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Influenza Vaccination Among Persons with Work-Related Asthma

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Abstract

Background—Seasonal influenza vaccination is recommended for all asthma patients. Persons with work-related asthma may have more severe disease than those with non-work-related asthma and may particularly benefit from receiving influenza vaccination.

Purpose—To determine if influenza vaccination coverage differs among individuals aged 18–64 years with work-related and non-work-related asthma.

Methods—Data from the 2006–2009 Behavioral Risk Factor Surveillance System Asthma Call-Back Survey collected in 38 states and the District of Columbia were analyzed in 2013.

Multivariable logistic regression and predictive marginal analyses were conducted to identify factors independently associated with influenza vaccination among respondents aged 18–64 years with work-related asthma.

Results—Among adults aged 18–64 years with current asthma, an estimated 42.7% received influenza vaccination in the past 12 months. Although influenza vaccination coverage was significantly higher among adults with work-related asthma than those with non-work-related asthma (48.5% vs 42.8%), this association became non-significant after adjustment for demographic and clinical characteristics (prevalence ratio=1.08, 95% CI=0.99, 1.20). Among individuals with work-related asthma, receiving the influenza vaccine was associated with being

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50–64 years old, being unemployed in the prior year, and seeking urgent treatment for worsening asthma symptoms.

Conclusions—Among persons with work-related and non-work-related asthma, less than half received influenza vaccination in the prior year, both below the Healthy People 2010 target of 60%. These results suggest the need for strengthening current vaccination interventions to meet the updated Healthy People 2020 objective of achieving at least 70% influenza vaccination coverage.

Introduction

In 2010, an estimated 18.7 (8.2%) million U.S. adults had asthma.¹ Asthma was the most frequently reported comorbid condition among patients hospitalized with 2009 H1N1 influenza.² Annual influenza vaccination is the most effective method for preventing infection with influenza virus, preventing infection-associated complications, and reducing work absenteeism.^{3–6} In 2006–2009, annual influenza vaccination was recommended for adults with asthma.^{4,7–11}

Work-related asthma (WRA) is asthma that is caused or exacerbated by work-related factors.¹² We previously reported that among adults with current asthma, 9% were diagnosed with WRA and an additional 38% describe their asthma as caused or worsened by workplace exposures (possible WRA).¹³ Persons with WRA have lower SES and may have more severe disease than those with non-WRA.^{13–15} Therefore, persons with WRA may be at higher risk for severe asthma exacerbation associated with influenza virus infection than those with non-WRA.^{16,17}

Although previous studies have examined influenza vaccination coverage in persons with asthma, no information is available for those with WRA.^{18–20} Data from the 2006–2009 Behavioral Risk Factor Surveillance System (BRFSS) Asthma Call-Back Survey (ACBS) were analyzed to determine influenza vaccination coverage differences among individuals with WRA and non-WRA.

Methods

A detailed description of the survey methods is available elsewhere.^{21–23} Classification of asthma, asthma-related healthcare utilization, asthma outcomes, and asthma control were based on previously used definitions.^{13–15} Participants with current asthma were classified as having WRA (diagnosed), possible WRA, and non-WRA (referent group). Influenza vaccine recipients were those who received an influenza vaccine injection or nasal spray. Number of physician contacts for asthma in the past 12 months was calculated based on information on the number of doctor's visits for routine asthma checkup, urgent treatment of worsening asthma symptoms, or an asthma episode or attack, as well as the number of asthma-related emergency room visits.

