Major Article

The association between history of screening for cancer and receipt of an annual flu vaccination: Are there reinforcing effects of prevention seeking?

S. Cristina Oancea MS, PhD *, Ian W. Watson MURP, MPH

Master of Public Health Program, Department of Population Health, School of Medicine and Health Sciences, University of North Dakota, Grand Forks, ND

Background: Receipt of an annual flu vaccination (AFV) is a preventative health measure that reduces the risk of infection with the flu. Screening for cancer (SC) is another recommended preventative health measure. The current study hypothesizes that people who have previously obtained a cancer screening are motivated to receive other preventative health measures.

Methods: Testing the association between a history of SC and receipt of an AFV used data from the 2016 Behavioral Risk Factor Surveillance System survey. The association was investigated using weighted and adjusted multivariable logistic regression models on multiple age-based groups chosen according to cancer screening recommendations.

Results: The odds of individuals with a history of SC receiving an AFV were significantly greater in women screened for colorectal cancer, breast cancer, and colorectal cancer, and men screened for colorectal cancer, when compared with those without a history of SC after adjusting for confounders of interest. It is notable that no association was found between screening for cervical cancer and the receipt of AFV for women aged 30-65 years (odds ratio: 1.06; 95% confidence interval: 0.92, 1.21), and 50-65 years (odds ratio: 1.14; 95% confidence interval: 0.93, 1.40).

Conclusions: More research is necessary to understand why cervical cancer screenings are not associated with receipt of an AFV.

© 2019 Association for Professionals in Infection Control and Epidemiology, Inc. Published by Elsevier Inc. All rights reserved.

Seasonal influenza (flu) is an acute viral respiratory disease that affects millions of people each year throughout the world.[1] Receipt of an annual flu vaccination (AFV) is currently the best method to prevent contracting the virus.[1,2] Receiving an AFV is imperative for individuals who are at greater risk for experiencing health-related complications from the flu. This includes: all children aged 6-59 months; all individuals aged ≥50 years; people with chronic pulmonary or cardiovascular disease; renal, hepatic, neurologic, hematologic, or metabolic disorders; people who are immunocompromised;

pregnant women; children aged 6 months through 18 years receiving aspirin- or salicylate-containing medications; residents of nursing homes and long-term care facilities; and individuals with a body mass index ≥40.[2,3] Therefore, the Advisory Committee on Immunization Practices recommends an AFV for all individuals aged ≥6 months who do not have a known contraindication to the vaccine.[2,3]

The number of individuals affected by the flu each season—from October to May[2-4]—varies. It is estimated that from 2010-2016, the incidence of flu in the United States was approximately 8%.[5] The 2016-2017 flu season saw an estimated 30.9 million people fall ill, 14.5 million doctor visits, and 600,000 hospitalizations,[4] and during the 2017-2018 season approximately 80,000 deaths,[6] all owing to the flu or its complications.

However, vaccination programs have been able to reduce the disease burden of flu. Vaccination has been associated with reducing the number of intensive care unit admissions,[6-8] days spent in the hospital,[7,8] and mortality[8,9] due to flu and flu-related complications. During the 2016-2017 season, flu vaccinations prevented 5.29 million illnesses, 2.64 million medical visits, 84,700 hospitalizations, and between 1,588

and 4,562 deaths.[4] If the United States was able to raise the AFV rate to 70%—the Healthy People 2020 goal[10]—an additional 1.89 million illnesses, 822,000 medical visits, and 17,300 hospitalizations could be prevented.[4]

The cumulative economic cost to the United States is significant. In one estimate, on average 610,660 potential life-years and 44.0 million days of productivity are lost annually.[11] This results in an estimated total annual economic burden to the United States of $87.1 billion (95% confidence interval [CI]: $47.2 billion, $149.5 billion).[11]

KNOWLEDGE GAP

Given the benefits of AFV, it is concerning that vaccination rates in the United States have remained low. Between 2009 and 2017, <50% of US adults received an AFV.[10,12]

Prior research has explored possible causes of these low vaccination rates such as personal attitudes toward vaccinations,[13,14] being at high risk of health-related complications if infected,[1] geographic constraints,[12,15] location of vaccine administration,[15] and ethnic/racial disparities.[16]

Another avenue of research has been the association between AFV and other preventative health measures.[17] However, in much of the literature, vaccinations and screenings are independent variables not in association with each other.[9,18] Only one study has looked specifically at the association between the receipt of a cancer screening (mammography) and AFV, but only among Medicare beneficiaries.[19]

The current study hypothesized that people who have received a screening for cancer (SC) are motivated to seek out other preventive health measures such as an AFV. The current study seeks to determine if there is an association between an individual's history of SC and their receipt of an AFV using a nationally representative sample of US adults.

