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RESEARCH ARTICLE

Child Influenza Vaccination and Adult Work Loss: Reduced Sick Leave Use Only in Adults With Paid Sick Leave

William K. Bleser, PhD, MSPH,[1] Patricia Y. Miranda, PhD, MPH,[2] Daniel A. Salmon, PhD, MPH[3]

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Introduction: Children are a population of interest for influenza. They are at increased risk for severe influenza, comprise a substantial portion of influenza morbidity, and significantly contribute to its transmission in the household and subsequent parental work loss. The association between influenza vaccination and work loss prevention, however, has rarely been studied, and the sparse existing literature has very limited generalizability to U.S. adults, thus requiring better characterization.

Methods: Using pooled National Health Interview Survey data (2013–2015, analyses conducted in 2018) nationally representative of working U.S. adults with household children (n=23,014), zero-inflated negative binomial regression examined the association of child influenza vaccination (exposure) with sick days (outcome) stratified by paid sick leave (no: n=10,741, yes: n=12,273).

Results: Child influenza vaccination was associated with significantly lower sick day usage, but only among adults with paid sick leave (prevalence rate ratio=0.79, 95% CI=0.67, 0.93), equating to average annual sick days of 4.07 vs 3.29 in adults with unvaccinated versus vaccinated household children (difference=0.78 fewer days annually).

Conclusions: Influenza vaccination of children is associated with reduced sick leave in household adults, helping to keep the workforce healthy and reduce influenza's costly annual economic burden. This only occurred among adults with paid sick leave, however, which is distributed inequitably by income, education, gender, occupation, and race/ethnicity. Health in All Policies considers downstream health effects of social and economic policy; the failure of federal policy to ensure paid sick leave likely contributes to propagating influenza and health inequities.

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INTRODUCTION

It is well established that young children (under age 5 years) are a high-risk population for influenza morbidity and mortality. They are at increased risk of influenza-related hospitalizations, doctor, urgent care, and emergency department visits,[1,2] and represent a substantial portion of all U.S. influenza-related morbidity.[3] The broader impact of influenza in young children on their environments is less studied, but child influenza is known to impact family members and caregivers,[4] parental work absenteeism,[5] and community epidemics.[6]

From the [1]Robert J. Margolis, MD, Center for Health Policy, Duke University, Washington, District of Columbia; [2]Department of Health Policy and Administration, Pennsylvania State University, University Park, Pennsylvania; and [3]Department of International Health, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Maryland

Dr. Bleser performed the majority of his work on this study while at Pennsylvania State University.

Address correspondence to: William K. Bleser, PhD, MSPH, Robert J. Margolis, MD, Center for Health Policy, Duke University, 1201 Pennsylvania Avenue NW, 5th Floor, Washington DC 20004. E-mail: william.bleser@duke.edu.

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Prospective studies show that influenza infection in children transmits influenza to household contacts.[7–9] Moreover, having a child with influenza or influenza-like-illness (ILI) in the household is significantly associated with annual parental work loss on the order of 0.6–6.3 days.[5,10–14] This literature demonstrates the epidemiologic link between household child ILI and parental work loss, but these studies are either decades old or their settings and locations (e.g., emergency department cases, mostly studies from Southeast Europe, certain U.S. employers) present generalizability issues to U.S. working adults.

The Centers for Disease Control and Prevention recommends all individuals age 6 months and older receive influenza vaccination annually.[15] Existing evidence suggests that childhood influenza vaccination prevents annual parental work loss (on the order of 0.5–1.6 days, or 33%–48% less),[16–19] but this topic has rarely been studied,[20] and also has generalizability issues to U.S. working adults.

Current understanding of the broader effects of influenza vaccination in U.S. children (e.g., to household contacts) is limited, but critically important, requiring better characterization.[4,21,22] The objective of this study is to understand the potential indirect benefit of child influenza vaccination on reducing work loss of household adults. This gap is important for several reasons: (1) as aforementioned, child influenza infection causes parental work absenteeism; (2) adjusted for inflation, influenza in the U.S. results in $126 billion in economic burden each year ($23.8 billion in lost earnings)[23]; and (3) influenza vaccination uptake in U.S. children remains suboptimal and substantially lower than uptake of other childhood vaccines.[24]

