

# **The association between having a household member with a cancer-related limitation and human papillomavirus vaccine uptake**

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## ABSTRACT

**OBJECTIVE:** To evaluate the association between having a household member with a cancer-related limitation (physical, mental, or emotional) and human papillomavirus (HPV) vaccine uptake among females aged 9 – 17 years.

**METHODS:** We analyzed 2008 National Health Interview Survey for our cross-sectional analysis. All households with females aged 9 – 17 years were eligible for inclusion in our analysis. Our outcomes of interest included HPV vaccine initiation ( $\geq 1$  dose) and series completion (full 3 doses). A dichotomous variable indicating a cancer-related limitation for a household member was created if at least one adult in the household responded to having a limitation caused by cancer. We used Firth's bias-reducing penalized likelihood for logistic regression[11] to estimate prevalence odds ratios (ORs) and corresponding 95% profile penalized likelihood confidence intervals (CIs) for HPV vaccine uptake among young females who had a household member with a cancer-related limitation compared to young females who did not have a household member with a cancer-related limitation after adjusting for child's age, race/ethnicity, and SES.

**RESULTS:** HPV vaccine initiation and completion were higher among females aged 9-17 years who had a household member with a cancer-related limitation (Initiation: OR=1.42, 95%CI: 0.26, 5.18); Completion: OR=2.50, 95%CI: 0.26, 11.58).

**CONCLUSION:** Our results suggest that females aged 9 – 17 years in the United States who have a household member with a cancer-related limitation (physical, mental, or emotional) may be more likely to initiate and complete the HPV vaccination. However, our point estimates lack precision (evident by wide confidence intervals) because of limited prevalence of the exposure in our study population.

## INTRODUCTION

Females aged 9 – 17 years are prime candidates for the quadrivalent human papillomavirus (HPV) vaccine to prevent cervical cancer because the vaccine is most effective prior to sexual initiation.[1,2] Preventive health behaviors in this age group are strongly influenced by family environment.[3-5] For example, the use of preventive health services is influenced by having a family member with limitations caused by a chronic illness.[6] Therefore, we evaluated whether females aged 9 – 17 years who have a household member with a cancer-related limitation (physical, mental, or emotional) are more likely to initiate and complete the HPV vaccination.

## METHODS

### *Data Source*

We utilized data from the 2008 National Health Interview Survey (NHIS), which was the first NHIS to incorporate questions regarding HPV vaccine[7]. The NHIS is an annual in-person random household survey of the civilian non-institutionalized population of the United States.[8] Individual-level health information was ascertained using the Family Core survey for participants aged  $\geq 18$  years. For households with children, one child within the selected household was randomly sampled to complete the Sample Child Core survey by a knowledgeable adult proxy. All households with females aged 9 – 17 years were eligible for inclusion in our analysis. We linked data for each child to the interviewed adult in her household and to relevant demographic and socioeconomic variables collected in the Household-Level, Family-Level, and Person-Level files.

## *Variables*

Our outcomes of interest included HPV vaccine initiation and series completion. HPV vaccine initiation was defined as receiving at least one dose of the vaccine, whereas HPV vaccine series completion was defined as receiving the full 3 doses of the vaccine. HPV vaccine initiation and series completion were ascertained from responses to the questions, “Did [the sample child] ever receive the HPV shot or cervical cancer vaccine?” and “How many HPV shots did [the sample child] receive?”

A cancer-related limitation for a household member was ascertained by combining data from the survey questions “Are you or any family members limited in any way in any activities because of physical, mental, or emotional problems?” and “What conditions or health problems cause the person’s limitations?” A dichotomous variable indicating a cancer-related limitation for a household member was created if at least one adult in the household responded to having a limitation caused by cancer.

## *Data analysis*

We encoded a directed acyclic graph (DAG)[9] based on current evidence regarding factors that influence HPV vaccine uptake and their inter-relations to identify a minimal sufficient set of covariates for which to adjust in our analyses (*Figure 1*). Covariates that required adjustment (age, race/ethnicity, and socioeconomic status) to reduce confounding bias were identified using the back-door criterion[9] in a directed acyclic graph. Therefore, we adjusted for child’s age, race/ethnicity, and SES in a multivariable regression model. Race/ethnicity was categorized as non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, Hispanic, and Other. SES was defined according to the education level of the person reported as the head of household (did

not graduate from high school, high school graduate, some, college, college graduate or more) and family income as a percent of the federal poverty level adjusted for family size (<100%, 100%-199%, 200%-399%,  $\geq$  400%).[10]