METHODS

Dataset

The data used for this study came from the 2016 Behavioral Risk Factor Surveillance System (BRFSS) survey.[20] The BRFSS is an annual population-based, cross-sectional, telephone survey of noninstitutionalized adults (aged ≥18 years) administered in 54 US states and territories. It is the largest continuously conducted health survey in the world with 486,303 respondents in 2016.[20] Self-reported data are collected on health risk behaviors, chronic diseases, access to care, and the use of preventive health services for noninstitutionalized adults aged ≥18 years.[20] The BRFSS 2016 survey data used in this study is publicly available and de-identified.

The BRFSS is a telephone-based survey using both landline and cell phone numbers. It uses iterative proportional fitting (also known as "raking") that improves the sample's ability to match a state or territory's actual sociodemographic characteristics.[21] The 50 states used a disproportionate stratified sample design for their landline surveys, whereas 4 territories used a simple random-sample design.[21] Cell phone surveys were based on random samples from the Telecordia database of exchanges.[21] Although all states and territories start with a single sampling stratum, many states choose to disproportionately sample populations of interest that can be defined as existing in a particular sub-state area.[21]

Exposure of interest: A history of SC

The BRFSS 2016 contained questions relating to breast, cervical, prostate, and colorectal cancer screenings.[20] A history of SC was determined by a respondent answering "Yes" to one or more of the following sex, age, cancer screening type, and question combinations. Women aged 40-65 years[22,23] who answered yes to, "Have you ever had a mammogram?" were considered to have a history of breast cancer screening. Women aged 30-65 years[22,23] who answered yes to either of the following, "Have you ever had a Pap (Papanicolaou) test?," or "Have you ever had an HPV (human papillomavirus) test?" were considered to have a history of cervical cancer screening. Men aged 50-70 years[22,23] who answered yes to, "Have you ever had a PSA (prostate-specific antigen) test?" were considered to have a history of prostate cancer screening. Finally, both men and women aged 50-75 years[22,23] were considered to have a history of colorectal cancer screening if they answered yes to either, "A blood stool test is a test that may use a special kit at home to determine whether the stool contains blood. Have you ever had this test using a home kit?" or "Sigmoidoscopy and colonoscopy are exams in which a tube is inserted in the rectum to view the colon for signs of cancer or other health problems. Have you ever had either of these exams?"

Outcome of interest: The receipt of influenza vaccination/flu shot

The receipt of flu-vaccination was assessed if the respondents answered with "Yes" the following question "There are two ways to get the flu vaccine, one is a shot in the arm and the other is a spray, mist, or drop in the nose called FluMist (MedImmune, Gaithersburg, MD). During the past 12 months, have you had either a flu shot or a flu vaccine that was sprayed in your nose?"[20] If necessary, surveyors could prompt respondents that the Fluzone Intradermal vaccine (Sanofi Pasteur, Lyon, France) is also considered a flu shot.[20] Individuals who did not answer this question were excluded from the study.

Covariates of interest

Covariates used in the model were chosen based on previous research showing they were risk factors associated with both AFV and SC. The variables chosen were: age[12-14,24] (in years), sex[12,13,24] (female, male), race[12,13] (white, non-Hispanic; black, non-Hispanic; other), marital status[12,13] (married, or a member of an unmarried couple; separated, divorced, or widowed; never married), education[12,24] (less than high school graduate; high school graduate; some college or technical school; college graduate or more), employment status[13] (employed for wages or self-employed; homemaker or student or retired; out of work; unable to work), health insurance[13,24] (purchased through employer/union, purchased yourself or through family, Medicare, other), and income[13,24] (<$15,000; $15,000 to <$25,000; $25,000 to <$35,000; $35,000 to <$50,000; $50,000 or more).

Final study sample

There were 486,303 eligible respondents in the BRFSS 2016. After review, 106,030 individuals were excluded because of missing data, for a final sample size of 380,273. Figure 1 is a cohort diagram of the current study.

