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Factors beyond Lack of Knowledge That Predict "I Don't Know" Responses to Surveys That Assess HPV Knowledge

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Accurately assessing the public's knowledge about the human papilloma virus (HPV) and the HPV vaccine remains critical for informing health education interventions aimed at increasing vaccine uptake. Responding "don't know" (DK) to survey questions that assess knowledge is common and DK responders are often systematically different from other responders, resulting in potential for bias. This study aimed to advance our understanding of DK responding to HPV knowledge items. Data from the nationally representative Health Information National Trends Survey Wave 5 Cycle 1 (N = 2,034) were used. Information seeking about cancer, information avoidance, health-related self-efficacy, and several cancer beliefs were examined as predictors of DK responding to six items that assessed HPV knowledge. DKs represented nearly half of responses. Adjusting for demographic factors, lower health-related self-efficacy, and greater information avoidance, cancer-mortality salience, and perceived ambiguity were associated with more DK responding, $ps < .05$. Even participants with incorrect responses had greater health-related self-efficacy, and less information avoidance, perceived ambiguity, and cancer-mortality salience than those who responded with DK. DK responding to HPV knowledge items is common and reflects factors beyond insufficient knowledge or motivation. Addressing causes of DK responding may reduce bias and improve interventions informed by surveys.

Although not always sufficient to motivate preventive health behaviors, accurate knowledge about health risks and prevention techniques is often necessary for behavior change, making it the target of interventions (Dempsey, Abraham, Dalton, & Ruffin, 2009; Fisher & Fisher, 1992; Glanz & Bishop, 2010). Knowledge is typically assessed with fact-based survey items that can be answered either correctly or incorrectly. Participants may also have the option to select a "don't know" (DK) response. Evidence suggests there may be important differences between responders who do and do not respond with DK (Luskin & Bullock, 2011; Mondak & Anderson, 2004). To examine these differences, this study assessed predictors of DK responding to knowledge items about human papilloma virus (HPV) and the HPV vaccine on a nationally representative survey.

Nearly 80 million Americans are infected with at least one strain of HPV (Satterwhite et al., 2013). Not all strains cause cancer, but HPV is the primary cause of cervical cancer and is a risk factor for several other anogenital and oropharyngeal cancers, contributing to approximately 41,038 new cancer cases each year (Centers for Disease Control and Prevention, 2018). The U.S. Food and Drug Administration has approved three vaccines as efficacious means of preventing HPV-related cancer (Munoz et al., 2004; Schiffman, Castle, Jeronimo, Rodriguez, & Wacholder, 2007). One is currently commercially available in the U.S., but uptake remains lower than coverage for other vaccines received during adolescence (Walker et al., 2017). In 2016, 65.1% of adolescent girls aged 13–17 had received one dose, and 43.0% had received all three recommended doses. Among boys, 56.0% and 31.5% received one and three doses, respectively (Walker et al., 2017).

Awareness and knowledge may be important modifiable barriers to vaccine uptake (Brewer, Chapman, Rothman, Leask, & Kempe, 2017; Brewer & Fazekas, 2007; Brewer et al., 2011). Only two-thirds of Americans have heard of HPV (Blake et al., 2015) and publicly available information about HPV and the vaccine often includes misconceptions, conveys uncertainty about the vaccine's efficacy and safety, and challenges expert knowledge (Briones, Nan, Madden, & Waks, 2012; Hendry, Lewis, Clements, Damery, & Wilkinson, 2013; Keelan, Pavri, Balakrishnan, & Wilson, 2010; Zimet, Rosberger, Fisher, Perez, & Stupiansky, 2013). This may contribute to perceptions of ambiguity and uncertainty about expert consensus on the benefits of HPV vaccination. Thus, accurately measuring the public's HPV knowledge remains critical for informing interventions. However, inferences based on survey results may be biased if they overlook potentially important differences between responders who do and do not respond with DK.

In the health domain, up to half of survey respondents will respond with DK to perceived risk items, or convey not knowing in another way, such as choosing a scale midpoint or

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skipping the item (Bruine de Bruin & Carman, 2012; Hay, Orom, Kiviniemi, & Waters, 2015; Waters, Hay, Orom, Kiviniemi, & Drake, 2013). These DK responders are often unique both sociodemographically (Bruine de Bruin & Carman, 2012; Waters et al., 2013) and in their health behaviors (Ellis, Ferrer, Taber, & Klein, 2018; Waters, Kiviniemi, Orom, & Hay, 2016). In other fields, DK responses to knowledge items is also common (Mondak & Canache, 2004; Tourangeau, Maitland, & Yan, 2016), and evidence suggests DK and incorrect responders are different, analogous to differences between the uninformed and misinformed (Luskin & Bullock, 2011; Mondak & Anderson, 2004). Thus, treating DK responses as missing data and/or equating them with incorrect responses may exclude or misrepresent important differences across respondents (Luskin & Bullock, 2011; Sturgis, Allum, & Smith, 2008). In the health domain, this has the potential to bias survey results (e.g., resulting in estimates that are inaccurate or do not generalize to all population subgroups) and the interventions they inform. Given these implications, as well as the widespread misconceptions about HPV, it is important to elucidate who responds with DK to items that assess HPV knowledge.

