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J Am Med Dir Assoc. 2017 August 01; 18(8): 735.e1–735.e14. doi:10.1016/j.jamda.2017.05.002.**Trends in influenza and pneumococcal vaccination among U.S. nursing home residents, 2006–2014****Carla L. Black, PhD¹, Walter W. Williams, MD, MPH¹, Inaki Arbeloa², Natasa Kordic², Lindsay Yang², Tom MacCurdy, PhD², Chris Worrall³, and Jeffrey A. Kelman, MMSc, MD³**¹Immunization Services Division, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, 1600 Clifton Road, NE, Atlanta, GA 30329-4027²Acumen, LLC, 500 Airport Blvd, Suite 365, Burlingame, CA 94010³Center for Medicare, Centers for Medicare & Medicaid Services, 7500 Security Boulevard, Baltimore, MD 21244**Abstract**

Background—Institutionalized adults are at increased risk of morbidity and mortality from influenza and pneumococcal infection. Influenza and pneumococcal vaccination have been shown to be effective in reducing hospitalization and deaths due to pneumonia and influenza in this population.

Objective—Assess trends in influenza vaccination coverage among U.S. nursing home residents from the 2005–06 through 2014–15 influenza seasons and trends in pneumococcal vaccination coverage from 2006–2014 among U.S. nursing home residents, by state and demographic characteristics.

Methods—Data were analyzed from the Centers for Medicare and Medicaid Services' (CMS) Minimum Data Set (MDS). Influenza and pneumococcal vaccination status were assessed for all residents of CMS-certified nursing homes using data reported to the MDS by all certified facilities.

Results—Influenza vaccination coverage increased from 71.4% in the 2005–06 influenza season to 75.7% in the 2014–15 influenza season and pneumococcal vaccination coverage increased from 67.4% in 2006 to 78.4% in 2014. Vaccination coverage varied by state, with influenza vaccination coverage ranging from 50.0% to 89.7% in the 2014–15 influenza season and pneumococcal vaccination coverage ranging from 55.0% to 89.7% in 2014. Non-Hispanic black and Hispanic residents had lower coverage compared with non-Hispanic white residents for both vaccines, and these disparities persisted over time.

Conclusion—Influenza and pneumococcal vaccination among U.S. nursing home residents remains suboptimal. Nursing home staff should employ strategies such as provider reminders and

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standing orders to facilitate offering vaccination to all residents along with culturally-appropriate vaccine promotion to increase vaccination coverage among this vulnerable population.

Keywords

influenza; pneumococcal; vaccination; nursing home

Introduction

Residents of long-term care facilities are at increased risk for hospitalization and death due to influenza and pneumonia.¹⁻⁴ Vaccination with influenza vaccine and 23-valent pneumococcal polysaccharide vaccine (PPSV23) have been shown to be effective in reducing the incidence of pneumococcal pneumonia and death due to pneumonia and influenza in this population.^{5,6} The Advisory Committee on Immunization Practices (ACIP) has recommended annual influenza vaccination for residents of long-term care facilities, regardless of age, since 1988.⁷ While annual influenza vaccination is currently recommended for all persons >6 months of age without contraindications for vaccination, residents of nursing homes and other long-term care facilities are listed as a group at risk for medical complications attributable to severe influenza for whom priority should be given when vaccine supply is limited.⁸ Due to reported outbreaks of pneumococcal disease in nursing homes and other long-term care facilities, in 1997 the ACIP recommended that pneumococcal vaccination status be assessed for residents of nursing homes and other long-term-care facilities.⁹ During 2002 through 2015, published ACIP recommendations indicated vaccination of nursing home residents with 23-valent pneumococcal polysaccharide vaccine (PPSV23).^{10,11} In 2016, the recommendation was clarified to indicate that nursing home residence alone was not an indication for PPSV23 vaccination for adults <65 years; however, these residents should be assessed for pneumococcal vaccination status and vaccinated as appropriate based on medical indications.¹²

A 1996 report by the Institute of Medicine on improving the quality of care in nursing homes recommended that all nursing home residents receive periodic standardized assessment of their functional, medical, mental, and psychosocial status.¹³ As a result, legislation requiring uniform resident assessment of all nursing home residents was included in the Omnibus Budget Reconciliation Act of 1987 (OBRA-87).¹⁴ Questions regarding influenza and pneumococcal vaccination status were added to the resident assessment instrument (RAI) in October 2005, when the Centers for Medicare and Medicaid Services (CMS) mandated that all nursing homes offer their residents annual influenza vaccination and at least one lifetime pneumococcal vaccination as a condition of certification.¹⁵

This paper reports influenza vaccination coverage for the 2005–06 through 2014–15 influenza seasons and pneumococcal vaccination coverage from 2006–2014 among residents of CMS-certified nursing homes.

Methods

The data for this analysis were obtained from the Minimum Data Set (MDS), which is maintained by CMS and includes the core set of screening, clinical, and functional status

elements collected on the RAI, including immunization assessments. Data collected prior to October 1, 2010 were obtained from the MDS version 2.0, and data collected from October 1, 2010 onward were obtained from the MDS version 3.0.^{16,17}

In accordance with OBRA-87, facilities are required to conduct assessments on all residents at admission, quarterly, annually, whenever there is a significant change in the resident's status, and at discharge. The RAI is also used for Medicare Prospective Payment System (PPS) assessments to determine payment for Medicare Part A beneficiaries covered under the skilled nursing facilities (SNF) benefit. Assessments are conducted for SNF PPS residents at 5 days, 14 days, 30 days, 60 days, and 90 days post-admission, and when a change in therapy occurs. When the timing of OBRA-87 and SNF PPS assessments coincide, one assessment can be used to satisfy both requirements.^{16,17}

Influenza and pneumococcal vaccination status is assessed on the RAI by medical record review when possible. If status cannot be determined from the medical record, the resident or the resident's legal guardian is questioned.^{16,17}

Influenza vaccination assessment

The study population for each influenza season included all adults aged 18 years in CMS-certified nursing homes and long-term care facilities who had at least one resident assessment of any type (OBRA-87 or SNF PPS) during each influenza season (defined as the period from October 1 through March 31 of the next year) during 2005–06 through 2014–15. While residents must have had at least one assessment during October through March to be included in the study population for a given influenza season, all assessments from October 1 through June 30 were used to determine vaccination status. The mean number of assessments per resident in the study population for each influenza season ranged from 4.3 to 5.0. The number of residents included in the study population ranged from 2,446,647 in 2005–06 to 2,640,219 in 2014–15. Size of the study population for each influenza season, by demographic characteristics and by state, are given in Supplemental Tables 1–2.

Influenza vaccination status for the 2005–06 through the 2009–10 influenza seasons was determined from the following questions in the MDS 2.0: 1) “Did the resident receive the Influenza vaccine in this facility for this year's influenza season (October 1 through March 31)?”; and 2) “If influenza vaccine not received, state reason.” Influenza vaccination status for the 2010–11 through 2014–15 influenza seasons was determined from the following questions in the MDS 3.0: 1) “Did the resident receive the influenza vaccine in this facility for this year's influenza season?”; and 2) “If influenza vaccine not received, state reason.” Residents with a “yes” response to the first question or a “no” response to the first question and response to the second question of “Received outside of this facility” were considered to be vaccinated. Residents considered vaccinated on any assessment conducted within an influenza season were counted as vaccinated for that season. Sensitivity analyses were conducted to examine the effect of excluding residents with discrepant assessments (i.e., indicated as vaccinated on one assessment and indicated as unvaccinated in a subsequent assessment during the same season) and counting residents with discrepant assessments as unvaccinated.

Residents with missing vaccination information on all assessments conducted within an influenza season were excluded from the study population for that season. Residents were also excluded from the study population if all assessments for a particular season indicated that the resident was unvaccinated and the reason given for non-vaccination was “not present in the facility during influenza season”. In total, 2–7% of nursing home residents with assessments from October 1 through March 31 were excluded from the study population for each influenza season.

Pneumococcal vaccination assessment

The study population for pneumococcal vaccination assessment in each year included all adults 18 years in CMS-certified nursing homes and long-term care facilities who had at least one resident assessment of any type from January 1 through December 31 of each calendar year. The mean number of assessments per resident in the study population for each year ranged from 4.7 to 5.4. The number of residents included in the study population ranged from 3,288,514 in 2006 to 3,786,938 in 2014. Size of the study population for each year, by demographic characteristics and by state, are given in Supplemental Tables 3–4.

