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2009–2010 Seasonal Influenza Vaccination Coverage Among College Students From 8 Universities in North Carolina

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Abstract

Objective—We sought to describe the 2009–2010 seasonal influenza vaccine coverage of college students.

Participants—4090 college students from eight North Carolina universities participated in a confidential, web-based survey in October–November 2009.

Methods—Associations between self-reported 2009–2010 seasonal influenza vaccination and demographic characteristics, campus activities, parental education, and email usage were assessed by bivariate analyses and by a mixed-effects model adjusting for clustering by university.

Results—Overall, 20% of students (range 14%–30% by university) reported receiving 2009–2010 seasonal influenza vaccine. Being a freshman, attending a private university, having a college-educated parent, and participating in academic clubs/honor societies predicted receipt of influenza vaccine in the mixed-effects model.

Conclusions—The self-reported 2009–2010 influenza vaccine coverage was one-quarter of the 2020 Healthy People goal (80%) for healthy persons 18–64 years of age. College campuses have the opportunity to enhance influenza vaccine coverage among its diverse student populations.

Influenza virus commonly causes fever and respiratory illness in persons of all ages. Previous studies have reported outbreaks on college campuses with the reported prevalence of influenza-like illness ranging from 9% to 48% of college students.^{1–8} Most college students (63%) presenting with influenza-like illness to one student health center over any of three influenza seasons had laboratory-confirmed influenza.⁹ The influenza-attributable hospitalization rate is low among healthy persons 5–49 years. However, an increased recognition of the large outpatient burden of influenza has contributed to the universal influenza vaccine recommendation from the Advisory Council on Immunization Practices in the U.S since 2010.¹⁰

All persons 6 months through 24 years of age were recommended to receive the 2009–2010 monovalent H1N1 influenza vaccine, which became available in October 2009.¹¹ In

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contrast, the recommendation for the 2009–2010 seasonal influenza vaccine, which became available in late summer of 2009, included an age-based recommendation for persons 6 months through 18 years of age and a recommendation for all persons with high-risk conditions, such as cardiac disease, asthma, or pregnancy. The 2009–2010 recommendations specifically encouraged all students, particularly those residing in dormitories "...to receive vaccine to minimize morbidity and the disruption of routine activities during influenza epidemics."¹² Since then, the 2020 Healthy People goals were announced and included the goal of having 80% vaccine coverage of healthy persons 18 to 64 years of age against influenza and 90% coverage for those with high-risk medical conditions.¹³

During the spring and fall of 2009, there was intense media coverage about the novel influenza A H1N1 pandemic, including the significant impact that it had on college campuses.¹⁴ Yet, despite the known impact of influenza during seasonal and pandemic influenza seasons on college campuses, the only studies that have assessed influenza vaccine coverage on college campuses have been single-site studies.^{1–9} We sought to assess student self-reported influenza vaccine coverage across 8 college campuses on a confidential survey that was administered in late October and November 2009. Most seasonal influenza campaigns were in September and early October, whereas most monovalent H1N1 vaccine campaigns began in late October or November 2009. Since this survey was administered after seasonal influenza vaccine campaigns and in the midst of monovalent H1N1 influenza vaccine campaigns, we focused on the results of seasonal influenza vaccine coverage among college students.

Methods

Sample

In the last week of October and in November 2009, a stratified random sample of college students from 8 North Carolina universities (7 public and 1 private) were invited to participate in a confidential, self-administered web-based survey with a goal of approximately 112 completions per class year (freshmen, sophomore, junior and senior) resulting in an estimated 448 completions per school. To account for the variation in response frequency by class year, the estimated sample size was approximately 4000.

The Wake Forest School of Medicine Institutional Review Board approved this protocol. Because participation in the survey involved providing voluntary responses to a survey questionnaire and the questions were classified as no greater than minimal risk, the IRB approved a waiver of signed consent. Participating universities also reviewed and approved this protocol or established oversight agreements with Wake Forest School of Medicine Institutional Review Board.

