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Promoting Adult Immunization Using Population-Based Data for a Composite Measure

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Abstract

Introduction: A composite adult immunization status measure is currently under consideration for adoption into the Healthcare Effectiveness Data and Information Set. This paper complements the Healthcare Effectiveness Data and Information Set health plan–level measure testing efforts by examining use of survey-based self-reported vaccination data to assess composite adult immunization coverage and identify limitations to using survey data to measure progress.

Methods: The 2015 National Health Interview Survey data were used in 2017 to calculate estimates for a composite of selected vaccines routinely recommended for adults aged ≥ 19 years, overall and in three age groups: 19–59, 60–64, and ≥ 65 years for tetanus and diphtheria toxoids (Td); tetanus toxoid; reduced diphtheria toxoid; and tetanus, diphtheria, acellular pertussis vaccine (Tdap); and herpes zoster, pneumococcal, and influenza vaccines.

Results: Composite coverage for adults aged ≥19 years including receipt of Tdap in the past 10 years and influenza vaccination was 11.9%, ranging from 6.3% in adults aged 60–64 years to 13.7% in adults aged 19–59 years. Excluding influenza, composite coverage was 20.7%, ranging from 8.1% (adults aged 60–64 years) to 25.2% (adults aged 19–59 years). In a composite including any Td-containing vaccine in the past 10 years, coverage including influenza vaccination for adults aged ≥19 years was 23.4%, ranging from 12.6% (adults aged 60–64 years) to 25.7% (adults aged 19–59 years). Excluding influenza, composite coverage was 51.4%, ranging from 15.8% (adults aged 60–64 years) to 63.0% (adults aged 19–59 years).

Conclusions: Survey-based vaccination data may under- or over-estimate coverage, but most adults require at least one additional vaccination by any metric. A composite measure provides a single focal point to promote adherence to standards of care.

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INTRODUCTION

Adults in the U.S. experience a considerable burden of vaccine-preventable disease; however, coverage with most Advisory Committee on Immunization Practices (ACIP) recommended vaccines[1,2] remains well below Healthy People 2020 targets.[3,4] An age-stratified composite adult immunization status (AIS) measure is currently under consideration for adoption into public and private healthcare quality measurement programs.[5] Measurement and feedback on vaccination coverage is an evidence-based strategy to increase vaccination uptake; adoption of a composite quality measure may facilitate and promote use of this strategy.[6]

Composite performance measures, which combine multiple measurement elements into a single construct, can be used to assess[7] performance of the healthcare system and health plans in addition to progress made on individual measure components. Composite measures of recommended childhood vaccines have long been used to monitor healthcare quality and prevention efforts,[4,8] and a composite measure for adolescent vaccinations was recently introduced.[8] Conversely, no composite measures for adult vaccination exist, though individual measures for influenza and pneumococcal vaccination are available.[9]

In 2016, the National Adult Immunization Plan was introduced to guide and support implementation of adult immunization standards of care across the U.S.; one National Adult Immunization Plan objective is evaluation and enhancement of targeted improvement initiatives.[10] In pursuit of this objective, the Indian Health Service tested the feasibility of, and subsequently implemented, an adult immunization composite measure that assesses receipt of all routine adult vaccinations as an Indian Health Service health system performance measure. Building on the success of this effort, the National Vaccine Program Office funded the National Committee on Quality Assurance to develop and test an AIS composite measure among patients in health plans as a possible Healthcare Effectiveness Data and Information Set (HEDIS®)[11] 2019 measure. Having an AIS composite measure and identifying a national benchmark will be important for assessing progress. This paper complements HEDIS® health plan-level measure testing efforts by examining use of survey-based self-reported vaccination data to assess immunization coverage of routinely recommended adult vaccines and identify limitations to using survey data to measure progress.