Further, public health and health policy researchers have placed increasing recognition on Health in All Policies[25]—that health is influenced by social, physical, and economic environments and thus health considerations must be incorporated into broader decision making. Evidence linking paid sick leave to downstream health effects, however, needs better characterization,[26] so this study also investigates the role paid sick leave plays. Conceptually, this study hypothesizes paid sick leave to be a critical enabling factor of health services use[27] moderating the relationship between household child influenza vaccination and sick leave usage. Reasons for this hypothesis, backed by U.S. survey data, are that paid sick leave encourages U.S. employees to stay at home when sick with influenza or similar symptoms,[28] and that parents who miss work to care for an ill child were more accepting of the vaccine,[29] indicating the importance that paid sick leave and being able to miss work without pay loss to care for oneself or one's family has for improving childhood influenza attitudes and uptake. Moreover, from an evidence and policy perspective, paid sick leave may be necessary to capture any positive economic/work force benefit to adults of getting their household children vaccinated. Because the status quo in the U.S. is no federally required paid sick leave, one goal of this study is to estimate what a potential counterfactual would look like (i.e., if the U.S. had mandatory paid sick leave like most other developed nations [paid sick leave group])—what would the potential indirect benefits of household child influenza vaccination be, and what does that look like in the status quo group (no paid sick leave)?

METHODS

Study Sample

Data come from 3 pooled years (2013–2015) of the National Health Interview Survey (NHIS). The 2016 NHIS was not used because there was a major sampling frame redesign, making comparisons to prior years difficult. The NHIS, run by the Centers for Disease Control and Prevention since 1957, is a cross-sectional household interview survey of health information of the civilian, non-institutionalized U.S. population. If there are any household children (aged <18 years), one is randomly selected and the household adult answers questions about them.[30–32] This study was reviewed by the Pennsylvania State University IRB and deemed "not human research."

The pooled data set contained data on 104,926 adults (total household response rate ranged from 70.1% to 75.7%).[30–32] A pooled weight was constructed as the weighted average of the 2013–2015 NHIS adult weights.[33] The sample was restricted to 67,366 adults eligible for the outcome—those indicating they had a job last week (or none last week but one in the past 12 months; how the NHIS defines working adults). The sample was then restricted to 24,314 working adults with household children completing the NHIS child component and not missing the key independent variable of child influenza vaccination. The conditional response rate for the child component ranged from 91.2% to 92.1%.[30–32]

Measures

The outcome is self-reported work loss days (previous 12 months). The exact question was, *During the past 12 months, that is, since [12-months before interview date], about how many days did you miss work at a job or business because of illness or injury (do not include maternity leave)?*

The independent variable is adult-reported household child influenza vaccination status (injection or nasal spray, previous 12 months). The second independent variable is adult-reported paid sick leave status.

The study includes covariates directly related to adult work status or indirectly to the relationship between health and need for sick leave using Andersen's behavioral model for health service use.[27] Two covariates directly relate to adult work status: (1) paid by the hour (yes/no), and (2) simplified occupation code (23 mutually exclusive U.S. Census Bureau and Bureau of Labor Statistics occupation categories). The remaining nine socioeconomic and demographic covariates influence the relationship between work, social position, and general health: (3) sex (male/female), (4) race/ethnicity

(Hispanic versus non-Hispanic: white, black/African American, Asian, other or multiple race), (5) age (18–24, 25–34, 35–44, 45–54, 55–64, or ≥65 years), (6) self-rated health (excellent, very good, good, fair, poor), (7) highest family educational attainment (less than high school, high school or General Educational Development test, associate's degree or some college but no degree, bachelor's degree or higher), (8) family income relative to poverty threshold (<100%, 100%–199%, ≥200%), (9) family size (two, three, four, five, six or more), (10) family type (one adult with children, multiple adults with children), and (11) adult-reported influenza vaccination status (previous 12 months). This study also adjusted for (12) survey year (dummies).

Statistical Analysis

Bivariate analyses were conducted to examine differences in mean work days lost by values of each covariate. Then, work loss was regressed on child influenza vaccination status in a series of multivariate analyses. Because work loss is an overdispersed and zero-inflated count variable, zero-inflated negative binomial (ZINB) regression was utilized to appropriately model it.[34,35] In the presented models, all values of sick leave are left in, given the general robustness of findings to outlier sensitivity checks, uncommonness of extreme values, and desire to avoid limiting generalizability (excluding extreme values would exclude very sick people, who have high cost, utilization, and risk of severe influenza complications, leaving the remaining population artificially healthy).

