

# H1N1 and Seasonal Influenza Vaccination of U.S. Healthcare Personnel, 2010

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**Background:** Seasonal influenza vaccination routinely has been recommended for healthcare personnel (HCP) since 1984. The influenza A (H1N1) 2009 monovalent vaccine (H1N1 vaccine) became available in the U.S. in October 2009.

**Purpose:** To assess 2009 H1N1 and seasonal influenza vaccination coverage and identify factors independently associated with vaccination among HCP in the U.S.

**Methods:** Data from the 2009–2010 Behavioral Risk Factor Surveillance System (BRFSS) influenza supplemental survey were analyzed in 2011. Multivariable logistic regression and predictive marginal models were performed to identify factors independently associated with vaccination among HCP. The Kaplan–Meier survival analysis procedure was used to estimate the cumulative proportion of people vaccinated.

**Results:** Among 16,975 HCP surveyed, 2009 H1N1, seasonal, and any-dose vaccination coverage were 34.1% (95% CI=32.7%, 35.5%); 52.4% (95% CI=50.9%, 53.9%); and 58.0% (95% CI=56.5%, 59.5%), respectively, all of which were significantly higher than those for non-HCP (19.1%, 34.9%, and 40.3%, respectively). The H1N1 vaccination coverage among HCP ranged from 18.4% in Mississippi to 56.1% in Massachusetts and seasonal influenza vaccination coverage ranged from 40.4% in Florida to 73.1% in Nebraska. Characteristics independently associated with an increased likelihood of 2009 H1N1, seasonal, and any-dose vaccinations among HCP were as follows: non-Hispanic white, higher income, having a high-risk condition, having health insurance, the ability to see a doctor if needed, and having had a routine checkup in the previous year.

**Conclusions:** Vaccination coverage was higher among HCP than non-HCP but still below the national health objective of 90%. Knowledge of national and state-specific H1N1 and seasonal vaccination coverage among HCP is useful for evaluating the vaccination campaign and implementing strategies for increasing yearly seasonal vaccination coverage and improving vaccination coverage among HCP in possible future pandemics.

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## Introduction

Healthcare personnel (HCP) can acquire influenza from patients or transmit influenza to patients.<sup>1–3</sup> Vaccination of HCP for influenza is important to reduce transmission of influenza in health-care settings.<sup>3</sup> Influenza outbreaks in hospitals and long-term care settings have been associated with low vaccination coverage among HCP.<sup>3–5</sup>

Annual influenza vaccination has been recommended by the Advisory Committee on Immunization Practices (ACIP) for HCP since 1984.<sup>6</sup> In April 2009, a novel influenza A (H1N1) virus emerged in the U.S., and within weeks it had spread to every region in the country.<sup>7</sup> In July 2009, the ACIP issued recommendations regarding the use of a new monovalent vaccine against infection with the 2009 influenza A (H1N1) virus.<sup>7</sup> HCP was one of five initial target groups to be recommended to receive the influenza A (H1N1) 2009 monovalent vaccine (2009 H1N1 vaccine) when it became available in October 2009.<sup>7</sup>

The current study mainly addresses and examines the following questions: (1) What is the national 2009 H1N1, seasonal, and any-dose vaccination coverage (seasonal and/or H1N1) among HCP and non-HCP? (2) What are

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**Table 1.** H1N1 and seasonal influenza vaccination coverage by demographic and access-to-care variables among those aged  $\geq 18$  years, BRFSS 2010, % (95% CI)

