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Do Vaccination Strategies Implemented by Nursing Homes Narrow the Racial Gap in Receipt of Influenza Vaccination in the United States?

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Abstract

OBJECTIVES—To determine whether the racial inequity between African Americans and Caucasians in receipt of influenza vaccine is narrower in residents of nursing homes with facility-wide vaccination strategies than in residents of facilities without vaccination strategies.

DESIGN—Secondary data analysis using the National Nursing Home Survey 2004, a nationally representative survey.

SETTING—One thousand one hundred seventy-four participating nursing homes sampled systematically with probability proportional to bed size.

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Author Contributions: Barbara Bardenheier: study concept and design (specifically worked on the facility vaccination policy questions on the survey), data analysis and interpretation, and preparation of the manuscript. Abigail Shefer: study design, data interpretation, and critical review of the manuscript. Faruque Ahmed: analysis and interpretation of data, revising it critically for important intellectual content, and final approval of the version to be published. Robin Remsburg was the chief of the long-term statistics branch at National Center for Health Statistics and participated in the development of the study questions, supervised data collection and database development, and was involved with interpretation of analyses, discussion, and review of the manuscript. Carol Hogue: review of data analysis and interpretation and preparation of the manuscript. Stefan Gravenstein: concept, design, interpretation, and manuscript.

Sponsor's Role: Data were collected and made available by the National Center for Health Statistics, CDC.

The authors have no conflicts of interest.

PARTICIPANTS—Thirteen thousand five hundred seven randomly sampled residents of nursing homes between August and December 2004.

MEASUREMENTS—Receipt of influenza vaccine within the last year. Logistic regression was used to examine the relationship between facility-level influenza immunization strategy and racial inequity in receipt of vaccination, adjusted for characteristics at the resident, facility, state, and regional levels.

RESULTS—Overall in the United States, vaccination coverage was higher for Caucasian and African-American residents; the racial vaccination gaps were smaller (<6 percentage points) and nonsignificant in residents of homes with standing orders for influenza vaccinations ($P = .14$), verbal consent allowed for vaccinations ($P = .39$), and routine review of facility-wide vaccination rates ($P = .61$) than for residents of homes without these strategies. The vaccination gap in residents of homes without these strategies were two to three times as high ($P = .009$, $P = .002$, and $P = .002$, respectively).

CONCLUSION—The presence of several immunization strategies in nursing homes is associated with higher vaccination coverage for Caucasian and African-American residents, narrowing the national vaccination racial gap.

Keywords

vaccination; nursing home; racial disparity; influenza; NNHS

Although the Advisory Committee for Immunization Practices (ACIP) recommends annual influenza vaccination for all residents of long-term care facilities (LTCFs),¹ there is a gap in vaccination between Caucasian and African-American nursing home residents.² A study conducted in 14 states during 2000 through 2002 found an 8-percentage-point racial gap.³ That difference was confirmed using the 2004 National Nursing Home Survey (NNHS), which reported a difference in vaccination of 9 percentage points between Caucasians and African Americans.² The gap was virtually the same, 8.3 percentage points, during the 2005/06 influenza vaccination season using the Centers for Medicare and Medicaid Services (CMS) Minimum Data Set.⁴ Reasons for the racial gap in vaccination have not been identified.

Various strategies have been reported to be associated with higher influenza and pneumococcal vaccination coverage in LTCFs, such as the implementation of standing orders protocols (SOPs),⁵ a written protocol for immunizations, documentation of refusals, documentation of vaccination status in a consistent place in medical records, and minimal consent requirements for vaccinations.³ The ACIP and the Task Force for Community Preventive Services specifically recommend SOPs.⁶ Since the ACIP and Task Force recommended these strategies, studies have assessed whether facility-wide vaccination strategies are associated with higher coverage when widely used in a real-world environment.^{3,7,8} Although previous studies did not specifically examine racial differences in vaccination status with use of vaccination strategies, one study using the NNHS reported race to be a strong, statistically significant confounder between use of standing orders for influenza vaccination and receipt of the vaccine.⁷

The objective of this analysis is to use the NNHS to determine whether specific facility-wide vaccination strategies narrow the national racial gap in influenza vaccination in nursing home residents.