DK Responding

Evidence about the causes and consequences of DK responding remains equivocal. DK respondents may have partial knowledge and their DK responses may reflect satisficing, or low motivation that results in suboptimal responses (Kaminska, McCutcheon, & Billiet, 2010; Krosnick, 1991; Krosnick & Presser, 2010; Oppenheimer, Meyvis, & Davidenko, 2009). On the other hand, participants spend more time generating a DK response than a substantive response, which suggests participants arrive at their DK response after more deliberation, not less (Luskin & Bullock, 2011; Sturgis et al., 2008; Turner, Sturgis, & Martin, 2015). Even providing incentives or additional time as a way to encourage substantive answers does little to increase overall correct responses (Luskin & Bullock, 2011). This work suggests DK responses may reflect participant and survey characteristics, including genuine lack of knowledge (Luskin & Bullock, 2011), perceived inadequacy of or uncertainty about one's knowledge (Beatty, Herrmann, Puskar, & Kerwin, 1998; Thuneberg & Salmi, 2018), the propensity to guess (Miller & Orr, 2008; Mondak & Canache, 2004; Mondak & Davis, 2001; Nadeau & Niemi, 1995), and characteristics of the knowledge being probed (Tourangeau et al., 2016; Turner et al., 2015). Because nearly all of this work has been conducted in nonhealth domains, the current study aimed to address this gap by examining predictors of DK responding to HPV knowledge items.

Knowledge

DK responding often reflects a lack of knowledge, information, experience, or the well-developed preferences needed to form a cogent belief on-the-spot (Fischhoff, 1991; Lichtenstein & Slovic, 2006; Luskin & Bullock, 2011; Nadeau & Niemi, 1995; Sturgis et al., 2008; Tourangeau et al., 2016; Turner et al., 2015). In other words, a DK response on a knowledge item may reflect not knowing the correct answer, being aware of one's lack of knowledge, and deciding a DK response is most accurate (Beatty et al., 1998). Given this, behaviors that increase one's knowledge base may reduce the likelihood that one will respond with DK. Such behaviors may include past information-seeking about the topic being probed, as well as interpersonal communication about it. In the current study, we examined cancer information-seeking and patient–provider discussions about the HPV vaccine as two sources of HPV-related knowledge that may be related to DK responding.

Individuals with the requisite knowledge may still respond with DK if they are uncertain about the accuracy or adequacy of their knowledge (Beatty et al., 1998; Tourangeau, Rips, & Rasinski, 2000). Prior work suggests greater self-efficacy or confidence is associated with less DK responding, perhaps because these individuals are more confident in their knowledge or more likely to guess when they have partial knowledge (Lee & Matsuo, 2018; Miller & Orr, 2008; Mondak & Anderson, 2004; Thuneberg & Salmi, 2018). Thus, we also examined self-efficacy for taking care of one's health (hereafter referred to as health-related self-efficacy) as a predictor of DK responding.

Uncertainty and Avoidance

People with insufficient knowledge often use their attitudes, feelings, contextual cues, and other factors to develop a heuristic-based educated guess to knowledge items (Nadeau & Niemi, 1995), similar to the on-the-spot construction of preferences (Fischhoff, 1991; Lichtenstein & Slovic, 2006; Nadeau & Niemi, 1995). In these instances, individuals rely on their global impressions about the information being probed (Nadeau & Niemi, 1995), so global attitudes and knowledge about HPV, vaccination, and cancer may influence responses to HPV-related questions (Kahan, Braman, Cohen, Gastil, & Slovic, 2010).

If individuals perceive that the science concerning HPV, vaccination, and/or cancer involves a high degree of uncertainty, they may be more likely to respond with DK to HPV-related questions. For example, "epistemic doubt" or uncertainty about science, and beliefs that science is relative and based on human interpretation are associated with more DK responding (Miller & Orr, 2008; Thuneberg & Salmi, 2018). At the national level, perceiving uncertainty as threatening is also associated with more DK responding (Mondak & Canache, 2004). In related work on ambiguity aversion, individuals are more likely to avoid information and decision making when the information is perceived as ambiguous, inadequate, not credible, or untrustworthy (Fox & Tversky, 1995; Han et al., 2009). Together, this evidence suggests that perceived ambiguity surrounding cancer-related information and science may be associated with greater likelihood of responding with DK to items probing cancer-related knowledge, including knowledge about HPV.

