Human Vaccines & Immunotherapeutics 10:8, 2454–2459; August 2014; © 2014 Landes Bioscience

Inequalities in vaccination coverage for young females whose parents are informal caregivers

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Keywords: informal caregiver, risk perception, strain, human papillomavirus vaccine, influenza vaccination, children, adolescents

The effects of caregiver strain and stress on preventive health service utilization among adult family members are well-established, but the effects of informal caregiving on children of caregivers are unknown. We aimed to assess whether inequalities in vaccination coverage (specifically human papillomavirus [HPV] and influenza) exist for females aged 9 to 17 years whose parents are informal caregivers (i.e., care providers for family members or others who are not functionally independent) compared with females whose parents are not informal caregivers. Data from the 2009 Behavioral Risk Factor Surveillance System were analyzed using Poisson regression with robust variance to estimate overall and subgroup-specific HPV and influenza vaccination prevalence ratios (PRs) and corresponding 95% confidence limits (CL) comparing females whose parents were informal caregivers with females whose parents were not informal caregivers. Our unweighted study populations comprised 1645 and 1279 females aged 9 to 17 years for the HPV and influenza vaccination analyses, respectively. Overall, both HPV and influenza vaccination coverage were lower among females whose parents were informal caregivers (HPV: PR = 0.72, 95% CL: 0.53, 0.97; Influenza: PR = 0.89, 95% CL: 0.66, 1.2). Our results suggest consistently lower HPV and influenza vaccination coverage for young females whose parents are informal caregivers. Our study provides new evidence about the potential implications of caregiving on the utilization of preventive health services among children of caregivers.

Background

Nearly 35 million individuals in the United States are now considered informal caregivers, which accounts for over 20% of households.[1,2] Informal caregivers are often responsible for providing physical and emotional support, promoting adherence to medication regimens, and ensuring attendance to scheduled healthcare provider visits for individuals with illness or disability.[3] They serve as a source of assistance and support for completing daily self-care activities for others (e.g., spouse, family member, child, or friend), without compensation.[3] Informal caregiving is associated with high levels of caregiver strain and stress, as well as compromised mental and physical health.[4,5]

Regardless of whether the care-recipient is an adult or child, caregiver stress has emerged as an important predictor of health care utilization. For example, perceived stress among informal caregivers has been associated with lower influenza vaccination coverage among adult care-recipients.[6] Informal caregivers of adult care-recipients may have the added responsibility of providing direct care for their own children or siblings of child care-recipients. Given that decisions regarding childhood preventive immunizations are dependent on parents, the responsibilities of informal caregiving may impact elective vaccine uptake in children.

In the United States, the uptake of elective vaccines such as human papillomavirus (HPV) and influenza is substantially lower than mandatory vaccines (e.g., tetanus, diphtheria, and pertussis [Tdap]). For children aged 13–17 y, the national estimates for one dose HPV and influenza vaccine coverage are 54% and 43%, respectively, whereas coverage for one dose Tdap is 85%.[7] Elective vaccine coverage is highly sensitive to the phenomenon of vaccine hesitancy,[8] which may be exacerbated by the caregiving experience. Nevertheless, little is known about the effect of caregiving on elective vaccination of children of caregivers. Therefore, we aimed to assess whether inequalities in elective vaccine coverage (specifically HPV and influenza) exist for females aged 9 to 17 y whose parents are informal caregivers compared with females whose parents are not informal caregivers.

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Submitted: 03/01/2014; Revised: 04/17/2014; Accepted: 05/02/2014; Published Online: 05/08/2014
http://dx.doi.org/10.4161/hv.29096

Methods

Data source

We used data from the 2009 Behavioral Risk Factor Surveillance System (BRFSS)[9] to designate a study population. The BRFSS recruits a probability-based sample of non-institutionalized individuals (one per household) aged 18 y or older to complete computer-assisted telephone interviews about behavioral risk factors related to morbidity and mortality.[9] Households with children are also invited to complete questionnaires about health behaviors for one randomly selected child in the household. A core module of questions is administered in all states with options for each state to include additional modules (e.g., HPV vaccination for children).[9] All responses are based on self-report for adults and adult proxy report for children.[9]

Study population

All females aged 9 to 17 y whose parents were administered the "Child human papillomavirus" or "Childhood immunization" modules were eligible for our analyses. Given the variation in administered modules across states, not all modules were completed by the same group of parents. Consequently, our analyses were based on different but largely overlapping groups of parents for each outcome.