DEMOGRAPHIC	H1N1 vaccination coverage		Seasonal influenza vaccination coverage		Any influenza vaccination coverage (seasonal and/or H1N1)	
	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel
<b>Total</b>	34.1 (32.7, 35.5)	19.1 (18.7, 19.6) <sup>a</sup>	52.4 (50.9, 53.9)	34.9 (34.4, 35.5) <sup>a</sup>	58.0 (56.5, 59.5)	40.3 (39.7, 40.9) <sup>a</sup>
<b>Age (years)</b>						
18–49 <sup>b</sup>	33.7 (31.7, 35.7)	16.3 (15.6, 17.0) <sup>a</sup>	48.0 (45.8, 50.2)	23.9 (23.2, 24.7) <sup>a</sup>	54.3 (52.1, 56.5)	30.1 (29.2, 31.0) <sup>a</sup>
50–64	35.0 (32.9, 37.1)	20.0 (19.3, 20.7) <sup>a,c</sup>	54.7 (52.6, 56.9) <sup>c</sup>	39.4 (38.5, 40.2) <sup>a,c</sup>	59.2 (57.1, 61.4) <sup>c</sup>	43.8 (42.9, 44.7) <sup>a,c</sup>
$\geq 65$	34.6 (32.1, 37.1)	27.2 (26.4, 27.9) <sup>a,c</sup>	70.1 (67.7, 72.5) <sup>c</sup>	64.2 (63.4, 65.0) <sup>a,c</sup>	74.3 (71.9, 76.5) <sup>c</sup>	68.4 (67.7, 69.2) <sup>a,c</sup>
<b>Gender</b>						
Male <sup>b</sup>	37.2 (34.3, 40.3)	18.7 (18.0, 19.4) <sup>a</sup>	50.2 (47.1, 53.3)	32.6 (31.8, 33.5) <sup>a</sup>	57.9 (54.8, 60.9)	37.8 (37.0, 38.8) <sup>a</sup>
Female	32.8 (31.3, 34.3) <sup>c</sup>	19.6 (19.1, 20.2) <sup>a,c</sup>	53.3 (51.6, 55.0)	37.3 (36.7, 38.0) <sup>a,c</sup>	58.1 (56.3, 59.8)	42.9 (42.2, 43.6) <sup>a,c</sup>
<b>Race/ethnicity</b>						
White, non-Hispanic <sup>b</sup>	37.3 (35.8, 38.8)	19.7 (19.2, 20.1) <sup>a</sup>	56.9 (55.3, 58.5)	38.7 (38.1, 39.3) <sup>a</sup>	62.3 (60.7, 63.9)	43.2 (42.6, 43.8) <sup>a</sup>
Black, non-Hispanic	21.7 (18.6, 25.2) <sup>c</sup>	15.4 (13.9, 17.1) <sup>a,c</sup>	39.4 (35.2, 43.7) <sup>c</sup>	27.6 (25.7, 29.5) <sup>a,c</sup>	43.9 (39.6, 48.3) <sup>c</sup>	33.1 (31.1, 35.1) <sup>a,c</sup>
Hispanic	27.7 (22.9, 33.1) <sup>c</sup>	18.5 (16.9, 20.3) <sup>a</sup>	44.4 (38.7, 50.3) <sup>c</sup>	23.5 (21.8, 25.2) <sup>a,c</sup>	49.7 (43.9, 55.5) <sup>c</sup>	32.1 (30.1, 34.1) <sup>a,c</sup>
Other	36.7 (30.7, 43.1)	20.4 (18.5, 22.4) <sup>a</sup>	47.6 (41.1, 54.3) <sup>c</sup>	32.1 (29.8, 34.5) <sup>a,c</sup>	56.6 (49.6, 63.3)	39.3 (36.8, 41.8) <sup>a,c</sup>
<b>Education level</b>						
Less than high school <sup>b</sup>	23.0 (17.8, 29.2)	18.1 (16.7, 19.5)	38.4 (32.2, 45.1)	27.8 (26.3, 29.3) <sup>a</sup>	46.8 (40.0, 53.8)	35.8 (34.1, 37.6) <sup>a</sup>
High school graduate	24.2 (21.7, 26.9)	17.0 (16.2, 17.9) <sup>a</sup>	44.2 (41.1, 47.3)	33.4 (32.4, 34.4) <sup>a,c</sup>	50.5 (47.3, 53.6)	38.4 (37.4, 39.5) <sup>a,c</sup>
College	38.6 (37.0, 40.3) <sup>c</sup>	20.9 (20.3, 21.5) <sup>a,c</sup>	56.5 (54.8, 58.3) <sup>c</sup>	37.9 (37.2, 38.6) <sup>a,c</sup>	61.7 (59.9, 63.4) <sup>c</sup>	42.8 (42.0, 43.5) <sup>a,c</sup>
<b>Income (\$)</b>						
<20,000 <sup>b</sup>	21.8 (18.1, 26.0)	17.5 (16.5, 18.6) <sup>a</sup>	38.6 (33.9, 43.6)	29.0 (27.8, 30.2) <sup>a</sup>	43.7 (38.9, 48.7)	35.6 (34.2, 37.0) <sup>a</sup>
20,000–50,000	29.3 (27.0, 31.6) <sup>c</sup>	18.5 (17.7, 19.4) <sup>a</sup>	47.8 (45.2, 50.4) <sup>c</sup>	35.2 (34.2, 36.2) <sup>a,c</sup>	54.0 (51.4, 56.6) <sup>c</sup>	40.2 (39.1, 41.2) <sup>a,c</sup>
$\geq 50,000$	42.1 (40.0, 44.2) <sup>c</sup>	20.5 (19.8, 21.2) <sup>a,c</sup>	60.8 (58.6, 62.9) <sup>c</sup>	37.3 (36.4, 38.2) <sup>a,c</sup>	65.8 (63.6, 67.9) <sup>c</sup>	40.2 (39.1, 41.2) <sup>a,c</sup>
<b>Marital status</b>						
Married <sup>b</sup>	37.9 (36.2, 39.6)	20.2 (19.7, 20.8) <sup>a</sup>	57.0 (55.2, 58.8)	37.0 (36.3, 37.7) <sup>a</sup>	62.8 (61.0, 64.5)	42.2 (41.5, 42.9) <sup>a</sup>
Widowed/divorced/separated	29.1 (26.3, 31.9) <sup>c</sup>	19.1 (18.3, 19.9) <sup>a,c</sup>	51.1 (48.0, 54.1) <sup>c</sup>	41.6 (40.6, 42.7) <sup>a,c</sup>	55.2 (52.1, 58.3) <sup>c</sup>	46.3 (45.3, 47.4) <sup>a,c</sup>
Never married	28.0 (24.5, 31.8) <sup>c</sup>	16.2 (15.0, 17.6) <sup>a,c</sup>	40.2 (36.1, 44.4) <sup>c</sup>	23.2 (21.8, 24.6) <sup>a,c</sup>	46.4 (42.1, 50.7) <sup>c</sup>	29.6 (28.0, 31.2) <sup>a,c</sup>

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**Table 1.** H1N1 and seasonal influenza vaccination coverage by demographic and access-to-care variables among those aged  $\geq 18$  years, BRFSS 2010, % (95% CI) (continued)