METHODS AND MATERIALS

Study Design and Study Population

Data from the 2004 National Nursing Home Survey, a cross-sectional nationally representative sample survey of nursing homes, were analyzed. NNHS is a stratified two-stage probability design. Nursing homes are selected using systematic sampling with probability proportional to number of beds. Of the 1,457 eligible facilities selected, 1,174 participated at the first stage by providing facility information, resulting in a first stage response rate of 81%.⁹ Up to 12 current residents from each facility were sampled from the facility roster as of midnight the day before the survey (conducted August to December). Fourteen thousand seventeen residents were sampled from the responding facilities. Data are weighted to represent the U.S. population of nursing home residents. The overall response rate for the resident component of the NNHS was 78%.⁹ Administrators and staff were interviewed about the facility and residents.

Some state-level descriptive variables collected by the AARP from the U.S. Census and CMS¹⁰ (proportion of African Americans aged 65 and older in the state, proportion of nursing homes with reported deficiencies in the state, and two variables as measures of the state's Medicaid generosity (state Medicaid payment rate per day for nursing facility care and Medicaid long-term care expenditures per person in the state)) were added to the data according to residents' state.

Main Exposure

The main exposure variables included non-Hispanic white and African-American race and facility vaccination strategies. Because the main objective of the analyses was to examine the association between facility vaccination strategies and differences between non-Hispanic whites and African Americans in receipt of the influenza vaccine, residents of other race and ethnicity were excluded (approximately 5% of residents) from the analyses, leaving 12,857 individuals in 1,131 nursing homes.

Outcome Measure

The outcome variable for influenza vaccination was worded: "Please look at this card and tell me which category best describes [the resident's] *documented* vaccination status for a flu shot during the past 12 months, that is, since {PAST 12 MONTHS}." Staff respondents were instructed to examine all relevant records to answer resident-related questions and to report information from documented vaccination status. A survey response of "no" indicated a record of evidence that the resident did not receive a vaccination. A survey response of "unknown" indicated an absence of evidence in all records of the resident's vaccination status or a record indicating an unknown status.⁹ All categories for reasons for not receiving the vaccine and unknown vaccination status were collapsed into one category for the analysis. This assumption was based on another study reporting vaccination proportions

from 2005 Census data for non-hospital administered CMS-certified facilities in the United States in which a similar proportion of residents were vaccinated as in the current study and fewer than 3% had unknown vaccination status.⁴ Thus it was assumed that the vast majority of the residents with unknown vaccination status (18%) were not vaccinated.

Other Variables Considered in the Analysis

Variables in the final model deemed to be confounders (variables associated with race and receipt of the influenza vaccine: sex, age, marital status at time of admission, length of stay, need of assistance with eating, total number of beds in the home, facility ownership, facility affiliation with a chain, facility certification status, proportion residents on Medicaid in the facility (<80% vs 80), metropolitan statistical area, region, proportion of state residents aged 65 who are African American, proportion of nursing homes with reported deficiencies in the state, and two variables as measures of the state's Medicaid generosity (state Medicaid payment rate per day for nursing facility care and Medicaid long-term care expenditures per person in the state)) were included.¹⁰

Facility Strategies to Increase Vaccination Coverage

Eleven strategies were evaluated in the data set. Respondents were asked whether they had used standing orders, preprinted orders, advance orders, or a personal physician order. Facility-wide standing orders were defined as "An institutional policy authorizes appropriate nursing or other non-physician staff to immunize residents by institution- or medical director-approved protocol without the need for a written or verbal order from the resident's personal physician." Because facility-wide standing orders are associated with higher rates of vaccination, whereas pre-printed orders, advance orders or personal physician orders were not, facilities were categorized as having standing orders or not. In addition, respondents were asked whether they had used any of the following 10 strategies: written vaccination policy, vaccinations offered to all in-facility residents during the fall vaccination campaign, vaccination offered throughout the influenza season (October–March) to all residents admitted during that period, a policy making verbal consent sufficient to allow vaccinations, seasonal vaccination campaigns (several campaigns could occur during different time periods during the season), primary care provider immunization reminder program, centralized tracking system for facility-wide influenza vaccination coverage, routine review of facility-wide influenza vaccination coverage, facility-level recommendation for healthcare workers to receive the influenza vaccine, and facility-level provision of free vaccine to healthcare workers.

Although healthcare personnel vaccination coverage was not considered a vaccination strategy, this variable was examined in relation to the main outcome measure of vaccination coverage of residents. The cutoff of 40% was chosen because information on healthcare personnel vaccination was collected in deciles, and the nationally reported coverage was 37%;¹¹ hence 40% was somewhat higher than the national average.

