ORIGINAL RESEARCH

Associations Between General Vaccine Hesitancy and Healthcare Access Among Arkansans

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BACKGROUND: Vaccines provide protection against numerous diseases that can cause serious illness and death. However, vaccine hesitancy threatens to undermine progress in reducing preventable diseases and illness. Vaccine hesitancy has been shown to vary by sociodemographic characteristics. However, studies examining associations between healthcare access and vaccine hesitancy are lacking.

OBJECTIVE: Using a statewide random sample of Arkansas adults, we examined the relationship between general vaccine hesitancy and healthcare access.

DESIGN: From July 12 to 30, 2021, participants were contacted by landlines and cellular phones using random digit dialing.

PARTICIPANTS: A total of 1500 Arkansas adults were surveyed. Black/African American and Hispanic/Latinx adults were oversampled to ensure adequate representation. The survey had a cooperation rate of 20%.

MAIN MEASURES: The dependent variable was an ordinal measure of general vaccine hesitancy. Age, gender, race, education, relationship status, and rural/urban residence were included in the model. Healthcare access was measured across four domains: (1) health insurance coverage; (2) having a primary care provider (PCP); (3) forgoing care due to cost; and (4) time since last routine checkup. The relationship between general vaccine hesitancy and healthcare access was modeled using ordinal logistic regression, controlling for sociodemographic characteristics.

KEY RESULTS: Mean age was 48.5 years, 51.1% were women, 28% reported a race other than White, and 36.3% held a bachelor's degree or higher. Those with a PCP and those with health insurance had approximately two-thirds the odds of being more hesitant ([OR=0.63, CI=0.47, 0.84] and [OR=0.68; CI=0.49, 0.94]) than those without a PCP and those without health insurance. Participants reporting a routine checkup in the last 2 years were almost half as likely to be more hesitant than those reporting a checkup more than 2 years prior (OR=0.58; CI=0.43, 0.79).

CONCLUSIONS: Results suggest improving access to health insurance, PCPs, and routine preventative care services may be critical to reducing vaccine hesitancy.

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INTRODUCTION

Vaccine hesitancy is the reluctance or refusal to get vaccinated despite the availability of vaccines.[1] In 2019, the World Health Organization identified vaccine hesitancy as a significant threat to global health,[1] and in the era of COVID-19, general vaccine hesitancy has become an even greater concern. Vaccination is responsible for preventing up to three million deaths a year; however, vaccine hesitancy presents a significant challenge to the progress made in reducing vaccine-preventable diseases.[1,2]

Vaccine hesitancy is multi-faceted.[3] Prior research has shown that vaccine hesitancy varies by age, gender, race/ethnicity, rural/urban location, education, and income. Those who are younger, women, lower income, and in a rural location with lower education are more likely to report vaccine hesitancy.[2,4–16] Several studies have also documented disparities by race and ethnicity, with minority communities being more likely to report general vaccine hesitancy.[17–19] Although research has consistently noted higher vaccine hesitancy among minoritized racial groups, these disparities appear to be narrowing for COVID-19 vaccines.[20] Moreover, emerging evidence suggests vaccine hesitancy and vaccination among minoritized racial groups is associated with structural racism and experiences of racial discrimination.[21–24]

While several studies have examined sociodemographic factors and associations with vaccine hesitancy in general and for specific vaccines,[18,25–28] to our knowledge, no studies have examined associations between general vaccine hesitancy and measures of healthcare access. However, there is an established body of research demonstrating that provider recommendation is a strong predictor of vaccination behaviors for specific vaccines,[29–32] and much of the work related to vaccine hesitancy has aimed to understand how such recommendations exert their effects.[29] Other parallel lines of research also suggest that

healthcare access may be an important piece of the vaccine hesitancy puzzle. For example, factors that influence individuals' ability to access and use healthcare, such as health literacy,[33,34] have been linked to adoption of preventive care such as MMR and influenza immunization.[35] Yet, provider recommendations and health literacy can do little to influence motivation to vaccinate if you lack healthcare coverage, have to forgo care due to cost, or do not have a provider. Healthcare access is upstream from many factors such as provider recommendations and health literacy that have already been identified as important predictors of vaccine hesitancy or vaccination behaviors we know are related to hesitancy. Studies have consistently demonstrated insurance to be an important predictor of vaccination coverage.[36,37] Furthermore, most recent studies focus on specific vaccines such as COVID-19 or influenza rather than general vaccine hesitancy. General vaccine hesitancy has been shown to be associated with vaccine behavior,[28,38] making it an important outcome to examine.