Statistical Analysis

Analyses were performed in 2013 following previously used methods using SAS, version 9.3 (SAS Institute Inc., Cary NC) and SUDAAN, Release 10.0.1 (Research Triangle

Institute, Research Triangle Park NC).^{15,23} We restricted analyses to adults aged 18–64 years with current asthma because of the age- and condition-specific recommendations for influenza vaccinations during 2006–2009.^{4,7–10}

Results

A total of 55,105 adults aged 18 years ever diagnosed with asthma participated in ACBS in 2006–2009; of these a total of 28,809 (representing an estimated annual average of 14.4 million) adults with current asthma aged 18–64 years were included in this analysis. The median response rates among the 38 states and District of Columbia providing data for this report ranged from 47.5% to 51.4% for BRFSS and 47.2% to 54.3% for ACBS.^{21,22}

Of all adults aged 18–64 years with current asthma, an estimated annual average 42.7% received influenza vaccination during 2006–2009 (range: 25.8% for persons with no health insurance to 60.3% for those who stayed overnight in a hospital) (Table 1). Although coverage was higher among adults with WRA than those with non-WRA (48.5% vs 42.8%, respectively), the association between WRA status and vaccination coverage was not significant after adjusting for covariates (adjusted prevalence ratio=1.08; 95% CI=0.98, 1.20).

Influenza vaccination coverage and multivariate logistic regression results for influenza vaccination by WRA status are shown in Table 2. Influenza vaccination coverage among persons with non-WRA (an estimated 7.7 million) ranged from 26.1% among persons with no health insurance to 61.2% among those who stayed overnight in a hospital because of asthma in the past 12 months.

On multivariate analysis, among persons with non-WRA, vaccination coverage was significantly higher in subgroups similar to those for all adults with current asthma. Influenza vaccination coverage among persons with WRA (an estimated 1.3 million) ranged from 36.6% among non-Hispanic blacks to 58.6% among Hispanics and was significantly associated with age 50–64 years, lack of employment, and receiving urgent treatment for worsening asthma. Overall, vaccination coverage was significantly higher among asthmatics with a history of at least one physician contact in the previous year compared with those with no contact (Table 2).

Discussion

In this population-based study, the estimated annual average influenza vaccination coverage during 2006–2009 in adults aged 18–64 years was 48.5% in those with WRA and 42.8% in those with non-WRA. These rates were higher than those of the general age-matched U.S. adult population during the 2006–2007 season (39.9%) but less than the Healthy People 2010 target of 60%.^{19,24} These results are similar to other studies showing that vaccine uptake in adults is suboptimal.^{19,20,25–27} The notable vaccination coverage difference among adults with WRA was the increased likelihood of vaccination among the unemployed. This may reflect the association between severity of WRA and job loss.^{28,29}

Barriers to vaccination include lack of knowledge about these vaccines among adult patients and healthcare providers, the perception of feeling healthy, vaccine safety concerns, vaccination costs, lack of health insurance, and lack of financing mechanisms.^{25,30} Low influenza vaccination coverage among employed adults and those with routine asthma checkups may indicate missed opportunities for vaccination.

Also, contrary to previous reports,^{27,31} among all asthma patients with at least one physician visit, influenza vaccination coverage did not increase with increasing number of physician contacts.⁹ No data were available in the ACBS to examine potential factors (e.g., vaccine availability, vaccination policies, public and clinician knowledge and practices, person's belief that they were in a high-risk group) that would explain why vaccination opportunities have been missed.^{8,30,32} The use of electronic health records with clinical decision support and physician prompts may improve influenza vaccination rates.³³

Additionally, influenza vaccination coverage may be increased by offering and improving vaccination in workplaces.³⁴ Blank et al.³⁰ reported that the most important motivating factors for receiving influenza vaccine in the U.S. were media advertising, physician's advice, and advice from family, friends, or relatives. The authors concluded that improvement in vaccine coverage rates can be achieved by accurate communication of health information, particularly by physicians. Similar results have been reported by others.^{32,35,36}

Across all analyzed groups, the lowest influenza vaccination coverage was noted among persons without health insurance. In the coming years, access to medical care and preventive services, including influenza vaccination, is expected to improve owing to passage of the Patient Protection and Affordable Care Act of 2010.^{27,37}

Information on asthma and influenza vaccination was not validated; thus, estimates may be subject to misclassification. However, previous studies have found self-report of adult influenza vaccination to be reliable compared with reviews of medical records.^{38,39} This analysis used combined data years and influenza vaccination reported in the past 12 months rather than influenza season-specific coverage, which may produce different vaccination prevalence (<http://cdc.gov/flu/fluview/index.htm>).