Survey Instrument

The College Drinking Survey (CDS) was conducted as part of the Study to Prevent Alcohol Related Consequences (SPARC).¹⁵ This survey, which included items on student background and demographics, extra-curricular activities, attitudes and behaviors related to alcohol use, and other risky and protective behaviors, typically took students 17 to 24 minutes to complete. Relevant items for this analysis included demographic characteristics, residence on or off campus, whether either parent was a college graduate, campus activities in which the student participated, the frequency of use of email for work or school, the self-reported seasonal influenza vaccination status and if vaccinated, location where the seasonal influenza vaccine was obtained. We did not ascertain whether an unvaccinated student planned to get the vaccine later this season. Students who completed this web-based survey received a \$15 gift card.

Statistical Analysis

The primary outcome of interest was self-reported receipt of the 2009–2010 seasonal influenza vaccine. Descriptive statistics of the sample were calculated as percentages and frequencies of discrete outcomes. Variability by university was reported as a range of percentages. Prevalence of seasonal influenza vaccine was reported as percentage and frequency.

Two methods were used to estimate the potential for non-response bias. First, the observed proportion sampled by sex, freshman status and race/ethnicity were compared to the proportions reported in the University of North Carolina Statistical Abstracts.¹⁶ Second, we used the Continuum of Resistance model,^{17–19} which states that non-responders are similar to late responders. Non-response bias was assessed by examining the relationship between response time and the primary outcome, receipt of seasonal influenza vaccine, through simple linear regression. If there is no response bias, then mean responses of early and later responders are identical within statistical fluctuation, and thus the slope of the regression line should be zero. In this analysis, both linearity and the slope of the regression model were tested.

Generalized linear mixed effects modeling accounting for clustering by university was used to assess the relationship between the primary outcome, receipt of seasonal influenza vaccine, and demographic characteristics. Bivariate and multivariate analyses were performed generating odds ratios and 95% confidence intervals. Predictors in the multivariate mixed effects modeling were chosen based on literature, clinical judgment, and initial exploratory (bivariate) analyses. They included race/ethnicity (non-Hispanic white, African-American, Hispanic, Asian or Pacific Islander, other), sex, class year (freshman, sophomore, junior, senior, other), residence location (on/off campus), campus activities (yes/no involvement in student government association/politics, academic club/honor society or community service), frequency of using email (often/very often versus sometimes/seldom/never), and parental education (yes/no either parent a college graduate). Since residence on-campus was highly correlated with class year, class year but not residence on-campus was included in multivariate analysis to avoid multi-collinearity. Statistical significance was accepted at $p < 0.05$, with all analyses performed using SAS version 9.2.

Results

A total of 4090 college students completed the survey during the fielding period from the last week of October through November 2009. The average response per college was 511 students with a range of 346 to 663 students per university. The majority of respondents were non-Hispanic white, female, attended a public university, resided on-campus, and reported that at least one parent was a college graduate (Table 1). Respondents represented all school classes, and the vast majority reported using email often or very often for work or school. Multiple campus activities were reported, with community service and volunteer work being most common, followed by academic club or honor society, and then student government association or political activity.

The overall response rate for the CDS was 34.8%, which varied from 23.2% to 46.5% across the eight universities. Non-response bias was accessed 1) by comparing demographic characteristics of responders to those reported of the population, and 2) by comparing outcome statistic between early and late responders. The means and standard deviations of the difference between the study sample and the overall NC college population (according to the University of North Carolina Statistical Abstracts) were 4% (2%) for percent male, 6.3% (3%) for percent freshmen, and 4.5% (3%) for percent non-Hispanic white. A one-sample t-test revealed no significant differences between the demographic characteristics of the study

population and overall student population for freshman status, sex and race/ethnicity ($p>0.05$ for each), suggesting that non-response bias was minimal. Also, no relationship was found for receipt of seasonal influenza vaccine versus time to response on the survey as indicated by a small β -coefficient and low R-square value ($\beta=-0.0001$, $p=0.26$, adjusted $R^2=0.002$). Hence, there was no evidence of non-response bias from both demographics and outcome analyses.

