheme developed to examine the association between this construct and mammography using HINTS 2003 data (30), we created a summary index score (range, 0-7) indicating the number of sources women ''did not trust at all.'' Then, a dichotomous variable was created with 0 representing trusting all sources ''a lot, some, or a little'', and 1 reflecting that the woman said she trusted one or more sources ''not at all.'' Trust was coded in the negative direction because we hypothesized that women who expressed no trust would be less likely to have heard of or have knowledge about HPV.

Cancer history was assessed with three dichotomous variables—cervical cancer family history, other cancer family history, and personal history of cancer other than cervical cancer. Women reporting a personal history of cervical cancer were excluded from the analyses.

Cervical cancer screening history was assessed with two questions about the timing of the most recent Pap test and the one before the most recent. Response options were a year ago or less, more than 1 but not more than 3 years ago, more than 3 years ago but not more than 5 years ago, and over 5 years ago. To determine a respondent's screening pattern, a three-level, composite variable was created: 1, never had a Pap test or not one in the past 3 years; 2, had a Pap test in the past 3 years and not one in the year before; or 3, on a regular schedule (had two Pap tests 1 year apart with the most recent in the past 3 years). The following factors were also included: ever had a hysterectomy, ever had an HPV infection, whether the main reason for the most recent Pap test was because of previous abnormal findings, and whether a woman had heard about the change in clinical guidelines for Pap test frequency from once a year to every 3 years (2, 31).

Data Analysis. Women reporting a history of cervical cancer ($n = 76$) and women older than age 75 ($n = 473$) were excluded from all analyses because cervical cancer screening recommendations differ for them (2, 31). A total of 3,108 women ages 18 to 75 years old with no history of cervical cancer completed the interviews. Women missing values for either of the dependent variables were also excluded from analyses ($n = 32$). The final sample size was 3,076 respondents. Women selecting ''refused'' or ''don't know'' for a survey item measuring a correlate variable were counted as missing for that variable and were excluded from relevant univariate and all multivariate analyses.

For univariate analyses, we used χ^2 statistics to assess associations. In the multivariate logistic regression analyses, a significance level of $P \leq 0.25$ from the univariate analyses was used as the cutoff for selecting correlate variables (32). To determine if collinearity among the correlate variables was affecting the fit of the multivariate model, we checked for large regression coefficients and SEs (32). Because of the sampling design of HINTS 2005, SUDAAN 9.0.1 was used to calculate weighted population estimates and confidence intervals in all analyses.

Results

Knowledge about HPV among U.S. women ages 18 to 75 years old was relatively low; 40% of women ($n = 1,248$) reported that they had ever heard of HPV (Table 1). Among those who had heard of it, less than half knew that HPV causes cervical cancer. Higher percentages of women knew that HPV is a STI, that it causes abnormal Pap tests, and that it is *not* rare (64%, 79%, and 70%, respectively). Very few knew that HPV often resolves

Table 1. Weighted percentages and 95% CIs of HPV knowledge items for women with no history of cervical cancer ages 18 to 75 yrs old (*n* = 3,076)—HINTS 2005

Variables	*N*	Weighted % (95% CIs)
Heard of HPV		
Yes	1,248	40.1 (38.4-41.8)
No	1,846	59.9 (58.2-61.6)
Missing	14	
Knows HPV causes cervical cancer*		
Yes	605	47.8 (44.2-51.3)
No	642	52.2 (48.7-55.8)
Missing	1	
Knows HPV is an STI*		
Yes	806	63.9 (60.6-67.0)
No	441	36.2 (33.0-39.5)
Missing	1	
Knows HPV causes abnormal Pap*		
Yes	962	79.2 (76.0-82.0)
No	285	20.8 (18.0-24.0)
Missing	1	
Knows HPV is *not* rare (reverse coded)*		
Yes	872	70.3 (66.7-73.7)
No	375	29.7 (26.3-33.3)
Missing	1	
Knows HPV often resolves without treatment*		
Yes	43	3.8 (2.5-5.7)
No	1,204	96.2 (94.3-97.6)
Missing	1	
Knows HPV does *not* affect chances of getting pregnant (reverse coded)*		
Yes	127	13.4 (10.6-16.7)
No	1,120	86.6 (83.3-89.4)
Missing	1	
Summary knowledge scale about other HPV issues*		
Zero out of five items correct	135	9.1 (7.4-11.3)
One out of five items correct	177	14.9 (12.3-18.0)
Two out of five items correct	276	22.7 (19.3-26.4)
Three out of five items correct	569	44.4 (40.6-48.2)
Four out of five items correct	76	7.4 (5.3-10.2)
Five out of five items correct	14	1.5 (0.8-3.1)
Missing	1	

*Questions about HPV knowledge were only asked among the 1,248 women who reported having heard of HPV.

without treatment (4%) and that it does *not* affect chances of getting pregnant (13%). Less than 2% correctly answered all five items of the HPV summary knowledge scale; slightly more than 50% answered three or more items items correctly.