Variables

Our outcomes of interest were HPV vaccine initiation ("Has this child ever had the HPV vaccination?") and influenza vaccination ("During the past 12 months, has he/she had a flu vaccination?"). We defined HPV vaccination as initiation (i.e., at least 1 shot) because of concerns about misclassifying series completion in a cross-sectional survey.[10] Influenza vaccination could have been administered as a shot or nasal spray. Our exposure of interest was females whose parents are also informal caregivers, where caregiver was defined as a parent who provided regular care or assistance during the past month to a friend or family member who has a health problem, long-term illness, or disability ("During the past month, did you provide any such care or assistance to a friend or family member?"). We also used sociodemographic information ascertained through the survey. Race/ethnicity was categorized as non-Hispanic White, non-Hispanic Black, Hispanic, and Other. Educational attainment was categorized as high school or less, some college, and college or beyond. Household income was measured as <$25 000, $25 000–$49 999, $50 000–$74 999, >$75 000. Insurance coverage was dichotomized based on the answer to the question, "Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare?"

Data analysis

We used Poisson regression with robust variance to estimate overall and subgroup-specific (i.e., by age group, racial/ethnic group, and insurance subgroup given evidence of potential differences in vaccine uptake by these factors)[11,12] HPV and influenza vaccination prevalence ratios (PR) and corresponding 95% confidence limits (CL)[13] comparing females whose parents were informal caregivers with females whose parents were not informal caregivers. We identified a minimal sufficient set of covariates for adjustment to reduce confounding bias using the back-door criterion in a directed acyclic graph.[14] Consequently, the overall, age subgroup, and insurance subgroup models were adjusted for the child's age (continuous covariate), race/ethnicity, household income, and parental education. The racial/ethnic subgroup model was adjusted for the child's age (continuous covariate), household income, and parental education. Observations with missing values for relevant covariates were excluded from the analyses. All models incorporated design effects and population weights to adjust for noncoverage and nonresponse in BRFSS, and enhance generalizability to the target population.[15]

Results

Table 1 summarizes the characteristics of the evaluable populations for the HPV and influenza vaccination analyses. Our unweighted evaluable study populations comprised 1645 and 1279 females aged 9 to 17 y for the HPV and influenza vaccination analyses, respectively. The distributions of characteristics were largely similar between study populations. Briefly, the mean ages of females were similar for study populations in the HPV and influenza vaccination analyses (mean = 13 y, standard deviation [SD] = 2.6 y). Females in both study populations were predominantly either non-Hispanic White (HPV: 55%, influenza: 53%) or Hispanic (HPV: 33%, influenza: 33%). In addition, females in both study populations were predominantly from households with a household income >$75 000 (HPV: 42%, influenza: 45%), and had at least one parent who was at least a college graduate (HPV: 41%, influenza: 41%). Most eligible females had some form of health care coverage (HPV: 80%, influenza: 75%). The proportion of parents who were informal caregivers was similar in both study populations (30%). HPV vaccination coverage was 25%, and influenza vaccination coverage was 32%.

HPV vaccination

Table 2 summarizes prevalence ratios for the associations between females whose parent was an informal caregiver and vaccine uptake. Overall, HPV vaccination coverage was lower among females whose parents were informal caregivers (PR = 0.72, 95% CL: 0.53, 0.97). The magnitude of this inverse association was stronger for HPV vaccine uptake among females aged 9 to 12 y (PR = 0.38, 95% CL: 0.17, 0.83) than females aged 13 to 17 y (PR = 0.84, 95% CL: 0.62, 1.1). HPV vaccine coverage was consistently lower among females whose parents were informal caregivers within all racial/ethnic subgroups, with the strongest inverse association among non-Hispanic Blacks (PR = 0.37, 95% CL: 0.14, 0.96). The magnitude of inverse association between females whose parents were informal caregivers and HPV vaccine coverage was largely similar between females of insured (PR = 0.64, 95% CL: 0.30, 1.4) and uninsured parents (PR = 0.70, 95% CL: 0.51, 0.96).