Statistical Analyses

Analyses were conducted to examine racial inequities in receipt of influenza vaccine within each category of resident and facility characteristics and are presented in Table 1. *P*-values

for these analyses are from the *t*-test for the difference in predicted marginal effects (of being vaccinated) between Caucasians and African Americans, within each stratum.

Logistic regression was used to examine the influence of nursing home vaccination strategies on race and resident vaccination status, controlling for confounders, using SAS version 9.2 (SAS Institute, Inc., Cary, NC) and SUDAAN version 9.0.0 (Research Triangle Institute, Research Triangle Park, NC) to account for the complex survey design. Multiplicative interaction between vaccination strategies and race was used to assess racial differences in vaccination between residents of facilities with vaccination strategies and those of facilities without such strategies. The two-factor interaction term in each model was assessed. The adjusted percentages (predictive margins) are a type of direct standardization that averages the predicted values from the logistic model, controlling for the confounding factors in the population.¹²

Adjusted estimates that describe the effect of each individual vaccination strategy are presented, holding constant the rest of the vaccination strategies, to isolate the effect for that individual strategy. In other words, estimates for adjusted vaccination coverage according to facility strategy and race in Tables 2 and 3 are adjusted for confounders of the relationship between race and receipt of influenza vaccine, as well as being simultaneously adjusted for all other vaccination policies studied.

The National Center for Health Statistics (Research Ethics Review Board reviewed and approved the survey. The CDC's human subject coordinator reviewed this project and determined it to be secondary data analysis.

RESULTS

Of the 13% of the study population that was African American, 50.8% were residents of nursing homes in the South (Table 1). Unadjusted vaccination coverage was 64.1% for Caucasians and 54.9% for African Americans ($P < .001$). For 10 of the 11 strategies, residents of homes with the strategy had higher vaccination coverage than residents in homes without such strategies in the unadjusted analyses. Residents in homes that used primary care provider immunization reminders had lower vaccination coverage than residents in homes that did not use this strategy (62.5% vs 63.3%, $P = .42$).

Logistic Models

In the logistic models, the adjusted vaccination coverage for Caucasian and African-American residents was higher overall than in the unadjusted vaccination levels, but the racial gap remained statistically significant (64.5% vs 58.2%, $P = .004$). Results of the logistic regression models adjusting for confounders of the relationship between race, facility vaccination strategy, and receipt of the influenza vaccine are presented according to race for each strategy in Table 2. For four of the 11 strategies, coverage was higher in Caucasian residents in homes with those strategies than in Caucasian residents in homes without those strategies. For six of the 11 strategies, vaccination coverage for African-American residents was higher than for their counterparts in homes without those strategies. The strategies that were associated with higher coverage varied according to racial group.

Strategies associated with higher vaccination coverage for both racial groups and statistically nonsignificant racial inequities included facility-wide standing orders, allowing verbal consent for influenza vaccinations, and routine review of facility-wide influenza vaccination rates (Table 3). In facilities with 40% or more of healthcare personnel vaccinated, vaccination coverage was higher for both racial groups, and the racial difference in vaccination was statistically nonsignificant.

DISCUSSION

Racial disparities for quality measures in nursing home residents have been documented.^{13,14} Findings from one study examining facility and county effects on racial differences in nursing home quality indicators suggest that intervention at the organization level is warranted to improve quality indicator outcomes for Caucasians and African Americans.¹⁵ Results of the analyses support this recommendation. Three of the 11 immunization strategies and reporting that 40% or more of healthcare personnel were vaccinated were associated with higher vaccination coverage for Caucasian and African-American residents and no racial gap in vaccination coverage.

Standing orders for influenza vaccination was associated with higher vaccination coverage than other vaccination strategies for African-American and Caucasian residents, and the difference between African Americans and Caucasians was small and not statistically significant. In 2002, the Federal Conditions of Participation (42 CFR Parts 482, 483, and 484) for Medicare- and Medicaid-certified LTCFs were changed to lift the requirement for a physician signature on orders for influenza and pneumococcal vaccines, allowing these vaccines to be administered according to physician-approved facility policy after an assessment of contraindications. The low prevalence of residents who lived in homes with standing orders for immunizations (41%) in the current study reflects dissemination of this intervention approximately 2 years after this rule was changed. It is likely that nursing home administrators and staff still have had misconceptions about liability concerns or lack of knowledge regarding standing orders. In another study conducted before 2002, the most frequently reported barriers for adoption of standing orders in LTCFs included barriers external to the nursing home (low reimbursement rates for immunizations, perception of patient or family vaccination refusal, liability and legal concerns for the facility, and requirement to work with a protocol) and internal to the nursing home (lack of support from facility leadership, high staff turnover rate, inadequate staffing, and lack of immunization tracking system; unpublished data). The authors are not aware of more recent data that show whether these barriers still exist, and if so, to what extent.