We compared the distribution of demographic and other characteristics between females who completed the full series of the HPV vaccine, females who initiated the HPV vaccine, and females who did not receive the HPV vaccine. Age was reported as medians and corresponding interquartile range (IQR), whereas categorical characteristics were reported as proportions. Furthermore, we used Firth's bias-reducing penalized likelihood for logistic regression[11] in SAS 9.2 (SAS Institute, Cary, NC) to estimate prevalence odds ratios (ORs) and corresponding 95% profile penalized likelihood confidence intervals (CIs) for HPV vaccine uptake among young females who had a household member with a cancer-related limitation compared to young females who did not have a household member with a cancer-related limitation after adjusting for child's age, race/ethnicity, and SES. Penalized logistic regression was used to address issues with sparse data and separation [11] in our analyses.

## RESULTS

Our study population consisted of 1,965 females aged 9 – 17 years with a median age of 13 years (IQR: 11, 15). Ethnic minorities comprised nearly half of our study population (Whites=48.2%, Hispanics=26.4 Blacks=18.2%, Asians=6.2%). The highest proportion of females (36.4%) lived in a household where the head of household had at least a college degree. Furthermore, 62.8% of females lived in households with a family income  $\geq$  200% of the federal poverty level. The distribution of demographic characteristics by vaccine status is detailed in *Table 1*.

The prevalence of HPV vaccine uptake initiation was 19.0% (95% CI: 17.0%, 21.1%) and the prevalence of HPV series completion (full 3 doses) was 7.8% (95% CI: 6.4%, 9.3%) in our study population. Females aged 9 – 17 years who had a household member with a cancer-related limitation had 42% and 150% higher odds of initiating and completing the HPV vaccination, respectively, compared to those who did not have a household member with a cancer-related limitation (Initiation: OR=1.42, 95% CI: 0.26, 5.18; Completion: OR=2.50, 95% CI: 0.26, 11.58). The estimates for HPV vaccine initiation and completion are provided in *Table 2*.

## DISCUSSION

Our results suggest that females aged 9 – 17 years in the United States who have a household member with a cancer-related limitation (physical, mental, or emotional) may be more likely to initiate and complete the HPV vaccination. However, our point estimates lack precision (evident by wide confidence intervals) because of limited prevalence of the exposure in our study population. Therefore, the durability of our findings is questionable without further analyses in a larger study population. Although we did not specifically define family history of cancer as our exposure, our study advances this line of research by incorporating severity (limitation attributed to cancer) and proximity (living in the household) of cancer in the family as potential influences on HPV vaccine uptake. Furthermore, our study provides preliminary evidence that cancer within the family may be an important influence on actual HPV vaccine uptake and not just HPV vaccine acceptability, as reported in a pre-licensure study [12].

Certain limitations of our analyses should be considered for appropriate interpretation of our results. Surveys with complex sampling methods, such as NHIS, require accounting for the complex survey design in the analyses to estimate parameters that can be generalized to the source population[13] (for NHIS, the source population is the United States population). However, our analyses required penalized methods to reduce bias created by sparse data and separation[11]. Unfortunately, penalized methods are currently unavailable for use with complex survey design analysis in SAS. We opted to compromise generalizability to the United States population for enhanced internal validity through bias reduction.

In summary, our results suggest that females aged 9 – 17 years in the United States who have a household member with a cancer-related limitation may be more likely to initiate and complete the HPV vaccination, but the durability of our findings are questionable because of few exposed individuals. Although preliminary, our findings may be useful for underscoring the important role of family environment on HPV vaccination uptake among young females, particularly for families that have experienced the debilitating potential of cancer. Given the promise of preventing cervical cancer through vaccination and the low prevalence of vaccine uptake observed in our study population, the identification of motivated subgroups may be useful for directing vaccine promotion efforts to less motivated subgroups that are eligible for the HPV vaccine.

## ACKNOWLEDGMENTS

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### KEY MESSAGES

- The 2-year post-licensure prevalence of HPV vaccine initiation and completion is relatively low among young females aged 9 – 17 years in our study population, which could have implications for vaccine promotion efforts.
- Familial factors may play an important role in HPV vaccine uptake.
- Identification of motivated subgroups may guide HPV vaccination efforts and facilitate efficient allocation of public health resources.