Information avoidance (Sweeny, Melnyk, Miller, & Shepperd, 2010) and fatalistic attitudes (Powe & Finnie, 2003) may also motivate people to respond with DK as a means of avoiding thinking about or reporting knowledge and beliefs perceived as threatening. Information avoidance involves behaviors intended to prevent the acquisition of

available but unwanted information, often because the information is inconsistent with one's beliefs (Kunda, 1990) and may cause discomfort or cognitive dissonance (Sweeny et al., 2010). Cancer fatalism and cancer-mortality salience, or beliefs that cancer is uncontrollable, predetermined, or inevitably leads to death (Moser et al., 2014; Powe & Finnie, 2003), may also lead individuals to avoid thinking about cancer-related topics that are perceived as threatening. Thus, information avoidance, fatalism, and cancer-mortality salience may increase DK responding by reducing exposure to or memory of threatening health information (Liberman & Chaiken, 1992), thereby reducing knowledge, and also by reducing the motivation to think about and use this knowledge in the survey response process.

Given this evidence, we examined cancer information-seeking, patient–provider discussions about the HPV vaccine, health-related self-efficacy, perceived ambiguity of cancer-related recommendations (hereafter referred to as perceived ambiguity), cancer information avoidance, cancer fatalism, and cancer-mortality salience as predictors of DK responding to items that assessed knowledge about HPV. HPV is an ideal domain in which to study DK responses because media portrayals of the HPV vaccine often evoke perceived ambiguity about the vaccine's efficacy and safety, which may heighten the motivation to respond with DK for reasons beyond having insufficient knowledge. We hypothesized that cancer information-seeking, patient–provider discussions, and health-related self-efficacy would be negatively associated with DK responding, whereas information avoidance, cancer fatalism, cancer-mortality salience, and perceptions of ambiguity would be positively associated with it.

Methods

Data were analyzed from the Health Information National Trends Survey Wave 5 Cycle 1 (N = 3,285), a nationally representative survey of US adults administered every 1–2 years since 2003 by the National Cancer Institute. The survey was administered in 2017 via mailed questionnaires and the overall response rate was 32.4% (Westat, 2017). These secondary analyses did not require ethical review, but the National Institutes of Health IRB approved the original study, and all participants provided informed consent. Deidentified individual participant data and codebooks are available for public use at hints.cancer.gov.

Participants

The current analyses include the 62% of participants (N = 2,034) who responded that they had heard of HPV and completed the HPV knowledge questions. Participants who had heard of HPV were younger (M = 44.44 vs. 52.22 years) and had more formal education (M = 4.96 vs. 4.12 on a 7-point scale) than those who had not heard of HPV. They were also more likely to be women (59.0% vs. 37.7%), married/cohabitating (57.5% vs. 51.0%), and white (82.2% vs. 73.7%), ps < .05.

Measures

Health-Related Self-Efficacy

Participants used a scale ranging from (1) *completely* to (5) *not at all* to answer, "Overall, how confident are you about your ability to take good care of your health?"

Cancer Information-Seeking

Participants were asked, "Have you ever looked for information about cancer from any source?" (yes/no).

Information Avoidance

Participants rated their level of agreement from (1) *strongly agree* to (4) *strongly disagree* with the statement, "I'd rather not know my chance of getting cancer." This item and the scale from which it originates is internally valid and reliable (Howell & Shepperd, 2014) and predicts avoidance and coping behaviors (Howell & Shepperd, 2014).

Cancer Fatalism

Participants rated their level of agreement from (1) *strongly agree* to (4) *strongly disagree* with the statement, "There's not much you can do to lower your chances of getting cancer" (Powe & Finnie, 2003).

Cancer-Mortality Salience

Participants indicated how much they agreed with the statement, "When I think about cancer, I automatically think about death" using a 4-point scale from (1) *strongly agree* to (4) *strongly disagree* (Moser et al., 2014).

Perceived Ambiguity

Two previously validated items assessed (1) confusion: "There are so many different recommendations about preventing cancer, it's hard to know which ones to follow," and (2) pessimism: "It seems like everything causes cancer," about cancer prevention recommendations. Items used a 4-point scale ranging from (1) *strongly agree* to (4) *strongly disagree*. They were weakly correlated, r = .35, and examined separately.

Provider Interactions

Provider discussions and recommendations about the HPV vaccine were assessed with two yes/no items: "In the last 12 months, has a doctor or health care professional ever talked with you or an immediate family member about the HPV shot or vaccine?" and "In the last 12 months, has a doctor or health care professional recommended that you or someone in your immediate family get an HPV shot or vaccine?" These items were only asked of the 48% of participants (n = 1,577) who had someone in their immediate family, including themselves, who was vaccine-eligible (aged 9–27 years).