Complete case analysis was performed. Nearly 95% of the eligible sample were complete cases (n=23,014). Sensitivity analyses found no association between being a complete case and key variables of interest (work loss, child influenza vaccination, paid sick leave), though complete cases adult respondents were slightly more likely to be female, have a bachelor's degree, have income above the poverty level, and to have the influenza vaccine. Because missingness was not completely at random, the complete case sample is large, and complete case missingness is very low and not associated with key variables, complete case analysis is appropriate and likely less biased than other methods of dealing with missingness.[36]

Model 1 includes paid sick leave and all covariates. A sensitivity analysis was conducted in Model 1 by adding an interaction term for paid sick leave and child influenza vaccination to both parts of the ZINB model (Part 1: modeling sick days for those at risk of having a sick day, and Part 2: modeling the odds of having no sick days). The interaction term coefficient for Part 1 was significant (0.68, p=0.011), although it was not for Part 2 (0.69, p=0.168), empirically confirming this study's conceptual and policy rationales that paid sick leave is a critical enabling factor. To best understand the counterfactual—what indirect benefits of child influenza vaccination to working adults might look like in the U.S. if everyone had paid sick leave—this study stratified Model 1 by whether the adult did not or did have paid sick leave (Model 2 [n=10,741] and Model 3 [n=12,273], respectively).

Analyses were performed using Stata/SE, version 15.1 statistical software, and applied weights to generate results nationally representative of non-institutionalized U.S. working adults with household children, 2013–2015, adjusting for complex survey design, ratio, nonresponse, post-stratification, and heteroscedasticity.

RESULTS

Table 1 contains weighted, descriptive statistics of the complete case sample. On average, respondents missed 3.5 days in the previous year because of illness or injury (not including maternity leave), and 54% had paid sick leave. Nearly half (48%) of household children received an influenza vaccination in the previous year. Table 2 stratifies weighted work loss days by all covariates for the overall population, as well as for those without and with paid sick leave. Unadjusted work loss days were nearly identical by household child influenza vaccination status in the overall population.

Table 3 shows weighted prevalence rate ratios of work loss days adjusted for all covariates from Part 1 of ZINB regression models. In Model 1 (all working adults with household children), having a vaccinated household child resulted in 0.92 times the prevalence of work loss days versus having an unvaccinated child (not significant; 95% CI=0.80, 1.06). Having paid sick leave was also associated nonsignificantly with missed work days (prevalence rate ratio=1.12, 95% CI=0.96, 1.31), although fewer work loss days was significantly associated with several covariates, such as male sex, non-Hispanic Asian race, younger age, higher income, and better respondent self-rated health. Table 4 shows weighted ORs of having no work loss days versus any work loss days adjusted for all covariates from Part 2 of ZINB regression models. In Model 1, having paid sick leave was associated with less odds of taking no sick days (OR=0.32, 95% CI=0.22, 0.47), though having a vaccinated household child was not (OR=1.04, 95% CI=0.81, 1.31).

Given that the interaction term sensitivity analyses indicated that having paid sick leave moderates the relationship between household child influenza vaccination and sick leave usage only for those in Part 1 of the model, the discussion of key results focuses on Part 1 (Table 3). In Model 2 (no paid sick leave), missed work time was still not significantly associated with household child influenza vaccination (prevalence rate ratio=1.10, 95% CI=0.87, 1.38). In Model 3 (paid sick leave), however, there was a large and statistically significant association—working adults with household children vaccinated against influenza had 0.79 times the prevalence of missed work time (95% CI=0.67, 0.93).

DISCUSSION

The primary finding of this study is that, among working adults with paid sick leave, having a household child vaccinated against influenza was significantly associated with 21% lower prevalence of all-cause sick leave in the previous year compared with those with an

Table 1. Descriptive Statistics of Study Population, Working U.S. Adults With Household Children, 2013–2015 NHIS (*n*=23,014)

Variable	%	*n*
Outcome variable		
Work loss day to injury or illness, previous 12 months, M (SD)	3.50 (16.60)	23,014
Had any work loss day, previous 12 months	44.7	10,467
Stratified by household child influenza vaccine status		
Unvaccinated household child, previous 12 months	44.2	5,375
Vaccinated household child, previous 12 months	45.3	5,092
Independent variables of interest		
Household child influenza vaccination status, previous 12 months		
Unvaccinated	52.5	12,011
Vaccinated	47.5	11,003
Paid sick leave status		
No	45.8	10,741
Yes	54.2	12,273
Covariates		
Paid by the hour		
No	40.1	8,699
Yes	59.9	14,315
Sex		
Female	50.0	12,987
Male	50.0	10,036
Race/ethnicity		
Non-Hispanic white	57.5	12,142
Non-Hispanic black or African American	11.9	3,053
Non-Hispanic Asian	6.1	1,371
Non-Hispanic other or multiple race	2.2	621
Hispanic	22.3	5,827
Age category, years		
18–24	11.8	1,980
25–34	25.6	6,607
35–44	35.1	8,452
45–54	22.1	4,764
55–64	4.7	1,019
≥65	0.8	192
Highest family educational attainment		
Less than high school	5.9	1,881
High school or GED	16.2	4,078
Associate's degree or some college (no degree)	33.7	7,901
Bachelor's degree or higher	44.2	9,154
Family income as a percentage of the federal poverty line		
<100%	12.5	3,749
100%–199%	20.8	5,278
≥200%	66.7	13,978
Family size		
2	4.6	2,209
3	26.5	6,832
4	36.6	7,964
5	19.2	3,824
≥6	13.1	2,185