The cross-sectional design of BRFSS does not allow for examination of causal associations between adverse asthma outcomes and receiving influenza vaccination. For example, it is not clear whether influenza vaccination occurred before, during, or after unscheduled asthma treatment. Also, during 2006–2009, persons who resided in households that lacked a landline telephone and those who only used cellular telephones were not interviewed, likely resulting in vaccination coverage overestimation.⁴⁰ Finally, estimates are limited to the 38 states and District of Columbia and do not represent the entire U.S. population.

Conclusions

More effective influenza vaccination and communication strategies are needed to meet the updated Healthy People 2020 goal of increasing annual influenza vaccination coverage among adults aged 18 years to 70%.⁴¹

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Table 1
Characteristics of adults aged 18–64 years with current asthma and influenza vaccination coverage^a

Characteristics	<i>n</i> in sample ^b	Population % ^c (95% CI)	Influenza vaccination coverage	
			% ^d (95% CI)	PR ^e (95% CI)
Age group (years)				
18–49	13,956	70.1 (69.0, 71.1)	36.3 (34.5, 38.2)	1.00 (ref)
50–64	14,853	29.9 (28.9, 31.0)	57.5 (55.9, 59.1)	1.52 (1.43, 1.61)
Gender				
Male	7,525	37.9 (36.4, 39.4)	38.9 (36.3, 41.5)	1.00 ref
Female	21,284	62.1 (60.6, 63.6)	45.0 (43.5, 46.5)	1.13 (1.05, 1.21)
Race/ethnicity				
White, non-Hispanic	23,191	74.1 (72.8, 75.5)	44.4 (42.9, 46.0)	1.00 ref
Black, non-Hispanic	1,721	9.0 (8.2, 9.8)	34.5 (30.3, 38.7)	0.81 (0.71, 0.92)
Hispanic	1,446	9.6 (8.6, 10.6)	37.0 (31.6, 42.4)	0.94 (0.82, 1.09)
Other, non-Hispanic	2,271	7.3 (6.5, 8.1)	42.1 (36.5, 47.8)	1.01 (0.89, 1.15)
Education level				
High school	9,462	34.3 (32.9, 35.8)	39.7 (37.0, 42.4)	0.98 (0.91, 1.06)
>High school	19,331	65.7 (64.2, 67.5)	44.3 (42.7, 45.9)	1.00 ref
Household income (\$)				
<50,000	14,911	51.0 (49.5, 52.4)	38.4 (36.4, 40.4)	1.00 ref
50,000	11,564	49.0 (47.6, 50.5)	47.0 (45.0, 48.9)	1.13 (1.06, 1.21)
Health insurance				
Yes	25,327	85.9 (84.8, 87.1)	45.5 (44.0, 46.9)	1.00 ref
No	3,383	14.1 (12.9, 15.2)	25.8 (21.6, 30.0)	0.64 (0.54, 0.75)
Employment status^f				
Employed	17,538	64.0 (62.6, 65.4)	41.3 (39.6, 43.0)	1.00 ref
Not employed	11,271	36.0 (34.6, 37.4)	45.3 (42.9, 47.7)	1.04 (0.96, 1.12)
Work-related asthma				
Work-related asthma	3,003	8.9 (8.3, 9.6)	48.5 (44.7, 52.4)	1.08 (0.98, 1.20)
Possible work-related asthma	11,421	36.9 (35.5, 38.2)	41.1 (39.0, 43.3)	0.98 (0.92, 1.05)
Non-work-related asthma	14,226	54.2 (52.8, 55.6)	42.8 (40.8, 44.8)	1.00 ref
Other chronic disease^g				
Yes	6,170	15.3 (14.5, 16.1)	53.4 (50.7, 56.1)	1.16 (1.08, 1.24)
No	22,372	84.7 (83.9, 85.5)	40.8 (39.2, 42.3)	1.00 ref
Ability to see a doctor for asthma if needed^f				
Yes	25,442	87.7 (86.7, 88.6)	44.6 (43.1, 46.0)	1.27 (1.12, 1.46)
No	3,213	12.3 (11.4, 13.3)	29.8 (26.3, 33.3)	1.00 ref
Routine checkup for asthma^f				

