Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
H1N1 and Seasonal Influenza Vaccination of U.S. Healthcare Personnel, 2010

Peng-jun Lu, MD, PhD, Helen Ding, MD, MSPH, Carla L. Black, PhD

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.

Am J Prev Med 2012;43(3):282–292 Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

Introduction

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

Annual influenza vaccination has been recommended by the Advisory Committee on Immunization Practices (ACIP) for HCP since 1984.6 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.7 In July 2009, the ACIP issued recommendations regarding the use of a new monovalent vaccine against infection with the 2009 influenza A (H1N1) virus.7 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 2009.7

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
Table 1. H1N1 and seasonal influenza vaccination coverage by demographic and access-to-care variables among those aged ≥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 |
|                      | 34.1 (32.7, 35.5)         | 19.1 (18.7, 19.6)                      | 52.4 (50.9, 53.9)                                     | 34.9 (34.4, 35.5)    | 58.0 (56.5, 59.5)       |
| Age (years)          |                           |                                        |                                                       |                      |                          |
|                     |                           |                                        |                                                       |                      |                          |
| 18–49b              | 33.7 (31.7, 35.7)         | 16.3 (15.6, 17.0)                      | 48.0 (45.8, 50.2)                                     | 23.9 (23.2, 24.7)    | 54.3 (52.1, 56.5)       |
|                     |                           |                                        |                                                       |                      | 30.1 (29.2, 31.0)       | a
| 50–64               | 35.0 (32.9, 37.1)         | 20.0 (19.3, 20.7)                      | 54.7 (52.6, 56.9)                                     | 39.4 (38.5, 40.2)    | 59.2 (57.1, 61.4)       |
|                     |                           |                                        |                                                       |                      | 43.8 (42.9, 44.7)       | a,c
| ≥65                 | 34.6 (32.1, 37.1)         | 27.2 (26.4, 27.9)                      | 70.1 (67.7, 72.5)                                     | 64.2 (63.4, 65.0)    | 74.3 (71.9, 76.5)       |
|                     |                           |                                        |                                                       |                      | 68.4 (67.7, 69.2)       | a,c
| Gender               |                           |                                        |                                                       |                      |                          |
|                     |                           |                                        |                                                       |                      |                          |
| Maleb               | 37.2 (34.3, 40.3)         | 18.7 (18.0, 19.4)                      | 50.2 (47.1, 53.3)                                     | 32.6 (31.8, 33.5)    | 57.9 (54.8, 60.9)       |
|                     |                           |                                        |                                                       |                      | 37.8 (37.0, 38.8)       | a
| Female              | 32.8 (31.3, 34.3)c        | 19.6 (19.1, 20.2)c                    | 53.3 (51.6, 55.0)                                     | 37.3 (36.7, 38.0)c   | 58.1 (56.3, 59.8)       |
|                     |                           |                                        |                                                       |                      | 42.9 (42.2, 43.6)c      | a,c
| Race/ethnicity       |                           |                                        |                                                       |                      |                          |
|                     |                           |                                        |                                                       |                      |                          |
| White, non-Hispanicb| 37.3 (35.8, 38.8)         | 19.7 (19.2, 20.1)                      | 56.9 (55.3, 58.5)                                     | 38.7 (38.1, 39.3)    | 62.3 (60.7, 63.9)       |
|                     |                           |                                        |                                                       |                      | 43.2 (42.6, 43.8)       | a
| Black, non-Hispanic  | 21.7 (18.6, 25.2)c        | 15.4 (13.9, 17.1)c                    | 39.4 (35.2, 43.7)c                                    | 27.6 (25.7, 29.5)c   | 43.9 (39.6, 48.3)       |
|                     |                           |                                        |                                                       |                      | 33.1 (31.1, 35.1)c      | a,c