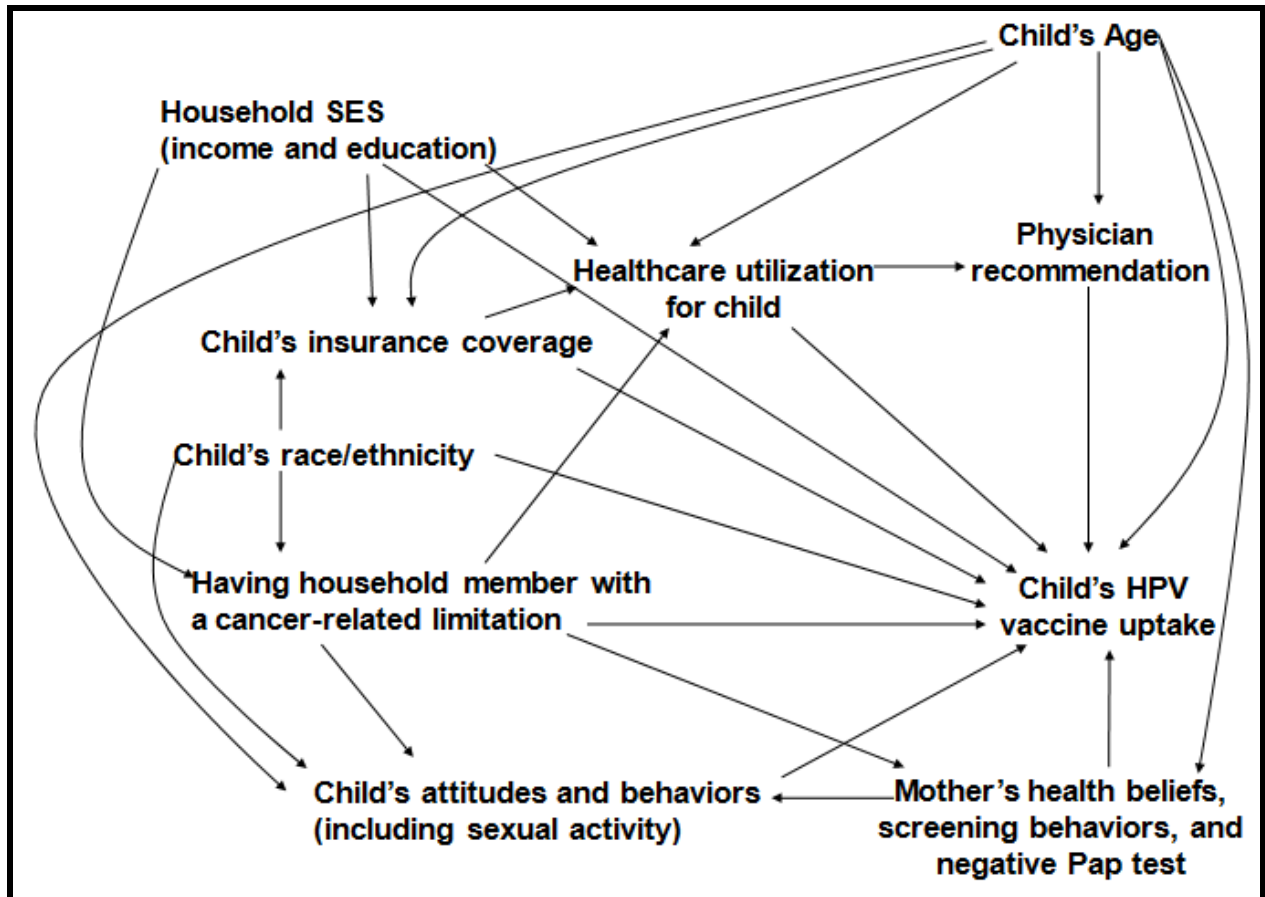
## REFERENCES

1. Markowitz LE, Dunne EF, Saraiya M, Lawson HW, Chesson H, Unger ER. Quadrivalent human papillomavirus vaccine: Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR*. 2007; 56: 1-24.
2. Wright TC Jr, Huh WK, Monk BJ, Smith JS, Ault K, Herzog TJ. Age considerations when vaccinating against HPV. *Gynecol Oncol*. 2008 May;109(2 Suppl):S40-7.
3. Mays RM, Sturm LA, Zimet GD. Parental perspectives on vaccinating children against sexually transmitted infections. *Soc Sci Med*. 2004 Apr;58(7):1405-13.
4. Rosenthal SL, Rupp R, Zimet GD, Meza HM, Loza ML, Short MB, Succop PA. Uptake of HPV vaccine: demographics, sexual history and values, parenting style, and vaccine attitudes. *J Adolesc Health*. 2008 Sep;43(3):239-45.
5. Sallis JF, Nader PR. Family determinants of health behavior. In Gochman DS. *Health behavior: Emerging research perspectives*. Springer Publishing, New York, NY: 1988.
6. Bomar P. *Promoting health in families: applying family research and theory to nursing practice*. 3<sup>rd</sup> ed. Saunders Publishing, Philadelphia, PA: 2004.
7. Division of Health Interview Statistics. National Center for Health Statistics. 2008 National Health Interview Survey (NHIS) Public Use Data Release. June 2009 [http://www.cdc.gov/NCHS/nhis/nhis\\_2008\\_data\\_release.htm](http://www.cdc.gov/NCHS/nhis/nhis_2008_data_release.htm). Accessed January 2010.
8. Division of Health Interview Statistics. National Center for Health Statistics. 2008 National Health Interview Survey (NHIS) Survey Description. June 2009