Pneumococcal vaccination status from assessments conducted prior to October 1, 2010 was determined based on the following question in the MDS 2.0: “Is the resident’s PPV status up to date?” Pneumococcal vaccination status from assessments conducted from October 1, 2010 through December 31, 2013 was determined based on the following question in the MDS 3.0: “Is the resident’s pneumococcal vaccination up to date?” The definition of “up to date” is not given directly on either version of the RAI; however, the RAI 2.0 and RAI 3.0 user’s manuals specify that vaccination is indicated for residents of nursing homes and other long-term care facilities, and revaccination is indicated for those with certain immunocompromising conditions and those who received their first dose of pneumococcal vaccination before age 65 years.^{16,17} Residents with a “yes” response on any assessment conducted in the calendar year of interest or in any earlier year were considered to be vaccinated, regardless of any subsequent “no” responses. Sensitivity analyses were conducted to examine the effect of excluding residents with discrepant assessments (i.e., indicated as vaccinated on one assessment and indicated as unvaccinated in a subsequent assessment) and counting residents with discrepant assessments as unvaccinated.

Residents were excluded from the study population for a calendar year if pneumococcal vaccination information was missing from all assessments conducted during that year and all previous years. Three to five percent of residents were excluded from the study population each year due to missing information.

Statistical analysis

Descriptive statistics are presented as proportions of residents nationally, by state, and by demographic characteristics. Because the study populations for each year or influenza season include all eligible residents of CMS-certified nursing homes in the United States, no sampling techniques were employed. Multivariable logistic regression was used to determine factors independently associated with influenza vaccination in the 2014–15 influenza season

and pneumococcal vaccination in 2014. Conditional logit models were used to control for facility fixed effects.

Results

Influenza vaccination

Influenza vaccination coverage among U.S. nursing home residents by select demographic characteristics is given in Table 1. Influenza vaccination coverage was 75.7% in the 2014–15 season, an increase of 4.3 percentage points since the 2005–06 influenza season. Vaccination coverage in the 2014–15 season decreased 2.7 percentage points from the peak coverage of 78.4% in the 2009–10 influenza season (while no modification was made to the RAI in response to the H1N1 pandemic in 2009–10, providers were instructed by CMS to report only seasonal influenza vaccination to the MDS). Coverage increased with increasing age and was highest in residents aged ≥ 85 years in all influenza seasons. Females had higher coverage than males in all influenza seasons, with differences ranging from 4.4 percentage points in 2005–06 (72.8% compared with 68.4%) to 2.3 percentage points in 2012–13 (77.5% compared with 75.2%). Among racial/ethnic groups, American Indian/Alaskan Native (AI/AN), Asian and Asian or Pacific Islander, and white residents had similar coverage across seasons, and had coverage of at least four percentage points higher than black and Hispanic residents in all seasons. Across all seasons, coverage among white residents was a mean of 7.8 percentage points higher than coverage among black residents. The difference in coverage between white and black residents increased from 7.1 percentage points in 2005–06 to 9.0 percentage points in 2014–15, when coverage among white residents was 77.3% compared with 68.3% among black residents. Residents with chronic medical conditions associated with higher risk for influenza-related complications had higher coverage compared with residents without high-risk chronic conditions, with coverage increasing with increasing number of medical conditions. Widowed residents had higher coverage than residents in other marital status groups in all seasons.

State-specific influenza vaccination coverage for the 2005–06 through 2013–14 influenza seasons is given in Table 2. Coverage varied by state, ranging from 44.0% to 86.6% in 2005–06. The variation in coverage persisted across seasons, ranging from 50.0% to 89.7% in 2014–15.

In the 2005–06 influenza season, the most commonly reported reason for non-vaccination among unvaccinated residents was that the vaccine was not offered (43.8%, Table 3). Beginning in 2006–07, the most commonly reported reason for non-vaccination was that the resident declined the vaccine (43.2%). This trend continued through the 2014–15 season, when 71.9% of unvaccinated residents were offered the vaccine and declined, and 10.6% of unvaccinated residents were not offered the vaccine (Table 3). By the 2014–15 influenza season, declination of vaccination was the most common reason for non-vaccination among residents of all racial/ethnic groups. However, unvaccinated non-white residents were less likely to be offered vaccination compared with unvaccinated white residents. In the 2014–15 influenza season, “not offered” was the reported reason for non-vaccination for 9.8% of unvaccinated white residents compared with 14.9%, 14.1%, 14.6%, 13.3%, 12.3%, and

14.0% of AI/AN, Asian, Native Hawaiian/Other Pacific Islander, black, Hispanic, and residents of multiple races, respectively.

Pneumococcal vaccination

Pneumococcal vaccination coverage in U.S. nursing home residents increased from 67.4% in 2006 to 79.9% in 2009 (Table 4). Coverage plateaued in 2009, and remained at approximately 78–80% from 2009–2014. In all years, coverage increased with increasing age and with increasing numbers of chronic medical conditions associated with invasive pneumococcal disease. Coverage among females was approximately four percentage points higher than coverage among males in all years. In all years from 2006–2014, white residents had higher vaccination coverage compared with all other race/ethnicity groups. In 2006, the race/ethnicity disparity ranged from 2.7 percentage points difference between white and AI/AN residents to 12.9 percentage points difference between white and black residents. Racial/ethnic disparities persisted across years, but had narrowed to 1.6 percentage points difference between white and AI/AN residents and 8.2 percentage points difference between white and black residents in 2014. In 2014, the largest disparity of 9.3 percentage points was observed between white and Hispanic residents (coverage of 80.1% versus 70.8%, respectively). Widowed residents had higher pneumococcal vaccination coverage than residents in other marital status groups in all years.

State-specific pneumococcal vaccination coverage from 2006–2014 is given in Table 5. Coverage varied widely by state in all years, ranging from 41.1% to 87.7% in 2006 and from 55.0% to 89.7% in 2014.

Reasons for non-vaccination among residents who have not received pneumococcal vaccine are given in Table 6. In 2006, the most commonly reported reason for non-vaccination was that the vaccine was not offered, reported for 49.7% of unvaccinated residents. From 2007–2014, the most common reason for non-vaccination was that that the resident declined vaccination when offered. In 2014, 73.2% of unvaccinated residents were offered and declined vaccination. The shift over time from “vaccine not offered” to “vaccine offered and declined” as the most common reason for non-vaccination occurred among residents of all racial/ethnic groups. However, similar to influenza vaccination, in most years unvaccinated non-white residents were less likely to be offered pneumococcal vaccination compared with unvaccinated white residents. In 2014, “not offered” was the reported reason for non-vaccination for 14.6% of unvaccinated white residents compared with 22.4%, 21.0%, 16.9%, 20.5%, 20.2%, and 16.9% of AI/AN, Asian, Native Hawaiian/Other Pacific Islander, black, Hispanic, and residents of multiple races, respectively.

Multivariable analyses

Results of the logistic regression analyses of factors associated with influenza and pneumococcal vaccination are given in Table 7. After controlling for other factors (sex, race/ethnicity, number of chronic medical conditions, and marital status), younger age was associated with the lowest odds of vaccination, with younger residents less likely to be vaccinated with both influenza and pneumococcal vaccine compared with residents 85 years, and the odds of vaccination decreasing with decreasing age. A similar effect was

observed with the number of chronic medical conditions, with residents more likely to be vaccinated as number of comorbidities increased. While black residents remained slightly less likely than white residents to be vaccinated after controlling for the other factors, the differences in coverage between black and white residents with both influenza and pneumococcal vaccination decreased after controlling for facility-level fixed effects. Hispanic residents were no longer less likely to be vaccinated compared with white residents after controlling for the other factors and facility-level fixed effects.

Sensitivity analyses

Results of the sensitivity analysis showed that influenza vaccination coverage in the 2014–15 season would have been 71.2% if all residents with discrepant assessments were considered to be unvaccinated, 74.5% if residents with discrepant assessments were excluded from the analysis, and 75.7% if all residents with discrepant assessments were considered to be vaccinated (the method used in this report). Pneumococcal vaccination coverage in 2014 would have been 66.7% if all residents with discrepant assessments were considered to be unvaccinated, 72.0% if residents with discrepant assessments were excluded from the analysis, and 78.4% if all residents with discrepant assessments were considered to be vaccinated (the method used in this report).