Statistical analyses

Ten weighted and adjusted multivariable logistic regression models—based on sex, age, and type of SC—were used to examine the association between SC and AFV. The first 5 models were based on sex, type of SC, and recommended screening age range. Table 1 contains the weighted prevalence and 95% CIs for the categorical and ordinal variables in these models. Subsequently, multivariable logistic regression was performed adjusting for the 8 confounders of interest: age, sex, race, marital status, education, employment, health insurance, and income. Table 2 shows the regression results.

The wide variation in recommended SC age ranges in the first 5 models had a potential to affect any results. To mitigate this, a common age range across all 4 SC types (ages 50-65 years) was found.
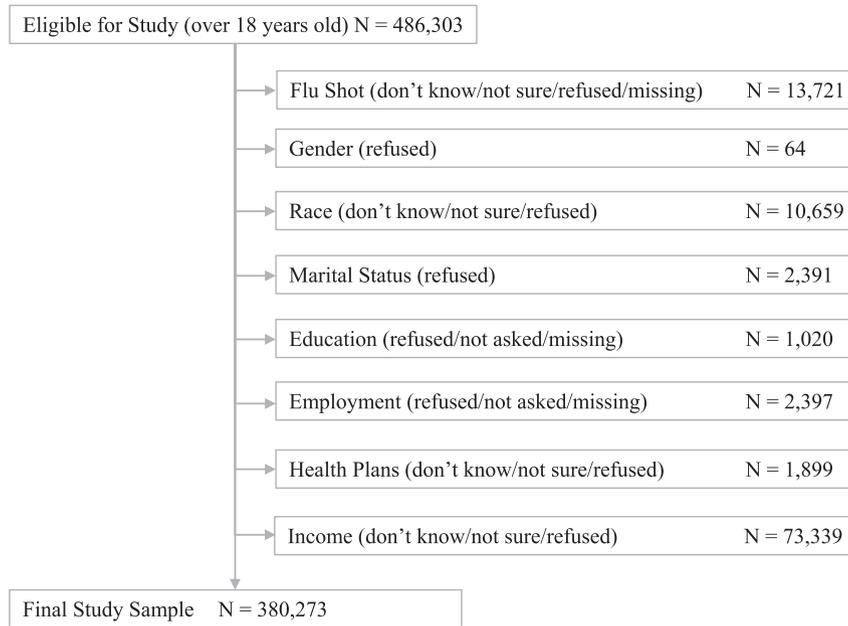
Fig 1. Cohort diagram of final study sample size.

Table 1
Descriptive statistics: Screening guideline-based age ranges for all screening types

Sex	Cancer screening type	Age range (years)	Final sample (unweighted N)	Received SC (unweighted N)	Received AFV (unweighted N)	% of those without an AFV who had an SC Weighted % (95% CI)	% of those with an AFV who had an SC Weighted % (95% CI)
Female	Breast	40-65	100,804	91,454	44,275	85.7% (85.1%, 86.3%)	92.4% (91.8%, 93.0%)
Female	Cervical	30-65	124,423	119,956	53,019	95.3% (94.9%, 95.6%)	96.1% (95.7%, 96.5%)
Male	Prostate	50-70	77,234	47,072	34,562	50.8% (49.8%, 51.8%)	67.0% (66.0%, 68.1%)
Female	Colorectal	50-75	114,902	90,725	57,964	68.5% (67.7%, 69.4%)	83.4% (82.7%, 84.1%)
Male	Colorectal	50-75	90,782	68,817	42,812	62.6% (61.7%, 63.6%)	82.5% (81.7%, 83.3%)

AFV, annual flu vaccine; *CI*, confidence interval; *SC*, screening for cancer.

Table 2
The weighted and adjusted association between screening for cancer and the receipt of annual flu vaccination: Varying age ranges based on recommended guidelines for all cancer screening types

Sex	Cancer screening	Age group (years)	AOR (95% CI)	*P* value
Female	Breast	40-65	**1.58** (1.43, 1.74)	<.0001
Female	Cervical	30-65	1.06 (0.92, 1.21)	.4392
Male	Prostate	50-70	**1.54** (1.44, 1.65)	<.0001
Female	Colorectal	50-75	**1.89** (1.77, 2.03)	<.0001
Male	Colorectal	50-75	**2.08** (1.93, 2.23)	<.0001

Bold text indicates statistical significance.
AOR; the odds of receiving an annual flu vaccination if the individual had a certain type of cancer screening versus individuals without that particular cancer screen after adjusting for all variables in the model: age, sex, race, marital status, education, employment status, health insurance, and income.
AOR, adjusted odds ratio; *CI*, confidence interval.