| Hispanic            | 27.7 (22.9, 33.1)c        | 18.5 (16.9, 20.3)c                    | 44.4 (38.7, 50.3)c                                    | 23.5 (21.8, 25.2)c   | 49.7 (43.9, 55.5)       |
|                     |                           |                                        |                                                       |                      | 32.1 (30.1, 34.1)       | a,c
| Other               | 36.7 (30.7, 43.1)         | 20.4 (18.5, 22.4)c                    | 47.6 (41.1, 54.3)c                                    | 32.1 (29.8, 34.5)c   | 56.6 (49.6, 63.3)       |
|                     |                           |                                        |                                                       |                      | 39.3 (36.8, 41.8)       | a,c
| Education level     |                           |                                        |                                                       |                      |                          |
|                     |                           |                                        |                                                       |                      |                          |
| Less than high schoolb| 23.0 (17.8, 29.2)         | 18.1 (16.7, 19.5)                      | 27.1 (18.7, 26.8)                                     | 27.8 (26.3, 29.3)    | 48.4 (40.0, 53.8)       |
|                     |                           |                                        |                                                       |                      | 35.8 (34.1, 37.6)       | a
| High school graduate | 24.2 (21.7, 26.9)         | 17.0 (16.2, 17.9)                      | 44.2 (41.1, 47.3)                                     | 33.4 (32.4, 34.4)c   | 50.5 (47.3, 53.6)       |
|                     |                           |                                        |                                                       |                      | 38.4 (37.4, 39.5)       | a,c
| College             | 38.6 (37.0, 40.3)c        | 20.9 (20.3, 21.5)c                    | 56.5 (54.8, 58.3)c                                    | 37.9 (37.2, 38.6)c   | 61.7 (59.9, 63.4)       |
|                     |                           |                                        |                                                       |                      | 42.8 (42.0, 43.5)       | a,c
| Income ($)          |                           |                                        |                                                       |                      |                          |
| <20,000a            | 21.8 (18.1, 26.0)         | 17.5 (16.5, 18.6)                      | 38.6 (33.9, 43.6)                                     | 29.0 (27.8, 30.2)    | 43.7 (38.9, 48.7)       |
|                     |                           |                                        |                                                       |                      | 35.6 (34.2, 37.0)       | a
| 20,000–50,000       | 29.3 (27.0, 31.6)c        | 18.5 (17.7, 19.4)c                    | 47.8 (45.2, 50.4)c                                    | 35.2 (34.2, 36.2)c   | 54.0 (51.4, 56.6)       |
|                     |                           |                                        |                                                       |                      | 40.2 (39.1, 41.2)       | a,c
| ≥50,000             | 42.1 (40.0, 44.2)c        | 20.5 (19.8, 21.2)c                    | 60.8 (58.6, 62.9)c                                    | 37.3 (36.4, 38.2)c   | 65.8 (63.6, 67.9)       |
|                     |                           |                                        |                                                       |                      | 40.2 (39.1, 41.2)       | a,c
| Marital status      |                           |                                        |                                                       |                      |                          |
|                     |                           |                                        |                                                       |                      |                          |
| Marriedb            | 37.9 (36.2, 39.6)         | 20.2 (19.7, 20.8)                      | 57.0 (55.2, 58.8)                                     | 37.0 (36.3, 37.7)    | 62.8 (61.0, 64.5)       |
|                     |                           |                                        |                                                       |                      | 42.2 (41.5, 42.9)       | a
| Widowed/divorced/separated | 29.1 (26.3, 31.9)c | 19.1 (18.3, 19.9)c | 51.1 (48.0, 54.1)c | 41.6 (40.6, 42.7)c | 55.2 (52.1, 58.3)c |
|                     |                           |                                        |                                                       |                      | 46.3 (45.3, 47.4)       | a,c
| Never married       | 28.0 (24.5, 31.8)c        | 16.2 (15.0, 17.6)c                    | 40.2 (36.1, 44.4)c                                    | 23.2 (21.8, 24.6)c   | 46.4 (42.1, 50.7)       |
|                     |                           |                                        |                                                       |                      | 29.6 (28.0, 31.2)       | a,c