The self-reported seasonal influenza vaccine coverage was 20% of students overall and ranged by university from 14% to 30% (Figure 1). More students reported receiving the seasonal influenza vaccine from a private physician or clinic than from student health services or another location on campus, such as a sorority or fraternity house (Table 2). A pharmacy was the third most common response, and few students reported receiving the vaccine from work, military, health department or another location.

Overall 91.9% of students reported using email often or very often with a range of 85.7% to 95.7%, and a similar proportion (91.4%) and range (86.4%–95.8%) for those who did not report receiving seasonal influenza vaccine. However, for students who reported receiving seasonal influenza vaccine, the proportion who reported using email often or very often was higher at 94.2% overall and with a wider range of variability (84.2% to 100%).

Overall, 54.8% of students resided on-campus, with self-reported variation of students by school ranging from 31.9% to 98.4%. Freshmen accounted for 43.5% of all students residing on-campus. Several factors predicted the receipt of the 2009–2010 seasonal influenza vaccine in bivariate analyses (Table 3). These included being a freshman, attending a private school, having a parent who graduated from college, participating in an academic club or honor society, participating in community service or volunteer work, and using email very often or often. Self-reported cigarette smoking, Hookah smoking, drinking alcohol, and binge drinking in the past 30 days were evaluated but did not demonstrate a difference in seasonal influenza vaccination status ($p>0.10$ for each) and thus were not included in multivariate analyses.

Factors that predicted receipt of the 2009–2010 seasonal influenza vaccine in bivariate and multivariate analyses were the same with two exceptions (Table 3). Both community and volunteer service and frequent email use were associated with increased odds of being vaccinated in bivariate analyses but neither of these increased odds was statistically significant in the multivariate analysis.

Comment

The Advisory Committee on Immunization Practices encouraged all college students, particularly those who reside in dormitories or have high-risk conditions, to receive the 2009–2010 seasonal influenza vaccine.¹² However, little is known about influenza vaccine coverage on college campuses. We found that 20% of college students reported receiving the 2009–2010 seasonal influenza vaccine during a year in which significant media attention focused on both seasonal and monovalent H1N1 influenza vaccines. The seasonal influenza vaccine coverage varied across these eight universities from 14% to 30% and was considerably less than half of the 2020 Healthy People goal of 80% influenza vaccine coverage for healthy persons 18 to 64 years of age and 90% for those with high-risk medical conditions.¹³

To our knowledge, this is the first multi-university study to assess seasonal influenza vaccine coverage and thus provides important reference data for comparative studies of US campuses. Additional strengths include that it is the first multi-university and largest study to identify predictors of receipt of seasonal influenza vaccine and the first study to report

seasonal influenza vaccine coverage in 2009–2010. Widespread media coverage of pandemic H1N1 influenza A and public health messages encouraging seasonal and monovalent H1N1 influenza vaccination occurred in the summer and fall of 2009 and resulted in widespread awareness of need for influenza vaccination. Further, seasonal influenza vaccination campaigns were essentially complete by October 2009, given the need for a second influenza vaccine campaign addressing pandemic H1N1 influenza that season. For this reason, few students were likely vaccinated after survey completion. Among U.S. children with private insurance healthcare claims for seasonal influenza vaccine, 77% received that vaccine prior to December 1, 2009 whereas the majority of children with monovalent H1N1 vaccine claims received it after December 1, 2009.²⁰