DEMOGRAPHIC	H1N1 vaccination coverage		Seasonal influenza vaccination coverage		Any influenza vaccination coverage (seasonal and/or H1N1)	
	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel
<b>Perceived health</b>						
Excellent/very good <sup>b</sup>	35.7 (33.9, 37.6)	18.3 (17.7, 19.0) <sup>a</sup>	53.1 (51.1, 55.0)	32.9 (32.1, 33.7) <sup>a</sup>	58.3 (56.3, 60.3)	38.1 (37.3, 39.0) <sup>a</sup>
Good	31.3 (28.8, 33.8) <sup>c</sup>	18.4 (17.7, 19.2) <sup>a</sup>	51.0 (48.1, 53.9)	34.2 (33.2, 35.1) <sup>a,c</sup>	56.1 (53.3, 58.9)	39.5 (38.4, 40.5) <sup>a</sup>
Fair	34.4 (30.2, 38.9)	21.4 (20.2, 22.6) <sup>a,c</sup>	53.3 (48.8, 57.7)	40.3 (38.8, 41.8) <sup>a,c</sup>	62.7 (58.3, 66.8)	45.9 (44.3, 47.5) <sup>a,c</sup>
Poor	30.7 (20.4, 43.4)	25.3 (23.4, 27.4) <sup>c</sup>	51.5 (41.3, 61.5)	45.1 (42.9, 47.2) <sup>c</sup>	57.5 (47.4, 67.0)	51.2 (49.0, 53.4) <sup>a,c</sup>
<b>People with high-risk conditions</b>						
Yes	37.2 (34.3, 40.2)	26.0 (25.1, 27.0) <sup>a,c</sup>	60.8 (57.6, 63.9) <sup>c</sup>	49.4 (48.4, 50.5) <sup>a,c</sup>	65.9 (62.7, 69.0) <sup>c</sup>	55.1 (54.0, 56.1) <sup>a,c</sup>
No <sup>b</sup>	33.2 (31.7, 34.8)	16.7 (16.2, 17.2) <sup>a</sup>	49.8 (48.1, 51.5)	29.8 (29.2, 30.5) <sup>a</sup>	55.6 (53.8, 57.3)	35.1 (34.4, 35.8) <sup>a</sup>
<b>Insurance status</b>						
Yes	37.3 (35.8, 38.8) <sup>c</sup>	21.1 (20.6, 21.6) <sup>a,c</sup>	56.9 (55.3, 58.4) <sup>c</sup>	39.6 (39.0, 40.2) <sup>a,c</sup>	62.6 (61.0, 64.2) <sup>c</sup>	45.0 (44.4, 45.6) <sup>a,c</sup>
No <sup>b</sup>	15.1 (12.5, 18.1)	10.3 (9.4, 11.3) <sup>a</sup>	25.5 (22.0, 29.4)	14.0 (13.0, 15.1) <sup>a</sup>	29.8 (26.1, 33.8)	19.2 (18.0, 20.5) <sup>a</sup>
<b>Need to see a doctor but could not</b>						
Yes <sup>b</sup>	18.7 (16.1, 21.7)	12.8 (11.8, 13.9) <sup>a</sup>	33.1 (29.5, 37.0)	20.3 (19.1, 21.6) <sup>a</sup>	39.0 (35.2, 42.9)	25.6 (24.3, 27.0) <sup>a</sup>
No	37.3 (35.8, 38.9) <sup>c</sup>	20.4 (19.9, 20.9) <sup>a,c</sup>	56.4 (54.7, 58.0) <sup>c</sup>	37.9 (37.3, 38.5) <sup>a,c</sup>	61.9 (60.2, 63.5) <sup>c</sup>	43.3 (42.6, 43.9) <sup>a,c</sup>
<b>Primary doctor</b>						
Yes	36.1 (34.7, 37.6) <sup>c</sup>	21.4 (20.9, 21.9) <sup>a,c</sup>	55.9 (54.3, 57.5) <sup>c</sup>	40.4 (39.7, 41.0) <sup>a,c</sup>	61.4 (59.8, 63.0) <sup>c</sup>	45.8 (45.1, 46.4) <sup>a,c</sup>
No <sup>b</sup>	22.0 (18.8, 25.7)	10.7 (9.7, 11.7) <sup>a</sup>	31.5 (27.5, 35.6)	14.3 (13.3, 15.4) <sup>a</sup>	37.6 (33.4, 42.1)	19.5 (18.3, 20.8) <sup>a</sup>
<b>Activity limitation</b>						
Yes	33.8 (30.7, 37.1)	22.2 (21.4, 23.1) <sup>a,c</sup>	55.1 (51.6, 58.4)	43.7 (42.6, 44.8) <sup>a,c</sup>	61.0 (57.6, 64.3)	48.4 (47.3, 49.5) <sup>a,c</sup>
No <sup>b</sup>	34.2 (32.7, 35.8)	18.2 (17.7, 18.8) <sup>a</sup>	51.8 (50.1, 53.5)	32.4 (31.8, 33.0) <sup>a</sup>	57.3 (55.6, 59.0)	37.9 (37.3, 38.6) <sup>a</sup>
<b>Time since last checkup (years)</b>						
<1	37.6 (36.0, 39.3) <sup>c</sup>	23.1 (22.5, 23.7) <sup>a,c</sup>	58.7 (57.0, 60.4) <sup>c</sup>	43.0 (42.3, 43.6) <sup>a,c</sup>	64.1 (62.4, 65.7) <sup>c</sup>	48.8 (48.1, 49.5) <sup>a,c</sup>
$\geq 1$ <sup>b</sup>	26.6 (24.2, 29.1)	11.6 (11.0, 12.3) <sup>a</sup>	38.0 (35.3, 40.8)	20.0 (19.2, 20.8) <sup>a</sup>	44.2 (41.3, 47.2)	24.4 (23.5, 25.3) <sup>a</sup>
<b>Smoking status</b>						
Current smoker <sup>b</sup>	27.8 (24.4, 31.5)	12.9 (11.9, 14.0) <sup>a</sup>	42.7 (39.0, 46.5)	23.7 (22.6, 24.8) <sup>a</sup>	49.5 (45.8, 53.3)	28.0 (26.7, 29.3) <sup>a</sup>
Former smoker	38.8 (36.0, 41.7) <sup>c</sup>	22.6 (21.8, 23.5) <sup>a,c</sup>	60.3 (57.4, 63.2) <sup>c</sup>	44.1 (43.1, 45.1) <sup>a,c</sup>	65.8 (62.9, 68.6) <sup>c</sup>	49.0 (48.0, 50.0) <sup>a,c</sup>
Never smoked	34.3 (32.5, 36.1) <sup>c</sup>	19.8 (19.2, 20.5) <sup>a,c</sup>	52.4 (50.4, 54.4) <sup>c</sup>	34.8 (34.1, 35.6) <sup>a,c</sup>	57.7 (55.7, 59.7) <sup>c</sup>	40.8 (40.0, 41.6) <sup>a,c</sup>

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Table 1. (continued)

DEMOGRAPHIC	H1N1 vaccination coverage		Seasonal influenza vaccination coverage		Any influenza vaccination coverage (seasonal and/or H1N1)	
	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel
MSA						
In MSA	34.0 (32.5, 35.5)	19.2 (18.7, 19.7) <sup>a</sup>	52.3 (50.7, 53.9)	35.0 (34.4, 35.6) <sup>a</sup>	58.0 (56.4, 59.6)	40.4 (39.8, 41.0) <sup>a</sup>
Not in an MSA <sup>b</sup>	35.7 (31.4, 40.2)	18.5 (17.2, 19.9) <sup>a</sup>	53.2 (48.6, 57.8)	34.0 (32.4, 35.6) <sup>a</sup>	57.7 (53.0, 62.3)	39.5 (37.8, 41.3) <sup>a</sup>

Note: This table is based on interviews conducted during March through June 2010 only.

<sup>a</sup>*p*<0.05 by *t*test for comparisons between HCP and non-HCP

<sup>b</sup>Reference level

<sup>c</sup>*p*<0.05 by *t*test for comparisons within each variable with indicated reference level

BRFSS, Behavioral Risk Factor Surveillance System, HCP, healthcare professional, MSA, metropolitan statistical area

state-specific vaccination levels among HCP and non-HCP? Do state-specific vaccination levels among HCP vary? (3) What factors affect vaccination coverage among HCP and non-HCP?