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

(continued on next page)
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.8

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.9,10

**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 1.** (continued)
Table 2. Adjusted H1N1 and seasonal influenza vaccination coverage among people aged ≥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 |
| Age (years) |                             |                          |                             |                          |                             |                          |
| 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> |
| ≥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> |
| Gender |                             |                          |                             |                          |                             |                          |
| 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> |
| Race/ethnicity |                             |                          |                             |                          |                             |                          |
| 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) |
| Education level |                             |                          |                             |                          |                             |                          |
| 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> |
| Income ($) |                             |                          |                             |                          |                             |                          |
| <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) |
| ≥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> |
| Marital status |                             |                          |                             |                          |                             |                          |
| 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) |

(continued on next page)
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 |
| Perceived health                      |                           |                          |                        |                           |                        |                          |
| Excellent/very good⁴                  | 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)        | 65.1 (60.4, 69.8)     | 42.5 (40.7, 44.2)      |
| Poor                                  | 39.0 (26.9, 51.2)        | 22.4 (20.0, 24.7)        | 56.6 (45.6, 67.7)     | 38.1 (35.7, 40.6)        | 62.6 (52.4, 72.9)     | 43.7 (41.0, 46.5)      |
| People with high-risk conditions      |                           |                          |                        |                           |                        |                          |
| Yes                                  | 39.3 (35.9, 42.6)        | 23.6 (22.4, 24.8)        | 59.9 (56.3, 63.5)     | 42.1 (40.9, 43.4)        | 65.2 (61.5, 68.8)     | 48.0 (46.7, 49.4)      |
| No⁴                                   | 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)     |
| Insurance status                      |                           |                          |                        |                           |                        |                          |
| Yes                                  | 36.3 (34.6, 38.0)        | 19.8 (19.3, 20.4)        | 55.2 (53.4, 57.0)     | 36.2 (35.5, 36.9)        | 61.1 (59.3, 62.9)     | 41.5 (40.8, 42.2)      |
| No⁴                                   | 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)     |
| Need to see a doctor but could not    |                           |                          |                        |                           |                        |                          |
| Yes³                                  | 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)        | 19.7 (19.1, 20.3)        | 55.3 (53.5, 57.1)     | 35.9 (35.2, 36.5)        | 60.6 (58.8, 62.4)     | 41.1 (40.4, 41.8)      |
| Primary doctor                        |                           |                          |                        |                           |                        |                          |
| Yes                                  | 35.5 (33.9, 37.1)        | 20.0 (19.4, 20.6)        | 54.6 (52.8, 56.3)     | 36.7 (36.0, 37.4)        | 60.0 (58.2, 61.7)     | 42.1 (41.3, 42.8)      |
| No⁴                                   | 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)      |
| Activity limitation                   |                           |                          |                        |                           |                        |                          |
| Yes                                  | 34.8 (31.4, 38.2)        | 20.5 (19.4, 21.5)        | 53.4 (49.8, 57.1)     | 37.6 (36.3, 38.9)        | 59.2 (55.7, 62.8)     | 42.7 (41.4, 44.1)      |
| No⁴                                   | 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)      |
| Time since last checkup (years)       |                           |                          |                        |                           |                        |                          |
| <1                                    | 37.2 (35.3, 39.0)        | 21.5 (20.8, 22.2)        | 56.9 (55.0, 58.8)     | 38.4 (37.6, 39.1)        | 62.4 (60.5, 64.3)     | 44.2 (43.4, 45.0)      |
| ≥1⁴                                   | 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)      |
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.

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.

Using the state-specific figures, the 2009 H1N1, seasonal influenza, and any-dose influenza vaccination coverage among HCP and non-HCP were correlated ($r = 0.8$, $0.5$, 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,11–15 which was well below the Healthy People 2020 objectives of 90%.

Despite HCP being included in the initial target groups recommended by the ACIP to receive the H1N1 vaccine as a reason for nonvaccination, in addition to all healthcare settings, 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 was lower than usual seasonal influenza vaccination coverage among HCP in recent seasons (50%–62%), including the seasonal coverage reported in our analysis,11–15 which was well below the Healthy People 2020 objectives of 90%.

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

| DEMOGRAPHIC | H1N1 vaccination coverage | Seasonal influenza vaccination coverage | Any influenza vaccination coverage (seasonal and/or H1N1) |
|-------------|----------------------------|----------------------------------------|--------------------------------------------------------|
| Smoking status | Healthcare personnel | Non–healthcare personnel | Healthcare personnel | Non–healthcare personnel | Healthcare personnel | Non–healthcare personnel |
| Current smoker | 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) | 57.0 (54.0, 60.1) | 35.8 (34.8, 36.8) | 62.6 (59.6, 65.6) | 41.3 (40.2, 42.4) |
| Never smoked | 34.2 (32.3, 36.0) | 20.1 (19.4, 20.8) | 53.1 (51.1, 55.2) | 36.7 (35.9, 37.6) | 58.3 (56.3, 60.4) | 42.3 (41.4, 43.1) |

MSA

| 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 | 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.

*Reference level

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

| State         | Sample size, n | Healthcare personnel, % | H1N1 vaccination coveragea | Seasonal influenza vaccination coveragea | Any influenza vaccination coverage (seasonal and/or H1N1)a |
|---------------|----------------|-------------------------|---------------------------|------------------------------------------|---------------------------------------------------------|
| 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                    | 47.7 (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      | 3,288          | 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)                                      |
in vaccination coverage among the general adult population also has been observed. 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; 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; and differences in the effectiveness of specific intervention programs being implemented by states (i.e., community campaigns, provider-based strategies, and workplace vaccination).