(*continued on next page*)

Table 1. Descriptive Statistics of Study Population, Working U.S. Adults With Household Children, 2013–2015 NHIS (*n*=23,014) (*continued*)

Variable	%	*n*
Family type		
One adult with ≥1 children	9.3	4,523
Multiple adults with ≥1 children	90.7	18,491
Respondent reported health status		
Excellent	35.8	7,825
Very good	34.1	7,820
Good	24.5	5,887
Fair	5.1	1,354
Poor	0.5	128
Respondent adult influenza vaccination status, previous 12 months		
Yes	64.2	14,824
No	35.8	8,190

Source: 2013–2015 NHIS data, working adult respondents with child respondents in the household and not missing on covariates.
Note: Detailed, 23-category occupation code not shown for brevity. Means and percentages weighted to be nationally representative of working adults with children in the household; *n* is un-weighted to show actual number of observations in each cell.
NHIS, National Health Interview Survey.

Table 2. Bivariate Statistics of Work Loss Days by Covariates, Working U.S. Adults With Household Children

	Work loss days					
	Model 1: all working adults with household children (*n*=23,014)		**Model 2: no paid sick leave subgroup (*n*=10,741)**		**Model 3: Paid sick leave subgroup (*n*=12,273)**	
Variable	**M (SE)**	***p*-value**	**M (SE)**	***p*-value**	**M (SE)**	***p*-value**
Independent variables of interest						
Has paid sick leave		0.40		—		—
No	3.35 (0.26)		—		—	
Yes	3.62 (0.17)		—		—	
Child influenza vaccination, previous 12 months		0.96		0.15		0.05
Unvaccinated	3.51 (0.17)		2.99 (0.24)		3.99 (0.28)	
Vaccinated	3.49 (0.26)		3.81 (0.51)		3.25 (0.24)	
Covariates						
Paid by the hour		**<0.01**		0.56		**<0.01**
No	2.99 (0.18)		3.13 (0.42)		2.91 (0.17)	
Yes	3.84 (0.23)		3.44 (0.32)		4.30 (0.30)	
Sex		0.06		0.60		**<0.01**
Female	3.79 (0.21)		3.23 (0.31)		4.30 (0.28)	
Male	3.21 (0.21)		3.49 (0.41)		2.99 (0.22)	
Race/ethnicity		**<0.01**		0.12		**<0.01**
Non-Hispanic white	3.56 (0.20)		3.54 (0.37)		3.57 (0.23)	
Non-Hispanic black or African American	3.97 (0.39)		2.77 (0.57)		4.93 (0.55)	
Non-Hispanic Asian	2.07 (0.20)		2.17 (0.40)		2.01 (0.21)	
Non-Hispanic other or multiple race	3.24 (0.56)		3.36 (0.90)		3.12 (0.68)	
Any Hispanic	3.49 (0.40)		3.45 (0.55)		3.56 (0.54)	
Age category, years		0.33		0.71		0.13
18–24	2.75 (0.44)		2.82 (0.53)		2.52 (0.70)	
25–34	3.43 (0.32)		3.79 (0.60)		3.11 (0.22)	
35–44	3.51 (0.22)		3.16 (0.41)		3.74 (0.25)	

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Table 2. Bivariate Statistics of Work Loss Days by Covariates, Working U.S. Adults With Household Children (*continued*)