To fill these gaps in the literature, the authors examined associations between healthcare access and general vaccine hesitancy, controlling for relevant sociodemographic characteristics. The authors hypothesized that having health insurance coverage, having a primary care provider (PCP), and having seen a provider for a routine checkup in the past 2 years would be associated with reduced general vaccine hesitancy. It was hypothesized that forgone care due to cost would be associated with increased general vaccine hesitancy.

METHODS

Procedures

Between July 12 and July 30, 2021, 1500 Arkansas adults were surveyed. The survey had a cooperation rate of 20%. Potential participants were contacted by telephone landlines and cellular phones using random digit dialing methods. Trained surveyors employed by a national polling company conducted the surveys using computer-assisted telephone interviewing techniques. Potential participants received a maximum of two contact attempts per day (at least 4 h apart) for a maximum of 3 days. Oversampling procedures were used to ensure adequate representation of Black/African American and Hispanic/Latinx participants. Spanish-speaking participants were surveyed in Spanish by bilingual interviewers using a Spanish translation of the survey.

Inclusion criteria required participants to be at least 18 years of age and currently residing in Arkansas. The study was explained to potential participants, and verbal consent was provided prior to beginning the survey. Participants were free to refuse to answer any question or state they did not know the answer. Participants were not provided incentives for participation. All study procedures were reviewed and approved by the Institutional Review Board at the University of Arkansas for Medical Sciences (IRB #262907).

Measures

General Vaccine Hesitancy. The dependent variable was an ordinal measure of general vaccine hesitancy developed by Quinn et al. (2019).[28] Participants were asked, "Overall, how hesitant are you about getting vaccinations?" Response options included "not at all hesitant," "a little hesitant," "somewhat hesitant," and "very hesitant."

Sociodemographic Characteristics. Age, gender, race, education, relationship status, and location (rural/urban residence) were included in the model. Age was calculated from participants' self-reported year of birth. Racial categorizations of White, Black/African American, or other race include only single-race, non-Hispanic responses. Participants who selected multiple races were categorized as multiracial, and those who selected Hispanic/Latinx ethnicity were categorized as Hispanic/Latinx regardless of their selected race(s). Gender was reported as man or woman. Third and fourth options of non-binary and self-defining were available; however, too few participants chose these options (n=3) to be included in the analyses. Participants reported their highest level of education completed and were combined into three groups for analysis: high school diploma/graduate equivalency degree (GED) or lower, some college/associate degree, and bachelor's degree or higher. Location of residence was designated as rural and urban based on the county where the participant currently resides. Determination of location category was based on United States Department of Agriculture Rural-Urban Continuum Codes.[39]

Healthcare Access. Healthcare access was measured based on four survey items: (1) health insurance coverage; (2) having a PCP; (3) forgoing healthcare due to cost; and (4) time since last routine doctor checkup. Health insurance coverage was captured by asking participants, "Do you have any kind of healthcare coverage, including health insurance, prepaid plans, such as HMOs, government plans such as Medicare, or Indian Health Service?" (Yes/No). PCP status was obtained by asking, "Do you have one person you think of as your personal doctor or healthcare provider? Is there more than one, or is there no person you think of as your personal doctor or healthcare provider?" Response options were, "Yes, only one," "More than one," and "No." This variable was dichotomized by collapsing the first two options into "Yes." Forgone care was captured by asking participants, "Was there a time in the past 12 months when you needed a doctor but could not see one because of the cost?" (Yes/No). Time since last checkup was recorded by asking, "About how long has it been since you last visited a doctor for a routine checkup?" Response options included "in the past year," "in the past 2 years," "in the past 5 years," "5 or more years ago," and "never." In order to account for potential changes in healthcare seeking behaviors as a result of the COVID-19 pandemic,

responses were collapsed into two categories: within the past 2 years and more than 2 years ago.