Influenza vaccination

Overall, influenza vaccination coverage was lower among females whose parents were informal caregivers (PR = 0.89, 95% CL: 0.66, 1.2). The magnitude of this inverse association was stronger among females aged 9 to 12 y (PR = 0.78, 95%

Table 1. Characteristics of evaluable females aged 9 to 17 y in the 2009 United States Behavioral Risk Factor Surveillance Survey[a]

Characteristic	HPV vaccination (n = 1645)[b]	Influenza vaccination (n = 1279)[c]
Age, *n* (%)		
9–12 y	610 (41)	491 (43)
13–17 y	1035 (58)	788 (57)
Race/ethnicity, *n* (%)		
non-Hispanic White	1050 (55)	884 (53)
non-Hispanic Black	95 (7.6)	79 (9.0)
Hispanic	434 (33)	257 (33)
Other	66 (4.5)	59 (5.2)
Family income, *n* (%)		
<$25 000	363 (23)	223 (22)
$25 000–$49 999	318 (21)	229 (19)
$50 000–$74 999	273 (15)	216 (14)
>$75 000	691 (42)	611 (45)
Parental education, *n* (%)		
High school or less	467 (32)	360 (33)
Some college	468 (27)	342 (26)
College graduate or higher	710 (41)	577 (41)
Insurance coverage	1413 (80)	1056 (75)
Parent is informal caregiver, *n* (%)	486 (28)	384 (30)
HPV vaccination, *n* (%)	494 (25)	-
Influenza vaccination, *n* (%)	-	404 (32)

[a]Sample sizes reported as unweighted values and percentages reported as weighted values. [b]*n*, = 1765 females eligible for HPV vaccination analysis (6.8% missing values for relevant covariates). [c]*n*, = 1381 females eligible for influenza vaccination analysis (7.4% missing values for relevant covariates).

CL: 0.50, 1.2) than females aged 13 to 17 y (PR = 0.99, 95% CL: 0.65, 1.5). In contrast to non-Hispanic Whites (PR = 1.1; 95% CL: 0.77, 1.66), influenza vaccine coverage was consistently lower for females whose parents were informal caregivers among racial/ethnic minorities (e.g., non-Hispanic Blacks: PR = 0.78, 95% CL: 0.27, 2.2; Hispanics: PR = 0.78, 95% CL: 0.40, 1.5). The magnitude of inverse association between females whose parents were informal caregivers and influenza vaccine coverage was similar between females of insured (PR = 0.88, 95% CL: 0.42, 1.8) and uninsured parents (PR = 0.91, 95% CL: 0.66, 1.2).

Discussion

Our overall and subgroup-specific results suggest lower HPV and influenza vaccination coverage for young females whose parents are informal caregivers, with stronger evidence of lower HPV vaccination coverage. A greater magnitude of inequality for HPV vaccination is observed for younger females (aged 9 to 12 y) and non-Hispanic Blacks whose parents are informal caregivers. In addition, a greater magnitude of inequality for influenza vaccination is observed for females from racial/ethnic minorities whose parents are informal caregivers.

Although the magnitude of inequality appears larger for HPV vaccination than influenza vaccination, these estimates may not be directly comparable because the HPV and influenza vaccination questions in BRFSS were not necessarily administered to the same parents. Furthermore, the smaller sample size in the influenza vaccination analysis resulted in greater imprecision, particularly for some subgroups. Nevertheless, differences in the magnitude of association for influenza and HPV vaccine coverage observed in our study could be attributable to mediating factors. For example, physicians could have recommended influenza vaccination for family members or household contacts of care recipients at risk of influenza-related complications.[16,17] Therefore, physician recommendation could mediate greater influenza vaccination coverage among young females in the same household of the care recipient. In contrast to influenza vaccination, HPV vaccination of family members or household contacts has little apparent benefit to care-recipients, and thus would not have a similar mediating effect. Future studies should explore the role of mediating factors,[18] such as physician recommendation, as potential explanations for differences in elective vaccine coverage for young females of parents who are informal caregivers.