Allowing for verbal consent was associated with higher vaccination coverage for both race groups, as well as with a narrower racial difference in vaccination coverage. A previous study found that a change in policy from requiring written consent to allowing verbal consent was strongly associated with greater vaccination coverage by at least 10 percentage points (odds ratio = 2.97, 95% confidence interval = 1.43–6.15) in nursing home residents.³ Soon thereafter, the American Medical Directors Association (AMDA) revised its tool kit for vaccination to remove the sample signed consent form.¹⁶ At that time, only one state, Maryland, required written consent for giving vaccinations.¹⁷

Routine review of facility-wide influenza vaccination rates was associated with a smaller racial gap in immunization coverage. Periodically monitoring vaccination coverage in nursing homes is important for facility administrators to be aware of how well residents are protected during the influenza season. It is also a tool that can be used to give staff feedback as to how well they are accomplishing the facility's goal of vaccination coverage. Since 2005, vaccination has been a quality indicator that is used to determine compliance for certification (for Medicare, Medicaid, or both). Hence the strategy of reviewing vaccination rates has probably increased since this study was conducted because it has become necessary for the facility administrator to monitor.

Another study that used the 2004 NNHS to examine national racial differences in receipt of the influenza vaccination found different results than ours. It reported higher unadjusted national vaccination coverage of 76.2%,¹⁸ compared with the current level of 62.9%. The main reason for the difference in overall vaccination coverage was that the previous study reported the offering level, whereas the current study reported vaccination coverage. The reported national coverage in the current study using the 2004 NNHS was more similar to the national coverage using CMS data from 2005/06 of 62.3%, in which the population was defined as cross-sectional, commensurate with the NNHS.¹⁹ Another reason for differences is that the previous study used the public use data set, so important confounders (region, Medicare and Medicaid certification, ownership of the facility, affiliation with a chain, proportion of residents on Medicaid, percentage of African Americans aged 65 and older in the state, proportion of nursing homes with reported deficiencies in the state, state Medicaid payment rate per day for nursing facility care, and Medicaid long-term care expenditures per person in the state) were not held constant.

One potential limitation of the current study is that definitions of "standing orders" vary, and although the interviewer read the definition to the interviewee, preconceived ideas about standing orders could have been what the respondent reported. Therefore, some misclassification may have occurred. In addition, the extent of implementation of reported policies was unknown, potentially resulting in underestimation of the association of policies with coverage. Finally, because this analysis is based on cross-sectional data, the results do not imply causality.

Consistent with studies of other nursing home quality indicators,^{15,20} the current study found racial inequities in vaccination in nursing home residents, the newest quality of care indicator.⁴ Unlike outcomes examined in other studies, the influenza vaccine is a simple preventive service that is low cost, minimally time consuming, and universally recommended for this population. For this reason, these findings are encouraging in that a standardized and proactive approach such as standing orders may effectively diminish racial inequities in receipt of the influenza vaccine. Because this study was conducted in 2004, and prevalence of these facility practices was low (<50%), research is needed to determine whether more nursing homes have adopted these effective strategies and practices. For example, has the change in CMS rules for reimbursement and in the AMDA policy for verbal consent resulted in increased use of SOPs and verbal consent in nursing homes? Have facilities changed their strategies since 2004, and if so, has vaccination coverage increased?

In addition to narrowing racial gaps, overall vaccination coverage needs to increase. One-third of nursing home residents unvaccinated for influenza is not acceptable. Future research examining how to best facilitate adoption of vaccination strategies is needed. Such research has the potential to increase protection against influenza-related disease in all long-term care residents and to narrow the racial gap in receipt of health care simultaneously. One way to improve vaccination outcomes and reducing racial inequities is to identify ways to assist nursing homes in effectively implementing such strategies as standing orders for vaccination, policies for verbal consent, and routine review of facility vaccination. Understanding to what extent internal facility barriers exist and how to modify barriers effectively, such as lack of support from facility leadership, high staff turnover rate, inadequate staffing, and lack of an immunization tracking system, are needed.