## Methods

Data from the 2009–2010 BRFSS influenza supplemental survey collected from March through June 2010 were used for national analysis. Influenza vaccination data were not collected for Delaware and Vermont. The BRFSS is a continuous, population-based telephone survey coordinated by state health departments in collaboration with the CDC.<sup>8</sup>

Point estimates and 95% CIs were calculated using SUDAAN, version 10.01. The following method was used to calculate vaccination coverage in both bivariate and multivariable analyses. For the estimate of national H1N1 vaccination coverage during the 2009–2010 season, only individuals who were interviewed March 2010–June 2010 and vaccinated October 2009–February 2010 were included. For the estimate of national seasonal vaccination coverage during the 2009–2010 season, only individuals interviewed March 2010–June 2010 and vaccinated August 2009–February 2010 were included. To increase sample size and get reliable state-specific H1N1 and seasonal influenza vaccination coverage, the cumulative proportion of people vaccinated during the 2009–2010 season was used in the Kaplan-Meier survival analysis procedure. Multivariable analyses using logistic regression models were performed between HCP and non-HCP to get adjusted percentages.<sup>9,10</sup>

## Results

Of the 130,774 adults, 12.3% (16,975) were HCP. Of those who worked within the healthcare setting, 41.3% had no direct patient contact and 58.7% had direct patient contact. Overall, H1N1, seasonal, and any-dose vaccination coverage were 34.1%, 52.4%, and 58.0%, respectively, which were higher than those for non-HCP (19.1%, 34.9%, and 40.3%, respectively). Across the majority of subgroups, H1N1, seasonal, and any-dose vaccination coverage were higher among HCP compared with non-HCP (Table 1). H1N1, seasonal, and any-dose vaccination coverage among HCP with direct patient contact were 38.1%, 55.8%, and 61.6%, respectively (data not shown), which were significantly higher than those for HCP.

In univariate analysis, among HCP, H1N1, seasonal, and any-dose vaccination coverage were lower for non-Hispanic blacks (21.7%, 39.4%, and 43.9%, respectively) and Hispanics (27.7%, 44.4%, and 49.7%, respectively) compared to non-Hispanic whites (37.3%, 56.9%, and 62.3%, respectively; Table 1). H1N1 vaccination coverage among HCP was higher among those who reported being male, having higher education, having higher income, being married, having access to a primary care physician, formerly or never smoking, and having health insurance. Additionally, people who needed to see a doctor but could not, and those who had not had a routine checkup within the past 1 year were less likely to be vaccinated

**Table 2.** Adjusted H1N1 and seasonal influenza vaccination coverage among people aged  $\geq 18$  years, BRFSS 2010, % (95% CI)

DEMOGRAPHIC	H1N1 vaccination coverage		Seasonal influenza vaccination coverage		Any influenza vaccination coverage (seasonal and/or H1N1)	
	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel
<b>Age (years)</b>						
18–49 <sup>a</sup>	36.6 (34.4, 38.9)	18.3 (17.5, 19.2)	52.5 (50.2, 54.8)	28.3 (27.4, 29.2)	58.7 (56.4, 60.9)	34.5 (33.5, 35.5)
50–64	33.8 (31.6, 36.0)	18.9 (18.1, 19.6)	52.5 (50.2, 54.8)	36.2 (35.2, 37.1) <sup>b</sup>	57.2 (54.8, 59.5)	40.8 (39.8, 41.8) <sup>b</sup>
$\geq 65$	30.8 (27.7, 33.9) <sup>b</sup>	22.3 (21.4, 23.3) <sup>b</sup>	64.0 (60.6, 67.4) <sup>b</sup>	54.1 (52.9, 55.4) <sup>b</sup>	67.9 (64.6, 71.3) <sup>b</sup>	58.7 (57.4, 60.0) <sup>b</sup>
<b>Gender</b>						
Male <sup>a</sup>	37.7 (34.5, 40.8)	19.5 (18.7, 20.2)	51.2 (48.0, 54.4)	34.4 (33.5, 35.3)	58.9 (55.8, 62.0)	39.6 (38.7, 40.6)
Female	34.1 (32.4, 35.7) <sup>b</sup>	19.1 (18.4, 19.7)	54.8 (53.0, 56.7)	36.0 (35.2, 36.7) <sup>b</sup>	59.4 (57.5, 61.2)	41.2 (40.4, 42.0) <sup>b</sup>
<b>Race/ethnicity</b>						
White, non-Hispanic <sup>a</sup>	36.8 (35.1, 38.5)	18.9 (18.4, 19.4)	55.8 (54.0, 57.7)	36.1 (35.5, 36.8)	61.2 (59.4, 63.1)	40.7 (40.0, 41.4)
Black, non-Hispanic	25.8 (21.9, 29.7) <sup>b</sup>	15.3 (13.6, 17.0) <sup>b</sup>	44.5 (39.9, 49.0) <sup>b</sup>	29.8 (27.7, 31.8) <sup>b</sup>	49.5 (44.9, 54.1) <sup>b</sup>	34.5 (32.4, 36.7) <sup>b</sup>
Hispanic	32.2 (26.7, 37.7)	23.4 (21.2, 25.7) <sup>b</sup>	52.3 (46.4, 58.2)	33.9 (31.7, 36.1)	56.8 (51.1, 62.6)	42.4 (40.1, 44.8)
Other	38.9 (32.1, 45.7)	21.3 (19.0, 23.6) <sup>b</sup>	53.5 (46.7, 60.3)	35.2 (32.6, 37.7)	61.8 (55.3, 68.4)	41.9 (39.3, 44.6)
<b>Education level</b>						
Less than high school <sup>a</sup>	31.9 (25.0, 38.7)	18.1 (16.5, 19.8)	50.6 (43.3, 57.9)	30.7 (28.8, 32.5)	57.3 (50.4, 64.2)	37.8 (35.8, 39.9)
High school graduate	28.0 (24.8, 31.2)	17.6 (16.6, 18.5)	49.2 (45.6, 52.8)	34.0 (32.9, 35.1) <sup>b</sup>	55.6 (52.0, 59.1)	39.1 (37.9, 40.2)
College	37.5 (35.7, 39.3)	20.6 (19.9, 21.2) <sup>b</sup>	55.4 (53.5, 57.4)	36.7 (36.0, 37.5) <sup>b</sup>	60.6 (58.7, 62.5)	41.7 (40.9, 42.5) <sup>b</sup>
<b>Income (\$)</b>						
<20,000 <sup>a</sup>	29.5 (24.2, 34.7)	19.6 (18.2, 21.0)	47.5 (41.9, 53.0)	32.3 (30.8, 33.8)	53.3 (48.0, 58.7)	38.8 (37.2, 40.4)
20,000–50,000	32.9 (30.3, 35.4)	19.1 (18.2, 20.0)	51.0 (48.3, 53.7)	35.2 (34.2, 36.2) <sup>b</sup>	57.3 (54.7, 60.0)	40.4 (39.3, 41.4)
$\geq 50,000$	37.8 (35.5, 40.1) <sup>b</sup>	19.2 (18.4, 20.1)	57.1 (54.6, 59.7) <sup>b</sup>	36.3 (35.3, 37.3) <sup>b</sup>	62.0 (59.5, 64.6) <sup>b</sup>	41.1 (40.0, 42.1) <sup>b</sup>
<b>Marital status</b>						
Married <sup>a</sup>	35.9 (34.0, 37.8)	19.7 (19.1, 20.4)	54.8 (52.8, 56.8)	35.8 (35.0, 36.5)	61.0 (59.0, 63.0)	41.0 (40.3, 41.8)
Widowed/divorced/separated	34.7 (31.4, 38.0)	17.6 (16.6, 18.5) <sup>b</sup>	53.8 (50.4, 57.1)	34.6 (33.4, 35.7)	57.8 (54.5, 61.2)	39.3 (38.1, 40.6)
Never married	33.0 (28.6, 37.5)	19.7 (18.0, 21.4)	50.2 (45.4, 55.0)	33.7 (31.9, 35.6)	55.0 (50.2, 59.8) <sup>b</sup>	39.3 (37.4, 41.2)