The decision was made to repeat our analysis on this common age range. Table 3 shows the weighted prevalence and 95% CIs for the categorical and ordinal variables in these models. Similarly, the same adjusted multivariable logistic regression was performed, with the results shown on Table 4.

All the statistical analyses were performed using SAS Version 9.4 (SAS Institute, Cary, NC). To account for the complex sampling design, the authors used the following SAS survey procedures: PROC SURVEYMEANS, PROC SUVEYFREQ, and PROC SURVEYLOGISTIC. The statistical significance level was set at *P* <.05.

RESULTS

Descriptive statistics

Table 1 shows the descriptive statistics for the first 5 models. The number of respondents in each age and SC group ranged from 77,234-124,423. The prevalence of cancer screening was highest for women aged 30-65 years screened for cervical cancer at 95.3% (95% CI: 94.9%, 95.6%) and lowest for men aged 50-70 years being screened for prostate cancer at 50.8% (95% CI: 49.8%, 51.8%).

The descriptive statistics for the next 5 models corresponding to the common age group of 50-65 years follow a similar pattern (Table 3). The number of respondents in each age and SC group ranged from 58,165-72,897. The prevalence of cancer screening was highest for women aged 50-65 years screened for cervical cancer at 95.7% (95% CI: 95.3%, 96.2%) and lowest for men aged 50-65 years being screened for prostate cancer at 48.1% (95% CI: 47.1%, 49.2%).

Analyses

Among women aged 40-65 years (Table 2), the weighted and adjusted odds of receiving flu vaccination were 58% significantly higher (adjusted odds ratio [AOR]: 1.58; 95% CI: 1.43, 1.74) if they were screened for breast cancer compared with their counterparts who were not screened for breast cancer. Within this model, after keeping all the other variables constant, the weighted and adjusted

Table 3
Descriptive statistics: Common age range 50-65 years for all screening types

Sex	Cancer screening type	Age range (years)	Final sample (unweighted N)	Received SC (unweighted N)	Received AFV (unweighted N)	% of those without an AFV who had an SC Weighted % (95% CI)	% of those with an AFV who had an SC Weighted % (95% CI)
Female	Breast	50-65	72,897	69,082	33,685	92.6% (92.0%, 93.1%)	96.4% (95.9%, 96.9%)
Female	Cervical	50-65	72,897	70,489	33,685	95.7% (95.3%, 96.2%)	96.7% (96.2%, 97.1%)
Male	Prostate	50-65	58,165	32,684	23,681	48.1% (47.1%, 49.2%)	63.2% (61.9%, 64.4%)
Female	Colorectal	50-65	72,897	54,156	33,685	64.4% (63.4%, 65.5%)	79.3% (78.3%, 80.2%)
Male	Colorectal	50-65	58,165	40,628	23,681	58.3% (57.3%, 59.4%)	78.1% (76.9%, 79.2%)

AFV, annual flu vaccine; CI, confidence interval; SC, screening for cancer.

Table 4
The weighted and adjusted association between screening for cancer and the receipt of annual flu vaccination: Common age range 50-65 years for all cancer screening types

Sex	Cancer screening	Age group (years)	AOR (95% CI)	P value
Female	Breast	50-65	**1.80** (1.52, 2.13)	<.0001
Female	Cervical	50-65	1.14 (0.93, 1.40)	.2187
Male	Prostate	50-65	**1.54** (1.43, 1.65)	<.0001
Female	Colorectal	50-65	**1.84** (1.70, 1.98)	<.0001
Male	Colorectal	50-65	**2.07** (1.91, 2.25)	<.0001

Bold text indicates statistical significance.
AOR; the odds of receiving an annual flu vaccination if the individual had a certain type of cancer screening versus individuals without that particular cancer screen after adjusting for all variables in the model: age, sex, race, marital status, education, employment status, health insurance, and income.
AOR, adjusted odds ratio; CI, confidence interval.

odds of women aged 40-65 years without a health plan receiving an AFV were 47% significantly lower than those with a health plan (AOR: 0.53; 95% CI: 0.46, 0.60). Other variables with a significant negative association with the receipt of AFV included being black, having less than college education, and an income <$50,000 per year. Being unable to work had a significantly positive association with the receipt of AFV when compared to being employed for wages. When looking at women aged 50-65 years (Table 4), the odds of receiving the AFV, although significantly higher among those who received breast SC (AOR: 1.80; 95% CI: 1.52, 2.13) when compared with those who didn't receive this type of SC, were not significantly different from the women aged 40-65 years. Therefore, the exclusion of women aged 40-49 years from this last group did not change the findings significantly.