HPV Knowledge

Six items assessed HPV knowledge. One assessed knowledge that HPV is a sexually transmitted infection: "Do you think that HPV is a sexually transmitted disease (STD)?" Four assessed knowledge about HPV as a cause of cancer. Each began with "Do you think HPV can cause … [cervical/penile/anal/oral] cancer?" Response options for these five items were Yes, No, and Not sure. The sixth

item assessed beliefs about the HPV vaccine's effectiveness: "In your opinion, how successful is the HPV vaccine at preventing cervical cancer?" This item was asked of all participants, but to avoid conflating awareness of the vaccine itself with beliefs about its effectiveness, analyses using this item were restricted to participants who had heard of the vaccine (n = 1,132). Response options ranged from (1) *not at all* to (4) *very successful*, plus DK, and were recoded as yes ("pretty/very successful"), no ("not at all/a little successful"), or DK. All knowledge items were dichotomized as having a valid response of yes or no (0), or a DK response (1). The proportion of DK responses was then calculated (number DK responses/number answered items).

Analysis Strategy

Analyses were conducted in Stata version 14 and incorporated jackknifed final survey replication weights, which account for the sampling design, population oversampling, and nonresponse patterns. Variables were recoded so that higher numbers indicated higher levels of the construct or greater agreement with the probed belief.

Prior to the release of the data, missing values for age, gender, educational attainment, marital status, race, and ethnicity were recoded using hot-deck imputation, which replaced missing values with the value reported by a similar case. For the nonimputed variables, between 0.8% (for doctor-discussed vaccine) and 5.0% (for "Do you think that HPV causes penile cancer?") of responses were missing. Respondents with missing values were omitted from respective analyses.

Weighted linear regression examined whether participant characteristics and the predictors of DK responding were associated with the proportion of DK responses on the six HPV knowledge items. Weighted logistic regression examined these constructs as predictors of DK responding on each knowledge item separately. These secondary analyses were not adjusted for multiple comparisons as they were intended to explore overall patterns. Finally, the logistic regression analyses were replicated using multinomial logistic regression with a 3-level outcome variable representing "yes," "no," and "DK" responses. This allowed us to separately compare DK responders to those who responded correctly and incorrectly to each item.

All reported results included age, sex, educational attainment, race (black and white), and marital status as covariates, as these have been shown to predict DK responding (Hay et al., 2015; Waters et al., 2013), HPV knowledge (Kobetz et al., 2010; Koshiol, Finney-Rutten, Moser, & Hesse, 2009), and cancer beliefs (Powe & Finnie, 2003). The statistical significance of the adjusted and unadjusted models was consistent for 53 of 54 tested models (reflecting 9 predictors × 6 HPV items), with the difference noted in Table 3. Income was not included as a covariate due to the item's high percentage (9%) of missing data, but the statistical significance of all but one model was the same when it was included.

Results

Patterns of DK Responding

On average, DK represented 41.8% of responses to the HPV knowledge items. The rate of DK responding across the six HPV items was lowest for the item that asked whether HPV causes cervical cancer (16.5%), and highest for the item that asked whether it causes anal cancer (55.1%; Table 1). Half of participants (45.1%) responded DK at least once on these items, and 20% responded DK on four or more items (range: 0–6).

The proportion of DK responses increased with participant age, $\beta = 0.0053$, $p = .001$, 95% CI (0.0021, 0.0086), and decreased with greater formal education, $\beta = -0.10$, $p < .001$, 95% CI (−0.14, −0.062). The proportion of DK responses was also higher among black than nonblack participants, $\beta = 0.16$, $p = .040$, 95% CI (0.0068, 0.31). No other participant characteristics were associated with the proportion of DK responses (Table 3).

Predictors of DK Responding

Table 2 reports pairwise correlations between continuous predictor variables. Of the nine tested predictors (health-related self-efficacy, cancer information-seeking, information avoidance, cancer fatalism, cancer-mortality salience, two perceived ambiguity items, and two provider interactions items), four were associated with the proportion of DK responses (Table 4).