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Table 2. (continued)

DEMOGRAPHIC	H1N1 vaccination coverage		Seasonal influenza vaccination coverage		Any influenza vaccination coverage (seasonal and/or H1N1)	
	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel
<b>Perceived health</b>						
Excellent/very good <sup>a</sup>	35.0 (33.0, 37.0)	18.9 (18.0, 19.7)	53.3 (51.1, 55.5)	34.5 (33.6, 35.4)	58.5 (56.3, 60.8)	39.8 (38.9, 40.8)
Good	33.7 (31.0, 36.4)	18.8 (17.9, 19.7)	53.5 (50.6, 56.4)	34.8 (33.8, 35.8)	58.5 (55.7, 61.4)	39.9 (38.8, 41.0)
Fair	40.2 (35.0, 45.4)	20.4 (19.0, 21.9)	57.1 (52.2, 61.9)	37.4 (35.8, 39.1) <sup>b</sup>	65.1 (60.4, 69.8) <sup>b</sup>	42.5 (40.7, 44.2) <sup>b</sup>
Poor	39.0 (26.9, 51.2)	22.4 (20.0, 24.7) <sup>b</sup>	56.6 (45.6, 67.7)	38.1 (35.7, 40.6) <sup>b</sup>	62.6 (52.4, 72.9)	43.7 (41.0, 46.5) <sup>b</sup>
<b>People with high-risk conditions</b>						
Yes	39.3 (35.9, 42.6) <sup>b</sup>	23.6 (22.4, 24.8) <sup>b</sup>	59.9 (56.3, 63.5) <sup>b</sup>	42.1 (40.9, 43.4) <sup>b</sup>	65.2 (61.5, 68.8) <sup>b</sup>	48.0 (46.7, 49.4) <sup>b</sup>
No <sup>a</sup>	33.8 (32.1, 35.5)	17.5 (16.9, 18.1)	51.7 (49.9, 53.5)	32.5 (31.8, 33.2)	57.3 (55.4, 59.1)	37.6 (36.8, 38.3)
<b>Insurance status</b>						
Yes	36.3 (34.6, 38.0) <sup>b</sup>	19.8 (19.3, 20.4) <sup>b</sup>	55.2 (53.4, 57.0) <sup>b</sup>	36.2 (35.5, 36.9) <sup>b</sup>	61.1 (59.3, 62.9) <sup>b</sup>	41.5 (40.8, 42.2) <sup>b</sup>
No <sup>a</sup>	24.6 (19.9, 29.3)	15.2 (13.6, 16.8)	42.4 (37.0, 47.8)	27.5 (25.6, 29.4)	46.0 (40.6, 51.3)	33.0 (31.0, 34.9)
<b>Need to see a doctor but could not</b>						
Yes <sup>a</sup>	26.6 (22.3, 30.8)	16.4 (14.9, 17.9)	45.6 (40.7, 50.4)	30.5 (28.8, 32.2)	52.0 (47.3, 56.6)	35.7 (33.9, 37.5)
No	36.5 (34.8, 38.2) <sup>b</sup>	19.7 (19.1, 20.3) <sup>b</sup>	55.3 (53.5, 57.1) <sup>b</sup>	35.9 (35.2, 36.5) <sup>b</sup>	60.6 (58.8, 62.4) <sup>b</sup>	41.1 (40.4, 41.8) <sup>b</sup>
<b>Primary doctor</b>						
Yes	35.5 (33.9, 37.1)	20.0 (19.4, 20.6) <sup>b</sup>	54.6 (52.8, 56.3) <sup>b</sup>	36.7 (36.0, 37.4) <sup>b</sup>	60.0 (58.2, 61.7) <sup>b</sup>	42.1 (41.3, 42.8) <sup>b</sup>
No <sup>a</sup>	32.3 (27.1, 37.4)	14.8 (13.4, 16.3)	47.8 (42.4, 53.2)	25.9 (24.2, 27.6)	54.2 (48.8, 59.6)	31.4 (29.7, 33.2)
<b>Activity limitation</b>						
Yes	34.8 (31.4, 38.2)	20.5 (19.4, 21.5) <sup>b</sup>	53.4 (49.8, 57.1)	37.6 (36.3, 38.9) <sup>b</sup>	59.2 (55.7, 62.8)	42.7 (41.4, 44.1) <sup>b</sup>
No <sup>a</sup>	35.2 (33.6, 36.9)	18.9 (18.3, 19.5)	53.8 (52.1, 55.6)	34.4 (33.8, 35.1)	59.2 (57.5, 61.0)	39.7 (39.0, 40.4)
<b>Time since last checkup (years)</b>						
<1	37.2 (35.3, 39.0) <sup>b</sup>	21.5 (20.8, 22.2) <sup>b</sup>	56.9 (55.0, 58.8) <sup>b</sup>	38.4 (37.6, 39.1) <sup>b</sup>	62.4 (60.5, 64.3) <sup>b</sup>	44.2 (43.4, 45.0) <sup>b</sup>
≥1 <sup>a</sup>	29.7 (26.9, 32.4)	13.9 (13.1, 14.8)	45.6 (42.5, 48.7)	27.3 (26.2, 28.3)	51.3 (48.1, 54.4)	31.6 (30.5, 32.8)

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Table 2. Adjusted H1N1 and seasonal influenza vaccination coverage among people aged ≥18 years, BRFSS 2010, % (95% CI) (continued)