Of note is the fact that among women aged 30-65 years (Table 2), there was no weighted and adjusted association between screened for cervical cancer and receiving a flu vaccination (AOR: 1.06; 95% CI: 0.92, 1.21). Within this model, after keeping all the other variables constant, the adjusted odds of women aged 30-65 years without a health plan receiving an AFV were 47.4% significantly lower than those with a health plan (AOR: 0.53; 95% CI: 0.47, 0.59). Other variables with a significant negative association with the receipt of AFV included being black, having less than college education, and an income <$50,000 per year. Being unable to work had a significantly positive association with the receipt of AFV when compared to being employed for wages. When looking at women aged 50-65 years (Table 4), there was also no weighted and adjusted association between receiving a flu vaccination and screened for breast cancer (AOR: 1.14; 95% CI: 0.93, 1.40). Therefore, the exclusion of women aged 30-49 years from this last group did not change the findings significantly.

Among men aged 50-70 years (Table 2), the odds of receiving flu vaccination were 54% significantly higher (AOR: 1.54; 95% CI: 1.44, 1.65) if they were screened for prostate cancer compared with their counterparts who were not screened for prostate cancer. Within this model, after keeping all the other variables constant, the weighted and adjusted odds of men aged 50-70 years without a health plan

receiving an AFV were 59% significantly lower than those with a health plan (AOR: 0.41; 95% CI: 0.35, 0.47). Other variables with a significant negative association with the receipt of AFV included being black, being separated/divorced/widowed, and having less than college education. Being unable to work and being a homemaker/student/retired both had a significantly positive association with the receipt of AFV when compared to being employed for wages. When looking at men aged 50-65 years (Table 4), the odds of receiving the AFV, although significantly higher among those who received prostate SC (AOR: 1.54; 95% CI: 1.43, 1.65) when compared with those who didn't receive this type of SC, were not significantly different from the men aged 50-75 years. Therefore, the exclusion of men aged 66-75 years from this last group did not change the findings significantly.

Among women aged 50-75 years (Table 2), the odds of receiving flu vaccination were 89% significantly higher (AOR: 1.89; 95% CI: 1.77, 2.03) if they were screened for colorectal cancer compared with their counterparts who were not screened for colorectal cancer. Within this model, after keeping all the other variables constant, the weighted and adjusted odds of women aged 50-75 years without a health plan receiving an AFV were 41% significantly lower than those with a health plan (AOR: 0.59; 95% CI: 0.50, 0.70). Other variables with a significant negative association with the receipt of AFV included being black, having less than college education, and an income <$50,000 per year. Being unable to work had a significantly positive association with the receipt of AFV when compared to being employed for wages. When looking at women aged 50-65 years (Table 4), the odds of receiving the AFV, although significantly higher among those who received colorectal SC (AOR: 1.84; 95% CI: 1.70, 1.98) when compared with those who didn't receive this type of SC, were not significantly different from the women aged 50-75 years. Therefore, the exclusion of women aged 66-75 years from this last group did not change the findings significantly.

Among men aged 50-75 years (Table 2), the odds of receiving flu vaccination were 108% significantly higher (AOR: 2.08; 95% CI: 1.93, 2.23) if they were screened for colorectal cancer compared with their counterparts who were not screened for colorectal cancer. Within this model, after keeping all the other variables constant, the weighted and adjusted odds of men aged 50-75 years without a health plan receiving an AFV were 55% significantly lower than those with a health plan (AOR: 0.45; 95% CI: 0.39, 0.53). Other variables with a significant negative association with the receipt of AFV included being black, being separated/divorced/widowed, and having less than college education. Being unable to work and being a homemaker/student/retired both had a significantly positive association with the receipt of AFV when compared to being employed for wages. When looking at men aged 50-65 years (Table 4), the odds of receiving the AFV, although significantly higher among those who received colorectal SC (AOR: 2.07; 95% CI: 1.91, 2.25) when compared with those who didn't receive this type of SC, were not significantly different from the men aged 50-75 years. Therefore, the exclusion of men aged 66-75 years from this last group did not change the findings significantly.

DISCUSSION

Multiple factors were consistently associated with a decrease in the odds of receiving an AFV. Many of these corroborate the findings of earlier studies involving receipt of an AFV. In particular, the lack of a health plan is a barrier to obtaining an AFV.[12,24] Other factors in this study negatively associated with receipt of an AFV included: an education level less than a college graduate, being black, being female sex with an income <$50,000, being a woman not employed for wages, and being a man who is not married or in an unmarried couple.

Our findings revealed significant associations for most sex/age group/ SC type combinations, even after adjusting for potential confounders of interest. A history of colorectal SC significantly increased the odds of receiving an AFV by 84%-89% in women, and 107%-108% in men.

However, the finding of no association between screening for cervical cancer and the receipt of AFV for women aged 30-65 and 50-65 years, is of concern. This finding may be partly owing to the fact that individual screening visits occurred outside of the appropriate time window for AFV.[25]

The difference between the cervical SC results when compared with other SC types suggests there are variations between various SC regarding clinical visit procedures that affect whether individuals receive an AFV. One factor may be individuals hearing a recommendation for and offer of an AFV from a health care provider during colorectal SC visits.[14] In a recent study, 63.9% of individuals whose doctor recommended an AFV received the vaccine within the last 12 months, compared to only 16.0% for individuals who did not get a provider recommendation.[13] This suggests an opportunity to change clinical visit procedures to support providers educating and offering an AFV during a clinical encounter.

Limitations

The present research does have certain limitations. As the BRFSS is a cross-sectional survey, it is not possible to infer causality from any association. The cross-sectional nature also obscures the temporal relationship between SC and AFV. For example, the SC may have followed an AFV, or it may have occurred years earlier, complicating any association. The BRFSS's reliance on self-reported data may introduce recall, social desirability, or other similar biases,[4] particularly involving cancer screenings.[26] Also, it is not possible to tell how personal beliefs and attitudes regarding vaccinations may affect usage rates as the BRFSS 2016 did not include such questions.[13,14]

Strengths

The first strength of this article is that the large sample size obtained from the BRFSS 2016—380,273 individuals—strengthened the precision of our results. Next, our sample is nationally representative. In addition, previous research supports the use of self-reported flu vaccination rates in this type of analysis.[18]

CONCLUSIONS

This research revealed an association between a history of SC and receipt of an AFV. The odds of individuals with a history of screening for colorectal, breast and prostate cancer receiving an AFV were significantly greater than those respondents without a history of SC, after adjusting for potential confounders of interest. However, there was no association between SC and AFV for women screened for cervical cancer.

These results are of interest to clinicians looking to promote preventative health measures in their practices, and to policy makers working on encouraging higher AFV rates, especially for individuals receiving cervical cancer screenings. Given the substantial impact flu can have on both individuals and the nation, it is important to continue research for more ways to improve flu vaccination rates.