Univariate Analyses. Weighted frequencies of sociodemographic, access to health care, health information, cancer history, and cervical cancer screening history for all respondents (n = 3,076), those who had heard of HPV (n = 1,248), and those who knew that HPV caused cervical cancer (n = 605) are provided in Table 2. For all respondents, the majority were White, had some college or a college degree, were married, had a household income >$50,000, had health insurance, visited with a health care provider in the past year, and felt comfortable speaking English. Approximately 19% of the women had had a hysterectomy, 76% got regular Pap tests, and ~21% were aware of the recent change in cervical cancer screening guidelines to less frequent Pap tests (2, 31).

Women who had heard of HPV were more likely to: be younger than 65 years old, be non–Hispanic White, have some college or a college degree, have a higher income, visit a health care provider in the past year, be exposed to two or more sources of health information, engage in a regular Pap test schedule, and be aware of the change in screening guidelines than those who had not heard of HPV (Table 2). Women who had heard of HPV were also less likely to lack trust in one or more sources for health information and to have had a hysterectomy. All of the women who reported testing positive for HPV also reported that they had heard of it. Because of lack of variability, HPV-positive status was not included in the multivariate model for ''heard of HPV.'' Three factors (being married, familial cervical cancer history, and no personal cancer history) were marginally associated ($P < 0.25$) with having heard about HPV.

Among women who had heard of HPV, those who knew about the causal link between HPV and cervical cancer were more likely to: be Hispanic, have some college or a college degree, report being HPV-positive, and have had abnormal Pap results. Five other factors (younger age, very low or high income, having health insurance, familial non–cervical cancer history, and comfortable speaking English) were marginally associated.

Two socioeconomic status indicators were measured in HINTS—education and household income. We decided to include only education in the multivariate analyses because (*a*) educational attainment is a robust measure of socioeconomic status that is relatively stable over the adult life span regardless of health status, and (*b*) income was not reported by many respondents, thus, the use of income as a covariate would have resulted in a substantial loss of participants.

Multivariate Analyses. The odds ratios and the 95% confidence intervals (CI) from the multivariate models are shown in Table 3. In the multivariate model for HPV awareness (i.e., heard of HPV), the following factors remained positively associated: younger age, being non–Hispanic White, higher educational attainment, exposure to more than one source of health information, getting regular Pap tests, and being aware of the change in screening guidelines. Lack of trust in health information from all sources remained negatively associated. In contrast, the only factors positively associated with accurate knowledge of the HPV-cervical cancer link were abnormal Pap and positive HPV test results.

Discussion

Awareness of HPV has increased over the past decade, but knowledge of its link to cervical cancer remains low. The earliest study of HPV knowledge (1992) that we identified found that 13% of women attending a southeastern university had ever heard of HPV and only 8% of them knew that it was associated with cervical cancer (15). In 2000, a population-based survey of women ages 18 to 65 living in the U.S. found that only 28% had ever heard of HPV and only 41% of those knew that it was sometimes associated with cervical cancer (24). Our study, in a national sample of women ages 18 to 75 years old, found that ~40% of women had heard of HPV, but less than half of those also knew that it caused cervical cancer. Additionally, only 50% of women who had heard of HPV could correctly answer at least three of the five items on a summary scale measuring knowledge of other aspects of HPV. These low levels of knowledge are consistent with findings from other studies of U.S. adult women (10-14, 23, 24), and are not surprising given that the HPV DNA test was only recommended for primary cervical cancer screening in 2002 to 2003 (2, 3). Although HPV is the most common STI in the U.S. (33), most infections are transient (median duration, 8 months; ref. 34); thus, most women probably do not receive treatment and therefore miss an opportunity to learn about the infection from a health care provider.

Caution should be exercised when comparing our results to past HPV knowledge studies. Several of these earlier studies did not assess whether the study population had ever heard of HPV before assessing knowledge (10, 14, 16, 19, 20, 35, 36). Others did not make clear whether they used a skip pattern after asking respondents about whether they had heard of HPV (18, 37), whereas some studies continued to ask questions about HPV knowledge even after respondents stated they had never heard of HPV (11, 12, 15, 25, 38). Question wording, sequence, and skip patterns have been shown to affect prevalence

Table 2. Distribution, weighted percentages and 95% CIs of sociodemographic, health care access, health information, cancer history, and cervical cancer screening variables by HPV awareness and knowledge for women with no history of cervical cancer ages 18 to 75 yrs old (*n* = 3,076)—HINTS 2005

