Published in final edited form as:

J Am Med Dir Assoc. 2014 October ; 15(10): 768–772. doi:10.1016/j.jamda.2014.06.005.

Healthcare worker influenza vaccination in Oregon nursing homes: correlates of facility characteristics

Lauren J. Campbell, MA¹, Qinghua Li, BMed¹, and Yue Li, PhD¹

¹Department of Public Health Sciences, Division of Health Policy and Outcomes Research, University of Rochester Medical Center

Abstract

Objectives—Nursing home (NH) employee influenza vaccination is associated with reductions in morbidity and mortality among residents. Little is known regarding associations between NH characteristics and employee influenza vaccination rates (EVRs). This study identifies NH characteristics that may be associated with EVRs.

Design—Data on employee vaccination rates and programs were gathered from Office for Oregon Health Policy and Research reports for three influenza seasons from 2009–2012 and merged with Online Survey, Certification, and Reporting files, from which facility characteristics were obtained. Market controls were obtained from the 2010 Area Health Resource File. Multivariate linear and logistic regression were used to model relationships between facility characteristics and EVR per facility per year, whether formal education for employees was conducted, and whether 2010, 2015, and 2020 Healthy People targets were met.

Setting—Oregon nursing homes from 2009–2012.

Participants—NHs reporting sufficient data to calculate an EVR were included. Based on information obtained from 2009–10, 2010–11, and 2011–12 surveys, EVRs were calculated for 113/140, 129/141, and 137/140 (81%, 91%, and 98% of) NHs, respectively.

Measurements—Dependent variables were EVR per facility per year, whether formal education for employees was conducted, and whether 2010, 2015, and 2020 Healthy People targets were met. Independent variables included facility characteristics and market controls.

© 2014 American Medical Directors Association. Published by Elsevier Inc. All rights reserved

Corresponding Author Lauren J. Campbell, MA Doctoral Candidate Department of Public Health Sciences Division of Health Policy and Outcomes Research University of Rochester Medical Center 265 Crittenden Blvd., CU 420644 Rochester, NY 14642 Phone: (716) 430-6071 Lauren_Campbell@urmc.rochester.edu.

Qinghua Li, BMed Doctoral Candidate Department of Public Health Sciences Division of Health Policy and Outcomes Research University of Rochester Medical Center 265 Crittenden Blvd., CU 420644 Rochester, NY 14642 Phone: (585) 752-1719 Qinghua_Li@urmc.rochester.edu

Yue Li, PhD Associate Professor Department of Public Health Sciences Division of Health Policy and Outcomes Research University of Rochester Medical Center 265 Crittenden Blvd., CU 420644 Rochester, NY 14642 Phone: (585) 275-3276 Fax: (585) 461-4532 yue_li@urmc.rochester.edu

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conflicts of Interest: no conflict of interest for any author.

Results—On average, chain-affiliated NHs had 9% higher EVRs ($P=0.01$) and 73% higher odds of achieving 60% EVR (2010 target, $P=0.05$) than free-standing NHs. For-profit NHs had, on average, 8% lower EVRs ($P=0.04$) than not-for-profit NHs. Surprisingly, a 10% increase in proportion of Medicaid residents was associated with a 2% increase in EVR ($P=0.01$) and higher odds of achieving 60% ($OR=1.20$, $P=0.004$) and 70% (2015 target, $OR=1.14$, $P=0.05$) EVR.

Conclusion—Given that NHs generally have low employee influenza vaccination rates, it may be necessary to target low-performing facilities to achieve substantial improvements. However, significant correlates of this study cannot be easily addressed by NH management or policymakers. Without policy change encouraging key components of vaccination programs, public reporting may be insufficient to improve EVRs.

Keywords

nursing homes; healthcare worker; influenza; vaccination

INTRODUCTION

Approximately 90% of annual influenza deaths occur in the elderly, and risk of influenza-related mortality increases substantially with age.^{1,2} Vaccination is one means of protecting the elderly, especially nursing home (NH) residents, from influenza and related complications. Among NH residents, vaccination is associated with improvements in morbidity and mortality, including reduced risk of complications and hospitalizations.^{3–5}

Additional improvements may be achieved through vaccinating NH employees. NH employee vaccination has been associated with significant reductions in morbidity and mortality among NH residents.^{2,6–8} Although the Centers for Disease Control and Prevention recommend that all healthcare workers receive annual influenza vaccination, only 54% of NH employees did so during the 2009–2010 influenza season.² As employee vaccination is associated with significant reductions in morbidity and mortality among NH residents, NHs could improve quality by improving EVRs.