METHODS

Data from the 2015 National Health Interview Survey (NHIS) were analyzed in 2017 to determine baseline estimates for a composite measure of vaccination coverage for select vaccines routinely recommended for all adults aged ≥19 years (tetanus and diphtheria toxoids [Td]; tetanus toxoid; reduced diphtheria toxoid; and tetanus, diphtheria, acellular pertussis vaccine [Tdap]; and influenza vaccines) or indicated based on age (herpes zoster and pneumococcal vaccines) and three age groups (age 19–59, 60–364, and ≥65 years) based on the vaccines recommended for that age group (Table 1). Estimates were calculated as the weighted proportion of respondents who reported receiving tetanus toxoid-containing (Td or Tdap), Tdap, herpes zoster, and pneumococcal vaccines using definitions from a

previous report,[3] producing nationally representative vaccination coverage estimates. Influenza vaccination coverage estimates were based on reported receipt of influenza vaccination in the past 12 months. Pneumococcal vaccination was assessed only in those aged ≥65 years; coverage among people aged 19–64 years with medical conditions that increase the risk for pneumococcal disease is not included in this composite measure.

Estimates for the AIS measures were calculated to include Tdap vaccine in the past 10 years (Method 1) or any tetanus-toxoid–containing vaccine in the past 10 years (Method 2), and both with and without influenza vaccination in the past 12 months. Respondents who did not answer *yes* or *no* to questions about vaccination with any vaccine or those who answered *don't know* were excluded from the analysis (Method 1: 38.7%–40.9%, Method 2: 5.6%–9.0%; Table 2). In addition, to estimate Tdap coverage among those who reported tetanus vaccination, those who were not told or did not know vaccine type (Td or Tdap), refused to answer, or for whom data were not obtained were also excluded (54.3% of those reporting tetanus vaccination). Point estimates and 95% CIs were calculated using SAS, version 9.3 and SUDAAN, version 11, to account for the complex sample design.

RESULTS

Table 3 presents a composite estimate of overall vaccination coverage among adults who have received the selected vaccines that are recommended for their age groups based on receipt ofTdap in the past 10 years (Method 1) or Td or Tdap in the past 10 years (Method 2), including or not including influenza vaccination. Vaccination coverage for the AIS measure including receipt of Tdap in the past 10 years (Method 1) and influenza vaccine was 11.9% for adults aged >19 years, 13.7% for adults aged 19–59 years, 6.3% for adults aged 60–64 years, and 7.4% for adults aged >65 years (Table 3). The AIS measure including receipt of Td or Tdap in the past 10 years (Method 2) and influenza vaccination was 23.4% for adults aged >19 years, 25.7% for adults aged 19–59 years, 12.6% for adults aged 60–64 years, and 19.2% for adults aged >65 years.

Excluding influenza vaccination, the AIS measure including receipt of Tdap in the past 10 years (Method 1) was 20.7% for adults aged >19 years, 25.2% for adults aged 19–59 years, 8.1% for adults aged 60–64 years, and 8.2% for adults aged >65 years. Vaccination coverage for the AIS measure excluding influenza vaccination and including receipt of Td or Tdap in the past 10 years (Method 2) was 51.4% for adults aged >19 years, 63.0% for adults aged 19–59 years, 15.8% for adults aged 60–64 years, and 8.2% for adults aged >65 years (Table 3).

Coverage with individual component vaccines is also shown in Table 3. Overall and for adults aged >19 years, component coverage was 43.3% for influenza received in the last 12 months, 61.6% for Td or Tdap received in the last 10 years, 23.1% for Tdap received in the past 10 years, 30.6% for herpes zoster ever received, and 63.6% for pneumococcal ever received.

DISCUSSION

The present findings highlight current gaps in national vaccine coverage with recommended adult vaccines and offer a single measure for assessing the success of overall adult vaccination efforts. From the AIS measure, most adults surveyed were missing one or more recommended vaccines, indicating the need to focus efforts to improve the overall vaccine delivery system for adults. As described here, estimates for age-appropriate composite immunization measures can be obtained using selfreported vaccination data, though there are challenges in constructing a measure that spans an adult's lifetime and establishing a national benchmark using self-reported data from a single source.