Statistical Analyses

Data management and analysis were conducted using STATA 15.1 and SAS 9.4. Participants with incomplete responses (*N*=95; 6.3%) were not included in the regression analyses. The most common missing pattern was a missing date of birth (*N*=36). Weights were generated by the polling company using raking ratio estimation to ensure the sample was representative of the Arkansas population based on 2019 census estimates for age (18–29, 30–39, 40–49, 50–59, 60–69, 70–79, 80+), gender (men, women), and race/ethnicity (non-Hispanic White, non-Hispanic Black/African American, non-Hispanic other or multiracial, and Hispanic/Latino any race). Weighted percentages and unweighted frequencies and percentages are provided to describe the sample. To determine the associations between general vaccine hesitancy and each of the healthcare access variables, a series of four bivariate ordinal regressions was run. Finally, the relationship between general vaccine hesitancy and healthcare access variables was then modeled using a weighted ordinal logistic regression, controlling for relevant sociodemographic characteristics. The Brant test indicated the assumption of proportional odds was met (p=0.061), and a proportional odds model was employed. Multicollinearity diagnostics revealed all tolerance values were above 0 and all variance inflation factors values were below 10. Additionally, eigenvalue estimates were above 0, and their ratios to each condition index indicated no significant multicollinearity in the model that would require correction.

RESULTS

Table 1 provides weighted estimates of descriptive statistics for all variables included in the regression model. The mean age of the sample was 48.5 years (±19.0). Slightly more than half of participants were women (51.1%). More than one-fourth of the sample reported a race other than White (28.0%). Participant education levels were approximately split into thirds, with 36.3% reporting a bachelor's degree or higher. Approximately half were married or members of an unmarried couple (50.7%). The majority (68.9%) of participants reported residing in an urban county.

The vast majority of participants reported having some form of health insurance coverage (88.4%), as well as having a PCP (82.7%). Approximately one in seven reported there was a time in the past year they had to forgo needed healthcare due to cost (14.5%), and approximately one in six reported their last routine checkup with a doctor was more than 2 years ago (16.4%). More than half reported they were "not at all hesitant" about getting vaccinations (55.0%).

Table 1 Weighted and Unweighted Descriptive Statistics – Sociodemographic Characteristics, Healthcare Access Measures, and General Vaccine Hesitancy

	Weighted %	Unweighted *N* (%)
Age (*N*=1454)		
18–29	20.8	228 (15.7)
30–44	25.3	257 (17.7)
45–59	23.0	316 (21.7)
60+	31.0	653 (44.9)
Gender (*N*=1491)		
Men	48.9	598 (40.1)
Women	51.1	893 (59.9)
Race (*N*=1500)		
White	72.0	757 (50.5)
Black/African American	15.4	366 (24.4)
Hispanic/Latinx	7.4	244 (16.3)
Multiracial	2.0	53 (3.5)
Other	3.2	80 (5.3)
Education (*N*=1493)		
HS diploma/GED or lower	30.8	480 (32.2)
Some college/associate degree	32.9	496 (33.2)
Bachelor's degree or higher	36.3	517 (34.6)
Relationship status (*N*=1482)		
Married/unmarried couple	50.7	765 (51.6)
Unmarried/single	49.3	717 (48.4)
Location (*N*=1500)		
Urban (Metro)	68.9	1029 (68.6)
Rural (Non-metro)	31.1	471 (31.4)
Health insurance coverage (*N*=1485)		
Yes	88.4	1320 (88.9)
No	11.6	165 (11.1)
Primary care provider (*N*=1493)		
Yes	82.7	1269 (85.0)
No	17.3	224 (15.0)
Forgone care due to cost (*N*=1492)		
Yes	14.5	202 (13.5)
No	85.5	1290 (86.5)
Routine doctor checkup (*N*=1491)		
Within the past 2 years	83.6	1304 (87.5)
More than 2 years ago	16.4	187 (12.5)
General vaccine hesitancy (*N*=1500)		
Not at all hesitant	55.0	830 (55.3)
A little hesitant	21.3	315 (21.0)
Somewhat hesitant	12.2	183 (12.2)
Very hesitant	11.5	172 (11.5)

Note: HS, high school; GED, graduate equivalency degree
Percentages may not total 100 due to rounding

Weighted Bivariate Ordinal Logistic Regression

Table 2 provides results of four separate bivariate ordinal regressions. Participants with health insurance coverage had less than half the odds of being more hesitant (OR=0.45; CI=0.33, 0.60) compared with those with no health insurance.