In order to improve EVRs, facility components influencing employee vaccination must be identified. Currently, little is known regarding potential associations between NH characteristics and EVRs. Given this knowledge gap, this study obtained data on NH employee vaccination rates and programs from the Office for Oregon Health Policy and Research (OHPR) during three influenza seasons from 2009–2012; data were merged with facility and county data from 2009–2012 Online Survey, Certification, and Reporting (OSCAR) files and 2010 Area Health Resource Files (AHRF). This study examines effects of facility characteristics on NH employee vaccination rates and vaccination education programs, controlling for market conditions, and adds to existing literature by improving awareness of these potential associations. This could better enable NH management and policymakers to invest in measures allowing for increased employee vaccination, possibly reducing influenza infection and related complications among residents. In addition, understanding which facility characteristics are most influential is imperative to developing policies to target low-performing facilities.

METHODS

Nursing Home Investment in Employee Influenza Vaccination

NHs may invest in employee vaccination if they have sufficient resources, are efficient, and have an incentive to improve quality, given the constraint of maintaining consistent flow of required inputs and prevailing market conditions.^{9,10} Existing literature recognizes that key factors influencing EVRs are employee vaccination education, free vaccine, and convenient access to vaccine.^{11,12} Facilities with characteristics associated with greater resource availability, efficiency, and higher quality should be more able to provide these key factors, and should have higher EVRs and increased likelihood of achieving recommended EVRs.

Data

Since 2009, OHPR has annually surveyed all NHs in Oregon during each influenza season, and publicly reported facility rates on its website with the intent to use this public reporting to improve healthcare worker vaccinations in NHs. Surveys request data on employee vaccination and vaccination program characteristics, and ask whether formal vaccination education is conducted for NH employees; for example, this could include a course or program incorporating staff in-service sessions, conferences, and/or educational videos providing information regarding influenza severity and transmission, as well as times and locations where influenza vaccination is offered.^{13–15} In addition, informal education may be provided through both promotion methods, such as posters, flyers, and fact sheets; and delivery methods, including mobile vaccination carts and occupational health clinics.^{13,16}

Facility characteristics were obtained from OSCAR files of corresponding years. OSCAR is widely used in NH research and is a comprehensive source of facility characteristics. County controls were obtained from AHRF 2010 and linked to OHPR results. AHRF is assembled annually from multiple sources and often used as a resource for county characteristics.

Sample

All NHs returned each of three surveys to OHPR, resulting in 100% response rates for all three surveys. No NHs were excluded from analyses, but not all facilities provided sufficient information to calculate an EVR. Based on information obtained from 2009–10, 2010–11, and 2011–12 surveys, 113/140, 129/141, and 137/140 (81%, 91%, and 98% of) NHs in Oregon provided sufficient data to calculate EVR for public reporting, respectively. The analytical sample contained between 353 and 388 observations (approximately 127 NHs each year over three years), due to missing values for some variables.

Variables

Outcome variables obtained from OHPR were EVR per facility per year, whether formal employee influenza vaccination education was conducted, and whether 2010, 2015, and 2020 Healthy People EVR goals (60%, 70% and 90%, respectively) were met or exceeded, controlling for facility and market conditions. OSCAR facility characteristics were profit status, chain affiliation, hospital-based, number of beds, occupancy rate, staffing (CNA, LPN, and RN) hours per resident day, number of health deficiency citations, and proportion of residents paid for by Medicaid. AHRF market controls were urban/rural location, market

competition, percent elderly in county, and median household income. Market competition was derived using the Herfindahl–Hirschman Index (HHI), calculated as the sum of squared market shares of all firms in the market. In this case, market share is defined as the share of beds of a NH relative to all NHs in a county. Market competition was then defined as 1-HHI, ranging from 0 (monopoly) to 1 (perfect competition).

Analyses

Linear regression was used to model associations between facility characteristics from OSCAR and the dependent variable, EVR per facility per year, controlling for market conditions from AHRF. Three logistic regression models were used to estimate relationships between facility characteristics and the dependent variables, whether 2010, 2015 and 2020 Healthy People EVR goals (60%, 70% and 90%, respectively) were met or exceeded, controlling for market conditions. A fourth logistic regression model was used to estimate relationships between facility characteristics and the dependent variable, whether formal education was conducted, controlling for market conditions. Huber-White standard errors were calculated for the above models.