Discussion

Influenza vaccination coverage among U.S. nursing home residents increased from 71.4% in the 2005–06 influenza season to 75.7% in the 2014–15 season. This estimate is below the Healthy People 2020 (HP2020) target of 90% influenza vaccination coverage among nursing home residents.¹⁸ Achieving and maintaining high vaccination coverage is important for reducing the excess influenza-related morbidity and mortality in this high risk population.

Pneumococcal vaccination coverage among U.S. nursing home residents from the present analysis of MDS data was 67.4% in 2006, a substantial increase from a prior report using data from the National Nursing Home Survey (NNHS), which reported coverage among nursing home residents age 65 years of 23.6%–37.4% from 1995–1999.¹⁹ Coverage continued to increase among residents of all ages from 67.4% in 2006 to 79.9% in 2009. Since 2009, coverage has plateaued at approximately 80%, and remains below the HP2020 target of 90% for pneumococcal vaccination coverage among nursing home residents.¹⁸ The 90% target was met in previous years by five states--Arkansas, Iowa, Minnesota, North Dakota, and South Dakota--and reached 89% in several other states. However, in 2014 coverage had dropped below 90% in all states.

Coverage varied widely by state for influenza and pneumococcal vaccination, with four states having coverage below 70% for both vaccinations in the most recent assessment periods. Differences in vaccination coverage among nursing home residents by state²⁰ and geographic region^{19,21–22} have consistently been reported in the literature and are likely due to factors such as differences between states in immunization policies for both residents and health care personnel, differences in state laws regarding nursing home staffing levels,²³ differences in the racial/ethnic distribution of nursing home residents,²⁴ and differences in

facility-level characteristics such as bed size, ownership status, and primary payment source.^{19,20–22}

Although influenza and pneumococcal vaccination coverage remain suboptimal in many states, the shift overall in the reason for non-vaccination for both vaccines from the majority of unvaccinated residents not being offered vaccine to the majority of unvaccinated residents being offered and declining vaccination is an encouraging finding, suggesting that more facilities are now complying with the CMS requirement to offer vaccination to all residents. In the most recent years of data collection, the proportion of unvaccinated residents that had not been offered influenza or pneumococcal vaccination had been reduced to 10.6% and 16.0%, respectively. However, the finding that vaccine refusal now plays the largest role in residents remaining unvaccinated underscores the need for effective patient education in conjunction with access to vaccination. Previous studies have shown that nursing home residents were more likely to receive influenza vaccination if they were advised to do so by a relative or nursing home health care worker,²⁵ and that coverage increases with more frequent physician recommendations.²⁶

Differences in influenza vaccination coverage between white and black nursing home residents have previously been reported in assessments conducted in the 2005–06 through 2008–09 influenza seasons using data from the MDS^{20,24,27} and in 2003–04 using data from the NNHS.^{28–29} Our analysis revealed that this difference has persisted through the 2014–15 influenza season, and in fact increased from a difference of 7.1 percentage points higher coverage in whites compared with blacks in the 2005–06 season to 9.0 percentage points higher coverage in whites in the 2014–15 season. Similarly, differences in pneumococcal vaccination coverage between white and black nursing home residents have been reported from the NNHS for the years 1995–2004.^{19,21,28–29} While we found that the difference in pneumococcal vaccination coverage between white and black residents was somewhat reduced between 2006 and 2014, in 2014 coverage among black residents remained 8.2 percentage points lower than coverage among white residents.

The vaccination coverage disparity between black and white nursing home residents has been attributed in part to the clustering of black residents in what Mor et al. have termed “lower-tier” nursing homes, characterized by a greater dependence on Medicaid for payment and fewer registered nurses, nurse practitioners and physician assistants, and administrative resources per resident compared with upper-tier facilities.^{19,30–32} The notion that lower vaccination coverage among blacks is a result of residence in poorer-quality nursing homes is supported by a study by Bardenheier et al. that found that vaccination coverage was lower for both blacks and whites in nursing homes with higher proportions of black residents.²⁴ However, other researchers have found that black residents were less likely to receive influenza vaccination than white residents in the same facility and that black residents were more likely to refuse vaccination, suggesting that the differences in influenza and pneumococcal vaccination coverage between black and white nursing home residents are not solely attributable to facility-level characteristics.²⁷ In the current study, the differences in vaccination coverage between black and white residents were decreased after controlling for clustering of residents within facilities, but facility-level effects did not completely explain the differences in coverage. Long-standing differences in both influenza and pneumococcal

vaccination coverage have been reported between community-dwelling black and white persons 65 years, even after adjustment for access to care and other socio-economic factors.^{33–37} These differences have been attributed to resistant attitudes and beliefs about vaccination, fewer vaccine-seeking behaviors, poorer provider communication, and less effective provider recommendations among blacks.^{34,38–39} In the current study, while vaccine refusal was the most common reason for non-vaccination in white and non-white residents, disparities in access to vaccination likely played a role in lower vaccination coverage among non-white residents, as these residents were more likely than unvaccinated white residents to report not being offered influenza and pneumococcal vaccination.

Little prior research has focused on the disparity between non-Hispanic white and Hispanic nursing home residents; however, in the current study, we found differences between non-Hispanic white and Hispanic residents similar in magnitude to those between non-Hispanic white and non-Hispanic black residents for both influenza and pneumococcal vaccination. We also found that these differences did not persist after controlling for facility-level effects, suggesting the clustering of Hispanics in nursing homes with lower vaccination coverage. Lower influenza and pneumococcal vaccination coverage has been reported among community-dwelling Hispanics aged 65 years compared with their non-Hispanic white counterparts.^{33–35,37,40,41} Unlike non-Hispanic black adults aged 65 years, studies have found that Hispanics aged 65 years were less likely than non-Hispanic whites to report resistant attitudes toward vaccination, but more likely to report that they did not know these vaccines were recommended for them, suggesting that poor communication or language barriers might contribute to lower vaccination coverage in this population.^{34,38}

Influenza and pneumococcal vaccination coverage increased with increasing age and increasing numbers of comorbidities among nursing home residents in this study in all measurement periods. Increased vaccination coverage with increasing age and increased number of high-risk medical conditions is well-documented, both among nursing home residents^{28–29} and community-dwelling persons, even those aged 65 years^{35–36,40–42} due to more frequent contacts with medical providers and increased opportunity for vaccination. Medical providers might also have increased awareness of age and condition-based indications for vaccination. Although less pronounced than differences by age and race/ethnicity, we found slightly higher influenza and pneumococcal vaccination coverage among women and among widowed residents compared with those with other marital statuses. However, these differences are likely attributable to higher proportions of older residents in these groups.

The findings in this study are subject to several limitations. Vaccination status is reported to the MDS by individual facilities. Although the RAI users' manual outlines the preferred procedure for assessing vaccination status, there are no quality checks to ensure that assessments are conducted uniformly across facilities. A recent validation study of the accuracy of influenza vaccination reported to the MDS found that, overall, influenza vaccination coverage measured using RAIs was only 1.8 percentage points lower compared to coverage using medical chart review as the gold standard. However, agreement rates varied widely by facility and state.⁴³ No such validation study has been published for pneumococcal vaccination. Assessment of pneumococcal vaccination status by nursing

home staff might be particularly difficult as it is not an annual event like influenza vaccination and requires a longer look-back period. Further work to validate pneumococcal vaccination data reported to the MDS based on Medicare claims data or medical chart review is needed. In the present study, we found disagreement in influenza vaccination status between assessments for approximately 5% of residents each influenza season, and disagreement in pneumococcal vaccination status for approximately 20% of residents each year. Re-vaccination with influenza vaccine is not recommended in the same season. And, while adults with certain immunocompromising conditions or those who were initially vaccinated prior to age 65 were recommended for re-vaccination with pneumococcal vaccine five years after the initial dose, these indications do not explain the high proportion of residents in our data who were reported to be vaccinated on one assessment and then unvaccinated on a subsequent assessment. These inconsistencies were considered to be errors in the subsequent assessments. Higher confidence was placed on earlier assessments, because as more time elapsed between the date of vaccination and the date of assessment, the likelihood increased that residents or their legal guardians could not recall vaccination status or that vaccination in the distant past might not be captured in current medical records. Sensitivity analyses revealed that, depending on the handling of these discrepant assessments in the analysis, actual influenza and pneumococcal vaccination coverage estimates could have been approximately 5% and 10% lower, respectively, than those reported in this study.