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). 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.
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.\textsuperscript{13,14} 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.\textsuperscript{13,14}

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.\textsuperscript{27–30} 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.\textsuperscript{29,30} In addition, Thailand was a SARS (severe acute respiratory syndrome) epicenter and has been dealing with H5N1 (avian influenza) outbreaks.\textsuperscript{31–33} 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\textsuperscript{34}; however, weight was adjusted to account for people without landline telephones and people with cell phone only.\textsuperscript{8,34} 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.\textsuperscript{35–37}

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.\textsuperscript{2,3,38 – 40}

The authors thank Elizabeth Monsell, James A. Singleton, Gary L. Euler, Stacy M. Greby, and Abigail M. Shefer for their important contributions to this manuscript.
The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of CDC.

No financial disclosures were reported by the authors of this paper.

References

1. DHHS. Definition of health-care personnel (HCP).
   www.hhs.gov/ash/programs/initiatives/vactoolkit/definition.html.

2. CDC. Immunization of health-care workers: recommendations of the Advisory Committee on Immunization Practices (ACIP) and the Hospital Infection Control Practices Advisory Committee (HICPAC).
   MMWR Recomm Rep 1997;46(RR-18):1–42.

3. CDC. Influenza vaccination of health-care personnel. MMWR 2006;54(RR-2):1–16.

4. Potter J, Stott DJ, Roberts MA, et al. Influenza vaccination of health-care workers in long-term-care hospitals reduces the mortality of elderly patients. J Infect Dis 1997;175(1):1–6.

5. Salgado CD, Giannetta ET, Hayden FG, Farr BM. Preventing nosocomial influenza by improving the vaccine acceptance rate of clinicians. Infect Control Hosp Epidemiol 2004;25(11):923–8.

6. CDC. Prevention and control of influenza. MMWR 1984;33(19):253–60, 265–6.

7. CDC. Use of influenza A (H1N1) 2009 monovalent vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2009. MMWR Recomm Rep 2009;58(RR-10):1–8.

8. CDC. 2009 BRFSS Summary Data Quality Report. Atlanta GA: DHHS, CDC, 2009. www.cdc.gov/brfss/technical_infodata/surveydata/2009.htm.

9. Korn EL, Graubard BI. Predictive margins (direct standardization). In: Analysis of health surveys. New York: Wiley, 1999:126–40.

10. Nadel MR, Shapiro JA, Klabunde CN, et al. A national survey of primary care physicians’ methods for screening for fecal occult blood. Ann Intern Med 2005;142(2):86–94.

11. CDC. Prevention and control of influenza: recommendations of the Advisory Committee on Immunization Practices. MMWR Recomm Rep 2010;59(RR-8):1–62.

12. Lu PJ, Bridges CB, Euler GL, Singleton JA. Influenza vaccination of recommended adult populations, U.S., 1989–2005. Vaccine 2008;26(14):1786–93.

13. Walker FJ, Singleton JA, Lu PJ, Wooten KG, Strikas RA. Influenza vaccination of healthcare workers in the U.S., 1989–2002. Infect Control Hosp Epidemiol 2006;27(3):257–65.

14. Lorick SA, Wortley PM, Lindley MC, Bardenheier BH, Euler GL. U.S. Healthcare personnel and influenza vaccination during the 2004–2005 vaccine shortage. Am J Prev Med 2008;34(6):455–62.

15. CDC. Interim results: Influenza A (H1N1) 2009 monovalent and seasonal influenza vaccination coverage among health-care personnel—U.S., August 2009–January 2010. MMWR Morb Mortal Wkly Rep 2010;59(12):357–62.

16. DHHS. Healthy People 2020. www.healthypeople.gov/2020/topicsobjectives 2020/objectiveList.aspx?topicId=23.

17. CDC. Update on influenza A (H1N1) 2009 monovalent vaccines. MMWR Morb Mortal Wkly Rep 2009;58(39):1100–1.

18. CDC. National influenza vaccination week—January 10–16, 2010. MMWR Morb Mortal Wkly Rep 2010;58(51 & 53):1444.

19. CDC. Update: influenza activity—U.S., August 30, 2009—March 27, 2010, and composition of the 2010–11 influenza vaccine. MMWR Morb Mortal Wkly Rep 2010;59(14):423–30.