Table 1. Responses to six items assessing knowledge about HPV and the HPV vaccine on the Health Information National Trends Survey Wave 5 Cycle 1

	Yes	No	DK
HPV causes			
1) Anal cancer (n = 1,924)	29.1%	15.8%	55.1%
2) Penile cancer (n = 1,920)	31.2%	15.8%	53.1%
3) Oral cancer (n = 1,929)	30.7%	16.6%	52.7%
4) Cervical cancer (n = 2,002)	81.5%	2.0%	16.5%
5) Do you think that HPV is a sexually transmitted disease (STD)? (n = 2,010)	67.8%	13.4%	18.8%
	Pretty/very successful	*Not at all/a little successful*	*DK*
6) In your opinion, how successful is the HPV vaccine at preventing cervical cancer? (n = 1,968)	38.7%	6.6%	54.7%
Average	46.5%	11.7%	41.8%

Table 2. Pairwise Pearson correlations between continuous predictor variables using the Health Information National Trends Survey Wave 5 Cycle 1

	Health-related self-efficacy	Information avoidance	Cancer fatalism	Cancer-mortality salience	Perceived ambiguity: Confusion	Perceived ambiguity: Pessimism
Health-related self-efficacy	2.86					
Information avoidance	−0.046**	1.18				
Cancer fatalism	−0.091***	0.23***	1.00			
Cancer-mortality salience	−0.14***	0.17***	0.22***	1.74		
Perceived ambiguity: Confusion	−0.074***	0.17***	0.35***	0.28***	1.90	
Perceived ambiguity: Pessimism	−0.065***	0.12***	0.28***	0.32***	0.35***	1.80

Weighted means located on the diagonal (N = 1,975–2,014).
Correlations are unweighted due to statistical programming limitations.
*p < .05; **p < .01; ***p < .001.

Table 3. Participant characteristics as predictors of the proportion of DK responses on six HPV knowledge items on the Health Information National Trends Survey Wave 5 Cycle 1 (N = 2,031)

	β	95% CI
Age	0.0053***	(0.0021, 0.0086)
Education	−0.10***	(−0.14, −0.062)
Sex		
Male	ref	
Female	−0.086	(−0.20, 0.030)
Race		
White	−0.080	(−0.25, 0.085)
Black	0.16*	(0.0068, 0.31)
Marital status		
Married	ref	
Unmarried	0.016	(−0.097, 0.13)

Race was dummy coded, such that the reference category for white is non-white ; the reference category for black is nonblack.
*p < .05; **p < .01; ***p < .001.

Table 4. Predictors of the proportion of DK responses on six HPV knowledge items on the Health Information National Trends Survey Wave 5 Cycle 1

	n	B	95% CI
Health-related self-efficacy	2,014	−0.083**	(−0.14, −0.031)
Cancer information-seeking	2,023	−0.072	(−0.19, 0.041)
Information avoidance	1,998	0.13***	(0.078, 0.19)
Cancer fatalism	1,992	0.053	(−0.011, 0.12)
Cancer-mortality salience	1,991	0.096***	(0.047, 0.14)
Perceived ambiguity			
Confusion	1,989	0.80**	(0.026, 0.13)
Pessimism	2,000	0.043	(−0.019, 0.10)
Provider interactions			
Doctor-discussed vaccine	729	−0.11	(−0.27, 0.039)
Doctor-recommended vaccine	712	−0.15	(−0.31, 0.0068)

Models adjusted for sex, race, education level, age, and marital status. There were no differences in statistical significance when models were unadjusted nor when income was included as an additional covariate.
*p < .05; **p < .01; ***p < .001.

Greater health-related self-efficacy was associated with less DK responding, β = −0.083, p = .002, 95% CI (−0.14, −0.031). Greater information avoidance, cancer-mortality salience, and the confusion aspect of perceived ambiguity were associated with more DK responding, ps < .05.

When the HPV knowledge items were examined separately, seven of the nine tested predictors were associated with the odds of responding DK to at least one item. Having had a discussion with one's doctor about the HPV vaccine and cancer information-seeking were the exceptions (Table 5). Information avoidance was the most consistent predictor; greater avoidance was associated with greater odds of responding DK on all six items, ps < .05. Cancer-mortality salience was associated with DK responding on four items. Health-related self-efficacy was associated with DK responding on three items, and the perceived ambiguity items were each associated with DK responding on two items. Receiving a doctor recommendation and cancer fatalism were each associated with DK responding on one item.

DK Compared to Correct and Incorrect Responses

To separately compare DK responders to those with correct and incorrect knowledge, we replicated the logistic regressions as multinomial logistic regressions with a 3-level outcome variable representing correct, incorrect, and DK responses. Using DK responding as the reference group, the nine predictors were associated with likelihood of *correctly* responding in 35.2% of models, and with *incorrectly* responding in 18.5% of models (Table 6). In each case, the adjusted marginal mean levels of each predictor suggested that DK responders had the least health-related self-efficacy, greatest information avoidance, cancer fatalism, cancer-mortality salience, and perceived ambiguity. They were also least likely to have searched for cancer information and received a vaccine recommendation.