An additional limitation of the study is that pneumococcal vaccination coverage estimates for the year 2014 might not reflect changes in the ACIP recommendation for adults aged 65 years that were published in September 2014. Prior to September 2014, most adults were recommended to get one lifetime dose of PPSV23, and the question, “Is the resident’s pneumococcal vaccination up to date?” in the MDS 3.0 was most likely interpreted by nursing home staff as referring to one dose of PPSV23. Beginning in September 2014, adults aged 65 years were recommended to receive both 13-valent pneumococcal conjugate vaccine (PCV13) and PPSV23, separated by a one-year interval.⁴⁴ While neither the question on the RAI nor the RAI user’s manual were updated to reflect this new recommendation, we cannot discount the possibility that personnel completing the assessment were aware of the change in the recommendation and considered residents aged 65 who did not have a dose of both PCV13 and PPSV23 as not up to date. However, as this change would only affect residents who had their first assessment in September 2014 or later, it was not likely to have had a meaningful impact on the coverage estimates in this report.

Conclusion

Influenza and pneumococcal vaccination coverage increased among U.S. nursing home residents from the 2005–06 through 2014–15 influenza seasons and the years 2006–2014, respectively, but remained below national targets of 90% for both vaccines. Non-Hispanic black and Hispanic residents were less likely to be vaccinated compared with non-Hispanic white residents, and these differences persisted over time. Nursing home administrators should employ evidence-based strategies such as standing orders and provider reminders^{45–47} to ensure compliance with the CMS mandate to offer influenza and

pneumococcal vaccination to all residents along with culturally-appropriate vaccination promotion to increase coverage and protection against disease in this vulnerable population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Janssens JP, Krause KH. Pneumonia in the very old. *Lancet Infect Dis*. 2004; 4:112–24. [PubMed: 14871636]
2. Loeb MB. Pneumonia in nursing homes and long-term care facilities. *Semin Respir Crit Care Med*. 2005; 26:650–6. [PubMed: 16388434]
3. Muder RR. Pneumonia in residents of long-term care facilities: epidemiology, etiology, management, and prevention. *Am J Med*. 1998; 105:319–30. [PubMed: 9809694]
4. Menec VH, MacWilliam L, Aoki FY. Hospitalizations and deaths due to respiratory illnesses during influenza seasons: a comparison of community residents, senior housing residents, and nursing home residents. *J Gerontol*. 2002; 57A:M629–35.
5. Chan TC, Hung IF, Luk JK, Chu LW, Chan FH. Effectiveness of influenza vaccination in institutionalized older adults: a systematic review. *J Am Med Dir Assoc*. 2014; 15:226. e1-226.e6.
6. Maruyama T, Taguchi O, Niederman MS, et al. Efficacy of 23-valent pneumococcal vaccine in preventing pneumonia and improving survival in nursing home residents: double blind, randomised and placebo controlled trial. *BMJ*. 2010; 340:c1004. [PubMed: 20211953]
7. Centers for Disease Control, Prevention. Recommendations of the Immunization Practices Advisory Committee prevention and control of influenza. *MMWR Morb Mortal Wkly Rep*. 1988; 37:361–73. [PubMed: 3131656]
8. Grohskopf LA, Shay DK, Shimabukuro TT, et al. Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices—United States, 2013–2014. *MMWR Recomm Rep*. 2013; 62(RR-7)
9. Centers for Disease Control and Prevention. Prevention of pneumococcal disease: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep*. 1997; 46(RR-08)
10. Centers for Disease Control and Prevention. Notice to readers: recommended adult immunization schedule --- United States, 2002—2003. *MMWR Morb Mortal Wkly Rep*. 2002; 51:904–8. [PubMed: 12418546]
11. Kim DK, Bridges CB, Harriman KH. Advisory Committee on Immunization Practices recommended immunization schedule for adults aged 19 years or older: United States, 2015. *Ann Intern Med*. 2015; 162:214–25.
12. Kim DK, Bridges CB, Harriman KH. Advisory Committee on Immunization Practices recommended immunization schedule for adults aged 19 years or older—United States, 2016. *MMWR Morb Mortal Wkly Rep*. 2016; 65:88–90. [PubMed: 26845417]
13. Institute of Medicine. *Improving the Quality of Care in Nursing Homes*. Washington, DC: National Academy Press; 1986.
14. Institute of Medicine. *Improving the Quality of Long-term Care*. Washington, DC: National Academy Press; 2001.

15. Centers for Medicare and Medicaid Services. Condition of participation: immunization standard for long term care facilities; final rule. Fed Regist. 2005; 70:58833–52. [Accessed June 28, 2016] Available at <http://www.gpo.gov/fdsys/pkg/FR-2005-10-07/pdf/05-19987.pdf>. [PubMed: 16211747]
16. Centers for Medicare and Medicaid Services. [Accessed June 28, 2016] Long-term care facility resident assessment instrument user's manual. Version 3.0. Oct. 2014 Available at <http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/NursingHomeQualityInits/MDS30RAIManual.html>
17. Centers for Medicare and Medicaid Services. [Accessed June 28, 2016] Revised long-term care facility resident assessment instrument user's manual. Version 2.0. Dec. 2008 Available at <http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/NursingHomeQualityInits/NHQIMDS20.html>
18. Healthy People. [Accessed August 3, 2016] Topics and objectives—immunization and infectious diseases. 2020. Available at <http://www.healthypeople.gov/2020/topics-objectives/topic/immunization-and-infectious-diseases/objectives>
19. Bardenheier B, Shefer A, Tiggle R, Marsteller J, Rensburg RE. Nursing home resident and facility characteristics associated with pneumococcal vaccination: National Nursing Home Survey, 1995–1999. J Am Geriatr Soc. 2005; 53:1543–51. [PubMed: 16137285]
20. Bardenheier BH, Wortley P, Ahmed F, Hales C, Shefer A. Influenza immunization coverage among residents of long-term care facilities certified by CMS, 2005–2006: the newest MDS quality indicator. J Am Med Dir Assoc. 2010; 11:59–69. [PubMed: 20129216]
21. Marsteller JA, Tiggle RB, Rensburg RE, Bardenheier B, Shefer A, Han B. Pneumococcal vaccination in nursing homes: does race make a difference? J Am Med Dir Assoc. 2008; 9:641–7. [PubMed: 18992696]
22. Travers JL, Stone PW, Bjarnadottir RI, Pogorzelska-Maziarz M, Castle NG, Herzig CTA. Factors associated with resident influenza vaccination in a national sample of nursing homes. Am J Infect Control. 2016 In press.
23. Harrington C. Nurse staffing in nursing homes in the United States. Health Serv Res. 2005; 31:18–23.
24. Bardenheier B, Wortley P, Shefer A, McCauley MM, Gravenstein S. Racial inequities in receipt of influenza vaccination among nursing home residents in the United States, 2008–2009: a pattern of low overall coverage in facilities in which most residents are black. J Am Med Dir Assoc. 2012; 13:470–6. [PubMed: 22420974]
25. Chan TC, Luk JK, Chan FH, Chu LW, Hung IF. Factors associated with seasonal influenza vaccination in Chinese nursing home older adults. J Am Med Dir Assoc. 2013; 14:772–4. [PubMed: 23916374]
26. Ganguly R, Webster TB. Influenza vaccination in the elderly. J Invest Allergol Clin Immunol. 1995; 5:73–7.
27. Cai S, Feng Z, Fennell ML, Mor V. Despite small improvement, black nursing home residents remain less likely than whites to receive flu vaccine. Health Aff. 2011; 30:1939–46.
28. Luo H, Zhang X, Cook B, Wu B, Wilson MR. Racial/ethnic disparities in preventive care practice among U.S nursing home residents. J Aging Health. 2014; 24:519–39.
29. Li Y, Mukamel DB. Racial disparities in receipt of influenza and pneumococcus vaccinations among US nursing-home residents. Am J Public Health. 2010; 100:S256–S262. [PubMed: 20147674]
30. Mor V, Zinn J, Angelelli J, Teno JM, Miller SC. Driven to tiers: socioeconomic and racial disparities in the quality of nursing home care. Milbank Q. 2004; 82:227–56. [PubMed: 15225329]
31. Grabowski DC. The admission of blacks to high-deficiency nursing homes. Med Care. 2004; 42:456–64. [PubMed: 15083106]
32. Smith DB, Feng Z, Fennell ML, Zinn JS, Mor V. Separate, unequal: racial segregation disparities in quality across U.S nursing homes. Health Aff. 2007; 26:1448–58.
33. Lu PJ, O'Halloran A, Bryan L, Kennedy ED, Ding H, Graitcer SB, et al. Trends in racial/ethnic disparities in influenza vaccination coverage among adults during the 2007–08 through 2011–12 seasons. Am J Infect Control. 2014; 42:763–9. [PubMed: 24799120]