In this analysis, age-appropriate composites were tested based on age indications for selected vaccines. Results from this analysis varied based on the individual measure components. Composite estimates cannot exceed coverage for the measure component with the lowest coverage, which was Tdap in all age groups. Together with a composite measure, tracking individual coverage metrics in practice settings is needed to increase vaccination coverage and establish a national baseline for measuring progress on the AIS measure. Providers, payers, and health plans could use results from individual vaccination components of the AIS measure to facilitate targeted interventions, such as reminder-recall systems and other outreach[6]; these interventions are agnostic to individual vaccines and age groups and could therefore increase performance on the overall composite measure even if directed toward coverage with a specific vaccine.

These findings highlight current gaps in coverage in the overall composite and in individual metrics at the national level. Immunization coverage rates may increase for non-targeted vaccines or age groups as a result of efforts to increase AIS measure coverage. Composite measures for childhood vaccination have been widely adopted and incorporated into existing national performance measurement sets, such as HEDIS®[11] and Healthy People 2020,[4] to monitor and support activities to increase immunization coverage levels in these age groups. Incorporating an adult immunization composite measure, such as the AIS measure discussed here, can serve a similar purpose, and provides a broader view of the overall vaccine delivery system for adults by offering a single estimate of all adults who are not fully protected by recommended vaccines.

There are unique aspects of influenza vaccination to consider when constructing composite vaccination measures. Influenza vaccine is widely available in many non-clinical settings, and adults often see multiple healthcare providers.[12–15] Both of these factors increase the burden of capturing influenza vaccination data from scattered records; increased use of immunization information systems for adult vaccinations could mitigate this concern. In addition, influenza vaccine is given annually and is only available at certain times of year, so measurement time periods may heavily influence composite estimates. Coverage with composites including influenza vaccine would be artificially low when influenza vaccine is not being administered, unless adjustments are made to take the seasonal nature of influenza vaccination into account. Finally, influenza vaccination coverage among older adults is relatively high due to the historic focus on vaccination of adults aged 65 years and older,

whereas coverage is lower in younger adults, underscoring the importance of age-stratified composites.

These analyses demonstrate substantially different results, based on whether the composite metric is restricted to Tdap vaccination or includes any tetanus toxoid-containing vaccine. For non-pregnant adults, ACIP recommends a single lifetime dose of Tdap in place of one decennial Td booster. Only 23.1% of adults aged 19 years and older reported receipt of a Tdap vaccine in the past 10 years, placing a low upper limit on achievable measure estimates when Tdap is included.

The Tdap estimates are subject to considerable uncertainty. Respondents who reported tetanus vaccination but were unable to say whether Td or Tdap was used (54.3%) were excluded from estimations of Tdap coverage, creating a potential for bias. Tdap is a once-in-a-lifetime vaccine for non-pregnant adults, but NHIS only captures data on Td-containing vaccines received in the past 10 years. Tdap given more than 10 years ago is not captured in the NHIS, which could lead to underestimation of actual vaccination coverage. The need for a lifetime “look-back period” for composite measures including Tdap vaccine should be considered when identifying data sources to be used for assessment in clinical practice settings.

Measuring pneumococcal vaccination over time for people aged 65 years and older presents unique challenges. The ACIP currently recommends routine use of 13-valent pneumococcal conjugate vaccine (PCV13) in series with 23-valent pneumococcal polysaccharide vaccine (PPSV23) among adults aged 65 years and older,[16,17] replacing the previous recommendation that adults aged 65 years and older should be vaccinated with a single dose of PPSV23.[16] The recommended intervals between PCV13 and PPSV23 differ by age, risk group,[18] and timing of doses received.[17] This complex recommendation has implications for measurement given the challenges of ascertaining an adequate medical history of PPSV23 receipt in adults aged 65 years and older.