	Work loss days					
	Model 1: all working adults with household children (*n*=23,014)		**Model 2: no paid sick leave subgroup (*n*=10,741)**		**Model 3: Paid sick leave subgroup (*n*=12,273)**	
Variable	**M (SE)**	***p*-value**	**M (SE)**	***p*-value**	**M (SE)**	***p*-value**
45–54	3.52 (0.30)		3.26 (0.51)		3.68 (0.37)	
55–64	5.27 (1.17)		4.51 (1.62)		5.75 (1.64)	
≥65	5.04 (1.89)		5.62 (2.34)		4.32 (3.10)	
Highest family educational attainment		**<0.01**		0.19		**<0.01**
Less than high school	2.90 (0.42)		3.01 (0.54)		2.59 (0.47)	
High school or GED	3.78 (0.40)		3.22 (0.48)		4.64 (0.69)	
Associate's degree or some college (no degree)	4.28 (0.32)		4.08 (0.49)		4.48 (0.41)	
Bachelor's degree or higher	2.88 (0.18)		2.70 (0.41)		2.97 (0.17)	
Family income as a percentage of the Federal Poverty Level		**<0.01**		0.05		**<0.01**
<100%	4.72 (0.58)		4.72 (0.70)		4.71 (0.93)	
100%–199%	3.97 (0.38)		2.88 (0.37)		5.62 (0.81)	
≥200%	3.12 (0.15)		3.03 (0.34)		3.17 (0.14)	
Family size		0.15		0.87		**0.02**
2	4.56 (0.44)		3.32 (0.42)		5.48 (0.69)	
3	3.34 (0.23)		3.56 (0.45)		3.19 (0.22)	
4	3.55 (0.26)		3.12 (0.34)		3.86 (0.36)	
5	3.48 (0.42)		3.75 (0.77)		3.19 (0.30)	
≥6	3.32 (0.46)		3.03 (0.69)		3.72 (0.60)	
Family type		**0.01**		0.17		**0.01**
One adult with ≥1 children	4.39 (0.33)		4.11 (0.53)		4.63 (0.40)	
Multiple adults with ≥1 children	3.41 (0.17)		3.27 (0.28)		3.52 (0.19)	
Respondent reported health status		**<0.01**		**<0.01**		**<0.01**
Excellent	1.95 (0.12)		1.67 (0.17)		2.17 (0.16)	
Very good	2.83 (0.19)		2.32 (0.28)		3.21 (0.28)	
Good	4.65 (0.37)		4.55 (0.64)		4.76 (0.38)	
Fair	10.05 (1.46)		8.77 (1.59)		12.16 (2.72)	
Poor	35.97 (10.09)		34.64 (16.07)		37.76 (9.98)	
Respondent adult influenza vaccination, previous 12 months		0.16		0.19		0.76
No	3.33 (0.31)		3.12 (0.27)		3.57 (0.25)	
Yes	3.79 (0.52)		3.99 (0.62)		3.68 (0.27)	

Source: 2013–2015 National Health Interview Survey data, working adult respondents with child respondents in the household and not missing on covariates.

Note: Detailed, 23-category occupation code not shown for brevity. Means and percentages weighted to be nationally representative of working adults with children in the household. The *p*-values of mean differences calculated using SEs adjusted for complex survey design. Boldface indicates statistical significance ($p<0.05$).

unvaccinated household child. As an illustrative example of the magnitude of this prevalence predicted by the regression equation, this equates to average work loss days of 4.07 versus 3.29 among those with unvaccinated versus vaccinated children, respectively (a difference of 0.78 days, on average). This association is independent of adult influenza vaccine status and many covariates related to occupation, social position, and general health. This magnitude of the association is more conservative than, but generally consistent with, studies showing that child influenza illness is associated with at least 1 missed day of work among household contacts,[11–13] and to the few European studies investigating reduction of parental work loss associated with child influenza vaccination.[16,17,19]

The second principal finding is that there was no association between household child influenza vaccination and sick leave among working adults without paid

Table 3. Adjusted PRRs of Work Loss Days, Working U.S. Adults With Household Children