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Table 1
Resident and Facility Characteristics According to Race of Nursing Home Resident: National Nursing Home Survey, 2004

Characteristic	n (%)	Total		White		Black		P-Value *
		Vaccinated for Influenza, %	n (%)	Vaccinated for Influenza, %	n (%)	Vaccinated for Influenza, %	n (%)	
Total	12,857 (100.0)	62.9	11,473 (87.0)	64.1	1,384 (13.0)	54.9		<.001
Facility characteristics								
Facility program for influenza immunizations: facility-wide standing orders								
Yes	5,311 (40.7)	67.0	4,757 (41.2)	67.7	554 (37.8)	61.6		.03
No	7,546 (59.3)	60.1	6,716 (58.8)	61.5	830 (62.2)	50.9		.001
Facility has written influenza vaccination policy								
Yes	8,134 (65.6)	63.1	7,348 (66.5)	64.4	786 (59.6)	53.4		.001
No	4,579 (34.4)	62.8	4,003 (33.5)	63.8	576 (40.4)	57.0		.03
Influenza vaccination offered to all residents during fall campaign								
Yes	10,921 (86.3)	63.3	9,783 (86.6)	64.5	1,138 (84.1)	55.3		.001
No	1,792 (13.7)	60.8	1,568 (13.4)	62.3	224 (15.9)	52.1		.11
Influenza vaccinations offered throughout influenza season to residents admitted during that period								
Yes	9,029 (73.0)	64.4	8,124 (73.7)	65.7	905 (67.9)	54.6		<.001
No	3,684 (27.0)	59.2	3,227 (26.3)	59.9	457 (32.1)	55.3		.28
Verbal consent allowed for influenza vaccinations								
Yes	4,942 (39.8)	63.8	4,390 (39.6)	64.3	552 (41.7)	60.6		.29
No	7,771 (60.2)	62.4	6,961 (60.4)	64.1	810 (58.3)	50.7		<.001
Seasonal influenza vaccination campaigns								

Characteristic	Total		White		Black		P-Value*
	n (%)	Vaccinated for Influenza, %	n (%)	Vaccinated for Influenza, %	n (%)	Vaccinated for Influenza, %	
Yes	5,661 (44.8)	64.4	5,172 (45.8)	65.3	489 (38.0)	57.7	.046
No	7,052 (55.2)	61.8	6,179 (54.2)	63.3	873 (62.0)	53.1	.001
Primary care provider influenza vaccination reminder program							
Yes	3,398 (27.0)	62.5	3,081 (27.5)	63.8	317 (24.2)	52.8	.02
No	9,339 (73.0)	63.3	8,287 (72.5)	64.4	1,052 (75.8)	55.9	.002
Centralized tracking system for facility-wide influenza vaccination rates							
Yes	4,466 (40.0)	63.7	4,065 (41.1)	64.5	401 (32.8)	57.6	.10
No	8,247 (60.0)	62.5	7,286 (58.9)	64.0	961 (67.2)	53.5	<.001
Routine review of facility-wide influenza vaccination rates							
Yes	5,094 (44.1)	65.1	4,613 (45.1)	65.7	481 (37.3)	60.2	.16
No	7,619 (55.9)	61.3	6,738 (54.9)	62.9	881 (62.7)	51.6	<.001
Proportion healthcare workers who received influenza vaccine							
<=40%	4,282 (37.2)	61.1	3,667 (35.1)	63.0	615 (50.9)	52.3	.004
440%	7,898 (62.8)	64.7	7,210 (64.9)	65.5	688 (49.1)	57.7	.007
Facility recommends influenza vaccine to healthcare workers							
Yes	10,685 (83.6)	63.0	9,577 (83.9)	64.3	1,108 (81.3)	54.4	<.001
No	2,105 (16.4)	63.2	1,836 (16.1)	63.8	269 (18.7)	59.6	.32
Facility provides free influenza vaccine to healthcare workers							
Yes	10,497 (82.1)	63.4	9,475 (83.3)	64.4	1,022 (73.9)	55.4	.001
No	2,293 (17.9)	61.6	1,938 (16.7)	63.1	355 (26.1)	55.2	.10

Proportions are weighted to represent the United States.

* P -values are from the t -test for the difference in predicted marginal effects (for being vaccinated) between whites and blacks, within each level of each variable.