Table 5. Associations (odds ratios) between predictors and odds of responding DK to six HPV knowledge items on the Health Information National Trends Survey Wave 5 Cycle 1 (analysis-specific sample sizes ranged from n = 1,890 to 1,993)

	HPV causes					
	Cervical cancer	Penile cancer	Anal cancer	Oral cancer	HPV is an STD	Vaccine successful
Health-related self-efficacy	0.92 (0.76, 1.13)	0.80* (0.67, 0.95)	0.84 (0.70, 1.01)	0.81* (0.67, 0.96)	0.84* (0.70, 0.99)	0.87 (0.73, 1.04)
Cancer information-seeking	0.72 (0.49, 1.05)	0.94 (0.69, 1.28)	0.82 (0.60, 1.11)	0.80 (0.59, 1.09)	1.13 (0.79, 1.64)	0.99 (0.72, 1.36)
Information avoidance	1.41*** (1.18, 1.69)	1.16* (1.01, 1.35)	1.24** (1.08, 1.44)	1.23** (1.07, 1.42)	1.37*** (1.19, 1.58)	1.21* (1.04, 1.41)
Cancer fatalism	1.48*** (1.19, 1.85)	0.96 (0.80, 1.13)	0.95 (0.80, 1.12)	1.07 (0.90, 1.27)	1.22 (0.98, 1.50)	1.17 [b] (0.97, 1.41)
Cancer-mortality salience	1.14 (0.94, 1.38)	1.14 (0.99, 1.31)	1.16* (1.01, 1.33)	1.26*** (1.10, 1.45)	1.29** (1.10, 1.51)	1.18* (1.02, 1.36)
Perceived ambiguity						
Confusion	1.19 (0.94, 1.50)	1.11 (0.93, 1.32)	1.15 (0.97, 1.36)	1.25** (1.06, 1.47)	1.02 (0.81, 1.28)	1.44*** (1.22, 1.72)
Pessimism	0.93 (0.73, 1.17)	1.09 (0.92, 1.30)	1.01 (0.84, 1.22)	1.23* (1.04, 1.46)	1.02 (0.83, 1.25)	1.22* (1.01, 1.47)
Provider interactions [a]						
Doctor-discussed vaccine	0.70 (0.37, 1.31)	0.79 (0.50, 1.24)	1.08 (0.69, 1.69)	0.94 (0.60, 1.48)	0.66 (0.39, 1.12)	0.72 (0.46, 1.14)
Doctor-recommended vaccine	0.56 (0.28, 1.11)	0.89 (0.56, 1.41)	0.91 (0.58, 1.44)	0.82 (0.52, 1.29)	0.39*** (0.23, 0.66)	0.76 (0.47, 1.21)

Models adjusted for sex, race, education level, age, and marital status.
[a]N = 683–720.
[b]Association statistically significant in unadjusted model.
*p < .05; **p < .01; ***p < .001.

Discussion

This study leveraged data from a nationally representative survey of US adults to examine predictors of DK responding to items that assessed HPV knowledge. DK responding was common, averaging 41.8% of responses across six items. Health-related self-efficacy, information avoidance, cancer-mortality salience, perceived ambiguity, and doctors' vaccine recommendations were all associated with DK responding, with information avoidance a particularly consistent predictor. In 18.5% of models, even participants who were misinformed (e.g., believed HPV did not cause cancer) had greater health-related self-efficacy, and less information avoidance, perceived ambiguity, and cancer-mortality salience than those who responded with DK.

The proportion of participants who correctly indicated that HPV causes cervical cancer (81.5%) and is an STD (67.8%) was greater in this 2017 HINTS survey than in the 2013 HINTS survey (62.2% and 55.7%, respectively; Blake et al., 2015), but accurate HPV knowledge remains relatively low. On average, less than half (47%) of respondents answered these items correctly; nearly the same proportion (42%) responded with DK. Given that our analyses only included the participants who had heard of HPV (two thirds of the overall sample), these estimates likely overestimate the public's HPV knowledge and underestimate rates of DK responding. For example, the participants included in these analyses were younger and had more formal education than those excluded because they had not heard of HPV. Given that older age and less formal education are associated with more DK responding (Hay et al., 2015; Waters et al., 2013), excluded participants may have been even more likely to respond with DK.

DK responses were more prevalent than incorrect responses (42% vs. 12%) and DK responders were often different from incorrect responders. This suggests HPV education efforts ought to correct the misperceptions that led to incorrect responses, and also target the potentially unique factors that contributed to DK responses, such as the preference to avoid cancer-related information or beliefs that link cancer with death. Indeed, interventions that target the factors that contribute to DK responding (e.g., information avoidance, health-related self-efficacy, or perceived ambiguity) in combination with HPV education may be the most effective means of shifting DK responses to correct ones. Not only would these efforts increase overall HPV knowledge, they would reduce the proportion of DK responses on surveys, thereby generating more reliable estimates of the public's knowledge.