Variable	Model 1, adjusted PRR, (95% CI) (*n*=23,014)	Model 2, adjusted PRR, (95% CI) (*n*=10,741)	Model 3, adjusted PRR (95% CI), (*n*=12,273)
Independent variables of interest			
Child received influenza vaccination, previous 12 months	0.92 (0.80, 1.06)	1.10 (0.87, 1.38)	**0.79**** (0.67, 0.93)
Has paid sick leave	1.12 (0.96, 1.31)	—	—
Covariates			
Not paid by the hour (vs paid by the hour)	0.86 (0.74, 1.01)	0.98 (0.77, 1.24)	**0.76**** (0.63, 0.91)
Male	**0.80**** (0.70, 0.92)	0.95 (0.76, 1.18)	**0.75**** (0.62, 0.90)
Race/ethnicity (ref: non-Hispanic white)			
Non-Hispanic black or African American	1.13 (0.91, 1.42)	0.91 (0.63, 1.30)	**1.30*** (1.00, 1.68)
Non-Hispanic Asian	**0.75*** (0.60, 0.94)	0.71 (0.43, 1.17)	**0.75*** (0.58, 0.98)
Non-Hispanic other or multiple race	1.15 (0.78, 1.71)	1.65 (0.87, 3.12)	0.75 (0.57, 1.00)
Any Hispanic	1.14 (0.89, 1.46)	1.08 (0.81, 1.44)	1.13 (0.83, 1.52)
Age category, years (ref: 35–44)			
18–24	**0.74*** (0.56, 0.99)	0.96 (0.68, 1.35)	**0.47***** (0.33, 0.66)
25–34	**0.84*** (0.72, 0.97)	0.86 (0.69, 1.08)	0.90 (0.75, 1.08)
45–54	1.01 (0.85, 1.21)	1.13 (0.81, 1.59)	1.01 (0.83, 1.24)
55–64	1.36 (0.98, 1.90)	1.66 (0.90, 3.05)	1.28 (0.88, 1.85)
≥65	1.51 (0.66, 3.46)	2.29 (0.84, 6.26)	0.40 (0.10, 1.57)
Highest family educational attainment (ref: ≥Bachelor's)			
Less than high school	0.72 (0.51, 1.02)	0.71 (0.46, 1.09)	0.77 (0.45, 1.31)
High school or GED	1.11 (0.83, 1.48)	0.90 (0.64, 1.28)	1.16 (0.82, 1.64)
Associate's degree or some college (no degree)	**1.22*** (1.02, 1.46)	1.22 (0.95, 1.56)	1.18 (0.96, 1.46)
Family income as % of the Federal Poverty Level (ref: ≥200%)			
<100%	**1.74***** (1.34, 2.28)	**1.80***** (1.32, 2.43)	1.39 (0.95, 2.04)
100%–199%	**1.24*** (1.00, 1.54)	1.05 (0.80, 1.39)	**1.37*** (1.04, 1.80)
Family size (ref: 2)			
3	1.14 (0.79, 1.65)	**1.97*** (1.10, 3.50)	0.78 (0.57, 1.08)
4	1.04 (0.71, 1.53)	1.68 (0.96, 2.94)	0.75 (0.53, 1.05)
5	1.02 (0.68, 1.53)	1.61 (0.89, 2.90)	0.72 (0.49, 1.06)
≥6	0.94 (0.61, 1.45)	1.21 (0.67, 2.19)	0.84 (0.51, 1.36)
One adult with ≥1 child (vs multiple adults with ≥1 child)	1.03 (0.73, 1.45)	1.40 (0.82, 2.39)	0.83 (0.64, 1.07)
Respondent reported health status (ref: excellent)			
Very good	**1.33***** (1.14, 1.54)	**1.40**** (1.10, 1.76)	**1.31**** (1.11, 1.56)
Good	**2.07***** (1.71, 2.49)	**2.49***** (1.93, 3.21)	**1.87***** (1.50, 2.34)
Fair	**4.27***** (3.11, 5.85)	**4.50***** (3.09, 6.54)	**4.50***** (2.93, 6.92)
Poor	**17.70***** (8.03, 39.03)	**34.61***** (9.88, 121.23)	**16.75***** (7.13, 39.32)
Respondent adult received influenza vaccination, previous 12 months	1.08 (0.92, 1.25)	1.12 (0.88, 1.43)	1.09 (0.90, 1.32)

Source: 2013–2015 National Health Interview Survey data, working adult respondents with child respondents in the household and not missing on covariates.

Note: Adjusted PRRs are weighted to be nationally representative of working adults with children in the household and calculated from multivariate zero-inflated negative binomial regression (part 1 of the model: adults experiencing any sick leave). SEs used to calculate 95% CIs are adjusted for complex survey design. All models model the relationship of work loss days due to illness or injury in the previous 12 months and both the influenza vaccination status of household children and adult's paid sick leave status. Model 1 includes all working adults with household children. Models 2 and 3 stratify Model 1 by adults who do not have and who do have paid sick leave, respectively. All models also control for the Bureau of Labor Statistics' 23-category simplified occupation code and survey year. Boldface indicates statistical significance (*$p<0.05$; **$p<0.01$; ***$p<0.001$).

PRR, prevalence rate ratio.