Characteristics	<i>n</i> in sample ^b	Population % ^c (95% CI)	Influenza vaccination coverage	
			% ^d (95% CI)	PR ^e (95% CI)
Yes	24,559	86.5 (85.5, 87.5)	42.9 (41.4, 44.4)	1.02 (0.92, 1.13)
No	3,965	13.5 (12.5, 14.5)	41.1 (37.4, 44.8)	1.00 ref
Physician contacts^h				
None	11,567	42.5 (41.1, 43.9)	32.1 (30.2, 34.0)	1.00 ref
1	5,127	18.7 (17.5, 19.9)	49.8 (46.1, 53.5)	1.40 (1.27, 1.54)
2–3	5,434	18.7 (17.7, 19.7)	48.6 (45.7, 51.5)	1.40 (1.28, 1.52)
4–9	4,683	14.0 (13.1, 14.8)	52.4 (49.1, 55.7)	1.42 (1.30, 1.55)
10	1,898	6.1 (5.5, 6.7)	50.7 (45.7, 55.6)	1.48 (1.30, 1.69)
Asthma control				
Well controlled	13,817	50.6 (49.2, 52.1)	40.3 (38.4, 42.3)	1.00 ref
Not well controlled	7,438	27.1 (25.8, 28.4)	43.1 (40.3, 45.9)	1.10 (1.02, 1.19)
Very poorly controlled	7,543	22.2 (21.2, 23.3)	47.7 (45.1, 50.3)	1.16 (1.07, 1.25)
Adverse asthma outcomes^f				
Asthma attack				
Yes	15,653	53.0 (51.6, 54.5)	44.4 (42.5, 46.3)	1.08 (1.01, 1.15)
No	12,902	47.0 (45.5, 48.4)	40.7 (38.6, 42.8)	1.00 ref
Urgent treatment for worsening asthma				
Yes	7,251	23.4 (22.4, 24.5)	49.2 (46.6, 51.7)	1.18 (1.10, 1.26)
No	21,155	76.6 (75.5, 77.6)	40.3 (38.7, 41.9)	1.00 ref
Asthma-related emergency room visit				
Yes	3,578	12.2 (11.3, 13.1)	45.0 (41.1, 48.9)	1.08 (0.97, 1.20)
No	25,083	87.8 (86.9, 88.7)	42.1 (40.7, 43.6)	1.00 ref
Overnight stay in hospital because of asthma				
Yes	1,120	3.2 (2.7, 3.7)	60.3 (53.5, 67.0)	1.28 (1.11, 1.45)
No	27,531	96.8 (96.3, 97.3)	41.9 (40.5, 43.3)	1.00 ref
Total	28,809		42.7 (41.3, 44.1)	

Note: Boldface indicates significance.

^aData were collected in 38 states (Alaska, Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin) and the District of Columbia during 2006–2009.

^bUnweighted sample size (the numbers may not add up to the total because of missing values)

^cDistribution presented as weighted average annual estimate

^dProportion presented as weighted average annual estimate

^eAdjusted for age, gender, race/ethnicity, annual household income, health insurance, and chronic disease. For each model, the outcome variable was influenza vaccination.