20. CDC. Update: influenza activity—U.S., August 30, 2009—January 9, 2010. MMWR Morb Mortal Wkly Rep 2010;59(2):38–43.

21. CDC. Interim results: influenza A (H1N1) 2009 monovalent vaccination coverage—U.S., October–December 2009. MMWR Morb Mortal Wkly Rep 2010;59(2):44–8.

22. Harris K, Maurer J, Black C, Euler G, Kadiyala S. Workplace efforts to promote influenza vaccination among healthcare personnel and their association with uptake during the 2009 pandemic influenza A (H1N1). Vaccine 2011;29(16):2978–85.

23. CDC. Interim results: state-specific seasonal influenza vaccination coverage—U.S., August 2009–January 2010. MMWR Morb Mortal Wkly Rep 2010;59(16):477–84.

24. Klaiman T, Ibrahim JK. State health department structure and pandemic planning. J Public Health Manag Pract 2010;16(2):E1–E7.

25. Nelson DE, Bland S, Powell-Griner E, et al. State trends in health risk factors and receipt of clinical preventive services among U.S. adults during the 1990s. JAMA 287(20):2659–67.

26. CDC. Immunization administration requirements for influenza. www2a.cdc.gov/nip/StateVaccApp/statevaccsApp/AdministrationbyVaccine.asp?Vaccinetmp=Influenza.

27. Sánchez-Payá J, Hernández-García I, Barrenengoa Sañudo J, et al. Determinants of influenza vaccination in health staff: 2009-2010 season. Gac Sanit 2011;25(1):29–34.

28. Amadio E, Anastasi G, Marsala MG, Torregrossa MV, Romano N, Firenze A. Vaccination against the 2009 pandemic influenza A (H1N1) among healthcare workers in the major teaching hospital of Sicily (Italy). Vaccine 2011;29(7):1408–12.

29. Park SW, Lee JH, Kim ES, et al. Adverse events associated with the 2009 H1N1 influenza vaccination and the vaccination coverage rate in health care workers. Am J Infect Control 2011;39(1):69–71.

30. Kiertiburanakul S, Malathum K, Watcharananpan SP, et al. High coverage and safety of influenza A (H1N1) 2009 monovalent vaccination among health-care personnel in Thailand. Am J Infect Control 2011;39(6):525–8.

31. Lee NE, Siriarayapon P, Tappero J, et al. Infection control practices for SARS in Lao People’s Democratic Republic, Taiwan, and Thailand: experience from mobile SARS containment teams, 2003. Am J Infect Control 2004;32(7):377–83.

32. Chantong W, Kaneene JB. Poultry raising systems and highly pathogenic avian influenza outbreaks in Thailand: the situation, associations, and impacts. Southeast Asian J Trop Med Public Health 2011;42(3):596–608.

33. Keawcharoen J, van den Broek J, Bouma A, Tiensin T, Osterhaus AD, Heesterbeek H. Wild birds and increased transmission of highly pathogenic avian influenza (H5N1) among poultry, Thailand. Emerg Infect Dis 2011;17(6):1016–22.

34. Blumberg SJ, Luke JV. Reevaluating the need for concern regarding non-coverage bias in landline surveys. Am J Public Health 2009;99(10):1806–10.

35. Donald RM, Baken L, Nelson A, Nichol KL. Validation of self-report of influenza and pneumococcal vaccination status in elderly outpatients. Am J Prev Med 1999;16(3):173–7.

36. Zimmerman RK, Raymund M, Janosky JE, Nowalk MP, Fine MJ. Sensitivity and specificity of patient self-report of influenza and pneumococcal polysaccharide vaccinations among elderly outpatients in diverse patient care strata. Vaccine 2003;21(13-14):1486–91.

37. Mangtani P, Shah A, Roberts JA. Validation of influenza and pneumococcal vaccine status in adults based on self-report. Epidemiol Infect 2007;135(1):139–43.

38. Poland GA, Shefer AM, McCauley M, et al. Standards for adult immunization practice. Am J Prev Med 2003;25(2):144–50.

39. Lindley MC, Horlick GA, Shefer AM, Shaw FE, Gorji M. Assessing state immunization requirements for healthcare workers and patients. Am J Prev Med 2007;32(6):459–65.

40. Guide to Community Preventive Services. www.thecommunityguide.org/index.html.