Table 4. AORs of Experiencing No Work Loss, Working U.S. Adults With Household Children

Variable	Model 1, AOR (95% CI) (*n*=23,014)	Model 2, AOR (95% CI) (*n*=10,741)	Model 3, AOR (95% CI) (*n*=12,273)
Independent variables of interest			
Child received influenza vaccination, previous 12 months	1.04 (0.81, 1.31)	1.16 (0.78, 1.72)	0.80 (0.51, 1.28)
Has paid sick leave	**0.32***** (0.22, 0.47)	—	—
Covariates			
Not paid by the hour (vs paid by the hour)	1.21 (0.93, 1.56)	**1.57*** (1.00, 2.47)	1.01 (0.58, 1.75)
Male	1.10 (0.84, 1.42)	1.08 (0.69, 1.68)	1.89 (0.99, 3.60)
Race/ethnicity (ref: non-Hispanic white)			
Non-Hispanic black or African American	**2.97***** (2.01, 4.40)	**3.44**** (1.53, 7.71)	**4.03***** (1.97, 8.24)
Non-Hispanic Asian	**2.27**** (1.24, 4.13)	1.63 (0.32, 8.27)	**4.54**** (1.46, 14.08)
Non-Hispanic other or multiple race	1.75 (0.80, 3.83)	**4.20**** (1.45, 12.17)	**0.00***** (0.00, 0.00)
Any Hispanic	**3.41***** (2.38, 4.89)	**4.29***** (2.27, 8.14)	**4.80***** (2.32, 9.92)
Age category, years (ref: 35–44)			
18–24	0.68 (0.45, 1.04)	0.75 (0.39, 1.44)	0.08 (0.00, 11.98)
25–34	**0.71*** (0.51, 0.98)	**0.55*** (0.33, 0.93)	1.13 (0.62, 2.04)
45–54	**1.71***** (1.27, 2.29)	**2.28**** (1.33, 3.89)	1.79 (0.95, 3.37)
55–64	**4.28***** (2.67, 6.87)	**6.82***** (2.87, 16.19)	**4.15**** (1.71, 10.07)
≥65	**5.34**** (1.76, 16.24)	4.22* (1.39, 14.15)	2.88 (0.00, 8663)
Highest family educational attainment (ref: ≥Bachelor's)			
Less than high school	1.40 (0.89, 2.19)	1.15 (0.60, 2.23)	2.68 (0.92, 7.85)
High school or GED	**1.76**** (1.18, 2.62)	1.43 (0.74, 2.77)	**2.84*** (1.29, 6.24)
Associate's degree or some college (no degree)	1.15 (0.80, 1.63)	0.99 (0.59, 1.69)	**2.09*** (1.11, 3.94)
Family income as % of the Federal Poverty Level (ref: ≥200%)			
<100%	**1.98**** (1.35, 2.90)	**2.74**** (1.40, 5.37)	1.70 (0.76, 3.78)
100%–199%	1.43* (1.01, 2.02)	1.52 (0.82, 2.80)	1.22 (0.61, 2.43)
Family size (ref: 2)			
3	1.37 (0.82, 2.30)	2.28 (0.92, 5.63)	0.76 (0.27, 2.15)
4	1.21 (0.69, 2.11)	1.93 (0.78, 4.77)	0.76 (0.27, 2.14)
5	1.39 (0.79, 2.47)	1.93 (0.72, 5.22)	0.89 (0.29, 2.61)
≥6	1.39 (0.73, 2.66)	1.44 (0.50, 4.10)	1.51 (0.43, 5.30)
One adult with ≥1 child (vs Multiple adults with ≥1 child)	0.77 (0.50, 1.16)	0.81 (0.40, 1.64)	0.77 (0.36, 1.62)
Respondent reported health status (ref: excellent)			
Very good	0.83 (0.62, 1.12)	1.06 (0.63, 1.77)	0.59 (0.31, 1.12)
Good	0.83 (0.61, 1.13)	1.12 (0.68, 1.85)	0.60 (0.32, 1.15)
Fair	**0.40***** (0.25, 0.64)	**0.38**** (0.18, 0.77)	0.40 (0.13, 1.21)
Poor	**0.29*** (0.10, 0.86)	0.50 (0.09, 2.76)	0.09 (0.01, 1.11)
Respondent adult received influenza vaccination, previous 12 months	**0.54***** (0.39, 0.75)	0.57 (0.30, 1.08)	**0.44*** (0.23, 0.85)

Source: 2013–2015 National Health Interview Survey data, working adult respondents with child respondents in the household and not missing on covariates.