Our findings suggest information avoidance may be particularly important to consider when examining why individuals respond with DK to health-related questions. Individuals with stronger information avoidance tendencies may be less likely to obtain (Sweeny et al., 2010) and remember (Liberman & Chaiken, 1992) the knowledge being probed, and may respond with DK accordingly. Particularly if the content being probed is perceived as threatening, their DK responses may also reflect

Table 6. Multinomial logistic regression results comparing DK responders to "yes" (Y) and "no" (N) responders separately, with Y and N denoting significant differences between yes (vs. DK) and no (vs. DK) responders (using the Health Information National Trends Survey Wave 5 Cycle 1)

	HPV causes					
	Cervical cancer	Penile cancer	Anal cancer	Oral cancer	HPV is an STD	HPV vaccine successful
Health-related self-efficacy	–	Y, N	N	Y	–	Y
Cancer information-seeking	–	-	Y	Y	N	–
Information avoidance	Y	Y	Y	Y	Y, N	–
Cancer fatalism	Y	–	–	–	Y	–
Cancer-mortality salience	–	N	N	Y, N	Y, N	Y, N
Perceived ambiguity						
Confusion	–	–	-	Y	–	Y
Pessimism	–	–	-	N	–	Y
Provider interactions						
Doctor-discussed vaccine	–	–	–	–	–	–
Doctor-recommended vaccine	–	–	–	–	Y	–

a motivated desire to avoid thinking about the question. Likewise, cancer-mortality salience, which was associated with DK responding on four of six knowledge items, may also increase DK responding as a means of avoiding thinking about threatening topics, such as cancer. DK responders had higher cancer-mortality salience than incorrect responders on all but one item, suggesting that cancer-mortality salience may not simply lead to the acquisition of incorrect information, but rather, motivate a unique active avoidance of acquiring and using the threatening information. Thus, both information avoidance and cancer-mortality salience may predict DK responding indirectly by limiting one's content knowledge and via a direct motivational pathway during the survey response process. Future work is needed to disentangle these two mechanisms and determine how to address them.

There may also be both knowledge and motivational pathways through which health-related self-efficacy predicts DK responding. Individuals who are highly efficacious in health domains may be more likely to seek out and acquire the information needed to answer knowledge items correctly (Case, Andrews, Johnson, & Allard, 2005; Rains, 2008). Such individuals may also be more motivated to exert the effort needed to answer the items if they are confident that they can successfully comprehend the question, retrieve, and use relevant information (Tourangeau et al., 2000). Thus, greater self-efficacy in the domain being probed may reduce the likelihood that participants will satisfice or select DK instead of making an educated guess (Beatty et al., 1998; Krosnick, 1991; Lee & Matsuo, 2018; Mondak & Anderson, 2004).

Greater perceived ambiguity about cancer prevention recommendations was also predictive of more DK responding. This is consistent with prior evidence that perceptions of uncertainty in science are associated with DK responding (Miller & Orr, 2008; Thuneberg & Salmi, 2018). Perceptions that cancer-related information is ambiguous, unreliable, or inadequate may cause people to feel overwhelmed by survey questions that assess cancer-related knowledge (Case et al., 2005; Han, Moser, & Klein, 2006). Perceived ambiguity also causes people to avoid decision-making (Fox & Tversky, 1995; Han et al., 2009), which may translate into avoidance of answering survey questions. Even individuals who are well-informed about cancer may respond DK if they perceive the science is too ambiguous or uncertain to warrant an unequivocal answer. For example, recommendations for preventing cancer evolve and change over time, which may result in perceptions to that the science is ambiguous or uncertain, and that knowledge items cannot be answered definitively.

Somewhat surprisingly, participants whose doctors discussed or recommended the HPV vaccine were no less likely (with one exception) to respond with DK. To the extent that this reflects providers' limited ability to change patients' HPV knowledge, these findings suggest that vaccination uptake should not depend on knowledge change and may benefit from approaches, such as creating default or opt-out policies (Chapman, Li, Colby, & Yoon, 2010; Charo, 2007; Johnson & Goldstein, 2003). However, there may be other explanations for why a doctor recommendation was not associated with DK responding that cannot be examined within this study. For instance, a single item that relies on patient recall may mask important variability across providers in communication approaches, and across patients in defensive processing and information avoidance, which may influence their memory of doctor-communicated HPV information (Golman, Hagmann, & Loewenstein, 2017; Liberman & Chaiken, 1992; Sweeny et al., 2010). Moreover, the current survey did not assess vaccination behavior/intentions, so it is not possible to elucidate whether a shift from DK to a correct response is needed to motivate vaccine uptake.