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Table 2

National Nursing Home Survey, 2004 Multivariable Models: Vaccination Coverage of Nursing Home Residents According to Presence of Vaccination Policy and Race

Variable	Predicted Margin (Standard Error)			
	With Vaccination Policy		Without Vaccination Policy	
	White	Black	White	Black
Resident vaccination strategy				
Facility-wide standing orders	68.0 (1.3)	64.3 (2.6)	63.0 (1.2)	54.8 (3.1)
Verbal consent allowed for influenza vaccinations	65.5 (1.3)	62.8 (3.2)	64.7 (1.2)	55.6 (3.0)
Seasonal influenza vaccination campaigns	65.0 (1.4)	60.3 (3.6)	65.1 (1.2)	57.6 (2.7)
Primary care provider influenza vaccination reminder program	64.8 (1.5)	58.4 (4.0)	65.1 (1.0)	58.6 (2.6)
Centralized tracking system for facility-wide influenza vaccination rates	62.7 (1.5)	58.7 (3.6)	66.6 (1.2)	58.9 (2.7)
Routine review of facility-wide influenza vaccination rates	66.5 (1.4)	64.2 (3.3)	63.9 (1.2)	54.8 (2.9)
Written influenza vaccination policy	64.8 (1.1)	56.9 (3.0)	65.5 (1.5)	61.3 (2.9)
Influenza vaccination offered to all residents during fall campaign	65.0 (1.0)	58.7 (2.3)	65.1 (2.3)	58.1 (5.8)
Influenza vaccination offered throughout influenza season to residents admitted during that period	66.3 (1.0)	58.1 (2.5)	61.5 (1.6)	58.9 (4.1)
Healthcare personnel vaccination strategy				
Facility provides free influenza vaccine to healthcare workers	64.8 (1.0)	58.7 (2.4)	66.1 (2.3)	58.5 (4.9)
Facility recommends influenza vaccine to healthcare workers	65.0 (1.0)	58.4 (2.5)	65.3 (2.4)	59.3 (4.3)
Healthcare personnel vaccination coverage (44% vs <40%)	65.6 (1.1)	60.8 (2.6)	64.2 (1.4)	56.0 (3.4)

Model adjusted for sex, age, marital status at time of admission, length of stay, needing assistance with eating, total number beds in home, facility ownership, affiliation with a chain, certification status, metropolitan statistical area, proportion residents on Medicaid (<80% vs 80%), region, proportion of African Americans aged 65 and older in the state, proportion of facilities with deficiencies in the state, Medicaid payment rate per day for nursing facility care, Medicaid long-term care expenditures per person in the state, and all other vaccination policies.

Table 3

National Nursing Home Survey, 2004 Multivariable Models: Racial Gap in Influenza Vaccination in Nursing Home Residents of Facilities with and without Vaccination Policies

Variable	White-Black Difference in Predicted Margins (Standard Error) P-Value	
	With Vaccination Policy	Without Vaccination Policy
Resident vaccination strategies		
Facility program for influenza immunizations: facility-wide standing orders	3.7 (2.5) .14	8.2 (3.2) .009
Verbal consent allowed for influenza vaccinations	2.7 (3.1) .39	9.1 (3.0) .002
Seasonal influenza vaccination campaigns	4.7 (3.6) .20	7.5 (2.7) .006
Primary care provider influenza vaccination reminder program	6.4 (4.0) .12	6.5 (2.5) .01
Centralized tracking system for facility- wide influenza vaccination rates	3.9 (3.6) .28	7.6 (2.7) .005
Routine review of facility-wide influenza vaccination rates	1.7 (3.3) .61	9.0 (2.9) .002
Written influenza vaccination policy	7.9 (3.0) .009	4.2 (2.9) .14
Influenza vaccination offered to all residents during fall campaign	6.4 (2.3) .005	7.0 (5.9) .23
Influenza vaccination offered throughout flu season to residents admitted during that period	8.2 (2.5) .001	2.6 (4.0) .52
Healthcare personnel vaccination strategies		
Facility provides free influenza vaccine to healthcare workers	6.1 (2.4) .01	7.6 (4.9) .12
Facility recommends influenza vaccine to healthcare workers	6.6 (2.5) .009	5.9 (4.0) .14
Healthcare personnel vaccination coverage (>40% vs <40%)	4.7 (2.7) .08	8.2 (3.4) .02

Model adjusted for sex, age, marital status at time of admission, length of stay, needing assistance with eating, total number beds in home, facility ownership, affiliation with a chain, certification status, metropolitan statistical area, proportion residents on Medicaid (<80% vs 80%), region, proportion African Americans aged 65years and over in the state, proportion facilities with deficiencies in the state, Medicaid payment rate per day for nursing facility care, Medicaid long-term care expenditures per person in the state, and all other vaccination policies.