34. Hebert PL, Frick KD, Kane RL, McBean AM. The causes of racial and ethnic differences in influenza vaccination rates among elderly Medicare beneficiaries. *Health Serv Res.* 2005; 40:517–37. [PubMed: 15762905]
35. Lu PJ, Nuorti P. Pneumococcal polysaccharide vaccination among adults aged 65 years and older, U.S., 1989–2008. *Am J Prev Med.* 2010; 39:287–95. [PubMed: 20837278]
36. O'Malley AS, Forrest CB. Immunization disparities in older Americans: determinants and future research needs. *Am J Prev Med.* 2006; 31:150–8. [PubMed: 16829332]
37. Winston CA, Wortley PM, Lees KA. Factors associated with vaccination of Medicare beneficiaries in five U.S communities: results from the racial and ethnic adult disparities in immunization initiative survey, 2003. *J Am Geriatr Soc.* 2006; 54:303–10. [PubMed: 16460383]
38. Fiscella K. Commentary—anatomy of racial disparity in influenza vaccination. *Health Serv Res.* 2005; 40:539–49. [PubMed: 15762906]
39. Lindley MC, Wortley PM, Winston CA, Bardenheier BH. The role of attitudes in understanding disparities in adult influenza vaccination. *Am J Prev Med.* 2006; 31:281–5. [PubMed: 16979451]
40. Williams WW, Lu PJ, O'Halloran A, Bridges CB, Kim DK, Pilishvili T, et al. Vaccination coverage among adults, excluding influenza vaccination coverage—United States, 2013. *MMWR Morb Mortal Wkly Rep.* 2015; 64:95–102. [PubMed: 25654611]
41. Williams WW, Lu PJ, O'Halloran A, Kim DK, Grohskopf LA, Pilishvili T, et al. Surveillance of vaccination coverage among adult populations—United States, 2014. *MMWR Surv Summ.* 2016; 65(SS-01)
42. Santibanez, TA., Kahn, KE., Zhai, Y., O'Halloran, A., Davis, N., Bridges, CB., et al. [Accessed June 28, 2016] Flu vaccination coverage, United States, 2014–15 influenza season. Available at <http://www.cdc.gov/flu/fluview/coverage-1415estimates.htm>
43. Grosholz JM, Blake S, Daugherty JD, Ayers E, Omer SB, Polivka-West L, et al. Accuracy of influenza vaccination rate estimates in United States nursing home residents. *Epidemiol Infect.* 2015; 143:2588–95. [PubMed: 25519437]
44. Tomczyk S, Bennett NM, Stoecker C, Gierke R, Moore MR, Whitney CG, et al. Use of 13-valent pneumococcal conjugate vaccine and 23-valent pneumococcal polysaccharide vaccine among adults age 65 years: recommendations of the advisory committee on immunization practices (ACIP). *MMWR Morb Mortal Wkly Rep.* 2014; 63:822–5. [PubMed: 25233284]
45. Community Preventive Services Task Force. Increasing appropriate vaccination. Atlanta, GA: The Guide to Community Preventive Services; Available at <https://www.thecommunityguide.org/topic/vaccination> [Accessed April 26, 2017]
46. Stevenson KB, McMhaon JW, Harris J, Hillman JR, Helgerson SD. Increasing pneumococcal vaccination rates among residents of long-term care facilities: provider-based improvement strategies implemented by peer-review organizations in four western states. *Infect Control Hosp Epidemiol.* 2000; 21:705–10.
47. Bardenheier BH, Shefer AM, Lu PJ, Remsburg RE, Marsteller JA. Are standing order programs associated with vaccination?—NNHS, 2004. *J Am Dir Assoc.* 2010; 11:654–61.

Table 1

Percent of nursing home residents vaccinated against influenza by select demographic characteristics, Minimum Data Set, United States, 2005–06 through 2014–15 influenza seasons*

	Influenza season										
	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	
Total	71.4	74.3	76.5	77.5	78.4	75.4	76.8	76.7	76.5	75.7	
Age											
18–24 years	56.9	57.9	61.1	61.5	63.4	61.6	62.3	63.1	63.1	63.3	
25–44 years	58.4	59.8	63.0	63.7	66.2	62.9	64.4	65.0	64.3	63.1	
45–54 years	60.8	63.4	66.0	67.2	69.2	65.9	67.4	68.0	67.6	66.4	
55–64 years	63.3	66.5	68.8	70.3	71.7	68.3	69.9	70.3	70.1	68.9	
65–74 years	66.7	70.1	72.7	73.9	74.9	71.5	73.1	73.1	72.8	72.1	
75–84 years	71.7	74.8	77.2	78.3	79.2	76.2	77.6	77.5	77.2	76.5	
85 years	76.4	79.0	80.9	81.9	82.5	79.8	81.3	81.0	81.2	80.5	
Sex											
Female	72.8	75.6	77.7	78.5	79.4	76.3	77.7	77.5	77.4	76.7	
Male	68.4	71.6	74.2	75.6	76.5	73.5	75.1	75.2	74.8	73.9	
Race/ethnicity											
American Indian or Alaska Native	74.3	75.8	78.5	79.3	79.4	77.6	78.7	79.5	78.7	77.8	
Asian or Pacific Islander	71.9	75.1	78.0	78.9	79.4	77.9	78.1	78.7	78.1	77.8	
Asian	– [†]	– [†]	– [†]	– [†]	– [†]	77.9	80.1	79.7	79.9	79.4	
Native Hawaiian or Other Pacific Islander	– [†]	– [†]	– [†]	– [†]	– [†]	72.1	73.9	74.6	74.9	74.4	
Black or African American, non-Hispanic	65.4	68.2	70.6	71.7	72.6	67.9	69.8	69.7	69.5	68.3	
Hispanic or Latino	65.2	70.1	72.5	74.2	74.2	69.7	71.9	72.0	71.1	70.3	
White, non-Hispanic	72.5	75.4	77.6	78.6	79.6	76.8	78.2	78.1	78.0	77.3	
Multiple races, non-Hispanic	– [†]	– [†]	– [†]	– [†]	– [†]	72.5	74.1	76.6	78.1	76.1	
Number of chronic medical conditions^{§§}											
0	–	–	–	–	–	–	71.2	71.3	71.1	70.1	
1	–	–	–	–	–	–	77.1	76.8	76.6	75.6	

		Influenza season										
		2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	
2		- //	- //	- //	- //	- //	- //	79.5	79.3	79.0	78.2	
3		- //	- //	- //	- //	- //	- //	81.4	81.1	80.9	80.1	
Marital status												
	Never married	72.0	73.8	75.9	76.5	77.1	72.5	73.9	73.9	73.7	72.8	
	Married	70.1	73.7	76.3	77.7	78.5	74.0	75.5	75.8	75.4	74.7	
	Widowed	76.1	78.8	80.8	81.7	82.2	78.2	79.7	79.6	79.6	78.9	
	Separated	68.0	71.4	73.4	75.0	76.0	69.6	71.6	71.9	71.5	70.6	
	Divorced	70.7	73.2	75.2	76.2	76.8	72.0	73.7	73.9	73.6	73.0	

* Each influenza season is defined as the period from October 1 through March 31 of the following year.

⁷ Beginning in October 2010, "Asian or Pacific Islander" was separated into two categories on the Resident Assessment Instrument, "Asian" and "Native Hawaiian or other Pacific Islander".

⁴ Not collected on the Resident Assessment Instrument prior to October 2010.