Although the NHIS-based pneumococcal estimate does not distinguish PCV13 from PPSV23, the estimated coverage (63.6%) for any pneumococcal vaccine administered provides an overall benchmark in assessing the current immunization gap for adults aged 65 years and older. Beginning in 2018, NHIS will include a question on the number of doses of pneumococcal vaccine ever received.[19] Even though this will not allow ascertainment of the type of pneumococcal vaccine received, it will allow better monitoring of ACIP recommendations for individuals aged 65 years and older, because most people who report receipt of at least two doses of pneumococcal vaccine will be in the target group for the PCV13 –PPSV23 series. In addition, Medicare claims data can serve as an additional data source in determining the receipt of PCV13 and PPSV23 for future refinement of the measure.[20] Setting up mechanisms or algorithms in practice settings to track up-to-date pneumococcal vaccination status for practice-based composite measurement will be challenging. Consideration will need to be given to documenting vaccination history, identifying the presence of medical conditions indicating the need for PCV13 and more than a single dose of PPSV23 in people under 65 years, as well as the order and timing of the type of vaccine received.

Limitations

As with all survey data, there are limitations to use of the NHIS for target setting and monitoring. First, the NHIS sample excludes people in the military and those residing in institutions, which might result in under- or overestimation of vaccination coverage levels. Second, the response rate for the 2015 NHIS was 55.2%. Nonresponse bias can result if respondents and nonrespondents differ in their vaccination rates. Third, reported vaccination status was not validated by medical records; self-report of vaccination might be subject to recall bias. Young adults, particularly, might not be able to recall accurately vaccines received as infants or adolescents. However, adult self-reported vaccination status has been shown to 70% or more sensitive in one or more studies for influenza, pneumococcal, tetanus-toxoid–containing, and herpes zoster vaccines, and 70% or more specific in one or more studies for all except tetanus vaccination.[21–24] Fourth, as noted, Tdap estimates are subject to considerable uncertainty due to exclusions from estimations of Tdap coverage. Fifth, age at vaccination is not known for adults reported having ever received pneumococcal and herpes zoster vaccines, so it is not clear how to interpret age-specific findings among older adults. Finally, the NHIS does not distinguish between types of pneumococcal vaccine (polysaccharide versus conjugate), making it difficult to monitor adherence to current ACIP recommendations indicating both types of vaccine for adults aged 65 years and older.[1,2,16]

Composite measures also have intrinsic limitations regardless of data source. For example, the larger size of the aged 19–59 years group relative to the older age groups influences the overall composite estimate for adults aged 19 years and older, masking lower composite estimates in the older age groups because of the greater number of vaccines recommended. This limitation is mitigated by presenting measure data by age group; age groups were selected to reflect age ranges for routine vaccine recommendations. Further, because the AIS measure comprises different components by age group, age standardization would be needed to compare estimates across vaccination delivery settings with different patient age distributions. Estimates from any AIS measure will be no higher than coverage for the component metric with the lowest coverage.

CONCLUSIONS

A national benchmark could help monitor adherence to adult immunization standards of care as outlined in ACIP recommendations, and encourage implementation of the National Vaccine Advisory Committee’s Standards for Adult Immunization Practice, which call on healthcare professionals to ensure their adult patients are fully immunized.[25] Despite its limitations, the NHIS, which uses nationally representative samples to ascertain vaccination status, could be used to establish a national benchmark. Although analysis and action based on individual components of the composite are essential to drive up coverage by addressing the challenges to uptake for each individual vaccine, a view of the overall immunization delivery system is critical to ensuring coverage for all routinely recommended ACIP vaccines. A composite metric to monitor age-appropriate vaccination of adults provides this view through a single construct that indicates how many adults need at least one recommended vaccination.[26]

Ideally, multiple data sources would be useful in identifying national benchmarks for an adult immunization composite measure. Other data sources, such as those being used in the testing of the AIS—electronic clinical data including administrative claims, medical records, case management systems, and registries—will be necessary to fully optimize the use of this measure. Current HEDIS® testing will identify the best measure specifications and data sources; multiple sources will likely be needed to maximize measure validity and feasibility. Appropriate targets for achievement will vary based on the measure specifications and data source. This report illustrates that the AIS measure can offer additional, streamlined means to promote and incentivize the provision of high-quality, standards-based care to include all recommended vaccines.