Our results are comparable to several studies in the literature. Merrill et al. and Uddin et al. both found that the self-reported influenza vaccination coverage in cross-sectional analyses of college students at one university in 2007–2008 was 12% and 17%, respectively.^{21,22} Both of these studies demonstrate that a minority of college students report receiving seasonal influenza vaccine, comparable to our range of 14% to 30% for seasonal influenza vaccine coverage by university in 2009–2010. Our results are also within the range of the results from the Behavioral Risk Factor Surveillance System and National 2009 H1N1 Flu Survey, which reported a mean of 28% and a median of 29% seasonal influenza vaccine coverage for persons 18–49 years not at high-risk. The results of this national survey by state ranged from 19% through 43% with coverage in North Carolina being 30% (95% confidence intervals of 26%–34%).²³ Further, Uddin et al. also found statistically significant higher vaccination coverage among students whose parents had graduated from college than those whose parents had not attended or graduated from college in both bivariate and multivariate analyses.²¹ The association between higher parental education and increased seasonal influenza vaccine coverage may reflect increased student knowledge about influenza vaccination and/or better health insurance. It is also possible that more college students with higher parental education had received influenza vaccine in the past than college students with lower parental education. Having been previously vaccinated with influenza vaccine is an independent predictor of receiving seasonal or monovalent H1N1 influenza vaccine among college students.^{21,24,25} Another possibility is that parents with higher education are more likely to have previously received the influenza vaccine than parents with lower education, and that the factors modulating the influenza vaccination status of parents have a similar impact on the students. This explanation would be consistent with previous studies showing an association between parental socioeconomic status and health behaviors and outcome of their children persisting into adulthood.^{26,27}

Vaccinated students most often received their seasonal influenza vaccine at a private physician's office or clinic, followed by student health services or another location on campus. A pharmacy was the third most common location, even though vaccine was available free of charge through each school's student health service. The prominence of private physician's office or clinic as the location of receiving the vaccine may reflect that students were more likely to receive the seasonal influenza vaccine after a specific recommendation from a health care provider, which is known to predict being vaccinated, than after more general recommendations from public health authorities or their university.²¹ Nonetheless, our findings are consistent with previous work showing that persons 18–49 years were the most likely age group to use non-traditional settings like pharmacies.²⁸ Our study found low vaccine coverage on college campuses, with approximately one-third of vaccinated students reporting that they received the influenza vaccine on campus. Colleges and universities should consider new or improved influenza vaccination strategies, such as vaccine administration at sporting events or campus-wide, 1-day intensive vaccine campaigns akin to the National Immunization Day in many countries.²⁹

Factors that predicted receipt of seasonal influenza vaccine in both bivariate and multivariate analyses included being a freshman, attending a private school, having parent who graduated from college, participating in academic club or honor society, and using email very often or often. Email usage and freshman status, which was associated with residence on campus, could influence exposure to university-based messages about the availability of seasonal influenza vaccine on campus and in the community. For example, announcements posted in residence halls or by resident advisers during residence hall meetings would target on campus students. Participating in an academic club or honor society may reflect higher class attendance and exposure to announcements posted in academic buildings. Alternatively, students who participate in an academic club or honor society may be more socially connected and thus more likely to hear about and be influenced by friends and acquaintances who received the vaccine. Christakis and Fowler demonstrated that the persons most proximal to the center of social networks were more likely to be infected earlier during an outbreak.³⁰ Further, Pastor-Sattoras and Vespignani showed that complex networks such as universities are less vulnerable to epidemics if persons with the greatest social connectivity were immunized.³¹ These results reflect the significant challenge confronting universities to increase influenza vaccine for their diverse students. They imply that a multi-faceted approach is needed to target students across the classification spectrum, including efforts that target upperclassmen and students who reside both on-campus and off-campus. Merrill et al. reported that 15% of students said that parents were their source of influenza vaccination information.²² Given this finding, implementing a university-wide communication sent concurrently to both students and parents may be effective to increase knowledge and perceived importance of influenza vaccination among college students. An additional challenge to educational efforts may be that college students' perception of their knowledge about influenza may exceed their actual knowledge, as was shown for H1N1 in one study.²⁴