⁸ Selected high-risk conditions for influenza-related complications, obtained from the "Active Diagnoses" section of the MDS from the residents' most recent annual assessment prior to the start of each influenza season. Includes cancer, coronary artery disease, heart failure, cirrhosis, renal insufficiency, renal failure, or end-stage renal disease, diabetes, Alzheimer's disease, cerebral palsy, cerebrovascular accident, transient ischemic attack, or stroke, non-Alzheimer's dementia, hemiplegia or hemiparesis, paraplegia, quadriplegia, multiple sclerosis, Huntington's disease, Parkinson's disease, seizure disorder or epilepsy, traumatic brain injury, and asthma, chronic obstructive pulmonary disease, or chronic lung disease.

// Comparable data on chronic conditions not available in the MDS 2.0 in use prior to 2011.

Table 2 Percent of nursing home residents vaccinated against influenza by state, Minimum Data Set, United States, 2005–06 through 2014–15 influenza seasons*

	Influenza season												
	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15			
All states	71.4	74.3	76.5	77.5	78.4	75.4	76.8	76.7	76.5	75.7			
Alabama	70.0	73.3	76.1	76.3	77.4	72.9	75.0	74.7	73.8	73.2			
Alaska	82.6	80.8	83.1	84.7	84.0	83.1	84.4	81.7	82.8	81.0			
Arizona	61.6	65.9	71.4	71.3	71.0	69.0	69.4	66.0	64.6	61.0			
Arkansas	85.5	85.5	88.6	89.3	88.2	86.0	87.9	88.3	87.9	87.2			
California	61.5	66.6	70.1	72.0	72.4	70.6	72.8	73.4	74.0	74.4			
Colorado	76.8	77.7	77.3	78.3	79.0	74.8	76.3	77.9	77.4	77.8			
Connecticut	72.3	76.3	77.8	79.1	79.5	75.9	79.7	80.5	80.7	80.7			
Delaware	79.5	79.2	80.2	80.6	82.1	80.9	83.4	82.6	83.5	82.9			
District of Columbia	69.2	70.9	70.9	71.0	70.5	67.0	69.7	70.8	66.9	69.0			
Florida	51.7	57.0	60.1	62.5	63.0	58.5	59.6	59.2	57.4	55.9			
Georgia	74.2	79.3	82.1	81.8	81.1	77.5	77.9	77.2	75.8	74.6			
Hawaii	85.1	84.9	86.8	87.1	87.3	83.6	83.8	79.9	78.3	78.4			
Idaho	73.3	76.1	77.6	79.3	78.8	75.6	74.9	74.3	71.8	73.8			
Illinois	64.9	66.7	67.6	69.7	73.0	70.4	72.9	73.9	74.8	73.4			
Indiana	71.9	75.2	75.5	77.1	79.8	75.7	77.3	77.8	78.2	77.9			
Iowa	85.9	87.0	87.5	87.6	88.5	87.1	88.1	87.8	87.2	87.3			
Kansas	81.1	81.8	82.4	82.9	84.9	82.0	82.4	83.0	82.3	81.7			
Kentucky	74.4	77.3	78.8	79.2	81.2	77.8	77.5	79.2	78.2	77.6			
Louisiana	73.8	78.3	81.5	82.3	84.7	77.3	79.1	79.1	79.2	78.7			
Maine	74.9	75.7	80.2	80.8	83.0	80.7	83.4	84.1	83.8	82.7			
Maryland	66.8	67.7	69.8	70.9	71.9	73.2	74.8	75.7	75.8	74.8			
Massachusetts	72.5	74.6	77.9	79.8	81.9	80.4	82.2	82.7	82.9	81.5			
Michigan	69.6	72.3	73.3	74.7	75.3	74.1	75.5	75.6	75.9	74.4			
Minnesota	80.7	83.1	85.4	85.8	88.0	86.1	86.4	85.7	85.2	84.7			
Mississippi	76.2	82.1	84.8	84.5	83.6	79.8	80.2	78.8	77.4	76.7			
Missouri	74.9	76.9	79.7	81.8	82.3	78.6	80.6	80.7	81.3	80.2			

	Influenza season										
	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	
Montana	82.6	82.6	83.4	83.2	83.2	81.7	83.0	82.3	81.7	80.6	
Nebraska	83.4	84.6	84.9	85.8	87.8	84.6	85.5	85.5	85.3	84.3	
Nevada	44.0	45.6	50.3	52.6	52.5	54.9	51.4	53.7	52.7	50.0	
New Hampshire	78.8	79.7	82.5	81.8	83.9	82.0	85.2	85.3	85.7	84.5	
New Jersey	72.3	74.4	76.2	76.8	77.7	74.7	77.2	77.4	77.8	77.6	
New Mexico	69.6	75.1	76.2	78.1	76.1	71.6	72.3	72.6	70.8	70.2	
New York	80.6	81.6	83.1	83.4	82.9	80.2	80.5	80.1	81.0	79.9	
North Carolina	72.1	74.7	78.6	78.4	79.3	75.4	76.8	74.4	74.1	72.0	
North Dakota	84.7	86.1	87.9	87.7	87.9	86.1	86.5	86.7	85.6	85.7	
Ohio	66.4	70.2	72.7	74.2	74.8	73.0	74.2	74.3	74.5	74.0	
Oklahoma	80.4	82.4	83.8	85.7	85.9	81.6	83.3	83.3	83.1	83.2	
Oregon	68.4	71.4	74.7	75.2	76.1	74.0	76.7	76.5	77.6	75.5	
Pennsylvania	74.2	75.7	78.5	79.4	80.5	79.5	81.2	81.6	81.6	80.9	
Rhode Island	76.5	78.6	79.0	79.1	81.3	79.6	81.3	83.9	83.7	83.2	
South Carolina	76.3	81.4	83.6	83.8	85.0	81.0	81.3	80.7	79.2	78.5	
South Dakota	86.6	86.3	86.6	86.9	89.1	88.0	89.4	89.4	90.2	89.7	
Tennessee	73.2	77.7	80.2	81.6	80.8	77.5	79.6	78.3	77.5	76.2	
Texas	74.5	79.9	81.8	81.8	82.6	72.6	73.8	72.9	71.3	71.1	
Utah	78.3	78.1	76.1	78.9	79.0	75.8	76.2	75.8	75.9	76.7	
Vermont	80.6	80.2	82.0	82.9	85.3	82.4	85.9	85.0	82.8	83.1	
Virginia	70.0	74.2	76.4	77.2	80.1	78.2	79.3	78.3	77.6	76.7	
Washington	71.7	73.0	75.8	76.0	78.0	76.5	78.1	78.3	78.5	77.3	
West Virginia	74.1	76.1	78.2	78.5	79.9	78.7	81.9	81.6	80.9	81.1	
Wisconsin	81.7	81.6	83.5	84.0	84.5	82.2	83.9	85.2	85.0	83.7	
Wyoming	82.2	82.7	82.3	82.6	81.4	81.4	80.9	81.6	81.6	81.0	
<i>Median</i>	<i>74.4</i>	<i>77.7</i>	<i>79.0</i>	<i>79.8</i>	<i>81.2</i>	<i>78.2</i>	<i>79.7</i>	<i>79.2</i>	<i>78.5</i>	<i>78.4</i>	
<i>Range across states</i>	<i>44.0-86.6</i>	<i>45.6-87.0</i>	<i>50.3-88.6</i>	<i>52.6-89.3</i>	<i>52.5-89.1</i>	<i>54.9-88.0</i>	<i>51.4-89.4</i>	<i>53.7-89.4</i>	<i>52.7-90.2</i>	<i>50.0-89.7</i>	

* Each influenza season is defined as the period from October 1 through March 31 of the following year.

Table 3

Reason for non-vaccination* with influenza vaccine among unvaccinated nursing home residents, Minimum Data Set, United States, 2005–06 through 2014–15 influenza seasons[†]

	Influenza season												
	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15			
Reason for non-vaccination													
Not eligible [‡]	5.8	5.6	5.6	5.4	5.3	4.5	4.5	4.7	4.5	4.5	4.3		
Offered and declined	36.2	43.2	50.8	55.7	61.3	63.9	69.6	71.1	72.0	71.9			
Not offered	43.8	38.8	33.7	29.6	20.9	17.8	13.6	11.6	10.9	10.6			
Inability to obtain vaccine [§]	10.4	7.2	4.1	3.5	7.0	0.5	0.2	0.2	0.3	0.4			
None of the above	-	-	-	-	-	11.5	9.9	10.0	10.0	10.1			
Missing	3.8	5.2	5.7	5.8	5.6	1.8	2.2	2.4	2.4	2.6			

* Presented as percent of unvaccinated residents. If resident had multiple assessments in one influenza season, the reason for non-vaccination at the last assessment in the season is presented.