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Table 1.

Definitions of AIS Measure and Methods Used in Analysis, NHIS

	Vaccines included		
Age group, years	**Method 1**	**Method 2**	**Optional**
≥19	Proportion of adults who received all vaccines recommended for their age group including Tdap	Proportion of adults who received all vaccines recommended for their age group including any Td-containing vaccine	Influenza (past 12 months)
19–59	Tdap vaccine in the past 10 years	Td-containing vaccine in the past 10 years	Influenza (past 12 months)
60–64	Tdap vaccine in the past 10 years AND Herpes zoster	Td-containing vaccine in the past 10 years AND Herpes zoster	Influenza (past 12 months)
≥65	Tdap vaccine in the past 10 years AND Herpes zoster AND PCV13 OR PPSV23	Td-containing vaccine in the past 10 years AND herpes zoster AND PCV13 OR PPSV23	Influenza (past 12 months)

AIS, adult immunization status; NHIS, National Health Interview Survey; PCV13, 13-valent pneumococcal conjugate vaccine; PPSV23, 23-valent pneumococcal polysaccharide vaccine; Td, tetanus and diphtheria toxoids; Tdap, tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine.

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Table 2.

Percent of Respondents Excluded in Vaccination Coverage Estimation Using Age-Appropriate AIS Measure,[a] NHIS 2015

	Age group, %			
Composite measure	**≥19 years (*n*[b]=33,348)**	**19–59 years (*n*[b]=22,168)**	**60–64 years (*n*[b]=2,802)**	**≥65 years (*n*[b]=8,378)**
Includes influenza				
Method 1: Tdap (past 10 years)	39.2	38.7	40.9	40.1
Method 2: Td or Tdap (past 10 years)	6.5	5.7	5.8	9.0
Does not include influenza				
Method 1: Tdap (past 10 years)	39.2	38.7	40.9	40.1
Method 2: Td or Tdap (past 10 years)	6.5	5.6	5.7	9.0

[a]Percent excluded in calculating estimates using data from the 2015 NHIS for age-based composite adult vaccination measures for tetanus toxoid-containing, pneumococcal, herpes zoster, and influenza vaccines. Composite measures “including influenza vaccination” indicates that individuals must have received influenza vaccination in the past 12 months to be considered vaccinated as part of the composite measure.

[b]Total unweighted sample size for the overall age group. Individuals who did not answer vaccination questions were excluded from the analysis. AIS, adult immunization status; NHIS, National Health Interview Survey; Td, tetanus and diphtheria toxoids; Tdap, tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine.

Table 3.

Vaccination Coverage Estimates Using Age-Appropriate AIS Measure and Individual Component Measures,[a] NHIS 2015