DEMOGRAPHIC	H1N1 vaccination coverage		Seasonal influenza vaccination coverage		Any influenza vaccination coverage (seasonal and/or H1N1)	
	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel	Healthcare personnel	Non-healthcare personnel
<b>Smoking status</b>						
Current smoker <sup>a</sup>	34.4 (30.5, 38.4)	15.2 (13.9, 16.5)	51.6 (47.8, 55.5)	29.5 (28.2, 30.9)	58.1 (54.4, 61.7)	33.8 (32.3, 35.2)
Former smoker	38.2 (35.1, 41.3)	20.2 (19.4, 21.1) <sup>b</sup>	57.0 (54.0, 60.1) <sup>b</sup>	35.8 (34.8, 36.8) <sup>b</sup>	62.6 (59.6, 65.6)	41.3 (40.2, 42.4) <sup>b</sup>
Never smoked	34.2 (32.3, 36.0)	20.1 (19.4, 20.8) <sup>b</sup>	53.1 (51.1, 55.2)	36.7 (35.9, 37.6) <sup>b</sup>	58.3 (56.3, 60.4)	42.3 (41.4, 43.1) <sup>b</sup>
<b>MSA</b>						
In MSA	34.9 (33.3, 36.4)	19.3 (18.8, 19.8)	53.6 (51.9, 55.3)	35.2 (34.6, 35.9)	59.1 (57.5, 60.8)	40.4 (39.8, 41.1)
Not in a MSA <sup>a</sup>	38.6 (33.7, 43.5)	18.8 (17.3, 20.3)	55.8 (50.9, 60.7)	34.4 (32.8, 35.9)	60.2 (55.5, 64.9)	39.8 (38.1, 41.5)

Note: This table is based on interviews conducted during March through June 2010 only.

<sup>a</sup>Reference level

<sup>b</sup>p<0.05 by t-test for comparisons within each variable with indicated reference level

BRFSS, Behavioral Risk Factor Surveillance Survey; MSA, metropolitan statistical area

(Table 1). Factors associated with seasonal and any-dose vaccinations were similar to factors associated with H1N1 vaccination.

Adjusted coverage estimates from the multivariable model did not differ greatly from the crude vaccination coverage. Overall, factors independently associated with H1N1, seasonal, and any-dose vaccinations were similar. Characteristics independently associated with an increased likelihood of H1N1, seasonal, and any-dose vaccinations among HCP were being non-Hispanic white, having higher income, having a high-risk condition, having health insurance, having the ability to see a doctor if needed, and having a routine checkup in the previous year (Table 2).

State-specific H1N1 vaccination coverage among HCP ranged from 18.4% in Mississippi to 56.1% in Massachusetts with a median of 37.7% among all states. Seasonal influenza vaccination coverage ranged from 40.4% in Florida to 73.1% in Nebraska with a median of 56.8% among all states. Any-dose influenza vaccination coverage ranged from 48.2% in Florida to 77.4% in Nebraska, with a median of 63.8% among all states (Table 3, Figure 1). Using the state-specific figures, the 2009 H1N1, seasonal influenza, and any-dose influenza vaccination coverage among HCP and non-HCP were correlated ( $r = 0.8, 0.5, \text{ and } 0.6$ , respectively).

### Discussion

Healthcare personnel were more likely to be vaccinated with H1N1 and seasonal influenza vaccine than those who were non-HCP; even among HCP, only about one in three received H1N1 vaccination and about one in two received seasonal-only or any-dose vaccination. Overall, H1N1 vaccination coverage among HCP (34.1%) was lower than usual seasonal influenza vaccination coverage among HCP in recent seasons (50%–62%), including the seasonal coverage reported in our analysis,<sup>11–15</sup> which was well below the Healthy People 2020 objectives of 90%.<sup>16</sup>

Despite HCP being included in the initial target groups recommended by the ACIP to receive the H1N1 vaccination, vaccination coverage was low. Vaccine unavailability at the time of epidemic activity may have contributed to the low H1N1 vaccination coverage.<sup>7,17–21</sup> One study<sup>22</sup> showed that 17.3% of unvaccinated HCP listed unavailability of 2009 H1N1 vaccine as a reason for nonvaccination.<sup>15</sup> In addition, not all healthcare settings offered worksite influenza vaccination. Worksite vaccination could significantly increase seasonal and H1N1 vaccination coverage among HCP, but one study<sup>22</sup> showed that one third of healthcare settings did not offer on-site vaccination for HCP.

Vaccination coverage among HCP for H1N1 and seasonal influenza varied widely by state. Variation by state

**Table 3.** State-specific H1N1 and seasonal influenza vaccination coverage among healthcare personnel aged  $\geq 18$  years, BRFSS 2010, % (95% CI) unless otherwise noted