Previous studies focused on assessing the impact of caregiving on the caregiver's health.[4,6] Few studies have explored the effects

Table 2. Prevalence ratios (PR) and 95% confidence limits (CL) for the associations between females with a parent who is an informal caregiver and vaccination practices

	HPV vaccination		Influenza vaccination	
	Prevalence (%)	PR (95% CL)	Prevalence (%)	PR (95% CL)
Overall[a]				
Parent is informal caregiver	21	0.72 (0.53, 0.97)	29	0.89 (0.66, 1.2)
Parent is not informal caregiver	27	1.0	34	1.0
Age group[a]				
9- to 12-y-olds				
Parent is informal caregiver	8.4	0.38 (0.17, 0.83)	30	0.78 (0.50, 1.2)
Parent is not informal caregiver	18	1.0	43	1.0
13- to 17-y-olds				
Parent is informal caregiver	27	0.84 (0.62, 1.1)	29	0.99 (0.65, 1.5)
Parent is not informal caregiver	34	1.0	26	1.0
Race/ethnicity[b]				
Non-Hispanic White				
Parent is informal caregiver	24	0.80 (0.56, 1.1)	32	1.1 (0.77, 1.6)
Parent is not informal caregiver	27	1.0	32	1.0
Non-Hispanic Black				
Parent is informal caregiver	12	0.37 (0.14, 0.96)	27	0.78 (0.27, 2.2)
Parent is not informal caregiver	36	1.0	50	1.0
Hispanics				
Parent is informal caregiver	21	0.75 (0.44, 1.3)	26	0.78 (0.40, 1.5)
Parent is not informal caregiver	27	1.0	29	1.0
Others				
Parent is informal caregiver	5.2	0.41 (0.06, 2.8)	26	0.39 (0.18, 0.83)
Parent is not informal caregiver	12	1.0	66	1.0
Parental insurance status[a]				
Insured				
Parent is informal caregiver	21	0.70 (0.51, 0.96)	29	0.91 (0.66, 1.2)
Parent is not informal caregiver	26	1.0	34	1.0
Uninsured				
Parent is informal caregiver	22	0.64 (0.30, 1.4)	30	0.88 (0.42, 1.8)
Parent is not informal caregiver	29	1.0	33	1.0

[a]Prevalence ratios adjusted for child's age (continuous covariate), race/ethnicity, household income, and parental education. [b]Prevalence ratios adjusted for child's age (continuous covariate), household income, and parental education.

of informal caregiving on the use of preventive health services for members of the caregiver's family, particularly children. For example, some studies described the impact of caregiving to a child with a serious chronic illness or cancer having a negative effect on siblings or family members.[19,20] In particular, influenza vaccination was underused among family members living with a pediatric cancer patient.[19] In addition, parents often underestimate the strain on a sibling when caregiving for a critically ill child.[20] Our findings thus extend the evidence about the negative effects of caregiving to include decreased use of preventive health services for the caregiver's child.

The mechanisms by which informal caregiving affects elective vaccine uptake among children of caregivers remain to be elucidated in future studies. We speculate based on prior evidence that perceived stress and caregiver strain may underlie our observed associations.[6] The caregiving experience may be influenced by competing priorities for informal caregivers who provide care not only for the care-recipient but also for their own families.[21] Informal caregivers without a social support network (i.e., assistance from friends and other family members) may be more negatively affected by the demands of the caregiving experience.[22] Therefore, informal caregivers who lack a strong support network

Table 3. Characteristics of females aged 9 to 17 y eligible and evaluable for the human papillomavirus (HPV) and influenza vaccination analyses

Characteristic	HPV vaccination		Influenza vaccination	
	Eligible (n = 1765)	Evaluable (n = 1645)	Eligible (n = 1381)	Evaluable (n = 1279)
Age, *n* (%)				
9–12 y	655 (42)	610 (41)	655 (44)	491 (43)
13–17 y	1110 (58)	1035 (58)	1110 (56)	788 (57)
Race/ethnicity, *n* (%)[a]				
non-Hispanic White	1107 (55)	1050 (55)	1107 (54)	884 (53)
non-Hispanic Black	99 (7.3)	95 (7.6)	99 (8.5)	79 (9.0)
Hispanic	476 (34)	434 (33)	476 (33)	257 (33)
Other	69 (4.3)	66 (4.5)	69 (5.1)	59 (5.2)
Parental education, *n* (%)[b]				
High school or less	505 (32)	467 (32)	505 (33)	360 (33)
Some college	505 (27)	468 (27)	505 (26)	342 (26)
College graduate or higher	753 (41)	710 (41)	753 (41)	577 (41)
Insurance coverage[c]	1507 (79)	1413 (80)	1507 (75)	1056 (75)
Parent is informal caregiver, *n* (%)	519 (28)	486 (28)	519 (30)	384 (30)
HPV vaccination, *n* (%)	528 (25)	494 (25)	-	-
Influenza vaccination, n (%)	-	-	528 (32)	404 (32)