References

1. Uyeki TM. Influenza. Ann Intern Med 2017;167:ITC33-48.
2. Grohskopf LA, Sokolow LZ, Broder KR, Walter EB, Bresee JS, Fry AM, et al. Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices—United States, 2017−18 influenza season. Am J Transplant 2017;17:2970-82.
3. Grohskopf LA, Sokolow LZ, Broder KR, Walter EB, Fry AM, Jernigan DB. Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices—United States, 2018−19 influenza season. MMWR Recomm Rep 2018;67:1-20.
4. Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases. Estimated influenza illnesses, medical visits, and hospitalizations averted by vaccination in the United States 2016-2017 influenza season. Atlanta (GA): Centers for Disease Control and Prevention; 2018.
5. Tokars JI, Olsen SJ, Reed C. Seasonal incidence of symptomatic influenza in the United States. Clin Infect Dis 2018;66:1511-8.
6. National Foundation for Infectious Diseases. Influenza and pneumococcal disease can be serious, health officials urge vaccination; data shows importance of protection against influenza for everyone 6 months and older. Washington (DC): National Foundation for Infectious Diseases; 2018.
7. Thompson MG, Pierse N, Sue Huang Q, Prasad N, Duque J, Claire Newbern E, et al. Influenza vaccine effectiveness in preventing influenza-associated intensive care admissions and attenuating severe disease among adults in New Zealand 2012−2015. Vaccine 2018;36:5916-25.
8. Arriola C, Garg S, Anderson EJ, Ryan PA, George A, Zansky SM, et al. Influenza vaccination modifies disease severity among community-dwelling adults hospitalized with influenza. Clin Infect Dis 2017;65:1289-97.
9. Udell JA, Zawi R, Bhatt DL, Keshtkar-Jahromi M, Gaughran F, Phrommintikul A, et al. Association between influenza vaccination and cardiovascular outcomes in high-risk patients: a meta-analysis. JAMA 2013;310:1711-20.
10. US Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Healthy people 2020. Topics & objectives—immunization and infectious diseases. Washington (DC): Department of Health and Human Services; 2018.
11. Molinari NA, Ortega-Sanchez IR, Messonnier ML, Thompson WW, Wortley PM, Weintraub E, et al. The annual impact of seasonal influenza in the US: measuring disease burden and costs. Vaccine 2007;25:5086-96.
12. La EM, Trantham L, Kurosky SK, Odom D, Aris E, Hogea C. An analysis of factors associated with influenza, pneumococcal, Tdap, and herpes zoster vaccine uptake in the US adult population and corresponding inter-state variability. Hum Vaccin Immunother 2018;14:430-41.
13. Nowak GJ, Cacciatore MA, Len-Ríos ME. Understanding and increasing influenza vaccination acceptance: insights from a 2016 National Survey of U.S. adults. Int J Environ Res Public Health 2018;15:711.
14. Nowak GJ, Sheedy K, Bursey K, Smith TM, Basket M. Promoting influenza vaccination: insights from a qualitative meta-analysis of 14 years of influenza-related communications research by U.S. Centers for Disease Control and Prevention (CDC). Vaccine 2015;33:2741-56.
15. Bennett KJ, Pumkam C, Probst JC. Rural-urban differences in the location of influenza vaccine administration. Vaccine 2011;29:5970-7.
16. Almario CV, May FP, Maxwell AE, Ren W, Ponce NA, Spiegel BMR. Persistent racial and ethnic disparities in flu vaccination coverage: results from a population-based study. Am J Infect Control 2016;44:1004-9.
17. Centers for Disease Control and Prevention, Administration on Aging, Agency for Healthcare Research and Quality, Centers for Medicare and Medicaid Services. Enhancing the use of clinical preventive services among older adults (CPS): closing the gap. Washington (DC): AARP; 2011.
18. Mangtani P, Shah A, Roberts J A. Validation of influenza and pneumococcal vaccine status in adults based on self-report. Epidemiol Infect 2007;135:139-43.
19. Kang SK, Jiang M, Duszak R, Heller SL, Hughes DR, Moy L. Use of breast cancer screening and its association with later use of preventive services among Medicare beneficiaries. Radiology 2018;288:660-8.
20. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. 2016 BRFSS survey data and documentation. Atlanta (GA): Centers for Disease Control and Prevention; 2017.
21. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. Overview: BRFSS 2016. Atlanta (GA): Centers for Disease Control and Prevention; 2017.
22. Smith RA, Andrews KS, Brooks D, Fedewa SA, Manassaram-Baptiste D, Saslow D, et al. Cancer screening in the United States, 2017: a review of current American Cancer Society guidelines and current issues in cancer screening. CA Cancer J Clin 2017;67:100-21.
23. Lambert M. Cancer screening recommendations from the ACS: a summary of the 2017 guidelines. Am Fam Physician 2018;97:208-10.
24. Takayama M, Wetmore CM, Mokdad AH. Characteristics associated with the uptake of influenza vaccination among adults in the United States. Prev Med 2012;54:358-62.
25. Burger AE, Reither EN. Monitoring receipt of seasonal influenza vaccines with BRFSS and NHIS data: challenges and solutions. Vaccine 2014;32:3950-4.
26. Rauscher GH, Johnson TP, Cho YI, Walk JA. Accuracy of self-reported cancer-screening histories: a meta-analysis. Cancer Epidemiol Biomarkers Prev 2008;17:748-57.