[†] Each influenza season is defined as the period from October 1 through March 31 of the following year.

[‡] Beginning in the 2010–11 influenza season, wording on Resident Assessment Instrument was changed to “Not eligible - medical contraindication”.

[§] Beginning in the 2010–11 influenza season, wording on Resident Assessment Instrument was changed to “Inability to obtain vaccine due to a declared shortage”.

^{||} Not an available option prior to the 2010–11 influenza season.

Table 4
Percent of nursing home residents vaccinated with pneumococcal vaccine by select demographic characteristics, Minimum Data Set, United States, 2006–2014

	Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Total	67.4	74.3	77.8	79.9	80.1	79.8	79.5	79.3	78.4	
Age										
18–24 years	41.9	45.3	49.3	49.8	52.4	50.2	48.3	48.7	46.7	
25–44 years	45.7	51.7	55.6	58.0	59.4	58.6	58.4	58.2	56.3	
45–54 years	50.0	56.8	60.5	63.2	64.4	63.9	64.1	64.4	62.8	
55–64 years	55.4	62.5	66.2	68.8	69.1	68.6	68.7	68.9	67.7	
65–74 years	64.3	71.5	75.0	77.4	77.5	77.2	76.8	76.7	75.9	
75–84 years	69.4	76.4	79.9	82.0	82.2	81.9	81.7	81.3	80.5	
85 years	72.8	79.5	82.8	85.0	85.3	85.3	85.1	84.9	84.3	
Sex										
Female	69.0	75.8	79.2	81.2	81.5	81.2	80.9	80.7	79.9	
Male	64.4	71.4	75.1	77.4	77.7	77.3	77.1	76.9	75.8	
Race/ethnicity										
American Indian or Alaska Native	66.7	71.9	77.3	80.2	80.1	80.1	80.1	79.4	78.5	
Asian or Pacific Islander	64.0	69.3	73.8	76.3	69.8	*	*	*	*	
Asian	₪	₪	₪	₪	65.4	77.7	78.1	77.3	76.5	
Native Hawaiian or Other Pacific Islander	₪	₪	₪	₪	64.6	71.7	72.9	75.9	75.4	
Black or African American, non-Hispanic	56.4	65.7	70.2	72.9	73.5	73.1	73.0	73.1	71.9	
Hispanic or Latino	59.0	66.8	70.8	73.3	73.1	72.2	72.5	72.0	70.8	
White, non-Hispanic	69.4	76.0	79.3	81.3	81.6	81.4	81.1	80.9	80.1	
Multiple races, non-Hispanic	₪	₪	₪	₪	63.5	75.6	75.8	77.0	76.8	
Number of chronic medical conditions[‡]										
0	₪	₪	₪	₪	₪	79.7	79.3	78.6	77.4	
1	₪	₪	₪	₪	₪	81.3	81.2	80.9	79.9	
2	₪	₪	₪	₪	₪	83.0	83.0	82.8	82.0	
	₪	₪	₪	₪	₪	85.0	85.3	85.2	84.6	

	Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	
3	-\$	-\$	-\$	-\$	-\$	79.7	79.3	78.6	77.4	
Marital status										
Never married	63.6	70.4	73.9	76.2	76.3	75.3	75.1	74.9	73.8	
Married	67.4	73.9	77.1	79.1	78.4	77.2	77.1	76.9	76.1	
Widowed	71.8	78.7	81.9	84.0	84.1	83.9	83.8	83.6	83.0	
Separated	59.9	68.2	72.1	75.9	74.8	74.5	74.6	74.0	73.4	
Divorced	64.7	72.0	75.5	77.7	77.8	77.2	77.3	77.3	76.6	

* Beginning in October 2010, "Asian or Pacific Islander" was separated into two categories on the Resident Assessment Instrument, "Asian" and "Native Hawaiian or other Pacific Islander".

† Not collected on the Resident Assessment Instrument prior to October 2010.

‡ Selected high-risk conditions for invasive pneumococcal disease, obtained from the "Active Diagnoses" section of the MDS from the residents' annual assessment during the calendar year of interest. Includes cancer, coronary artery disease, heart failure, cirrhosis, renal insufficiency, renal failure, or end-stage renal disease, diabetes, and asthma, chronic obstructive pulmonary disease, or chronic lung disease.

§ Comparable data on chronic conditions not available in the MDS 2.0 in use prior to 2011.

Table 5

Percent of nursing home residents vaccinated with pneumococcal vaccine by state, Minimum Data Set, United States, 2006–2014

	Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	
All states	67.4	74.3	77.8	79.9	80.1	79.8	79.5	79.3	78.4	
Alabama	59.7	72.0	75.9	77.1	77.8	77.5	77.1	76.4	75.5	
Alaska	78.8	82.1	85.2	86.1	87.7	87.3	86.4	85.0	86.1	
Arizona	65.1	71.9	74.5	74.6	74.5	74.2	71.8	68.0	65.8	
Arkansas	73.5	86.3	89.7	90.7	91.3	90.7	90.2	89.9	88.5	
California	56.5	64.9	70.8	74.3	75.6	76.2	76.6	77.0	76.8	
Colorado	75.4	79.8	82.3	82.7	82.1	81.7	82.3	80.6	79.4	
Connecticut	68.9	75.9	79.5	80.5	81.0	81.7	82.9	83.0	82.7	
Delaware	82.9	84.9	85.8	86.6	86.3	87.6	86.4	86.2	85.5	
District of Columbia	47.0	60.1	64.2	63.3	64.1	64.9	64.4	63.3	61.5	
Florida	49.9	57.5	63.0	65.7	64.6	64.1	63.5	62.8	60.9	
Georgia	64.9	77.7	81.7	82.8	82.0	80.6	79.5	78.7	77.7	
Hawaii	81.2	80.2	83.3	84.4	84.9	84.7	84.4	81.6	80.7	
Idaho	75.7	81.5	83.0	84.1	83.0	80.9	80.0	77.2	75.9	
Illinois	52.9	60.7	65.7	70.6	74.2	74.9	76.0	77.1	76.2	
Indiana	66.2	73.7	76.2	79.1	79.4	79.4	79.8	80.3	79.7	
Iowa	87.1	89.9	90.9	91.3	91.5	91.2	90.9	90.4	89.4	
Kansas	78.0	81.5	84.5	86.6	86.5	85.5	85.0	84.8	83.5	
Kentucky	74.4	78.8	80.6	82.2	81.8	81.7	80.9	80.7	80.4	
Louisiana	57.7	74.4	80.2	83.5	82.9	80.7	80.0	80.9	79.0	
Maine	76.2	82.9	85.5	85.8	85.2	85.6	86.7	86.7	87.5	
Maryland	63.0	65.7	69.0	71.8	73.4	74.3	74.9	75.8	75.3	
Massachusetts	69.7	76.7	80.7	83.6	84.0	84.6	84.7	85.2	84.1	
Michigan	67.2	72.8	75.0	78.1	79.3	80.4	80.5	80.9	79.3	
Minnesota	84.9	88.0	89.9	90.8	90.9	90.5	90.1	89.9	89.4	
Mississippi	71.3	83.1	86.0	85.7	83.8	82.5	80.4	78.7	77.8	
Missouri	68.2	75.2	79.9	83.5	84.1	84.1	83.5	83.0	82.7	