Insights may be garnered from several studies that have assessed university responses and communication strategies during the pandemic H1N1 influenza of 2009–2010. Schwartz and Bayles assessed the web-sites of each of 51 sampled universities and measured their accessibility and comprehensiveness based on 10 pre-specified indicators. Most universities (42/51, 82%) had dedicated influenza web-sites, 57% (24/51) provided information specifically for students, and 33% (17/51) covered at least 8 pre-specified indicators.³² Both faculty and students at one Australian university reported that email was the preferred method for communicating important health issues, however, more faculty (78%) than students (54%) endorsed email as the preferred method ($p<0.001$). College students also endorsed announcements in lectures, posters and short message service as preferred methods for communicating important health issues.³³ College students from one university reported that they sought health information from family, online, friends, and television more frequently than from university flyers, the student health center or their professors.³⁴ Taken together, these studies suggest evaluating the accessibility and comprehensiveness of a university-based web-site dedicated to influenza and using a variety of communication techniques, including the latest modes of communication. Social media outlets have become an increasingly popular source of disseminating information though they should be clearly denoted as "must read" notification.

Limitations

Our study has several limitations. We did not collect information on insurance status, so we were unable to assess the relationship between insurance coverage and vaccination. However, many universities require either purchasing insurance through the school or proof of insurance. Seasonal influenza vaccine status was determined by self-report, and was not confirmed. Yet, self-report of seasonal influenza vaccine has been shown to be accurate. For

persons 5–49 years of age over two influenza seasons, self-report was 97% sensitive and 92% specific and had a positive predictive value of 83% and a negative predictive value of 99% based on comparisons with the Wisconsin Immunization Registry.³⁵ We included a diverse group of universities in North Carolina, however, there could be geographic variability in seasonal vaccine coverage. Because residence on-campus was highly correlated with class year, we could not assess the role of residing on campus in the multivariate analyses.

Conclusions

Self-reported seasonal influenza vaccine coverage among college students in 2009–2010 was one-quarter of the 2020 Healthy People objective of having 80% vaccine coverage for healthy persons 18 through 64 years of age. This study highlights the opportunity that college campuses have to implement effective strategies and increase influenza vaccine coverage among its diverse student populations. Future research is needed to identify the essential elements of effective influenza vaccine campaigns on college campuses.

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Figure 1.

Self-reported 2009–2010 seasonal influenza vaccination coverage for college students at eight universities in North Carolina with a dotted red line showing the 2020 Health People goal for college students (color figure available online).

Table 1

Demographic characteristics of All Survey Respondents and Variability Among Eight North Carolina Colleges

Characteristics	Overall N (col %)	Variability Range of %
Race/ethnicity		
Non-Hispanic White	3266 (80.0)	49.6 – 92.7
African American	347 (8.5)	1.7 – 23.8
Hispanic	141 (3.5)	2.0 – 4.8
Asian or Pacific Islander	117 (2.9)	1.1 – 7.9
Other	210 (5.1)	2.1 – 20.9
Sex		
Female	2583 (63.5)	58.2 – 70.3
Male	1486 (36.5)	29.7 – 41.8
Classification		
Freshman	1081 (26.5)	19.2 – 29.9
Sophomore	957 (23.2)	17.7 – 27.6
Junior	1057 (25.9)	24.0 – 28.9
Senior	832 (20.4)	17.0 – 25.8
Other	159 (3.9)	0.1 – 6.2
Type of school		
Private	617 (15.1)	not applicable
Public	3473 (84.9)	not applicable
Campus Residence		
On-campus	2230 (54.9)	31.9 – 98.2
Off-campus	1835 (45.1)	1.8 – 68.1
Parental education		
College graduate	2679 (66.3)	39.9 – 83.2
No college graduate	1360 (33.7)	16.7 – 60.1
Campus activities		
SGA/politics (Yes)	290 (7.7)	3.7 – 14.4
Academic club/honor society (yes)	1124 (29.3)	20.5 – 42.6
Community service/volunteer work (yes)	1881 (48.4)	37.7 – 67.5
Used email for work or school		
Often/very often	3721 (91.9)	85.7 – 95.8
Sometimes/seldom/never	328 (8.1)	4.2 – 14.3
Reported seasonal influenza vaccine		
Yes	797 (19.8)	13.6 – 29.9
No	3234 (80.2)	70.1 – 86.4

Table 2

Location where vaccinated student reported receiving 2009–2010 seasonal influenza vaccine

Location	% of all vaccinated students
Private Physician or clinic	45%
Student Health Services or another location on campus	37%
Pharmacy	8%
Work or military	5%
Health department or clinic	2.5%
Other	2.5%

Table 3
Bivariate and multivariate analyses identifying predictors of receipt of 2009–2010 seasonal influenza vaccine.

Characteristic	Seasonal influenza vaccine N(column %)		Odds Ratio (95% CI)	
	Vaccinated	Unvaccinated	Clustered Bivariate analysis	Clustered Multivariate analysis
Sex				
Female	518 (65%)	2029 (63%)	1.07 (0.91–1.26)	1.02 (0.85–1.22)
Male	277 (35%)	1188 (37%)	--	--
Race/ethnicity				
Non-Hispanic White	645 (81%)	2576 (80%)	--	--
African American	63 (8%)	281 (9%)	0.86 (0.64–1.15)	0.95 (0.70–1.31)
Hispanic	32 (4%)	108 (3%)	1.16 (0.77–1.74)	1.28 (0.84–1.95)
Asian or Pacific Islander	25 (3%)	89 (3%)	1.06 (0.67–1.68)	1.00 (0.61–1.65)
Other	30 (4%)	176 (5%)	0.73 (0.49–1.10)	0.75 (0.48–1.16)
Classification				
Freshman	249 (31%)	818 (25%)	1.31 (1.05–1.63)	1.43 (1.13–1.81)
Sophomore	178 (22%)	761 (24%)	--	--
Junior	199 (25%)	847 (26%)	1.04 (0.83–1.30)	1.00 (0.79–1.28)
Senior	143 (18%)	675 (21%)	0.93 (0.73–1.19)	1.05 (0.81–1.36)
Other	27 (3%)	130 (4%)	0.99 (0.63–1.55)	1.03 (0.64–1.66)
Type of school				
Private	181 (23%)	425 (13%)	1.97 (1.33–2.94)	1.94 (1.26–3.00)
Public	616 (77%)	2809 (87%)	--	--
Parental education				
College graduate	569 (72%)	2086 (65%)	1.35 (1.13–1.62)	1.28 (1.06–1.54)
No college graduate	219 (28%)	1130 (35%)	--	--
Campus activities				
Student Government Association/politics (Yes)	73 (10%)	213 (7%)	1.28 (0.96–1.70)	1.23 (0.91–1.66)
Academic club/honor society (Yes)	254 (34%)	854 (28%)	1.23 (1.03–1.46)	1.26 (1.05–1.53)
Community service/volunteer work (Yes)	402 (53%)	1446 (47%)	1.18 (1.001–1.38)	1.13 (0.95–1.35)

Characteristic	Seasonal influenza vaccine N(column %)		Odds Ratio (95% CI)	
	Vaccinated	Unvaccinated	Clustered Bivariate analysis	Clustered Multivariate analysis
Used email for work or school				
Often/very often	747 (94%)	2937 (91%)	1.54 (1.12–2.14)	1.40 (0.99–1.97)
Sometimes/seldom/never	46 (6%)	278 (9%)	--	--

* Multivariate analysis used a mixed effects model that accounted for clustering within colleges. **Bold** indicates 95% CI do not cross 1.