^fIn the past 12 months

^gDiabetes or cardiovascular disease

^hIncludes doctor's visits for routine asthma checkup, doctor's visits for urgent treatment of worsening asthma symptoms or an asthma episode or attack, and emergency room visits because of asthma in the past 12 months

PR, prevalence ratio

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Table 2
Influenza vaccination coverage and multivariate logistic regression results for influenza vaccination by work-related asthma status^a

Characteristics	Work-related asthma				Possible work-related asthma				Non-work-related asthma			
	<i>n</i> in sample ^b	% (95% CI) ^c	PR ^{c,d} (95% CI)	<i>n</i> in sample ^b	% ^c (95% CI)	PR ^{c,d} (95% CI)	<i>n</i> in sample ^b	% ^c (95% CI)	PR ^{c,d} (95% CI)	<i>n</i> in sample ^b	% ^c (95% CI)	PR ^{c,d} (95% CI)
Age group (years)												
18–49	1,206	42.0 (36.3, 47.6)	1.00 (ref)	5,351	33.9 (31.0, 36.7)	1.00 (ref)	7,340	37.1 (34.6, 39.7)	1.00 (ref)			
50–64	1,797	57.2 (52.3, 62.1)	1.36 (1.15, 1.61)	6,070	56.5 (54.1, 59.0)	1.48 (1.36, 1.62)	6,886	58.5 (60.3, 65.4)	1.56 (1.44, 1.69)			
Gender												
Male	936	46.9 (40.4, 53.3)	1.00 ref	3,020	37.7 (33.5, 42.0)	1.00 ref	3,522	38.3 (34.5, 42.0)	1.00 ref			
Female	2,067	49.5 (44.7, 54.3)	1.08 (0.91, 1.29)	8,401	43.4 (41.1, 45.6)	1.05 (0.93, 1.17)	10,704	45.4 (43.1, 47.6)	1.19 (1.07, 1.32)			
Race/ethnicity												
White, non-Hispanic	2,318	48.4 (44.0, 52.8)	1.00 ref	9,051	44.4 (42.0, 46.7)	1.00 ref	11,707	43.9 (41.6, 46.1)	1.00 ref			
Black, non-Hispanic	224	36.6 (25.0, 48.3)	0.77 (0.55, 1.08)	733	35.6 (29.0, 42.2)	0.84 (0.68, 1.02)	745	33.2 (27.0, 39.4)	0.80 (0.65, 0.97)			
Hispanic	155	58.6 (45.1, 72.2)	1.22 (0.92, 1.62)	582	28.4 (21.5, 35.3)	0.77 (0.62, 0.96)	698	38.9 (31.0, 46.9)	1.00 (0.81, 1.24)			
Other, non-Hispanic	290	52.9 (40.7, 65.2)	1.01 (0.78, 1.32)	979	35.8 (26.4, 45.1)	0.89 (0.70, 1.12)	989	45.3 (38.0, 52.5)	1.12 (0.94, 1.34)			
Education level												
High school	1,084	42.7 (36.3, 49.1)	0.87 (0.72, 1.05)	3,930	36.3 (32.5, 40.2)	0.94 (0.85, 1.05)	4,384	41.6 (37.5, 45.7)	1.03 (0.93, 1.15)			
>High school	1,919	52.4 (47.6, 57.2)	1.00 ref	7,486	44.0 (41.4, 46.6)	1.00 ref	9,831	43.3 (41.0, 45.5)	1.00 ref			
Household income (\$)												
<50,000	1,851	46.7 (41.5, 51.9)	1.00 ref	6,536	36.1 (33.1, 39.1)	1.00 ref	6,441	38.5 (35.6, 41.4)	1.00 ref			
50,000	946	51.8 (45.4, 58.3)	1.07 (0.91, 1.27)	4,008	48.6 (45.4, 51.7)	1.19 (1.07, 1.32)	6,559	45.4 (42.8, 48.0)	1.11 (1.01, 1.23)			
Health insurance												
Yes	2,558	50.9 (46.8, 55.0)	1.00 ref	9,817	45.1 (42.8, 47.3)	1.00 ref	12,818	44.8 (42.7, 46.9)	1.00 ref			
No	437	37.0 (26.4, 47.6)	0.72 (0.52, 1.00)	1,565	23.1 (16.9, 29.4)	0.58 (0.45, 0.76)	1,356	26.1 (19.4, 32.7)	0.67 (0.52, 0.85)			
Employment status^e												
Employed	1,635	43.1 (38.1, 48.1)	1.00 ref	6,995	38.2 (35.5, 40.8)	1.00 ref	8,811	43.2 (40.8, 45.6)	1.00 ref			
Not employed	1,368	55.6 (49.9, 61.3)	1.44 (1.20, 1.73)	4,426	47.2 (43.7, 50.7)	1.08 (0.95, 1.22)	5,415	42.0 (38.5, 45.6)	0.93 (0.83, 1.04)			
Other chronic disease^f												