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	Year										
	2006	2007	2008	2009	2010	2011	2012	2013	2014		
Montana	81.9	84.7	86.0	86.7	87.2	87.1	86.3	86.6	84.9		
Nebraska	80.6	86.3	88.2	89.6	89.3	89.1	89.0	88.7	88.2		
Nevada	41.1	47.2	48.9	50.9	54.7	57.3	56.1	56.8	55.0		
New Hampshire	79.9	85.7	88.4	87.9	87.6	88.6	89.8	89.8	89.7		
New Jersey	73.3	76.7	78.0	79.5	79.9	79.4	79.9	80.4	80.0		
New Mexico	58.9	68.2	72.9	77.9	77.9	73.9	75.8	76.5	72.9		
New York	82.2	84.7	85.3	85.6	84.7	83.9	83.1	82.8	81.6		
North Carolina	63.7	75.8	79.8	81.1	79.9	79.1	78.4	76.6	74.4		
North Dakota	86.4	89.4	90.5	90.5	90.1	90.1	89.4	89.3	89.0		
Ohio	57.2	68.0	73.8	76.9	77.7	77.7	77.6	77.9	78.1		
Oklahoma	74.8	81.8	84.2	86.3	87.2	85.7	84.7	84.7	84.2		
Oregon	70.8	76.3	79.4	82.3	82.8	83.4	82.8	82.7	83.0		
Pennsylvania	74.5	78.7	81.4	83.2	83.4	83.8	84.0	84.0	83.4		
Rhode Island	78.9	81.2	83.2	84.1	85.5	85.1	85.9	86.7	86.0		
South Carolina	73.5	82.7	87.8	88.1	86.8	85.7	84.5	83.3	82.0		
South Dakota	87.7	89.5	90.2	91.0	91.2	91.3	90.6	90.4	89.3		
Tennessee	69.0	77.4	81.6	82.6	81.9	81.6	80.6	79.0	78.9		
Texas	70.2	76.7	79.3	81.5	80.6	77.1	75.3	73.4	72.1		
Utah	67.3	74.0	78.8	80.1	80.7	80.4	79.9	79.1	79.8		
Vermont	75.9	82.6	84.7	86.1	87.0	86.1	88.5	86.2	86.6		
Virginia	61.0	72.6	76.5	79.9	81.4	81.7	81.3	81.0	80.2		
Washington	71.3	77.0	80.3	82.5	83.1	83.1	83.0	83.3	82.6		
West Virginia	67.6	73.6	77.0	78.6	80.4	81.4	82.5	82.2	81.7		
Wisconsin	82.0	86.1	87.4	88.9	88.6	88.1	88.7	89.3	89.1		
Wyoming	82.3	84.2	83.8	84.7	87.3	86.5	85.4	86.0	82.9		
<i>Median</i>	<i>71.3</i>	<i>77.7</i>	<i>81.4</i>	<i>83.2</i>	<i>83.0</i>	<i>82.5</i>	<i>82.8</i>	<i>82.2</i>	<i>81.6</i>		
<i>Range across states</i>	<i>41.1–87.7</i>	<i>47.2–89.9</i>	<i>48.9–90.9</i>	<i>50.9–91.3</i>	<i>54.7–91.5</i>	<i>57.3–91.3</i>	<i>56.1–90.9</i>	<i>56.9–90.4</i>	<i>55.0–89.7</i>		

Reason for non-vaccination* with pneumococcal vaccine among unvaccinated nursing home residents, Minimum Data Set, United States, 2006 through 2014

Table 6

Reasons for non-vaccination	Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Not eligible [†]	7.0	7.2	7.0	6.7	5.8	4.9	4.8	4.7	4.8	
Offered and declined	38.5	48.7	56.7	63.8	68.0	69.7	71.9	73.3	73.2	
Not offered	49.7	39.3	31.3	24.5	21.5	20.8	18.4	16.7	16.0	
Missing	4.8	4.8	5.0	5.0	4.7	4.7	4.8	5.4	6.0	

* Presented as percent of unvaccinated residents. If resident had multiple assessments in one year, the reason for non-vaccination at the last assessment during the year is presented.

[†] Beginning in October 2010, wording on Resident Assessment Instrument was changed to “Not eligible - medical contraindication”.

Table 7
 Logistic regression analysis of factors associated with influenza and pneumococcal vaccination among nursing home residents, with and without controlling for facility fixed effects, Minimum Data Set, United States, 2014–15

	Influenza vaccination*		Pneumococcal vaccination [†]	
	Model 1 [‡] OR (95% CI)	Model 2 [§] OR (95% CI)	Model 1 [‡] OR (95% CI)	Model 2 [§] OR (95% CI)
Age				
18–24 years	0.5 (0.5, 0.6)	0.5 (0.4, 0.5)	0.2 (0.2, 0.2)	0.2 (0.2, 0.2)
25–44 years	0.5 (0.5, 0.5)	0.5 (0.5, 0.6)	0.3 (0.3, 0.3)	0.3 (0.3, 0.3)
45–54 years	0.6 (0.6, 0.6)	0.6 (0.6, 0.6)	0.4 (0.4, 0.4)	0.4 (0.3, 0.4)
55–64 years	0.6 (0.6, 0.6)	0.6 (0.6, 0.7)	0.4 (0.4, 0.4)	0.4 (0.4, 0.4)
65–74 years	0.7 (0.7, 0.7)	0.7 (0.7, 0.7)	0.6 (0.6, 0.6)	0.7 (0.7, 0.7)
75–84 years	0.8 (0.8, 0.8)	0.9 (0.8, 0.9)	0.8 (0.8, 0.8)	0.8 (0.8, 0.8)
85 years	Reference	Reference	Reference	Reference
Sex				
Female	Reference	Reference	Reference	Reference
Male	0.9 (0.9, 1.0)	0.9 (0.9, 1.0)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)
Race/ethnicity				
American Indian or Alaska Native	1.2 (1.1, 1.2)	1.1 (1.0, 1.2)	1.1 (1.1, 1.2)	1.1 (1.0, 1.2)
Asian	1.1 (1.1, 1.2)	1.2 (1.2, 1.2)	0.8 (0.8, 0.9)	0.9 (0.8, 0.9)
Native Hawaiian or Other Pacific Islander	1.0 (0.9, 1.1)	1.1 (1.0, 1.2)	0.9 (0.8, 1.0)	1.0 (0.9, 1.1)
Black or African American, non-Hispanic	0.7 (0.6, 0.7)	0.8 (0.8, 0.8)	0.7 (0.7, 0.7)	0.9 (0.9, 0.9)
Hispanic or Latino	0.7 (0.7, 0.7)	1.1 (1.1, 1.1)	0.7 (0.7, 0.7)	1.0 (1.0, 1.0)
White, non-Hispanic	Reference	Reference	Reference	Reference
Multiple races, non-Hispanic	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	0.9 (0.8, 0.9)	0.8 (0.8, 0.9)
Number of chronic medical conditions //				
None	Reference	Reference	Reference	Reference
One	1.3 (1.3, 1.3)	1.3 (1.3, 1.3)	1.2 (1.2, 1.2)	1.2 (1.2, 1.2)
Two	1.5 (1.5, 1.5)	1.5 (1.5, 1.5)	1.3 (1.3, 1.4)	1.4 (1.4, 1.4)
Three	1.8 (1.7, 1.8)	1.8 (1.8, 1.8)	1.6 (1.6, 1.6)	1.8 (1.8, 1.8)
Marital status				

	Influenza vaccination*		Pneumococcal vaccination [†]	
	Model 1 [‡] OR (95% CI)	Model 2 [§] OR (95% CI)	Model 1 [‡] OR (95% CI)	Model 2 [§] OR (95% CI)
	Reference	Reference	Reference	Reference
Never married				
Married	0.9 (0.9, 0.9)	0.9 (0.9, 1.0)	0.8 (0.8, 0.8)	0.9 (0.8, 0.9)
Widowed	0.9 (0.9, 1.0)	0.9 (0.9, 1.0)	0.9 (0.9, 0.9)	1.0 (1.0, 1.0)
Separated	0.9 (0.8, 0.9)	0.9 (0.9, 1.0)	0.9 (0.9, 0.9)	1.0 (1.0, 1.0)
Divorced	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	1.0 (0.9, 1.0)

Abbreviations: OR = odds ratio; CI = confidence interval.

* Includes residents with at least one assessment during October 1, 2014 through March 31, 2015.

[†] Includes residents with at least one assessment during January 1, 2014 through December 31, 2014.

[‡] Model includes all variables listed in Table 7.

[§] Model includes all variables listed in Table 7 as well as adjustment for facility-level fixed effects.

// Selected high-risk conditions for influenza-related complications or invasive pneumococcal disease. Includes cancer, coronary artery disease, heart failure, cirrhosis, renal insufficiency, renal failure, or end-stage renal disease, diabetes, and asthma, chronic obstructive pulmonary disease, or chronic lung disease. Influenza vaccination models additionally include Alzheimer's disease, cerebral palsy, cerebrovascular accident, transient ischemic attack, or stroke, non-Alzheimer's dementia, hemiplegia or hemiparesis, paraplegia, quadriplegia, multiple sclerosis, Huntington's disease, Parkinson's disease, seizure disorder or epilepsy, and traumatic brain injury.