RESULTS

Descriptive Characteristics

NH and county characteristics for 2011 are provided in Table 1. Most NHs are for-profit (82.48%) and chain-affiliated (70.07%). Only 2.19% of facilities are hospital-based. Average number of beds is 90, and average occupancy rate is 63%. Roughly 27% of counties are rural. Highest staffing intensity occurs in CNAs, followed by RNs and LPNs. Approximately 61% of NH residents are paid for by Medicaid, and average number of deficiency citations is 4.89. HHI is 0.24, closer to perfect competition than monopoly. Average percent elderly in county is 14.6%, and median household income is \$46,395. EVR remained stable across all three influenza seasons (Figure 1), ranging from a high of 54% (95% Confidence Interval [CI]: 49.24–58.85%) in 2009 to a low of 52% (95% CI: 47.89–56.24%) in 2010.

Facility Characteristics Influencing Employee Influenza Vaccination

Table 2 provides results of the linear model estimating EVR per facility per year and of logistic models estimating whether Healthy People EVR goals were met. On average, chain-affiliated NHs had 9% ($P=0.01$) higher EVRs and had 73% ($P=0.05$) greater odds of achieving 60% EVR (2010 target), compared to individual facilities. For-profit NHs had, on average, 8% ($P=0.04$) lower EVRs, compared to not-for-profit NHs. As number of beds increased, facilities had higher odds of achieving 60% EVR ($OR=1.01$, $P=0.05$). Hospital-based NHs had higher odds of achieving 90% EVR (2020 target, $OR=12.13$, $P=0.04$), compared to free-standing NHs. Although literature suggests that NHs with higher proportions of residents paid for by Medicaid have lower quality, results show that, as proportion of Medicaid residents increased by 10%, EVR increased by 2% ($P=0.01$), and NHs had greater odds of achieving 60% ($OR=1.20$, $P=0.004$) and 70% (2015 target, $OR=1.14$, $P=0.05$) EVR. Analyses were also run with a binary variable for whether formal employee education was conducted. Estimates were similar in models with and without this

variable. On average, NHs with formal education programs have 10% higher EVRs ($P<0.001$), and higher odds of achieving 60% EVR ($OR=1.77$, $P=0.01$).

Results of the logistic model estimating whether facilities conducted formal education programs are reported in Table 3. In 2009, 2010, and 2011, 71% (95% CI: 63.37–78.86%), 56% (95% CI: 46.68–63.61%), and 50% (95% CI: 41.89–58.84%) of facilities conducted formal education programs, respectively (Figure 1). As number of beds increased, odds of providing formal education increased by 1% ($P=0.01$).

DISCUSSION

This study identified NH characteristics associated with EVRs and employee vaccination education programs. Results provide some evidence that facility characteristics are associated with EVR. OHPR administered surveys and publicly reported facility EVRs, thereby giving NHs an incentive to improve EVRs. However, rates did not improve, and decreased slightly over time, suggesting non-effect of this public reporting (for the first 3 years). In addition, proportion of NHs conducting formal education decreased substantially. NHs may not provide staff education annually, or may not be aware of its benefits. As this decrease was also observed in hospitals, there may have been some unidentified policy or circumstance discouraging facilities from conducting formal staff education. Furthermore, the data collection period may have been too brief to capture substantial improvements, such as effects of NHs implementing new protocols. Given more time, increases in EVRs and in NHs reporting formal education programs may be observed.

At this time, no other studies recognizing NH characteristics associated with EVRs or using OHPR data have been identified. Study findings may increase awareness of importance of employee vaccination and may encourage NH management and policy makers to invest in employee vaccination and education programs, possibly increasing EVRs. Although NH characteristics associated with EVRs cannot be easily addressed by NH management or policymakers, findings may be used to identify a subset of low-performing NHs, with respect to EVRs. Future research could develop approaches to target root causes of low EVRs in this group of NHs.

Literature suggests that employee influenza vaccination education, free vaccine, and convenient access to vaccine are crucial to improving EVRs. Employee surveys often reflect misinformation about influenza and vaccination, demonstrating need for education programs. Although education alone has, generally, been insufficient to significantly improve EVRs, when coupled with on-site vaccination, significant improvements are observed across care sites.¹² Free vaccine is usually a component of mandatory and voluntary vaccination programs.^{17–19} For example, California, which does not have a mandatory vaccination policy, mandated that, beginning in 2006, acute care hospitals provide free influenza vaccination to all employees; other facilities in the state, though not mandated, have followed suit, resulting in higher EVRs across care sites.²⁰ NHs that are more able to provide these key factors should have higher EVRs.

This study identified NH characteristics indicating ability and incentive to invest in employee vaccination. Chain-affiliated and hospital-based NHs, which may have greater capacity and motivation to invest in employee vaccination, had significantly higher EVRs, as was expected from hypotheses and existing literature.^{10,18,19,21–23} Although for-profit status implies greater financial resources, for-profit NHs had lower EVRs, compared to not-for-profit NHs; this may be due to profit (rather than quality) maximization incentives.^{24–26} Contrary to existing literature, staffing intensity and deficiency citations were not associated with EVRs, and results were inconsistent.^{10,27,28}

Estimates for proportion of residents paid for by Medicaid were expected to be negatively associated with all outcome variables. However, this variable was positively associated with all outcome variables, except for proportion of NHs achieving 90% vaccination; all positive associations were significant ($P \leq 0.05$), except for association with whether formal education was conducted ($P = 0.13$). By vaccinating employees, residents will be less susceptible to influenza and related complications; in the long run, this should improve influenza-associated morbidity and mortality and reduce costs. Thus, NHs with higher proportions of Medicaid patients may have an incentive to invest in employee vaccination.

This study has several limitations. First, omitted variable bias may occur and, although relevant facility characteristics were identified from literature, variables included are not direct measures of NH ability and incentive to vaccinate employees; subsequently, more appropriate mechanisms to explain EVR may exist. In addition, unidentified local policies or community level factors, such as pro- or anti-vaccination sentiment, might have influenced results. As this study examines only NHs in Oregon, any generalization to national EVRs are also beyond the scope of this analysis. Furthermore, this study does not address personal reasons why NH employees may not be vaccinated. EVR is differential with respect to education-level, and healthcare workers most often fail to receive vaccination due to attitudinal barriers, such as mistrust of modern medicine and preference for homeopathic remedies, and lack of awareness regarding recommendations, including misperception of influenza risk.^{2,17,18} Future research should address these and other potential barriers to employee influenza vaccination, such as prior negative vaccination experiences.

CONCLUSION

Results show associations between facility characteristics and EVRs and can be used to develop future methods to target low-performing facilities, which may be necessary to achieve substantial improvements. As the elderly population grows, it will be increasingly important for NHs to educate and vaccinate staff to protect this vulnerable population. Identifying characteristics of facilities that meet EVR targets could help NH decision-makers consider ways to increase investment in employee vaccination. However, significant correlates of this study cannot be easily addressed by NH management or policymakers. Without policy change encouraging key components of vaccination programs, such as free and convenient access to vaccine and formal employee influenza vaccination education, public reporting may be insufficient to improve EVRs.

Acknowledgments

Funding: this work was supported by the National Institute on Minority Health and Health Disparities of the National Institute of Health [R01 MD007662]; and the Agency for Health Care Quality and Research [T32 HS000044].

REFERENCES

1. Estimates of deaths associated with seasonal influenza --- United States, 1976–2007. *MMWR Morb Mortal Wkly Rep.* 2010; 59(33):1057–62. [PubMed: 20798667]
2. Fiore AE, Uyeki TM, Broder K, et al. Prevention and control of influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2010. *MMWR Recomm Rep.* 2010; 59(RR-8):1–62. [PubMed: 20689501]
3. Patriarca PA, Weber JA, Parker RA, et al. Efficacy of influenza vaccine in nursing homes: Reduction in illness and complications during an influenza A (H3N2) epidemic. *JAMA.* 1985; 253(8):1136–9. [PubMed: 3968844]
4. Jefferson T, Rivetti D, Rivetti A, et al. Efficacy and effectiveness of influenza vaccines in elderly people: a systematic review. *Lancet.* 2005; 366(9492):1165–74. [PubMed: 16198765]
5. Monto AS, Hornbuckle K, Ohmit SE. Influenza vaccine effectiveness among elderly nursing home residents: a cohort study. *Am J Epidemiol.* 2001; 154(2):155–60. [PubMed: 11447049]
6. Carman WF, Elder AG, Wallace LA, et al. Effects of influenza vaccination of health-care workers on mortality of elderly people in long-term care: a randomised controlled trial. *Lancet.* 2000; 355(9198):93–7. [PubMed: 10675165]
7. Fiore A, Fry A, Shay D, et al. Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep.* 2011; 60(RR-7): 1–45. [PubMed: 21248682]
8. 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. [PubMed: 8985189]
9. Banaszak-Holl J, Zinn JS, Mor V. The impact of market and organizational characteristics on nursing care facility service innovation: a resource dependency perspective. *Health Serv Res.* 1996; 31(1):97–117. [PubMed: 8617612]
10. Zhang N, Li Y, Temkin-Greener H. Prevalence of Obesity in New York Nursing Homes: Associations with Facility Characteristics. *Gerontologist.* 2013; 53(4):567–81. [PubMed: 23480892]
11. Sand KL, Lynn J, Bardenheier B, et al. Increasing Influenza Immunization for Long - Term Care Facility Staff Using Quality Improvement. *J Am Geriatr Soc.* 2007; 55(11):1741–7. [PubMed: 17979897]
12. Willis BC, Ndiaye SM, Hopkins DP, Shefer A. Improving influenza, pneumococcal polysaccharide, and hepatitis B vaccination coverage among adults aged < 65 years at high risk: a report on recommendations of the Task Force on Community Preventive Services. *MMWR Recomm Rep.* 2005; 54(RR5):1–11. [PubMed: 15800472]
13. [Accessed on April 10, 2014] <http://www.oregonpatientsafety.org/healthcare-professionals/articles/2013-whats-newfor-flu/977>
14. Ofstead CL, Tucker SJ, Beebe TJ, Poland GA. Influenza vaccination among registered nurses: information receipt, knowledge, and decision - making at an institution with a multifaceted educational program. *Infect Control Hosp Epidemiol.* 2008; 29(2):99–106. [PubMed: 18179363]
15. Hofmann F, Ferracin C, Marsh G, Dumas R. Influenza vaccination of healthcare workers: a literature review of attitudes and beliefs. *Infection.* 2006; 34(3):142–7. [PubMed: 16804657]
16. Healthcare Acquired Infection Reporting Program: Healthcare Worker Influenza Vaccination Rates 2011–2012 Season. Office for Oregon Health Policy and Research; 2012.
17. Ajenjo MC, Woeltje KF, Babcock HM, et al. Influenza Vaccination among Healthcare Workers: Ten-Year Experience of a Large Healthcare Organization. *Infect Control Hosp Epidemiol.* 2010; 31(3):233–40. [PubMed: 20055666]

18. Babcock HM, Gemeinhart N, Jones M, et al. Mandatory influenza vaccination of health care workers: translating policy to practice. *Clin Infect Dis*. 2010; 50(4):459–64. [PubMed: 20064039]
19. Talbot TR, Schaffner W. On being the first: Virginia Mason Medical Center and mandatory influenza vaccination of healthcare workers. *Infect Control Hosp Epidemiol*. 2010; 31(9):889–92. [PubMed: 20653446]
20. Lee SJ, Harrison R, Rosenberg J, et al. Influenza vaccination among health care personnel in California: 2010–2011 influenza season. *Am J Infect Control*. 2013; 41(8):e65–71. [PubMed: 23394860]
21. Harrington C, Hauser C, Olney B, Rosenau PV. Ownership, Financing, and Management Strategies of the Ten Largest For-Profit Nursing Home Chains in the United States. *Int J Health Serv*. 2011; 41(4):725–46. [PubMed: 22053531]
22. McKay NL. An econometric analysis of costs and scale economies in the nursing home industry. *J Hum Resour*. 1988; 23(1):57–75.
23. McKay NL. The effect of chain ownership on nursing home costs. *Health Serv Res*. 1991; 26(1): 109–24. [PubMed: 1826676]
24. Grabowski DC, Stevenson DG. Ownership conversions and nursing home performance. *Health Serv Res*. 2008; 43(4):1184–203. [PubMed: 18355255]
25. Nyman JA, Bricker DL. Profit incentives and technical efficiency in the production of nursing home care. *Rev Econ Stat*. 2003; 71(4):586–94.
26. Harrington C, Woolhandler S, Mullan J, et al. Does investor ownership of nursing homes compromise the quality of care? *Am J Public Health*. 2001; 91(9):1452–5. [PubMed: 11527781]
27. Konetzka RT, Stearns SC, Park J. The staffing–outcomes relationship in nursing homes. *Health Serv Res*. 2008; 43(3):1025–42. [PubMed: 18454779]
28. Xing J, Mukamel DB, Temkin-Greener H. Hospitalizations of Nursing Home Residents in the Last Year of Life: Nursing Home Characteristics and Variation in Potentially Avoidable Hospitalizations. *J Am Geriatr Soc*. 2013; 61(11):1900–8. [PubMed: 24219191]

FIGURE 1.
TRENDS IN INFLUENZA VACCINATION RATE AND VACCINATION EDUCATION
PROGRAM IN OREGON NURSING HOMES (2009–2011)

Table 1Facility Characteristics of Nursing Homes in Oregon (2011)^a

	Mean (SD) / Percent
For profit	82.48%
Chain affiliation	70.07%
Hospital based	2.19%
Number of beds	90 (40)
Occupancy	0.63 (0.19)
Rural	27.74%
CNA hours/resident day ^b	3.02 (0.57)
LPN hours/resident day ^c	0.57 (0.30)
RN hours/resident day ^d	0.88 (0.34)
Percent of residents paid by Medicaid	60.60% (21.23%)
Number of health deficiency citations	4.89 (4.16)
Herfindahl-Hirschmann Index (HHI)	0.24 (0.26)
Proportion of people in county who are 65 years and older	14.58% (3.91%)
Median household income (\$, 2010)	46,395 (7,023)

^a Number of facilities varies from 117 to 137 due to missing values for some variables.

^b CNA: Certified nurse aid

^c LPN: Licensed practical nurse

^d RN: Registered nurse

Table 2

Factors Associated with Influenza Vaccination Rate among Nursing Home Employees

	Vaccination Rate		Vaccination Rate 0.60		Vaccination Rate 0.70		Vaccination Rate 0.90	
	Coefficient	P	OR	P	OR	P	OR	P
For profit	-0.08	0.04	0.53	0.07	0.46	0.04	1.20	0.73
Chain	0.09	0.01	1.73	0.05	1.47	0.18	1.14	0.72
Hospital based	0.08	0.53	4.06	0.09	3.88	0.10	12.13	0.04
Number of beds	0.00	0.08	1.01	0.05	1.00	0.13	1.00	0.47
Occupancy	-0.05	0.51	0.98	0.98	1.11	0.88	2.72	0.32
CNA hours/resident day ^a	-0.01	0.76	0.89	0.65	0.81	0.41	1.39	0.41
LPN hours/resident day ^b	-0.02	0.63	1.14	0.79	0.97	0.96	1.36	0.59
RN hours/resident day ^c	0.05	0.14	1.68	0.10	1.39	0.37	0.72	0.57
N of health deficiency citations	0.01	0.11	1.03	0.16	1.00	0.91	1.06	0.12
Rural	0.00	0.92	1.49	0.29	1.54	0.27	1.17	0.77
Proportion of residents paid by Medicaid (unit=10%)	0.02	0.01	1.20	0.004	1.14	0.05	1.00	0.97
Herfindahl-Hirschmann Index (HHI)	-0.02	0.64	0.36	0.09	0.41	0.15	0.74	0.76
Proportion of people in county who are 65 years and older (unit=10%)	0.02	0.76	0.86	0.73	0.72	0.50	0.34	0.15
Median household income (unit=\$100)	0.00	0.33	1.00	0.58	1.00	0.64	1.00	0.93
Year reference=2009								
2010	-0.02	0.63	0.64	0.08	0.65	0.11	0.39	0.01
2011	-0.01	0.73	0.50	0.01	0.43	0.003	0.16	<0.001

^a CNA: Certified nurse aid^b LPN: Licensed practical nurse^c RN: Registered nurse

Table 3

Facility Characteristics Associated with Formal Education on Influenza Vaccination

	OR	P
For profit	0.66	0.26
Chain	1.54	0.11
Hospital based	0.41	0.30
Number of beds	1.01	0.01
Occupancy	3.44	0.07
CNA hours/resident day ^a	0.92	0.71
LPN hours/resident day ^b	0.92	0.86
RN hours/resident day ^c	1.14	0.65
N of health deficiency citations	1.01	0.71
Rural	1.01	0.97
Proportion of residents paid by Medicaid (unit=10%)	1.10	0.13
Herfindahl–Hirschmann Index (HFfl)	1.50	0.52
Proportion of people in county who are 65 years and older (unit=10%)	0.93	0.87
Median household income (unit=\$100)	1.00	0.33
Year (reference=2009)		
2010	0.52	0.01
2011	0.43	0.002

^aCNA: Certified nurse aid^bLPN: Licensed practical nurse^cRN: Registered nurse