Characteristics	Work-related asthma			Possible work-related asthma			Non-work-related asthma		
	<i>n</i> in sample ^b	Influenza vaccination coverage		<i>n</i> in sample ^b	Influenza vaccination coverage		<i>n</i> in sample ^b	Influenza vaccination coverage	
		% (95% CI) ^c	PR ^{c,d} (95% CI)		% ^c (95% CI)	PR ^{c,d} (95% CI)		% ^c (95% CI)	PR ^{c,d} (95% CI)
Yes	848	51.8 (44.4, 59.2)	1.07 (0.87, 1.31)	2,631	46.3 (52.5, 60.1)	1.25 (1.13, 1.39)	2,647	51.5 (47.2, 55.8)	1.10 (0.99, 1.23)
No	2,125	47.3 (42.7, 51.9)	1.00 ref	8,657	38.2 (35.8, 40.7)	1.00 ref	11,479	41.4 (39.2, 43.7)	1.00 ref
Ability to see a doctor for asthma if needed^e									
Yes	2,433	50.8 (46.5, 55.1)	1.08 (0.84, 1.40)	9,746	44.4 (42.0, 46.8)	1.28 (1.07, 1.55)	13,178	43.7 (41.6, 45.8)	1.37 (1.09, 1.71)
No	563	40.9 (31.6, 50.2)	1.00 ref	1,640	26.0 (21.6, 30.4)	1.00 ref	999	30.8 (24.7, 36.9)	1.00 ref
Routine checkup for asthma^e									
Yes	2,636	49.1 (45.1, 53.2)	1.18 (0.87, 1.60)	9,745	41.6 (39.3, 43.9)	1.07 (0.88, 1.31)	12,050	42.7 (40.5, 44.8)	0.97 (0.86, 1.09)
No	332	42.7 (29.4, 55.9)	1.00 ref	1,579	37.7 (31.6, 43.8)	1.00 ref	2,043	43.2 (38.3, 48.2)	1.00 ref
Physician contacts^g									
None	952	39.5 (32.5, 46.5)	1.00 ref	4,330	27.9 (25.1, 30.8)	1.00 ref	6,240	33.7 (31.1, 36.4)	1.00 ref
1	410	50.0 (39.8, 60.2)	1.32 (1.02, 1.71)	1,924	50.1 (44.6, 55.6)	1.58 (1.32, 1.90)	2,778	49.7 (44.5, 54.9)	1.33 (1.19, 1.49)
2-3	574	53.1 (44.0, 62.2)	1.39 (1.09, 1.78)	2,256	46.3 (41.9, 50.7)	1.45 (1.27, 1.66)	2,579	49.8 (45.6, 54.0)	1.38 (1.22, 1.56)
4-9	704	56.3 (49.0, 63.5)	1.48 (1.17, 1.87)	2,028	53.0 (47.7, 58.3)	1.61 (1.40, 1.85)	1,908	50.3 (45.3, 55.3)	1.29 (1.12, 1.48)
10	353	50.0 (38.5, 61.4)	1.33 (1.00, 1.77)	854	53.5 (46.9, 60.1)	1.71 (1.44, 2.03)	671	48.8 (39.7, 57.8)	1.43 (1.14, 1.81)
Asthma control									
Well controlled	1,137	46.8 (40.6, 53.1)	1.00 ref	4,848	37.2 (34.0, 40.4)	1.00 ref	7,766	41.1 (38.5, 43.8)	1.00 ref
Not well controlled	763	45.4 (38.1, 52.7)	1.05 (0.85, 1.30)	3,167	43.5 (39.3, 47.8)	1.15 (1.01, 1.31)	3,462	42.6 (38.5, 46.7)	1.08 (0.97, 1.21)
Very poorly controlled	1,102	52.9 (46.4, 59.3)	1.20 (0.99, 1.46)	3,403	45.2 (41.4, 48.9)	1.16 (1.03, 1.30)	2,996	48.6 (44.4, 52.7)	1.15 (1.01, 1.30)
Adverse asthma outcomes^d									
Asthma attack									
Yes	1,983	49.8 (45.1, 54.5)	1.05 (0.88, 1.26)	6,865	43.5 (40.7, 46.3)	1.13 (1.01, 1.27)	6,721	43.7 (40.8, 46.7)	1.06 (0.97, 1.16)
No	999	45.9 (39.1, 52.7)	1.00 ref	4,458	37.7 (34.2, 41.2)	1.00 ref	7,387	41.7 (39.0, 44.5)	1.00 ref
Urgent treatment for worsening asthma									
Yes	1,054	55.0 (48.6, 61.4)	1.25 (1.06, 1.48)	3,202	49.4 (45.7, 53.1)	1.23 (1.12, 1.36)	2,929	47.3 (43.2, 51.3)	1.11 (1.00, 1.23)
No	1,905	45.4 (40.6, 50.3)	1.00 ref	8,046	37.7 (35.1, 40.4)	1.00 ref	11,127	41.2 (38.9, 43.5)	1.00 ref
Asthma-related emergency room visit									