Table 2 Weighted Unadjusted Ordinal Logistic Regressions—Bivariate Associations Between Each Healthcare Access Measure and General Vaccine Hesitancy

Healthcare access measure	General vaccine hesitancy	
	OR (95% CI)	*p*
Health insurance coverage	0.45 (0.33, 0.60)	<0.0001
Primary care provider	0.46 (0.36, 0.59)	<0.0001
Forgone care due to cost	1.59 (1.21, 2.07)	<0.001
Routine doctor checkup	0.43 (0.33, 0.55)	<0.0001

Note: OR, odds ratio

Compared with those without a PCP, those with a PCP had almost half the odds of being more hesitant (OR=0.46; CI=0.36, 0.59). Compared with those who had not forgone care due to cost, those who had forgone care due to cost had more than one and a half the odds of being more hesitant (OR=1.59; CI=1.21, 2.07). Participants who reported a routine checkup within the last 2 years had less than half the odds of being more hesitant, compared with those whose last checkup was more than two years prior (OR=0.43; CI=0.33, 0.55).

Weighted Ordinal Logistic Regression

Table 3 provides results of the weighted ordinal logistic regression analysis. Race, education, PCP, health insurance coverage, and time since last routine checkup were significant predictors of increased general vaccine hesitancy.

Black/African American participants had more than double the odds of White participants of being more hesitant toward vaccines (OR=2.22; CI=1.68, 2.93). Those with higher levels of education were less likely to be hesitant toward vaccines. Compared with those who reported having a high school diploma/GED or lower, participants with some college/an associate degree had approximately two-thirds the odds of being more hesitant (OR=0.63; CI=0.49, 0.81), and participants with a bachelor's degree or higher had less than half the odds of being more hesitant (OR=0.40; CI=0.31, 0.52).

Participants with a PCP, those with health insurance, and those who had a routine checkup in the last 2 years were less hesitant toward vaccines. Participants with health insurance coverage had approximately two-thirds the odds of being more hesitant (OR=0.68; CI=0.49, 0.94) compared with those with no health insurance. Compared with those without a PCP, those with a PCP had approximately two-thirds the odds of being more hesitant (OR=0.63, CI=0.47, 0.84). Participants who reported a routine checkup in the last 2 years were almost half as likely to be more hesitant, compared with those whose last checkup was more than two years prior (OR=0.58; CI=0.43, 0.79).

DISCUSSION

This study examined the association between general vaccine hesitancy and healthcare access among a large random sample of adults in Arkansas. Lower education level and Black/African American race were associated with greater odds of general vaccine hesitancy, which is consistent with prior

Table 3 Weighted Adjusted Ordinal Logistic Regression—Relationship Between General Vaccine Hesitancy and Healthcare Access Measures, Controlling for Sociodemographic Characteristics (*N*=1405)

	B	*SE*	*p*	*OR (95% CI)*
Health insurance coverage				
Yes	−0.39	0.164	**0.018**	0.68 (0.49, 0.94)
No	-	-	-	-
Primary care provider				
Yes	−0.47	0.151	**0.002**	0.63 (0.47, 0.84)
No	-	-	-	-
Forgone care due to cost				
Yes	0.04	0.152	0.788	1.04 (0.77, 1.40)
No	-	-	-	-
Routine doctor checkup				
Within the past 2 years	−0.54	0.155	**<0.001**	0.58 (0.43, 0.79)
More than 2 years ago	-	-	-	-
Age				
60+	−0.17	0.166	0.309	0.84 (0.61, 1.17)
45–59	0.22	0.168	0.199	1.24 (0.89, 1.72)
30–44	0.25	0.158	0.121	1.28 (0.94, 1.74)
18–29	-	-	-	-
Gender				
Women	0.09	0.107	0.385	1.09 (0.89, 1.35)
Men	-	-	-	-
Race				
Black/African American	0.80	0.141	**<0.001**	2.22 (1.68, 2.93)
Hispanic/Latinx	−0.12	0.207	0.577	0.89 (0.59, 1.34)
Multiracial	0.19	0.380	0.619	1.21 (0.57, 2.54)
Other	0.06	0.294	0.828	1.07 (0.60, 1.90)
White	-	-	-	-
Education				
Bachelor's degree or higher	−0.91	0.133	**<0.001**	0.40 (0.31, 0.52)
Some college/associate degree	−0.46	0.129	**<0.001**	0.63 (0.49, 0.81)
HS diploma/GED or lower	-	-	-	-
Relationship status				
Married/unmarried couple	−0.12	0.109	0.256	0.88 (0.71, 1.09)
Unmarried/Single	-	-	-	-
Location				
Rural (non-metro)	0.07	0.114	0.547	1.07 (0.86, 1.34)
Urban (metro)	-	-	-	-