Note: AORs are weighted to be nationally representative of working adults with children in the household and calculated from multivariate zero-inflated negative binomial regression (part 2 of the model: the odds of being a "certain zero"—experiencing no work loss). SEs used to calculate 95% CIs are adjusted for complex survey design. All models model the relationship of work loss days due to illness or injury in the previous 12 months and both the influenza vaccination status of household children and adult's paid sick leave status. Model 1 includes all working adults with household children. Models 2 and 3 stratify Model 1 by adults who do not have and who do have paid sick leave, respectively. All models also control for the Bureau of Labor Statistics' 23-category simplified occupation code and survey year. Boldface indicates statistical significance (*p<0.05; $^{**}p$<0.01; $^{***}p$<0.001).

sick leave. Those without paid sick leave are less likely to take off work when they or their child are sick,[37] indicating both the importance of paid sick leave in caring for children but also in preventing working adults from bringing their illness into the workplace because they cannot afford to take off. Lack of paid sick leave is also associated with decreased usage of other preventive services in the U.S., such as mammography, Pap testing, endoscopy, fecal occult blood testing, and general medical screening.[38]

This is a social policy issue—more than a third of the U.S. work force does not have paid sick leave, and it is distributed inequitably by income, education, gender, occupation, and race/ethnicity, even causing fear of job loss for using sick leave among some racial/ethnic minorities.[38–41] Further complicating the potential negative public health effects of not ensuring paid sick leave as it relates to influenza specifically, lack of paid sick leave is associated with increased likelihood of Hispanics going to work when sick with influenza or ILI,[28] and many of the same populations mentioned above as being less likely to have paid sick leave are also more likely to have chronic conditions that increase the risk of severe influenza complications, more likely to have social experiences resulting in less vaccination, and less likely to be vaccinated against influenza.[42] All things considered, this study's hypothesis is reinforced: having paid sick leave may be a critical enabling factor not just for improved and more equitable sick leave usage, but also for child influenza vaccination and other downstream preventive health services use.

Limitations

This study has four limitations. First, the work loss question asks about work loss because of any illness or injury (excluding maternity leave) in the previous year. That there are many causes of work loss and this finding was observed in the stratified paid sick leave analysis despite not being observed in the overall population, however, indicates the strength of the relationship and the importance of sick leave in allowing working adults to potentially experience indirect benefits of household child influenza vaccination. The estimates in this study are therefore likely conservative and future studies might detect a larger effect when examining ILI-specific work loss just within the influenza season. Second, ideally vaccine uptake data would be provider-verified, so recall bias is present, although because the influenza vaccine is given annually, recall bias is less likely relative to other routine vaccinations, which are given less frequently. Third, examining work loss requires individuals to have worked within the previous year, which inherently excludes non-working adults who likely have different contexts for not working (e.g., voluntary stay-at-home spouses versus unemployed adults who want to work) and thus also different health contexts. Although it is impossible to capture work loss of these adults, and that is not the study objective, other studies may consider investigating the benefits of household child influenza vaccination in preventing other negative health outcomes that pertain to all U.S. household adults. Future studies should also consider looking at unpaid sick leave, which the NHIS does not capture. Last, these data are cross-sectional, and do not allow for causal claims. It is possible that respondents' work loss occurred before household child influenza vaccination, though even in those cases, the child was likely vaccinated the previous year if prior vaccine history is indicative of future vaccine behavior. Nonetheless, future studies should use methods, such as difference-in-difference or fixed effects, to assess changes in this relationship before and after paid sick leave policy implementation changes (this study's data did not allow for such analyses).

CONCLUSIONS

Influenza in children is known to affect family members and caregivers, causing substantial parental work loss and contributing to community epidemics.[4–6] The main motivation of this study is that despite these known secondary risks of influenza in children to their contacts, there remains a call for better characterization of how childhood influenza vaccination can prevent such secondary risks.[4,21] This study is the first to investigate the association of child influenza vaccination with sick leave in a nationally representative study of U.S. working adults with household children. Further, motivated by calls in the field to use the Health in All Policies approach,[25] this study illustrates the potential critical role of paid sick leave in allowing working household adults to capitalize on these indirect benefits.

Public health professionals, providers, and policymakers should take from these results two main preventive health implications. First, child influenza vaccination may have secondary benefits in preventing sick leave in household adults, which in turn keeps the workforce healthier and prevents the costly annual economic burden of influenza. Second, this study serves as a major example of why the Health in All Policies approach of considering the health effects of upstream social and economic policy is critical. The U.S. lags behind other developed nations in federally ensuring paid sick leave and this study observes a previously uncaptured potential downstream negative effect of this status quo: those without paid sick leave may not be able to capitalize on potential reduced work loss benefits of childhood influenza vaccination. The failure of

U.S. policy to ensure paid sick leave may thus contribute to spreading influenza in the household, workplace, and broader community. Further, given that sick leave is distributed inequitably to women, those with lower income or education, and to historically disadvantaged racial and ethnic minorities, U.S. paid sick leave policy likely contributes to substantial health inequities. Hopefully the results of this study provide one key example of many to build the case for practitioners and policymakers as to why influenza vaccination of children is not just important for protecting child health but also for maintaining a strong and equitably healthy work force, and economy.

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