Characteristics	Work-related asthma			Possible work-related asthma			Non-work-related asthma		
	<i>n</i> in sample ^b	Influenza vaccination coverage		<i>n</i> in sample ^b	Influenza vaccination coverage		<i>n</i> in sample ^b	Influenza vaccination coverage	
		% (95% CI) ^c	PR ^{c,d} (95% CI)		% ^c (95% CI)	PR ^{c,d} (95% CI)		% ^c (95% CI)	PR ^{c,d} (95% CI)
Yes	555	49.9 (41.5, 58.3)	1.09 (0.91, 1.32)	1,627	47.2 (41.1, 53.4)	1.19 (1.01, 1.40)	1,376	41.1 (35.4, 46.9)	1.00 (0.84, 1.14)
No	2,428	48.5 (44.2, 52.9)	1.00 ref	9,751	39.9 (37.6, 42.1)	1.00 ref	12,786	42.6 (40.5, 44.7)	1.00 ref
Overnight stay in hospital because of asthma									
Yes	212	57.0 (42.0, 72.0)	1.15 (0.81, 1.63)	489	60.7 (50.1, 71.4)	1.30 (1.11, 1.53)	408	61.2 (50.7, 71.6)	1.29 (1.03, 1.61)
No	2,775	48.2 (44.2, 52.2)	1.00 ref	10,880	40.2 (38.0, 42.3)	1.00 ref	13,749	42.1 (40.0, 44.1)	1.00 ref

Note: Boldface indicates significance.

^aData were collected in 38 states (Alaska, Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin) and the District of Columbia during 2006–2009.

^bUnweighted sample size (the numbers may not add up to the total because of missing values)

^cProportion presented as weighted average annual estimate

^dAdjusted for age, gender, race/ethnicity, annual household income, health insurance, and other chronic disease. For each model, the outcome variable was influenza vaccination.

^eIn the past 12 months

^fDiabetes or cardiovascular disease

^gIncludes doctor's visits for routine checkup for asthma, doctor's visits for worsening asthma symptoms or an asthma episode or attack, and emergency room visits because of asthma in the past 12 months

PR, prevalence ratio