[ftp://ftp.cdc.gov/pub/Health\\_Statistics/NCHS/Dataset\\_Documentation/NHIS/2008/srv\\_ydesc.pdf](ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2008/srv_ydesc.pdf) Accessed January 2010.

9. Pearl, J. Causality: Models, Reasoning, and Inference. Cambridge Univ. Press, Cambridge, UK: 2009.
10. Braveman PA, Cubbin C, Egerter S, Williams DR, Pamuk E. Socioeconomic disparities in health in the United States: what the patterns tell us. *Am J Public Health*. 2010 Apr 1;100 Suppl 1:S186-96.
11. Heinze G, Schemper M. A solution to the problem of separation in logistic regression. *Stat Med*. 2002 Aug 30;21(16):2409-19.
12. Marlow, L.A., Waller, J., & Wardle, J. (2007) Parental attitudes to pre-pubertal HPV vaccination. Ethnic differences in HPV awareness and vaccine acceptability. *Vaccine*. 2007 (25): 1945-52.
13. Natarajan, S., Lipsitz, S.R., Fitzmaurice, G., Moore, C.G., & Gonin, R. Variance estimation in complex survey sampling for generalized linear models. *Appl Stat*. 2008 (57): 75-87.

**Figure 1. Proposed causal structure for the relation between a household member with a cancer-related limitation (physical, mental, or emotional) and HPV vaccine uptake**



**Table 1. Characteristics of females aged 9 – 17 years from the 2008 National Health Interview Survey.**

<b>Characteristic</b>	<b>No doses (n=1608)</b>	<b>Initiation (≥1 dose) n=357</b>	<b>Completion (3 doses) n=146</b>
Age, median (IQR) <sup>a</sup>	13.0 (11.0, 15.0)	15.0 (13.0, 16.0)	13.0 (11.0, 15.0)
Race/ethnicity, n (%)			
White	755 (47.0)	193 (54.1)	90 (61.6)
Black	301 (18.7)	56 (15.7)	12 (8.2)
Asian	105 (6.5)	17 (4.8)	6 (4.1)
Hispanic	434 (27.0)	84 (23.5)	33 (22.6)
Other	13 (0.8)	7 (2.0)	5 (3.4)
Family Income, n (%)			
<100%	231 (15.1)	63 (18.6)	19 (13.6)
100%-199%	331 (21.7)	68 (20.1)	24 (17.1)
200%-399%	517 (33.9)	92 (27.2)	43 (30.7)
≥400%	446 (29.2)	115 (34.0)	54 (38.6)
Education level of head of household, n (%)			
Did not graduate HS	287 (18.0)	64 (17.9)	26 (17.8)
High school graduate	466 (29.2)	73 (20.4)	23 (15.8)
Some college	286 (17.9)	68 (19.0)	19 (13.0)
College graduate or higher	559 (35.0)	152 (42.6)	78 (53.8)
Household member with cancer-related limitation, n (%)	11 (0.7)	4 (1.1)	2 (1.4)

<sup>a</sup>IQR= Interquartile range

**Table 2. Prevalence odds ratios for the association between cancer-related physical limitations and human papillomavirus vaccine uptake among females aged 9 – 17 years, 2008 United States National Health Interview Survey.**

<i><b>HPV vaccine uptake status</b></i>	<i><b>Unadjusted Odds Ratio (95% C.I.)</b></i>	<i><b>Adjusted Odds Ratio<sup>a</sup> (95% C.I.)</b></i>
Completion (3 doses)	2.40 (0.46, 8.23)	2.50 (0.26, 11.58)
Initiation (≥ 1 dose)	1.77 (0.53, 4.99)	1.42 (0.26, 5.18)
No doses received	1.00	1.00

<sup>a</sup>Adjusted for age, race/ethnicity, and socioeconomic status.