[a]HPV, Based on information from eligible n = 1751 in HPV analysis; eligible n = 1366 in influenza analysis. [b]HPV, Based on information from eligible n = 1763 in HPV analysis; eligible n = 1379 in influenza analysis. [c]HPV, Based on information from eligible n = 1762 in HPV analysis; eligible n = 1377 in influenza analysis.

may not prioritize elective vaccinations for their children, particularly the 3-dose HPV vaccination series which requires multiple visits over a 6-mo period.

One consideration when interpreting our results is potential misclassification of parent-reported vaccination status. For example, parent-reported HPV[10] and influenza[23] vaccination status are already imperfect, and chronic stress and psychological distress associated with caregiving may further impair short- and long-term recall (or memory).[24] If parents who are informal caregivers more frequently misreported that their child did not receive the HPV or influenza vaccine, then our estimated prevalence ratios may be biased away from the null, which could explain our results. In contrast, if parents who are informal caregivers more frequently misreported that their child received the HPV or influenza vaccines, then misclassification could bias our estimates toward the null (i.e., our prevalence ratios may underestimate the magnitude of association). Unfortunately, information about recall accuracy in our study population is unavailable, and thus the effect of misclassification is uncertain. Future studies should emphasize accurate classification of vaccination status for the child. In addition, small proportions of the eligible study populations were excluded from the analyses because of missing values, primarily for household income. This exclusion could induce selection bias if the values were not missing at random in relation to the exposure and outcomes. Nevertheless, we observed virtually similar distributions of available sociodemographic characteristics among the eligible and evaluable study populations (**Table 3**), which suggests that our estimates may have limited sensitivity to potential selection bias from excluding individuals with missing values for relevant covariates.

Another consideration when interpreting our findings is our definition of informal caregiver. We defined informal caregivers as parents of females who reported caring for a friend or family member with a health problem, long-term illness, or disability. Unfortunately, our outcomes of interest resulted in a study population that precluded responses to the Caregiver Module of the BRFSS, which could have provided more detailed information about the caregiver and the care-recipient. Therefore, we were unable to explore potential heterogeneity by caregiver and care-recipient characteristics. Furthermore, our data preclude differentiating who accompanied the child to the provider. For caregivers with strong social support, if a friend or family member of the caregiver accompanied the child to the provider but was not authorized or uncomfortable with decisions about elective vaccination, then consent to vaccinate could partially explain our findings. Future studies should obtain detailed information about the caregiver and care-recipient.

In summary, our findings suggest a deleterious effect of informal caregiving on HPV vaccination, and possibly influenza vaccination, coverage for young females in the United States. Our study provides a general perspective about the caregiving experience and its relation to children in the caregiving family. With a growing population of caregiving families, the potential impact on children should be further explored, and healthcare providers may need to be aware of potential opportunities to discuss vaccine recommendations with parents who are informal caregivers. For

example, if future studies elucidate that caregiver stress underlies the association between informal caregiving and elective vaccination for females in a caregiving family, then identification of distressed caregivers could be facilitated by the use of screening questionnaires such as the American Medical Association's Caregiver Self-Assessment Questionnaire.[25] This questionnaire could be given to caregivers who accompany the care-recipient (whether adult or child) during the provider visit. If caregivers screen positive for distress and are also parents of vaccine-eligible females, follow-up care for the caregiver may need to incorporate discussions about preventive health services for their children, including elective vaccinations. Regardless of approach, cumulative evidence suggests that the effects of caregiving on individual and familial health warrant greater acknowledgment and action.

Disclosure of Potential Conflicts of Interest

J.S.S. has received research grants or contracts, honoraria, or consulting fees during the past 6 y from GlaxoSmithKline and Merck. The other authors declare no financial or non-financial competing interests.

Acknowledgments

R.P.O. and T.M.B. were supported by the American Lebanese Syrian Associated Charities (ALSAC). K.P.S. was partially supported by awards from the National Cancer Institute (P30 CA013148) and Cervical SPORE (P50CA098252). The funding sources were not involved in the study design, data collection, analysis, interpretation, writing, or decision to submit this report.

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