	Age group, years, % (95% CI)			
Measure	**≥19 (*n*[b]=33,348)**	**19–59 (*n*[b]=22,168)**	**60–64 (*n*[b]=2,802)**	**≥65 years (*n*[b]=8,378)**
Composite measure				
Includes influenza				
Method 1: Tdap (past 10 years)	11.9 (11.3, 12.6)[c]	13.7 (12.8, 14.6)[d]	6.3 (5.1, 7.8)[e]	7.4 (6.4, 8.4)[f]
Method 2: Td or Tdap (past 10 years)	23.4 (22.7, 24.1)[g]	25.7 (24.8, 26.5)[h]	12.6 (10.9, 14.4)[i]	19.2 (17.9, 20.5)[j]
Does not include influenza				
Method 1: Tdap (past 10 years)	20.7 (19.7, 21.7)[k]	25.2 (24.1, 26.5)[l]	8.1 (6.6, 9.9)[m]	8.2 (7.2, 9.3)[n]
Method 2: Td or Tdap (past 10 years)	51.4 (50.5, 52.3)[o]	63.0 (62.0, 64.0)[p]	15.8 (14.1, 17.7)[q]	8.2 (7.2, 9.3)[r]
Component measures				
Influenza (past 12 months)[s]	43.3 (42.5, 44.0)	34.9 (34.0, 35.8)	56.0 (53.4, 58.6)	69.0 (67.7, 70.3)
Td or Tdap (past 10 years)[t]	61.6 (60.7, 62.5)	63.0 (62.0, 64.0)	60.5 (58.1, 62.9)	56.9 (55.3, 58.4)
Tdap (past 10years)[u]	23.1 (22.1, 24.2)	25.2 (24.1, 26.5)	19.7 (17.4, 22.3)	16.5 (15.0, 18.1)
Herpes zoster (ever)[v]	30.6 (29.3, 31.9)[w]	–	21.7 (19.5, 24.0)	34.2 (32.7, 35.7)
Pneumococcal (ever)[x]	63.6 (62.1, 65.1)[y]	–	–	63.6 (62.1, 65.1)

[a] Estimates using data from the 2015 NHIS for age-based composite adult vaccination measures for tetanus toxoid-containing, pneumococcal, herpes zoster, and influenza vaccines. Composite measures "including influenza vaccination" indicates that persons must have received influenza vaccination in the past 12 months to be considered vaccinated as part of the composite measure.

[b] Total unweighted sample size for the overall age group. The denominators for each point estimate will vary since individuals who did not answer vaccination questions were excluded from the analysis.

[c] A composite estimate of overall vaccination coverage among adults aged ≥19 years who have received the selected vaccines that are recommended for their age group: adults aged 19–59 years who have received influenza vaccine (past 12 months) AND Tdap (past 10 years); adults aged 60–64 years who have received influenza vaccine (past 12 months) AND Tdap (past 10 years) AND who have received zoster vaccine (ever); and, adults aged ≥65 years who have received influenza vaccine (past 12 months) AND Tdap (past 10 years) AND who have received zoster vaccine (ever) AND who have received pneumococcal vaccine (ever). The NHIS does not include information on persons who have received one dose of Tdap ever. NHIS composite estimates includingTdap, past 10 years, might differ from actual practice-based composite measures includingTdap based on "ever receipt" of Tdap in accordance with ACIP policy (www.cdc.gov/mmwr/preview/mmwrhtml/rr5517a1.htm).

[d] individuals aged 19–59 years who have received influenza vaccine (past 12 months) AND Tdap (past 10 years).

[e] individuals aged 60–64 years who have received influenza vaccine (past 12 months) AND Tdap (past 10 years) AND who have received zoster vaccine (ever).

[f] Adults aged ≥65 years who have received influenza vaccine (past 12 months) AND Tdap (past 10 years) AND who have received zoster vaccine (ever) AND who have received pneumococcal vaccine (ever).

[g] A composite estimate of overall vaccination coverage among adults aged ≥19 years who have received the selected vaccines that are recommended for their age group: adults aged 19–59 years who have received influenza vaccine (past 12 months) ANDTd or Tdap (past 10 years); individuals aged 60–64 years who have received influenza vaccine (past 12 months) AND Td or Tdap (past 10 years) AND who have received zoster vaccine (ever); and, adults aged ≥65 years who have received influenza vaccine (past 12 months) AND Td or Tdap (past 10 years) AND who have received zoster vaccine (ever) AND who have received pneumococcal vaccine (ever).

[h] individuals aged 19–59 years who have received influenza vaccine (past 12 months) AND Td or Tdap (past 10 years).