Variables	Women ages 18-75 (*n* = 3,076)		Heard of HPV (*n* = 1,248, 40.1%)			Knew HPV caused cervical cancer among those who had heard (*n* = 605, 47.8%)		
	n	Weighted % (95% CI)	*n*	Weighted % (95% CI)	*P*, χ^2, *df*	*n*	Weighted % (95% CI)	*P*, χ^2, *df*
Sociodemographic								
Age group (y)					**0.0000***			**0.1199***
18-29	394	23.7 (22.3-25.2)	201	46.1 (41.9-50.3)	76.5	105	44.9 (36.0-54.3)	4.4
30-64	2,156	64.9 (63.3-66.4)	916	41.1 (38.8-43.4)	2	452	49.8 (45.9-53.6)	2
65-75	558	11.5 (10.7-12.3)	131	22.4 (18.5-26.7)		48	38.6 (28.3-50.1)	
Race/Ethnicity					**0.0000**			**0.0052**
Non–Hispanic White	2,263	68.9 (67.7-70.2)	986	44.5 (42.4-46.6)	34.3	460	44.8 (40.6-49.1)	14.4
Hispanic	289	12.3 (11.7-12.9)	91	27.6 (21.2-35.1)	3	60	63.5 (49.3-75.7)	3
Non–Hispanic Black	285	12.2 (11.1-13.3)	87	33.0 (26.7-39.9)		36	41.5 (28.3-56.1)	
Other	159	6.6 (5.2-8.3)	55	36.0 (27.2-45.9)		33	67.6 (46.9-83.1)	
Missing	112							
Education					**0.0000**			**0.0151**
<High school	339	12.9 (12.0-13.9)	59	16.3 (11.6-22.4)	264.7	32	47.4 (31.6-63.8)	11.5
High school graduate	794	30.0 (28.7-31.2)	203	27.0 (22.9-31.5)	3	81	35.7 (26.9-45.5)	3
Some college	912	33.1 (31.8-34.4)	402	47.0 (42.9-51.1)		188	47.3 (41.4-53.3)	
College graduate	964	24.1 (23.4-24.7)	557	60.5 (57.0-64.0)		289	54.3 (48.7-59.8)	
Missing	99							
Marital status					**0.1583**			0.9579
Married/living with partner	1,785	63.5 (31.2-35.7)	755	41.8 (39.2-44.4)	2.1	364	47.3 (42.9-51.6)	0.0
Single/divorced/widowed	1,222	36.5 (34.3-38.9)	464	38.0 (34.3-41.8)	1	225	47.5 (40.0-55.1)	1
Missing	101							
Household income ($)					**0.0000**			**0.2101**
<15,000	166	5.8 (4.7-7.1)	49	28.0 (20.3-37.2)	52.6	29	64.5 (43.4-81.2)	4.7
15,000-34,999	627	25.4 (22.9-28.2)	191	30.8 (25.4-36.8)	3	85	43.0 (31.5-55.3)	3
35,000-49,999	384	15.2 (13.0-17.8)	158	40.5 (34.2-47.2)		72	48.1 (39.7-56.7)	
50,000+	1,191	53.5 (50.8-56.2)	598	49.7 (46.5-52.9)		318	51.2 (46.6-55.7)	
Missing	740							
Health insurance					0.3863			**0.2430**
Yes	2,648	84.5 (82.6-86.3)	1,095	41.1 (39.0-43.2)	0.8	526	46.0 (42.2-49.9)	1.4
No	368	15.5 (13.7-17.4)	130	37.2 (29.7-45.4)	1	66	55.0 (41.1-68.2)	
Missing	92							
Visit with health care provider in past year					**0.0207**			0.4738
Yes	2,742	89.1 (87.2-90.8)	1,136	41.6 (39.7-43.6)	5.71	550	46.8 (43.1-50.5)	0.5
No	270	10.9 (9.2-12.8)	88	31.1 (23.5-39.7)	1	42	53.5 (36.1-70.0)	1
Missing	96							
Comfortable speaking English					0.5246			**0.1762**
Yes (completely, very, somewhat)	2,909	95.5 (94.4-96.3)	1,184	40.6 (38.9-42.3)	0.41	563	46.7 (43.4-50.1)	1.88
No (a little or not at all)	109	4.5 (3.7-5.6)	41	36.9 (25.7-49.6)	1	29	60.2 (36.1-80.2)	1
Missing	90							
Health information								
Exposure to health information (no. of sources)					**0.0000**			0.6220
0	722	25.3 (22.8-28.1)	221	30.6 (25.6-36.1)	43.1	98	50.1 (40.8-59.5)	1.8
1	1,124	36.9 (34.4-39.6)	440	38.4 (35.4-41.5)	3	212	45.8 (41.2-50.6)	3
2	946	27.4 (25.3-29.5)	411	46.3 (42.5-50.1)		196	46.5 (39.6-53.6)	
3	316	10.4 (9.0-11.9)	176	53.0 (46.5-59.4)		99	52.1 (41.4-62.7)	
Trust sources of health information					**0.0000**			0.5405
Does not trust one or more sources	1,838	57.8 (56.0-59.6)	602	31.1 (28.3-34.0)	78.2	276	46.5 (41.6-51.5)	0.4
Trusts all sources	1,270	42.2 (40.4-44.1)	646	52.4 (49.2-55.6)	1	329	48.7 (43.7-53.8)	1
Cancer history								
Family member had cervical cancer					**0.0728**			0.6757
Yes	93	3.5 (2.7-4.6)	46	51.0 (39.0-62.8)	3.4	20	43.8 (25.3-64.2)	0.2
No	3,002	96.5 (95.4-97.3)	1,198	39.7 (37.8-41.6)	1	583	48.0 (44.5-51.6)	1
Missing	13							
Family member had non–cervical cancer					**0.0015**			**0.0731**
Yes	2,327	73.4 (71.2-75.5)	970	42.6 (40.8-44.5)	11.3	465	46.1 (41.9-50.2)	3.4
No	768	26.6 (24.5-28.8)	274	32.9 (28.2-38.1)	1	138	54.2 (46.7-61.6)	1
Missing	13							
Personal experience with non–cervical cancer					**0.1449**			**0.4373**
Yes	370	8.7 (7.7-9.8)	138	35.6 (29.4-42.2)	2.2	54	42.8 (30.7-56.0)	0.6
No	2,734	91.3 (90.2-92.3)	1,109	40.6 (38.7-42.4)	1	550	48.1 (44.4-51.8)	1
Missing	4							
Cervical cancer screening history								
Hysterectomy					**0.0000**			0.2925
Yes	724	18.7 (17.2-20.3)	220	29.2 (24.5-34.3)	20.7	82	42.8 (33.3-52.9)	1.13
No	2,384	81.3 (79.7-82.8)	1,028	42.6 (40.6-44.7)	1	523	48.5 (44.7-52.4)	1

(*Continued on the following page*)

Table 2. Distribution, weighted percentages and 95% CIs of sociodemographic, health care access, health information, cancer history, and cervical cancer screening variables by HPV awareness and knowledge for women with no history of cervical cancer ages 18 to 75 yrs old (*n* = 3,076)—HINTS 2005 (Cont'd)

Variables	Women ages 18-75 (*n* = 3,076)		Heard of HPV (*n* = 1,248, 40.1%)			Knew HPV caused cervical cancer among those who had heard (*n* = 605, 47.8%)		
	n	Weighted % (95% CI)	*n*	Weighted % (95% CI)	*P*, χ^2, *df*	*n*	Weighted % (95% CI)	*P*, χ^2, *df*
HPV-positive					**0.0000**			**0.0090**
Yes	74	2.6 (2.0-3.5)	74	100.0	51.0	57	71.8 (55.7-83.7)	12.6
No	2,995	97.4 (96.5-98.1)	1,166	38.5 (36.8-40.2)	1	545	46.2 (42.6-79.8)	1
Missing	39							
Pap test					**0.0000**			0.6698
Never/not recent	512	17.8 (15.5-20.3)	124	23.8 (19.4-28.8)	58.6	49	44.9 (31.6-59.0)	0.8
Recent	193	6.6 (5.5-7.9)	45	26.4 (18.7-36.0)	2	23	55.8 (36.5-73.5)	2
Regular	2,395	75.7 (73.1-78.1)	1,079	45.2 (43.0-47.4)		533	47.7 (44.0-51.4)	
Missing	8							
Reason for most recent Pap was due to past abnormal findings					0.2800			**0.0090**
Yes	179	6.4 (5.2-7.9)	71	39.6 (32.2-47.4)	0.6	42	68.3 (53.3-80.2)	7
No	2,825	93.6 (92.1-94.8)	1,155	41.6 (39.8-43.4)	1	553	46.8 (43.7-50.0)	1
Missing	104							
Aware of change in screening guidelines					**0.0000**			0.2817
Yes	761	20.8 (19.5-22.2)	411	52.9 (48.3-57.4)	44.5	203	51.6 (44.2-58.8)	1.2
No	2,334	79.2 (77.8-80.5)	837	36.7 (35.0-38.5)	1	402	46.3 (41.6-51.1)	1
Missing	13							

*All variables (except for income) with a boldfaced $P < 0.25$ were selected for inclusion in the multivariate analyses. Income was not included because of the large numbers of participants missing this information and because education is a robust measure of socioeconomic status.

estimates (39, 40). Additionally, several studies did not describe whether they used a prompted (recognition) or an open-ended (recall) question format. This methodologic difference could explain why a 2004 study of a representative population sample of British women, which used an open-ended format, found extremely low levels of HPV knowledge (e.g., only 1% knew that HPV caused cervical cancer; ref. 35). Respondents were more likely to guess with the prompted format, which tends to yield higher scores of cancer knowledge (8, 41). This tendency suggests that our findings, which were based on a prompted question format, may overestimate U.S. women's true levels of knowledge about HPV and cervical cancer.

Although some studies have looked at whether sociodemographic and cervical cancer screening variables were associated with HPV knowledge (23, 25, 26), ours was the first to use a national sample of U.S. women and the first to include health communication and cancer history variables. Our main finding was that factors associated with HPV awareness differed substantially from those associated with HPV-cervical cancer knowledge. Only one variable was consistently associated with both outcomes—HPV-positive status. All of the women who reported testing positive for HPV had heard of it and they were also 3.5 times more likely to know that HPV causes cervical cancer. This finding is consistent with past research (25, 26). Although HINTS 2005 data are cross-sectional and prevent us from establishing a temporal sequence, our findings may suggest that education is more likely to occur after a woman has experienced an adverse consequence from an HPV infection. Also supportive of this hypothesis are the higher levels of general HPV knowledge found among women attending colposcopy clinics (19, 22). However, not all women who tested positive knew about the HPV-cervical cancer link, which suggests that some women do not remember the purpose of an HPV test. Another explanation is that they are confusing HPV with another STI diagnosis like herpes simplex virus. A longitudinal analysis would clarify whether HPV status predicts accurate knowledge.

Having had an abnormal Pap result was associated with knowing that HPV causes cervical cancer, but was not associated with having heard about it. This distinction further supports the idea that women gain knowledge when they experience cervical abnormalities or HPV positivity. In the HINTS data, we do not know where women acquired information about HPV. Women who tested positive could have received information from their health care providers or actively sought out information about HPV from other sources. Future research should investigate cognitive processing and information-seeking behaviors among women receiving abnormal Pap or positive HPV test results.

Our findings also suggest that familiarity with HPV does not guarantee accurate knowledge about its link to cervical cancer. Thus, health communication researchers have two tasks when crafting messages: (*a*) to increase recognition of the name, human papillomavirus, and its acronym, and (*b*) to increase the depth of knowledge of the potential consequences of HPV infection. Several sociodemographic subgroups (older women, less educated) seem to be largely unaware of HPV and would benefit from educational messages. Increasing the depth of knowledge among women who have heard about HPV is a more difficult task, but is crucial to prevent misinformation among women who have not received positive test results.

Interestingly, women who did not trust one or more sources of health information were less likely to report having heard about HPV. This finding may suggest that individuals who lack trust in the typical sources (e.g., doctor, media) do not attend to or recall new health information. Future research should investigate whether exposure to health information and trust in sources interact to affect awareness of HPV and receptivity to health education interventions.

Our study had some limitations. The overall response rate of the HINTS 2005 was significantly lower than HINTS 2003 and is mainly attributable to the screener response rate (34% and 55%, respectively); however, the extended interview response rate held steady at ~60%. The strong decline in response rates to random-digit-dial surveys seems to be continuing (42) and is probably exacerbated by technologies that allow individuals to screen and block incoming calls (e.g., Privacy Manager; ref. 43) and by adults who use only cell phones (6.7% of households in early 2005; ref. 44). Recent methodologic investigations suggest that lower response rates do not necessarily indicate larger

Table 3. Multivariate logistic regression models of HPV awareness and knowledge with sociodemographic, health care access, health information, cancer history, and cervical cancer screening variables for women with no history of cervical cancer ages 18 to 75 yrs old—HINTS 2005

Variables	Heard of HPV (n = 2,953)	Knew HPV caused cervical cancer among those who had heard (n = 1,186)
	Odds ratios (95% CI)	Odds ratios (95% CI)
Sociodemographic		
Age group (y)		
18-29	1.00	1.00
30-64	0.55 (0.42-0.72)	1.34 (0.90-2.00)
65-75	0.32 (0.21-0.49)	1.10 (0.60-2.04)
Race/ethnicity		
Non–Hispanic White	1.00	1.00
Hispanic	0.77 (0.51-1.16)	2.24 (0.86-5.86)
Non–Hispanic Black	0.68 (0.47-0.97)	0.77 (0.42-1.38)
Other	0.70 (0.46-1.06)	2.26 (0.74-6.91)
Education		
<High school	1.00	1.00
High school graduate	1.50 (0.91-2.49)	1.27 (0.44-3.61)
Some college	2.97 (1.76-5.02)	1.93 (0.59-6.34)
College graduate	5.11 (3.16-8.28)	2.41 (0.79-7.37)
Marital status		
Married/living with partner	0.99 (0.77-1.26)	
Single/divorced/ widowed	1.00	
Health care access		
Health insurance		
Yes		0.84 (0.38-1.84)
No		1.00
Visit with health care provider in past year		
Yes	1.03 (0.63-1.69)	
No	1.00	
Comfortable speaking English		
Yes		0.95 (0.16-5.76)
No		1.00
Health information		
Exposure to health information (no. of sources)		
0	1.00	
1	1.32 (0.95-1.83)	
2	1.87 (1.34-2.61)	
3	1.67 (1.07-2.58)	
Lack trust in health info from sources		
Does not trust one or more sources	0.70 (0.54-0.90)	
Trusts all sources	1.00	
Cancer history		
Family member had cervical cancer		
Yes	1.29 (0.76-2.17)	
No	1.00	
Family member had non–cervical cancer		
Yes	1.33 (1.00-1.77)	0.75 (0.50-1.13)
No	1.00	1.00
Personal experience with non–cervical cancer		
Yes	0.83 (0.56-1.22)	
No	1.00	
Cervical cancer screening history		
Hysterectomy		
Yes	0.79 (0.57-1.08)	
No	1.00	
HPV positive		
Yes	*	3.51 (1.69-7.27)
No	1.00	1.00
Pap test		
Never/not recent	0.48 (0.33-0.69)	
Recent	0.52 (0.34-0.78)	
Regular	1.00	
Reason for most recent pap test was because of previous abnormal findings		
Yes		2.18 (1.12-4.24)
No		1.00
Aware of change in cervical cancer screening guidelines		
Yes	1.87 (1.55-2.25)	
No	1.00	

*All of the women who were HPV-positive reported having heard about HPV; the lack of variability in HPV status prevented us from including it in the multivariate analysis.

biases in survey estimates (42, 45). HINTS 2005 tried to reduce the potential for screener nonresponse bias through weighting adjustments of the following characteristics: time of the telephone numbers' release into the field, whether an invitation letter could be mailed to the household, percentage of college graduates estimated for the telephone exchange, and percentage of minorities estimated for the telephone exchange. Regardless of the weighting adjustment, our data may not be generalizable to all women living in the U.S. In addition, researchers should exercise caution when comparing our results to studies in other countries. Another possible limitation mentioned earlier is that the prompted question format probably encouraged guessing; however, nothing in the literature suggests that guessing is differential across sociodemographic groups. Therefore, we expect that bias was towards the null and probably underestimated the magnitude of the patterns of association. Finally, items for the HINTS survey were not developed with a particular theoretical framework in mind. The survey measured a limited set of psychosocial correlates, thus limiting our ability to examine whether theoretical models like the Cognitive-Social Health Information Processing Model (46) or Leventhal's Common-Sense Model (47) explain how HPV knowledge influences cervical cancer prevention behavior.

Conclusion. Individuals are constantly presented with new health care research that updates previous knowledge, conflicts with prior knowledge, or provides entirely new options for diagnosis and treatment (48). Media coverage about and direct-to-consumer marketing for the HPV vaccine should raise women's awareness of HPV's link to cervical cancer. However, Anhang et al.'s 2004 study showed that news media coverage of HPV from 1995 to 2002 has been incomplete and sometimes misleading (49). Another study found that patients searching for information about vaccines on the Internet are likely to encounter sophisticated antivaccination web sites (50). Thus,

key communication challenges are to prevent misinformation, minimize confusion, and track the diffusion of knowledge. Because HPV is both a carcinogenic virus and a STI, HPV-based technologies may suffer from stigma which could adversely affect women's use of them and the public's acceptance of HPV vaccination programs (26).

A first step in addressing these communication challenges is to identify women least likely to have accurate HPV knowledge and to develop clear and appropriate messages for them. Our data indicate that awareness of HPV and cervical cancer among U.S. women is low, especially among those who are older, less educated, and less exposed to health information. If HPV testing and vaccination are the future for cervical cancer control, then accurate understanding of persistent HPV infection and its relationship to cancer is crucial. If targeted to and accessible by the right audiences, these efforts may reduce current health disparities in mortality and make possible the eradication of cervical cancer among U.S. women.

Acknowledgments

The authors appreciate the assistance of Bradford Hesse, Richard Moser, and Lila Finney Rutten.

References

1. Walboomers JM, Jacobs MV, Manos MM, et al. Human papillomavirus is a necessary cause of invasive cervical cancer. J Pathol 1999;189:12–9.
2. Saslow D, Runowicz CD, Solomon D, et al. American Cancer Society guideline for the early detection of cervical neoplasia and cancer. CA Cancer J Clin 2002;52:342–62.
3. Wright TC, Jr., Schiffman M, Solomon D, et al. Interim guidance for the use of human papillomavirus DNA testing as an adjunct to cervical cytology for screening. Obstet Gynecol 2004;103:304–9.
4. Wright TC, Jr., Cox JT, Massad LS, Twiggs LB, Wilkinson EJ, for the 2001 ASCCP-Sponsored Consensus Conference. 2001 Consensus guidelines for the management of women with cervical cytological abnormalities. JAMA 2002;287:2120–9.
5. Advisory Committee on Immunization Practices. ACIP provisional recommendations for the use of quadrivalent HPV vaccine. Available from: http://www.cdc.gov/nip/recs/provisional_recs/hpv.pdf. Last updated: August 14, 2006. Accessed August 30, 2006.
6. Waller J, McCaffery KJ, Forrest S, Wardle J. Human papillomavirus and cervical cancer: issues for biobehavioral and psychosocial research. Ann Behav Med 2004;27:68–79.
7. Viswanath K, Breen N, Meissner HI, et al. Cancer knowledge and disparities in the information age. J Health Commun 2006;11:1–17.
8. Waller J, McCaffery K, Wardle J. Measuring cancer knowledge: comparing prompted and unprompted recall. Br J Psychol 2004;95:219–34.
9. Kahn JA, Rosenthal SL, Hamann T, Bernstein DI. Attitudes about human papillomavirus vaccine in young women. Int J STD AIDS 2003;14:300–6.
10. Lambert EC. College students' knowledge of human papillomavirus and effectiveness of a brief educational intervention. J Am Board Fam Pract 2001; 14:178–83.
11. Yacobi E, Tennant C, Ferrante J, Pal N, Roetzheim R. University students' knowledge and awareness of HPV. Prev Med 1999;28:535–41.
12. Ramirez JE, Ramos DM, Clayton L, Kanowitz S, Moscicki AB. Genital human papillomavirus infections: knowledge, perception of risk, and actual risk in a nonclinic population of young women. J Womens Health 1997;6:113–21.
13. Baer H, Allen S, Braun L. Knowledge of human papillomavirus infection among young adult men and women: implications for health education and research. J Community Health 2000;25:67–78.
14. Mays RM, Zimet GD, Winston Y, Kee R, Dickes J, Su L. Human papillomavirus, genital warts, Pap smears, and cervical cancer: knowledge and beliefs of adolescent and adult women. Health Care Women Int 2000;21:361–74.
15. Vail-Smith K, White DM. Risk level, knowledge, and preventive behavior for human papillomaviruses among sexually active college women. J Am Coll Health 1992;40:227–30.
16. Hasenyager C. Knowledge of cervical cancer screening among women attending a university health center. J Am Coll Health 1999;47:221–4.
17. Denny-Smith T, Bairan A, Page MC. A survey of female nursing students' knowledge, health beliefs, perceptions of risk, and risk behaviors regarding human papillomavirus and cervical cancer. J Am Acad Nurse Pract 2006;18: 62–9.
18. Le T, Hicks W, Menard C, et al. Human papilloma virus testing knowledge and attitudes among women attending colposcopy clinic with ASCUS/ LGSIL pap smears. J Obstet Gynaecol Can 2004;26:788–92.
19. Boardman LA, Cooper AS, Clark M, Weitzen S, Whiteley JA, Peipert JF. HPV, cervical neoplasia and smoking: knowledge among colposcopy patients. J Reprod Med 2004;49:965–72.
20. Gerhardt CA, Pong K, Kollar LM, Hillard PJ, Rosenthal SL. Adolescents' knowledge of human papillomavirus and cervical dysplasia. J Pediatr Adolesc Gynecol 2000;13:15–20.
21. Massad LS, Meyer P, Hobbs J. Knowledge of cervical cancer screening among women attending urban colposcopy clinics. Cancer Detect Prev 1997; 21:103–9.
22. Pruitt SL, Parker PA, Peterson SK, et al. Knowledge of cervical dysplasia and human papillomavirus among women seen in a colposcopy clinic. Gynecol Oncol 2005;99:S236–44.
23. Holcomb B, Bailey JM, Crawford K, Ruffin MT. Adults' knowledge and behaviors related to human papillomavirus infection. J Am Board Fam Pract 2004;17:26–31.
24. The Kaiser Family Foundation. National Survey of Public Knowledge of HPV, the Human Papillomavirus. Available from: http://www.kff.org/ womenshealth/upload/The-HPV-Test-Coming-Soon-to-a-Doctor-s-Office-Near-You-Is-It-Better-than-the-Pap-Smear-for-Detecting-Cervical-Cancer-Chart-Pack.pdf. Last updated: February 17, 2000. Accessed: August 30, 2006.
25. Pitts M, Clarke T. Human papillomavirus infections and risks of cervical cancer: what do women know? Health Educ Res 2002;17:706–14.
26. Waller J, McCaffery K, Forrest S, Szarewski A, Cadman L, Wardle J. Awareness of human papillomavirus among women attending a well woman clinic. Sex Transm Infect 2003;79:320–2.
27. Jemal A, Siegel R, Ward E, et al. Cancer statistics, 2006. CA Cancer J Clin 2006;56:106–30.
28. The American Association for Public Opinion Research. Standard definitions: final dispositions of case codes and outcome rates for surveys. Lenexa (KS): AAPOR; 2006.
29. Westat for the National Cancer Institute. Health Information Trends Survey (HINTS) 2005 final report. Available from: http://cancercontrol.cancer.gov/ hints/docs/HINTS2005FinalReport-0523.pdf. Last updated: November 2005. Accessed: August 30, 2006.
30. Rakowski W, Meissner HI, Vernon SW, Breen N, Rimer BK, Clark MA. Correlates of repeat and recent mammography for women aged 45–75 in the 2002–2003 Health Information National Trends Survey (HINTS 2003). Cancer Epidemiol Biomarkers Prev 2006;15:2093–101.
31. U.S. Preventive Services Task Force. Screening for cervical cancer: recommendations and rationale. AHRQ pub. no. 03–515A. Available from: http:// www.ahrq.gov/clinic/3rduspstf/cervcan/cervcanrr.pdf. Last updated: January 2003. Accessed: August 30, 2006.
32. Hosmer DW, Lemeshow S. Applied logistic regression. New York: John Wiley & Sons, Inc.; 2000.
33. Moscicki AB, Hills N, Shiboski S, et al. Risks for incident human papillomavirus infection and low-grade squamous intraepithelial lesion development in young females. JAMA 2001;285:2995–3002.
34. Ho GY, Bierman R, Beardsley L, Chang CJ, Burk RD. Natural history of cervicovaginal papillomavirus infection in young women. N Engl J Med 1998;338:423–8.
35. Waller J, McCaffery K, Wardle J. Beliefs about the risk factors for cervical cancer in a British population sample. Prev Med 2004;38:745–53.
36. Klug SJ, Hetzer M, Blettner M. Screening for breast and cervical cancer in a large German city: participation, motivation and knowledge of risk factors. Eur J Public Health 2005;15:70–7.
37. Philips Z, Johnson S, Avis M, Whynes DK. Human papillomavirus and the value of screening: young women's knowledge of cervical cancer. Health Educ Res 2003;18:318–28.
38. Dell DL, Chen H, Ahmad F, Stewart DE. Knowledge about human papillomavirus among adolescents. Obstet Gynecol 2000;96:653–6.
39. Warnecke RB, Johnson TP, Chavez N, et al. Improving question wording in surveys of culturally diverse populations. Ann Epidemiol 1997;7:334–42.
40. Brener ND, Grunbaum JA, Kann L, McManus T, Ross J. Assessing health risk behaviors among adolescents: the effect of question wording and appeals for honesty. J Adolesc Health 2004;35:91–100.
41. Weinstein ND. What does it mean to understand a risk? Evaluating risk comprehension. J Natl Cancer Inst Monogr 1999;25:15–20.
42. Keeter S, Miller C, Kohut A, Groves R, Presser S. Consequences of reducing nonresponse in a large national telephone survey. Public Opin Q 2000;64:125–48.
43. Curtin R, Presser S, Singer E. Changes in telephone survey nonresponse over the past quarter century. Public Opin Q 2005;69:87–98.
44. Tucker C, Brick JM, Meekins B. Household telephone service and usage patterns in the U.S. in 2004: implications for telephone samples. Paper presented at the annual conference of the American Association for Public Opinion Research in Miami, FL; 2005.
45. Tourangeau R. Survey research and societal change. Annu Rev Psychol 2004; 55:775–801.
46. Miller SM, Shoda Y, Hurley K. Applying cognitive-social theory to health-protective behavior: breast self-examination in cancer screening. Psychol Bull 1996;119:70–94.
47. Leventhal H, Brissett I, Leventhal EA. The common-sense model of self-regulation of health and illness. In: Cameron LD, Leventhal H, editors. The self-regulation of health and illness behaviour. New York (NY): Routledge; 2003. p. 42–65.
48. Viswanath K. Science and society: the communications revolution and cancer control. Nat Rev Cancer 2005;5:828–35.
49. Anhang R, Stryker JE, Wright TC, Jr., Goldie SJ. News media coverage of human papillomavirus. Cancer 2004;100:308–14.
50. Davies P, Chapman S, Leask J. Antivaccination activities on the world wide web. Arch Dis Child 2002;87:22–5.