State	Sample size, <i>n</i>	Healthcare personnel, %	H1N1 vaccination coverage <sup>a</sup>	Seasonal influenza vaccination coverage <sup>a</sup>	Any influenza vaccination coverage (seasonal and/or H1N1) <sup>a</sup>
Nevada	2,922	8.3	29.5 (21.8, 39.0)	41.1 (33.1, 50.2)	48.4 (39.4, 58.3)
Tennessee	3,680	8.6	33.7 (25.9, 43.1)	64.6 (56.1, 73.1)	70.0 (61.5, 78.2)
Colorado	7,232	9.8	40.5 (34.8, 46.7)	63.0 (57.2, 68.8)	69.0 (63.3, 74.4)
Texas	10,756	10.3	28.6 (23.6, 34.4)	56.2 (50.3, 62.2)	62.4 (56.5, 68.3)
California	10,410	10.3	38.9 (32.4, 46.2)	53.3 (46.8, 60.1)	64.5 (57.1, 72.0)
Wyoming	3,786	10.8	43.9 (37.0, 51.5)	59.4 (52.7, 66.3)	66.4 (59.8, 72.9)
Missouri	3,161	10.9	18.5 (9.9, 33.0)	53.3 (37.4, 70.9)	58.8 (42.7, 75.7)
Oklahoma	5,457	11.0	26.8 (22.1, 32.2)	56.8 (49.6, 64.3)	61.2 (53.7, 68.8)
West Virginia	2,967	11.1	34.6 (28.0, 42.1)	58.3 (51.2, 65.7)	63.2 (55.8, 70.5)
Utah	5,827	11.1	47.4 (41.0, 54.2)	63.3 (57.4, 69.2)	69.2 (63.0, 75.2)
Idaho	5,207	11.2	37.7 (32.2, 43.7)	55.0 (49.6, 60.5)	61.1 (55.4, 66.9)
Georgia	3,451	11.2	29.0 (21.2, 39.0)	46.5 (39.3, 54.3)	55.8 (47.1, 64.9)
District of Columbia	2,356	11.3	20.6 (14.5, 29.0)	45.8 (35.5, 57.5)	49.5 (38.9, 61.4)
Washington	12,195	11.3	48.4 (43.4, 53.6)	58.9 (54.5, 63.4)	68.7 (64.1, 73.1)
Hawaii	4,973	11.4	52.4 (43.9, 61.5)	56.3 (50.3, 62.5)	71.6 (64.4, 78.5)
Louisiana	4,510	11.7	29.7 (23.8, 36.6)	55.6 (49.4, 61.9)	63.4 (56.9, 69.8)
Arizona	3,643	11.8	35.0 (26.8, 44.9)	50.6 (39.4, 62.9)	59.5 (48.1, 71.2)
Montana	4,807	12.0	42.3 (36.4, 48.8)	55.9 (49.8, 62.3)	63.6 (57.5, 69.7)
Mississippi	6,089	12.1	18.4 (13.8, 24.2)	48.1 (42.8, 53.8)	52.9 (47.2, 58.7)
Florida	18,416	12.1	25.4 (21.7, 29.6)	40.4 (36.1, 45.0)	48.2 (43.4, 53.3)
Alabama	4,908	12.2	20.4 (15.2, 27.2)	47.3 (40.5, 54.7)	50.7 (43.1, 58.9)
North Carolina	7,488	12.2	39.9 (34.1, 46.1)	56.7 (50.9, 62.7)	63.6 (57.6, 69.5)
New Mexico	4,343	12.4	44.5 (35.2, 55.0)	59.5 (51.9, 67.3)	67.1 (58.8, 75.3)
Oregon	3,705	12.5	41.8 (34.8, 49.7)	53.3 (46.6, 60.2)	61.5 (54.4, 68.8)
New Jersey	7,563	12.6	28.1 (23.7, 33.2)	47.3 (42.1, 52.7)	53.0 (47.4, 58.9)
New Hampshire	3,566	12.8	53.5 (45.6, 61.9)	63.1 (56.0, 70.2)	72.5 (65.1, 79.5)
Virginia	3,268	12.9	34.3 (27.0, 43.0)	55.9 (47.3, 64.9)	61.2 (51.5, 71.1)
Michigan	5,904	13.1	34.5 (29.4, 40.2)	52.2 (46.9, 57.7)	59.7 (54.1, 65.3)
Ohio	6,952	13.2	39.4 (34.6, 44.7)	58.7 (54.2, 63.3)	65.1 (60.4, 69.8)
Arkansas	2,505	13.3	31.8 (23.8, 41.7)	65.7 (56.1, 75.0)	68.9 (59.4, 77.9)
Kentucky	5,256	13.3	33.0 (27.1, 39.7)	61.5 (55.7, 67.4)	68.6 (62.5, 74.4)
Wisconsin	2,018	13.4	49.4 (40.9, 58.7)	68.3 (60.2, 76.1)	73.4 (65.6, 80.6)

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**Table 3.** State-specific H1N1 and seasonal influenza vaccination coverage among healthcare personnel aged  $\geq 18$  years, BRFSS 2010, % (95% CI) unless otherwise noted (*continued*)

	Sample size, <i>n</i>	Healthcare personnel, %	H1N1 vaccination coverage <sup>a</sup>	Seasonal influenza vaccination coverage <sup>a</sup>	Any influenza vaccination coverage (seasonal and/or H1N1) <sup>a</sup>
Indiana	5,668	13.4	39.5 (33.4, 46.4)	53.1 (47.5, 59.0)	63.1 (56.7, 69.6)
New York	4,740	13.4	30.5 (24.5, 37.6)	57.3 (50.8, 63.9)	61.3 (54.5, 68.1)
Illinois	2,779	13.5	35.9 (27.8, 45.5)	54.0 (44.6, 63.9)	58.2 (48.8, 67.9)
South Carolina	6,290	13.5	29.0 (22.9, 36.4)	53.8 (46.7, 61.1)	58.8 (50.8, 66.9)
Pennsylvania	6,472	13.6	31.9 (27.4, 36.9)	60.9 (54.5, 67.3)	65.7 (59.5, 71.8)
Maine	5,003	13.7	54.1 (46.5, 62.0)	68.4 (62.4, 74.3)	76.6 (70.3, 82.4)
Rhode Island	4,309	13.9	44.4 (38.3, 51.0)	60.4 (54.5, 66.3)	67.8 (61.9, 73.7)
Kansas	7,329	13.9	35.5 (30.9, 40.5)	56.4 (51.6, 61.3)	63.8 (58.7, 69.0)
Maryland	5,906	14.2	40.5 (33.6, 48.3)	56.9 (51.4, 62.6)	65.0 (57.9, 72.1)
Alaska	1,313	14.4	54.1 (39.8, 69.7)	62.1 (48.1, 76.2)	69.0 (54.7, 82.3)
North Dakota	3,241	14.6	42.2 (33.6, 51.9)	63.2 (57.0, 69.4)	70.3 (62.2, 78.0)
Connecticut	3,851	14.9	35.8 (29.0, 43.6)	54.4 (47.0, 62.1)	58.3 (50.7, 66.1)
South Dakota	4,621	15.1	52.3 (46.6, 58.3)	68.8 (63.6, 73.8)	76.8 (72.0, 81.4)
Massachusetts	10,308	15.1	56.1 (51.3, 61.0)	66.9 (62.5, 71.4)	74.2 (70.1, 78.1)
Nebraska	10,240	15.4	48.6 (41.9, 55.7)	73.1 (66.5, 79.4)	77.4 (71.1, 83.2)
Iowa	3,780	15.8	45.9 (39.8, 52.5)	70.5 (64.8, 76.0)	75.9 (70.0, 81.5)
Minnesota	4,568	16.0	44.1 (37.8, 50.9)	64.0 (57.7, 70.3)	67.7 (61.4, 74.0)
Delaware	2,983	— <sup>b</sup>	— <sup>b</sup>	— <sup>b</sup>	— <sup>b</sup>
Vermont	4,414	— <sup>b</sup>	— <sup>b</sup>	— <sup>b</sup>	— <sup>b</sup>
<b>Median</b>		12.5	37.7	56.8	63.8
<b>Range</b>		8.3–16.0	18.4–56.1	40.4–73.1	48.2–77.4