[i] individuals aged 60–64 years who have received influenza vaccine (past 12 months) AND Td or Tdap (past 10 years) AND who have received zoster vaccine (ever).

[j] Adults aged ≥65 years who have received influenza vaccine (past 12 months) AND Td or Tdap (past 10 years) AND who have received zoster vaccine (ever) AND who have received pneumococcal vaccine (ever).

[k] A composite estimate of overall vaccination coverage among individuals aged ≥19 years who have received the selected non-influenza vaccines that are recommended for their age group: individuals aged 19–59 years who have received Tdap (past 10 years); adults aged 60–64 years who have received Tdap (past 10 years) AND who have received zoster vaccine (ever); and, adults aged ≥65 years who have received Tdap (past 10 years) AND who have received zoster vaccine (ever) AND who have received pneumococcal vaccine (ever).

[l] Individuals aged 19–59 years who have received Tdap (past 10 years).

[m] individuals aged 60–64 years who have received Tdap (past 10 years) AND who have received zoster vaccine (ever).

[n] Individuals aged ≥65 years who have received Tdap (past 10 years) AND who have received zoster vaccine (ever) AND who have received pneumococcal vaccine (ever).

[o] A composite estimate of overall vaccination coverage among persons aged ≥19 years who have received the selected non-influenza vaccines which are recommended for their age group: adults aged 19–59 years who have received Td or Tdap (past 10 years); adults aged 60–64 years who have received Td or Tdap (past 10 years) AND who have received zoster vaccine (ever); and, adults aged ≥65 years who have received Td or Tdap (past 10 years) AND who have received zoster vaccine (ever) AND who have received pneumococcal vaccine (ever).

[p] individuals aged 19–59 years who have received Td orTdap (past 10 years).

[q] individuals aged 60–64 years who have received Td or Tdap (past 10 years) AND who have received zoster vaccine (ever).

[r] Individuals aged ≥65 years who have received Td orTdap (past 10 years) AND who have received zoster vaccine (ever) AND who have received pneumococcal vaccine (ever).

[s] Respondents were asked if they received an influenza shot or nasal spray in the past 12 months.

[t] Respondents were asked if they had received a tetanus shot in the past 10 years. Vaccinated respondents included adults who received Td during the past 10 years orTdap during 2005–2015.

[u] Respondents who had received a tetanus shot in the past 10 years were asked if their most recent shot was given in 2005 or later. Respondents who had received a tetanus shot since 2005 were asked if they were told that their most recent tetanus shot included the pertussis or whooping cough vaccine. Among 33,348 respondents aged ≥19 years, those without a “yes” or “no” classification for tetanus vaccination status within the preceding 10 years (n=1,907 [5.7%]), for tetanus vaccination status during 2005–2015 (n=591 [1.7%]), or those who reported tetanus vaccination during 2005–2015, but were not told vaccine type by the provider (n=8,408 [25.2%]), did not know vaccine type (Td or Tdap) (n=2,031 [6.1%]), or refused to answer or for whom data were not obtained (n=5 [0.01%]) were excluded, yielding a sample of 20,406 respondents aged ≥19 years for whom Tdap vaccination status could be assessed. In February 2012, ACIP recommended Tdap vaccination for all adults aged ≥19 years, including adults aged ≥65 years.

[v] Respondents were asked if they had ever received a shingles vaccine.

[w] Zoster vaccination coverage among adults aged ≥60 years.

[x] Respondents were asked if they had ever had a pneumonia shot. There were no questions in the 2015 NHIS to ascertain pneumococcal vaccination by type of vaccine (PPSV23 versus PCV13).

[y] Pneumococcal vaccination coverage among adults aged ≥65 years.

AIS, adult immunization status; NHIS, National Health Interview Survey; PCV13, 13-valent pneumococcal conjugate vaccine; PPSV23, 23-valent pneumococcal polysaccharide vaccine; Td, tetanus and diphtheria toxoids; Tdap, tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine.