



Willingness to Vaccinate Against COVID-19: Predictors of Vaccine Uptake Among Adults in the US

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Abstract

The uptake of the COVID-19 vaccine will determine the trajectory for improved population health and economic recovery from the COVID-19 pandemic. Identifying factors associated with vaccine acceptance is imperative as public health officials strategize to improve uptake. In this study, we identified predictors of vaccine willingness and acceptance using univariate logistic regression to model predictors and calculate odds ratios. Participants ($N=946$) who reported greater vaccine willingness were male, older, and had a higher level of education and income. Behaviors indicative of reducing the spread of COVID-19 (e.g., testing) and perceived risk of COVID-19 infection were associated with vaccine willingness, as were participants who believed they were “highly likely” to be infected (by a factor of 8). Education tailored to demographic groups with low vaccine uptake should focus on the high degree of communicability associated with COVID-19. Implementing mobile healthcare screenings could remove barriers to healthcare, thereby improving health equity.

Keywords COVID-19 · Vaccine uptake · Perceived infection risk

Introduction

In December 2020, the Food and Drug Administration (FDA) announced its approval of an emergency use authorization for the first Coronavirus (COVID-19) vaccine. This historic announcement came as the COVID-19 death toll in the United

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States (US) passed 300,000 and the virus continued to spread at unprecedented rates. Approval of the vaccine introduced a new challenge for public health officials as federal and state agencies worked to implement a phased distribution of the vaccine. Government agencies gave prioritized status to populations determined to be at greatest risk for exposure or poor outcomes from the virus—frontline workers, the elderly, and those with preexisting conditions known to increase the risk for COVID-19 mortality. Once these populations were vaccinated, a tiered stratification system would determine the subsequent groups eligible for vaccination.

Uptake of the COVID-19 vaccine has significant societal implications and will determine the trajectory for improved population health and economic recovery from the pandemic. Despite the obvious need for the virus' containment, many individuals have rejected non-pharmacologic containment measures, including social distancing, tracking, and face coverings. Furthermore, new evidence suggests many Americans will also refuse the COVID-19 vaccine; a survey conducted by the Pew Research Center found that four out of ten Americans are likely to decline vaccination (2020). Identifying factors associated with vaccine acceptance is imperative as government agencies and public health officials strategize to improve vaccine uptake in the coming months. This study aimed to identify predictors of willingness to accept a COVID-19 vaccine and compare them to predictors of previous acceptance of an influenza vaccine among adults in the southeastern US.

Methods

Inclusion Criteria: We conducted a cross-sectional, regional survey in December 2020 with questions focused on health and healthcare utilization, COVID-19 testing and results, perceived risk of infection, COVID-19 vaccine willingness, and influenza vaccine acceptance. Subjects were eligible if they lived in the eastern 29 counties of North Carolina and were at least 18 years old. The University and Medical Center Institutional Review Board at East Carolina University (ECU) approved all study activities.

Polling Methods We contacted respondents using a mixed mode approach that included a telephone Interactive Voice Response (IVR) system and an online opt-in panel. We screened telephone and online participants according to our location parameters, which enabled only self-described residents of the eastern 29 counties of North Carolina to complete our survey. Aristotle, Inc. (<https://www.aristotle.com>) provided phone numbers sampled from their database of consumer landlines for the IVR calls. The company placed a total of 40,000 IVR calls which yielded a random sample of 524 completed responses, or a 2.4% response rate. Lucid, Inc., a web-based opt-in survey research platform, recruited the online sample which yielded 422 completed responses. Lucid, Inc. utilizes a combination of quota sampling and screening questions to ensure a demographically representational sample (Coppock & McClellan, 2019). Lucid, Inc. providers compensated online participants \$2.00 for their participation in our 5- to 10-min survey. For the combined sample of 946, the Bayesian Credibility Interval, a measure of the statistical uncertainty of polling results based on the assumptions of a statistical model, was ± 3.7 percentage points.

Poststratification person-level weights (design effect of weights is available from the corresponding author upon reasonable request) were applied to survey results for all analyses to represent the sociodemographic characteristics of the region. An iterative proportional fitting algorithm known as a raking adjustment was implemented based on four dimensions: age, education, race, and gender. Control values used for this raking adjustment were obtained from the US Census. ECU's Center for Survey Research supervised all survey activities and performed weighting and raking adjustments.

Statistical Analysis We employed a series of univariate logistic regressions to investigate and compare predictors of respondents' (1) willingness to accept a COVID-19 vaccine, and (2) previous acceptance of the influenza vaccine for the current flu season. Predictors included demographic variables, health and insurance status, healthcare utilization, COVID-19 testing, and their perceived risk of contracting COVID-19. We calculated odds ratios and 95% confidence intervals for each predictor as well as probabilities for a select group of predictors. For the purposes of this exploratory study, we did not make adjustments for multiple comparisons. We performed all analysis based on weighted data using IBM SPSS version 27 and considered a p value of <0.05 to be statistically significant.

Results

Our study analyzed data from 946 participants sampled at random in the eastern 29 counties of North Carolina. We performed analyses on data weighted by sex, race, age, and education. An overview of the demographic breakdown of unweighted data (from the same 29-counties) as compared to our region of interest is included in Table 1. All sex, race, age, education and income groups were well represented in the sample in relation to the demographic composition of our region (see Table 2).

When asked to rate their overall health, nearly half of participants indicated being in good health, followed by fair and excellent health. Fewer than 6% of participants reported that they were in poor health. Despite overall good ratings of health, over half the sample reported a chronic health condition, and the majority of these participants indicated that they were taking at least one prescription medication. Most participants had health insurance coverage, and nearly three quarters had visited a healthcare provider in the past year for a reason other than an emergency visit.

Almost half the sample had been tested for COVID-19, with 74 participants receiving a positive diagnosis. Excluding participants who had tested positive for COVID-19, nearly half of the remaining participants indicated they were "not very likely" to contract COVID-19, one third perceived their risk as "somewhat likely," and fewer than ten percent felt they were "highly likely" to contract COVID-19. Over half of the total sample endorsed willingness to receive the COVID-19 vaccine when it became available. Half of the total sample reported receiving the influenza vaccine for the 2020–21 season, of these, over three quarters reported a willingness to receive the COVID-19 vaccine when it became available.

Several of the demographic, health status, healthcare utilization, and COVID-19 testing and perceived risk variables were associated with our two questions of

Table 1 Demographics of survey sample before weighting as compared to the demographic breakdown of eastern North Carolina according to data from the 2015 US Census

Demographic	US Census 2015 population estimate from 29 counties in eastern North Carolina <i>n</i> (%)	Health behaviors poll <i>n</i> (%)
<i>Sex</i>		
Male	699,679 (49.5)	419 (44.3)
Female	713,651 (50.5)	505 (53.4)
<i>Race</i>		
White	812,858 (57.5)	572 (60.5)
Black	422,011 (29.9)	256 (27.1)
<i>Age</i>		
18–24	163,323 (14.8)	125 (13.2)
25–54	510,069 (46.2)	302 (31.9)
55–64	188,138 (17.0)	163 (17.2)
65–74	143,826 (13.0)	229 (24.2)
> 75	98,317 (8.9)	127 (13.4)
<i>Education</i>		
HS (or equivalent) or Below HS	428,955 (30.4)	264 (27.9)
Some college or associate Degree	317,798 (22.5)	362 (38.3)
College degree	111,251 (7.9)	194 (20.5)
Postgraduate degree	53,516 (3.8)	126 (13.3)

primary interest: respondents' (1) willingness to accept a COVID-19 vaccine, and (2) previous receipt of an influenza vaccine for the current season (see Table 2). Two of our respondents' demographic characteristics—sex and income—were related to their willingness to accept a COVID-19 vaccination, but not an influenza immunization. Males were more likely than females to accept the COVID-19 vaccination, but not an influenza vaccine. Likewise, income was a significant factor in respondents' willingness to accept a COVID-19 but not an influenza immunization (see Supplementary Information).

Participants reporting an annual household income greater than \$100,000 were one and a half times more likely to accept the COVID-19 vaccine than those with an annual household income less than \$25,000.

Older adults were more willing to take either vaccine than those between the ages of 18 and 24. The difference was greatest for those who were 75 or older for both the COVID-19 and the influenza vaccine. The probability of receiving a COVID-19 vaccine by age is represented in Fig. 1.

Respondents' level of education was a significant predictor of vaccine uptake. Participants who had a graduate degree were twice as likely as someone with a high school education to accept either vaccination. Participants reporting their overall health status as “fair” were most likely to accept either vaccine, as were participants with health insurance coverage, chronic health problems, and those taking prescription medications. Healthcare utilization was also a significant

Table 2 Predictors of COVID-19 vaccine willingness and influenza vaccine acceptance

Characteristic			COVID-19 vaccine willing- ness		Influenza vaccine accept- ance	
			Beta-coefficient	95% CI	Beta-coefficient	95% CI
<i>Sex†</i>	<i>n</i>	Percent				
Male	466	49.2	2.03	1.56, 2.64	1.29	1.00, 1.67
Female	475	50.3	–	–	–	–
<i>Race</i>						
White	544	57.7	1.16	0.87, 1.54	1.12	0.84, 1.50
Black	284	30.0	–	–	–	–
<i>Age group (years)*</i>						
> 74	85	9.0	7.04	3.62, 13.70	3.45	1.94, 6.13
65–74	123	13.0	3.24	1.94, 5.39	3.12	1.88, 5.18
55–64	161	17.0	2.36	1.49, 3.75	2.36	1.49, 3.75
25–54	435	46.0	1.36	0.93, 2.00	0.93	0.63, 1.37
18–24	142	15.0	–	–	–	–
<i>Education*</i>						
Postgraduate Degree	57	6.0	2.08	1.12, 3.87	2.14	1.19, 3.86
College Degree	114	12.0	1.22	0.80, 1.87	1.40	0.92, 2.12
Some college or associate degree	331	35.0	0.82	0.62, 1.09	0.84	0.63, 1.12
HS (or equivalent) or Below HS	445	47.0	–	–	–	–
<i>Income†</i>						
> \$100,000	83	8.8	1.59	0.95, 2.65	1.01	0.62, 1.64
> \$50,000 to \$100,000	184	19.4	1.19	0.81, 1.74	1.01	0.70, 1.47
\$25,000 to \$50,000	296	31.3	0.76	0.55, 1.06	0.98	0.71, 1.36
< \$25,000	276	29.2	–	–	–	–
<i>Health status*</i>						
Excellent	191	20.2	1.50	0.81, 2.79	1.29	0.69, 2.41
Good	460	48.6	1.35	0.76, 2.41	1.35	0.75, 2.42
Fair	243	25.7	2.24	1.22, 4.12	1.98	1.07, 3.64
Poor	51	5.4	–	–	–	–
<i>Insurance status*</i>						
Yes	771	81.5	1.95	1.37, 2.78	3.87	2.61, 5.76
No	151	15.9	–	–	–	–
<i>Healthcare visit in previous year*</i>						
Yes	706	74.6	1.81	1.35, 2.43	2.70	1.99, 3.68
No	240	25.4	–	–	–	–
<i>Years since last healthcare visit*</i>						
More than fifteen years	10	1.0	0.12	0.02, 0.88	–	–
Ten to fifteen years	13	1.4	0.30	0.08, 1.09	0.17	0.03, 1.11
Five to nine years	53	5.6	0.73	0.39, 1.37	0.62	0.31, 1.23
Less than five years	156	16.5	–	–	–	–

Table 2 (continued)

Characteristic			COVID-19 vaccine willing- ness		Influenza vaccine accept- ance	
	<i>n</i>	Percent	Beta-coefficient	95% CI	Beta-coefficient	95% CI
<i>Chronic health problems*</i>						
Yes	508	53.7	2.20	1.69, 2.85	2.37	1.82, 3.08
No	438	46.3	–	–	–	–
<i>Prescription medication*</i>						
Yes	445	47.1	2.83	1.73, 4.63	3.65	2.19, 6.08
No	77	8.1	–	–	–	–
<i>Tested for COVID-19*</i>						
Yes	418	44.2	1.72	1.32, 2.24	2.44	1.87, 3.18
No	528	55.8	–	–	–	–
<i>Tested + COVID-19*</i>						
Yes	74	7.8	3.45	1.79, 6.68	1.97	1.13, 3.46
No	368	38.9	–	–	–	–
<i>Perceived risk of COVID-19*</i>						
Highly likely	72	7.6	8.64	4.37, 17.07	2.75	1.46, 5.20
Somewhat likely	296	31.3	4.46	2.70, 7.36	3.23	1.97, 5.30
Not very likely	395	41.8	4.50	2.76, 7.33	3.67	2.27, 5.93
Not at all likely	108	11.4	–	–	–	–

N = 946

HS = high school

† *p* < .05, two-sided for COVID-19 only

* *p* < .05, two-sided for COVID-19 and influenza

"–" designates indicator variable

predictor of vaccine uptake. Among those who had visited a healthcare provider in the last year, willingness to receive the COVID-19 vaccine was nearly twice as high and influenza acceptance was more than two and a half times greater than those who had not visited a healthcare provider in the preceding year. We observed a continuing trend of decreased acceptance for either vaccination that was proportional to increases in the length of time since the last healthcare visit. Figure 2 demonstrates the probability of accepting a COVID-19 vaccine by healthcare utilization.

Previous exposure to COVID-19 testing and testing positive were also related to increased COVID-19 vaccine uptake. Those who tested positive for this virus were three and half times more likely to endorse willingness to take the COVID-19 vaccine and twice as likely to accept the influenza vaccine. An increase in perceived risk of contracting COVID-19 was associated with respondents' willingness to take the COVID-19 vaccine – those in the "highly likely" group were over eight and a half times more willing than those who did not believe they were at risk for contracting the virus. Though not as strong, the association between

perceived risk of COVID-19 infection and vaccine acceptance was also present for the influenza vaccine. The probabilities of COVID-19 vaccine acceptance according to testing behaviors and perceived risk are displayed in Fig. 3.

Discussion

To better understand willingness to accept a COVID-19 vaccination, we surveyed subjects living in a region in the southeastern US in December 2020. Respondents in over half our sample were willing to receive the COVID-19 vaccine. Half the sample reported receiving the influenza vaccine for the 2020–21 season and, among these, more than three quarters reported a willingness to receive the COVID-19 vaccine when it became available. These findings are congruent with results from a nationally representative sample of adults in the US conducted by the Pew Research Center (2020) in December 2020, which found that sixty percent of adults say they would “definitely” or “probably” get a COVID-19 vaccine if one were available today. In alignment with the results of our study, others have found that receipt of the influenza vaccine is associated with intention to be vaccinated against COVID-19 (Sherman et al., 2020; J. Wang et al., 2020a, 2020b; K. Wang et al., 2020a, 2020b).

Several investigators have reported an association between perceived risk of COVID-19 infection and vaccination willingness (Guidry et al., 2020; Reiter et al., 2020; J. Wang et al., 2020a, 2020b). In our sample, participants reporting a high likelihood of contracting COVID-19 were eight times as likely to endorse an intent to vaccinate as those who felt they were not at all likely to contract COVID-19. Likewise, participants engaging in behaviors related to reducing the spread of the virus (e.g., being tested for COVID-19) also showed an increased intent to vaccinate. Vaccine communication campaigns currently under development to improve vaccine uptake should emphasize the high communicability of the COVID-19 virus.

Respondents’ healthcare utilization, and more specifically recent healthcare utilization, was significantly associated with both their intention to receive the COVID-19 vaccine and their previous receipt of the influenza vaccine. Willingness to vaccinate was highest among those who had visited a doctor in the past year and declined steadily as the number of years since their last healthcare visit increased. Among participants who had not seen a doctor in more than 15 years, intent to vaccinate against COVID-19 was a meager ten percent of the sample. While having health insurance coverage was reported by most of our sample, only three quarters of them had been to a doctor in the last year. Furthermore, over a third of the sample had not seen a doctor in the previous five or more years.

These results highlight the need to increase individual engagement with the healthcare system. Although there is some disagreement regarding the utility of annual wellness visits, having access to a trusted source of health information and healthcare is imperative for the management of chronic disease (DeVoe et al., 2009; Fullerton et al., 2018; Spatz et al., 2010). Moreover, patients who have a usual source of healthcare are more likely to accept preventative services (DeVoe et al., 2003), including vaccinations (Blewett et al., 2008; Doescher et al., 2004). As the

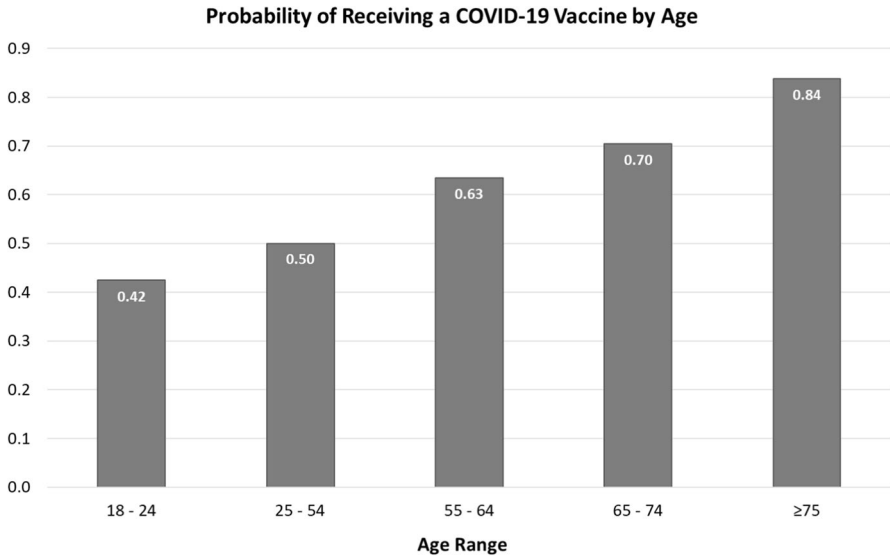


Fig. 1 Probability of receiving a COVID-19 vaccine by age

U.S. attempts to reach widespread vaccine-induced immunity against COVID-19, expanding healthcare delivery methods to include community healthcare workers such as emergency medical service personnel could improve vaccine uptake, particularly within populations without a regular source of healthcare.

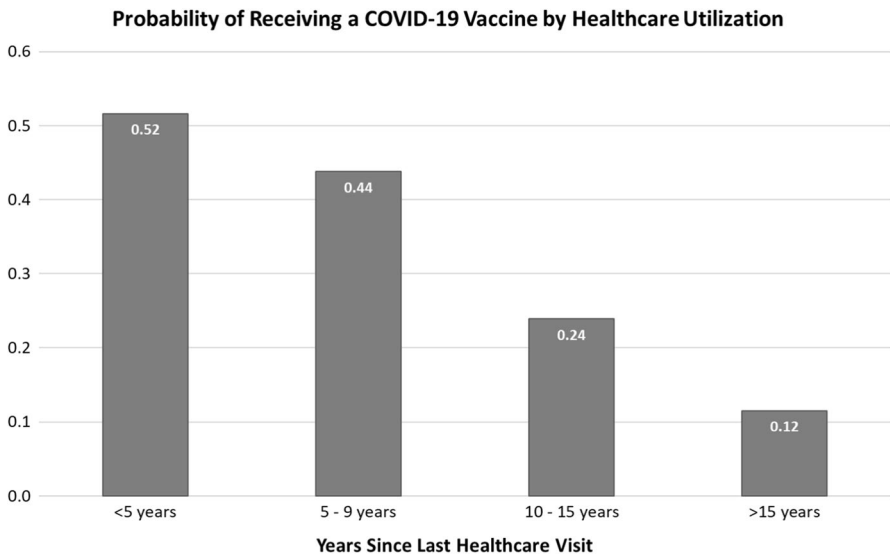


Fig. 2 Probability of receiving a COVID-19 vaccine by healthcare utilization

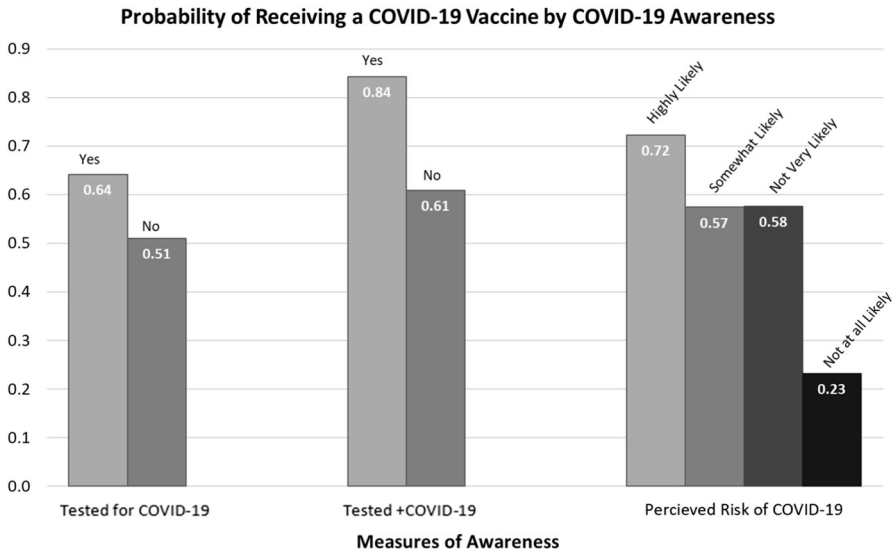


Fig. 3 Probability of receiving a COVID-19 vaccine by testing and perceived risk

We acknowledge some limitations to this study. First, a willingness to be vaccinated may not always translate into an actual vaccination. Further, other important factors that may be related to willingness to accept the vaccine – such as trust in the healthcare system and perceived likelihood of side effects – were not included in the survey. Earlier investigations of COVID-19 vaccination intention (Callaghan et al., 2020; Daly & Robinson, 2021; Romer & Jamieson, 2020) reported higher rates of willingness to be vaccinated (69–86%) than we found in this study. These results suggest there may be a temporal effect of intent to vaccinate. As the novelty and incidence of the virus declines, and daily reports of COVID-19 rates becomes repetitious, the importance of receiving the COVID-19 vaccine may become less salient. Lastly, although responses were appropriately weighted for the demographic make-up of the region from which our population was drawn, selection biases may well be present in our sample; most notably, self-selection bias from our online sample.

Conclusion

Behaviors indicative of reducing the spread of COVID-19, by being tested for the virus, and perceived risk of COVID-19 infection were both associated with respondents' willingness to receive the vaccine. Participants who believed they were “highly likely” to be infected were eight times as likely to demonstrate a willingness to be vaccinated. Education tailored to demographic groups with low vaccine uptake willingness should focus on the high degree of communicability associated with the virus. In our study, recent healthcare utilization was related to improved vaccine uptake. Implementing non-traditional healthcare delivery methods, namely mobile

healthcare screenings and vaccine administration, could aid in removing barriers to healthcare, improving health equity, and increasing COVID-19 vaccine uptake.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10935-021-00653-0>.

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Declarations

Conflict of Interest The authors declare they have no conflicts of interest.

References

- Blewett, L. A., Johnson, P. J., Lee, B., & Scal, P. B. (2008). When a usual source of care and usual provider matter: Adult prevention and screening services. *Journal of General Internal Medicine*, *23*(9), 1354.
- Callaghan, T., Moghtaderi, A., Lueck, J. A., Hotez, P., Strych, U., Dor, A., Fowler, E. F., & Motta, M. (2020). Correlates and disparities of intention to vaccinate against COVID-19. *Social Science and Medicine*, *1982*, 113638.
- Coppock, A., & McClellan, O. A. (2019). Validating the demographic, political, psychological, and experimental results obtained from a new source of online survey respondents. *Research and Politics*, *6*(1), 1–14. <https://doi.org/10.1177/2053168018822174>
- Daly, M., & Robinson, E. (2021). Willingness to vaccinate against COVID-19 in the US: Representative longitudinal evidence from April to October 2020. *American Journal of Preventive Medicine*, *60*(6), 766–773.
- DeVoe, J. E., Fryer, G. E., Phillips, R., & Green, L. (2003). Receipt of preventive care among adults: Insurance status and usual source of care. *American Journal of Public Health*, *93*(5), 786–791. <https://doi.org/10.2105/AJPH.93.5.786>
- DeVoe, J. E., Tillotson, C. J., & Wallace, L. S. (2009). Usual source of care as a health insurance substitute for U.S. adults with diabetes? *Diabetes Care*, *32*(6), 983–989. <https://doi.org/10.2337/dc09-0025>
- Doescher, M. P., Saver, B. G., Fiscella, K., & Franks, P. (2004). Preventive care: Does continuity count? *Journal of General Internal Medicine*, *19*(6), 632–637.
- Fullerton, C. A., Witt, W. P., Chow, C. M., Gokhale, M., Walsh, C. E., Crable, E. L., & Naeger, S. (2018). Impact of a usual source of care on health care use, spending, and quality among adults with mental health conditions. *Administration and Policy in Mental Health and Mental Health Services Research*, *45*(3), 462–471. <https://doi.org/10.1007/s10488-017-0838-6>
- Guidry, J. P. D., Laestadius, L. I., Vraga, E. K., Miller, C. A., Perrin, P. B., Burton, C. W., Ryan, M., Fuemmeler, B. F., & Carlyle, K. E. (2020). Willingness to get the COVID-19 vaccine with and without emergency use authorization. *American Journal of Infection Control*. <https://doi.org/10.1016/j.ajic.2020.11.018>
- Pew Research Center. (2020). Intent to get a COVID-19 vaccine rises to 60% as confidence in research and development process increases. *Pew Research Center Science and Society*. <https://www.pewresearch.org/science/2020/12/03/intent-to-get-a-covid-19-vaccine-rises-to-60-as-confidence-in-research-and-development-process-increases/>. Date accessed December 3, 2020.
- Reiter, P. L., Pennell, M. L., & Katz, M. L. (2020). Acceptability of a COVID-19 vaccine among adults in the United States: How many people would get vaccinated? *Vaccine*, *38*(42), 6500–6507. <https://doi.org/10.1016/j.vaccine.2020.08.043>

- Romer, D., & Jamieson, K. H. (2020). Conspiracy theories as barriers to controlling the spread of COVID-19 in the U.S. *Social Science and Medicine*, 263, 113356. <https://doi.org/10.1016/j.socscimed.2020.113356>
- Sherman, S. M., Smith, L. E., Sim, J., Amlôt, R., Cutts, M., Dasch, H., Rubin, G. J., & Sevdalis, N. (2020). COVID-19 vaccination intention in the UK: Results from the COVID-19 Vaccination Acceptability Study (CoVAccS), a nationally representative cross-sectional survey. *Human Vaccines and Immunotherapeutics*, 1–10.
- Spatz, E. S., Ross, J. S., Desai, M. M., Canavan, M. E., & Krumholz, H. M. (2010). Beyond insurance coverage: Usual source of care in the treatment of hypertension and hypercholesterolemia. Data from the 2003–2006 National Health and Nutrition Examination Survey. *American Heart Journal*, 160(1), 115–121. <https://doi.org/10.1016/j.ahj.2010.04.013>
- Wang, J., Jing, R., Lai, X., Zhang, H., Lyu, Y., Knoll, M. D., & Fang, H. (2020a). Acceptance of COVID-19 vaccination during the COVID-19 Pandemic in China. *Vaccines*, 8(3), 482.
- Wang, K., Wong, E. L. Y., Ho, K. F., Cheung, A. W. L., Chan, E. Y. Y., Yeoh, E. K., & Wong, S. Y. S. (2020b). Intention of nurses to accept coronavirus disease 2019 vaccination and change of intention to accept seasonal influenza vaccination during the coronavirus disease 2019 pandemic: A cross-sectional survey. *Vaccine*, 38(45), 7049–7056. <https://doi.org/10.1016/j.vaccine.2020.09.021>

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