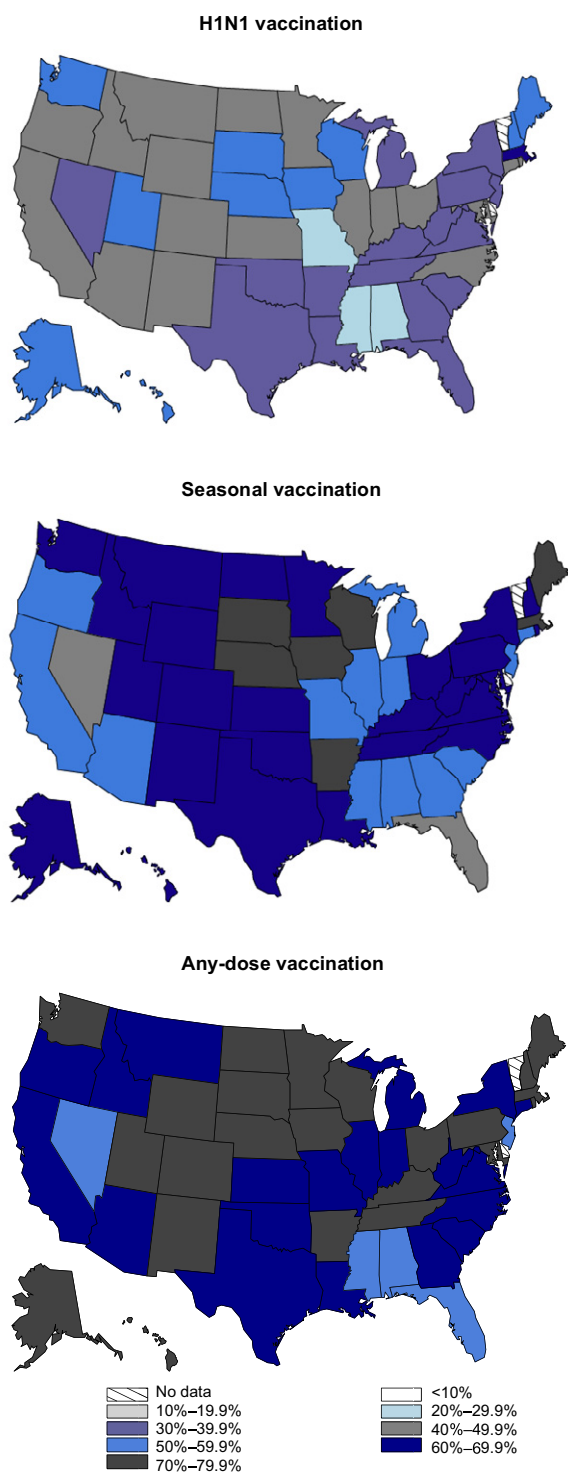
<sup>a</sup>To increase sample size and get reliable state-specific H1N1 vaccination coverage, data were analyzed from interviews conducted November 2009–June 2010 to estimate the cumulative proportion of people vaccinated during October 2009–May 2010 using the Kaplan-Meier survival analysis procedure. To increase sample size and get reliable state-specific seasonal influenza vaccination coverage, data were analyzed from interviews conducted October 2009–June 2010 to estimate the cumulative proportion of people vaccinated August 2009–May 2010 using the Kaplan-Meier survival analysis procedure.

<sup>b</sup>Influenza vaccination data were not collected for Delaware and Vermont.

in vaccination coverage among the general adult population also has been observed.<sup>23</sup> Factors that may have contributed to the wide variation in vaccination coverage include the following: epidemic activity had virtually declined or disappeared in many southern states when vaccine became available, whereas it was still ongoing in many northern states<sup>18–20</sup>; wide variations in state-specific vaccination program and pandemic planning preparation: states that were well prepared for a pandemic may have found it easier to implement vaccination programs on very short notice<sup>24</sup>; and differences in the effectiveness of specific intervention programs being implemented by states (i.e., commu-

nity campaigns, provider-based strategies, and workplace vaccination).<sup>24,25</sup>

Influenza vaccination among HCP legislation also may influence vaccination coverage. During the time of the pandemic, eight states had influenza vaccination legislation requirements among HCP, either to offer (seven states) or ensure vaccination (one state).<sup>26</sup> Of those eight states, six had influenza vaccination coverage among HCP that was higher than the national average, which may indicate that legislation requirements help increase vaccination coverage. Vaccination coverage among HCP may be further increased when more states recommend or require influenza vaccination for HCP.



**Figure 1.** State-specific H1N1 and seasonal influenza vaccination coverage among healthcare personnel aged  $\geq 18$  years, BRFSS 2010

Note: Influenza vaccination data were not collected for Delaware and Vermont.

BRFSS, Behavioral Risk Factor Surveillance System

In the current study, vaccination coverage was found to be higher among HCP who have a regular physician and have visited a physician for a routine checkup within 1 year than among those who did not. Physician contacts play an important role in vaccination uptake.<sup>13,14</sup> HCP may have more-frequent contacts than do non-HCPs with their healthcare providers. Routine physician visits can provide important opportunities for providers to vaccinate HCP. The current study found that race/ethnicity, income, high-risk conditions status, and health insurance status were also independently associated with vaccination. Those findings concurred with those of previous studies.<sup>13,14</sup>

Studies showed that 2009 H1N1 vaccination coverage among HCP in other countries was 18% in Italy and 22% in Spain. Coverage among HCP was 92% in South Korea and 79% in Thailand.<sup>27–30</sup> There are likely factors that contribute to higher coverage. A well-prepared vaccination plan with strong support from hospital administrators, free vaccine, and well-distributed H1N1 pandemic information may have contributed to the higher vaccination coverage among HCP in South Korea and Thailand.<sup>29,30</sup> In addition, Thailand was a SARS (severe acute respiratory syndrome) epicenter and has been dealing with H5N1 (avian influenza) outbreaks.<sup>31–33</sup> This past experience probably increased support for pandemic planning and implementation.

The findings in this paper are subject to several limitations. First, BRFSS is a landline, telephone-based survey that excludes people without telephones and those with only cellular phones and thus may produce a biased coverage estimate<sup>34</sup>; however, weight was adjusted to account for people without landline telephones and people with cell phone only.<sup>8,34</sup> Second, vaccination status is self-reported and is subject to recall bias. However, self-reported influenza vaccination status has been shown to have relatively high agreement with medical records among older adults.<sup>35–37</sup>

Comprehensive strategies are needed to further improve uptake of vaccination coverage for HCP. Recommended approaches include emphasizing the benefits of HCP vaccination for staff and patients; considering the level of vaccination coverage among HCP to be one measure of patient safety and quality assurance; electronic tracking of coverage levels by ward, unit, and occupation; providing vaccinations in the workplace so they are easily accessible; and implementing catch-up vaccination programs for HCP who are already employed and ensuring that newly hired HCP receive necessary vaccinations.<sup>2,3,38–40</sup>

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