Our findings suggest DK responding to HPV knowledge items was more common among older and black participants, and those with less formal education, but unlike findings from work that has examined DK responding to items that assess risk perceptions (Bruine de Bruin & Carman, 2012; Hay et al., 2015; Waters et al., 2013), it was largely unassociated with sex and marital status. This suggests patterns of DK responding may depend on the construct being probed, with some

sociodemographic predictors being more important for items that assess beliefs (e.g., risk perceptions) than those that assess knowledge. This pattern is consistent with a prior study in which sociodemographic factors were less predictive of knowledge-based than belief-based items (Ellis et al., 2018).

DK responders in this study appear to be a relatively unique subset of respondents; they had less health-related self-efficacy, and greater information avoidance and fatalism than incorrect and correct responders in 18.5% and 35.2% of models, respectively. This is consistent with evidence that DK responders are demographically different (Hay et al., 2015; Waters et al., 2013), provide different perceived risk estimates (Waters et al., 2013), and engage in health behaviors at different rates than non-DK responders (Ellis et al., 2018; Waters et al., 2016). Thus, although debate continues about the effects of DK response options on scale reliability and validity (Krosnick et al., 2002; Luskin & Bullock, 2011; Miller & Orr, 2008; Mondak, 2001; Mondak & Canache, 2004; Mondak & Davis, 2001; Sturgis et al., 2008; Tourangeau et al., 2016), including DK as a response option may contribute unique knowledge about survey respondents. Forcing a different response by not including this option may misrepresent participants' knowledge or beliefs and conflate important differences between being misinformed, uninformed, or uncertain about the nature of the evidence and science. Analytically, DK and valid responders ought to be compared on predictors and outcomes of interest before making decisions about whether to statistically omit or combine them with other response categories (Luskin & Bullock, 2011; Mondak & Canache, 2004; Sturgis et al., 2008).

One limitation of this study is its cross-sectional design, which precludes the ability to infer causal associations, rule out unmeasured factors that are causally associated with our predictors and/or DK responding, or fully examine the complex relationships suggested by these findings. Another limitation was that several constructs were assessed with one or two items, introducing potential for measurement error. However, this approach is common in national surveys and items were rigorously pretested, originated from validated scales, and have been examined in several published studies (Han et al., 2006; Klein, Ferrer, Graff, Kaufman, & Han, 2014; Moser et al., 2014). There is also variability in the labels used to describe the item assessing cancer-mortality salience (Agurs-Collins et al., 2015; Kannan & Veazie, 2014; Kobayashi & Smith, 2016; Moser et al., 2014; Nan, Zhao, & Briones, 2014), which may hinder efforts to compare the current findings to other work. The survey response rate of 32.4% is typical for mailed surveys (Dillman, 2011), but may have resulted in a biased sample. Additionally, the HINTS survey uses "Don't know" and "Not sure" interchangeably on items that assess knowledge about health topics. Past work on DK responding has also used such terms interchangeably in response option labels and scale instructions (e.g., Mondak, 2001; Thuneberg & Salmi, 2018). Examining whether these labels are interpreted similarly by respondents remains an area for future research. Also, the survey did not include measures of HPV vaccination, making it impossible to examine the implications of DK responding for vaccine uptake.

Future studies should examine whether these findings generalize to different health topics and information acquisition mechanisms. Much public dialogue about the HPV vaccine has challenged scientific evidence, perpetuated misconceptions, and conveyed uncertainty (Zimet et al., 2013). HPV vaccination is also relatively new compared to domains, such as cigarette smoking and physical activity. Examining DK responding in more established or less controversial behavioral contexts may elucidate how the knowledge being probed influences DK responding. Additionally, the current study examined information-seeking, an active purposeful process that occurs outside the context of one's typical behavioral patterns. Future work may examine whether more passive forms of information acquisition, such as information scanning or incidental exposure (e.g., television commercials; Kelly et al., 2010; Lenz, 1984; Niederdeppe et al., 2007), are also related to DK responding, especially given that vaccine advertisements are a common source of HPV vaccine information (Cartmell et al., 2018; Lai et al., 2017; Sandfort & Pleasant, 2009). Lastly, the current study measured perceived ambiguity, fatalism, and information-seeking about cancer broadly, and assessed health-related self-efficacy instead of domain-specific self-efficacy. Although these broader constructs are known to influence subdomain knowledge (Nadeau & Niemi, 1995), future work is needed to examine whether behavior-specific beliefs and self-efficacy are similarly associated with DK responding.

These findings suggest DK responding to knowledge items about HPV is common and reflects factors more complicated than insufficient knowledge or motivation. Often, DK responders represent a unique participant subgroup that should not be subsumed within other respondent groups or excluded from analyses. Understanding and addressing the causes of DK responding will ensure the input from all survey respondents is accurately and fully considered, thereby increasing the meaningfulness of survey data and improving the interventions informed by them.

Disclaimer

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