Note: HS, high school; GED, graduate equivalency degree; B, Beta coefficient; SE, standard error; OR, odds ratio; CI, confidence interval
Bolded p-values indicate statistical significance

literature.[2,4,5,13–16] However, rural/urban residence was not associated with general vaccine hesitancy. This finding is in contrast with past literature which has shown rural location to be associated with vaccine hesitancy.[6–12] Literature regarding rural/urban location has been mixed, with some studies showing null associations[40] or even higher vaccination receipt in rural locations.[15]

The hypothesis that healthcare access is related to general vaccine hesitancy was partially supported. Having health insurance coverage, having a PCP, and having seen a provider for a routine checkup in the past 2 years were all associated with lower general vaccine hesitancy in both the bivariate and multivariate models. However, there was no significant association between general vaccine hesitancy and forgone care due to cost in the multivariate model. These findings point to the importance of insurance, PCPs, and access to primary care for general well care and preventative care visits. These findings add to the recent literature which has demonstrated the importance of healthcare provider relationships.[41,42] While this study did not collect information about healthcare provider conversations and recommendations, the findings are consistent with the literature that demonstrates the positive influence of healthcare providers' conversations on receipt of vaccines.[43–45]

The proportion of uninsured adults in our sample (11.6%) was slightly higher than that of the general population of Arkansas (9.1%).[46] The study found that having health insurance was associated with lower levels of vaccine hesitancy. This is consistent with past research that demonstrates similar patterns of vaccine hesitancy based on insurance status. A nationally representative survey of adults in the United States found that being uninsured was a significant predictor of COVID-19 vaccine hesitancy.[47] Another nationally representative study found insurance coverage to be related to COVID-19 vaccine hesitancy, but this relationship differed by race, where hesitant Hispanic/Latinx adults were significantly more likely to be uninsured.[48] In addition to predicting vaccination attitudes, insurance status has also been shown to be associated with vaccination coverage for both children and adults.[37,49,50]

Although it may seem obvious why indicators of healthcare access are associated with lower odds of general vaccine hesitancy, our study raises important questions about the pathways through which access shapes hesitancy. Given that vaccination (or remaining unvaccinated) is often a passive act, it may be that healthcare access simply leads to increased passive acceptance.[29] Moreover, given the literature demonstrating that trust is an important predictor of vaccine hesitancy,[18] it may be that it is not just access but consistency in healthcare access that allows time for trustworthiness to be demonstrated by healthcare professionals.

Strengths and Limitations

The study used a large, random sample with data collection in both English and Spanish, which is a strength. However, the study is limited by possible recall bias or social desirability bias because the study relied on self-reported data. The study is also limited by the use of cross-sectional data which does not allow for causal analysis. Our measure of vaccine hesitancy, while developed by a leading scholar on the subject,[28] is limited as a single-item measure that may not capture all dimensions of the concept of hesitancy. Additionally, the study only surveyed adults in Arkansas and may not be generalizable to other populations. Despite these limitations, this study makes a significant contribution to the literature as one of the first studies to examine healthcare access and general vaccine hesitancy.

Conclusion

This study is one of the first to document the important association between having health insurance coverage, having a PCP, and engaging in routine checkups with reduced general vaccine hesitancy. These results suggest that improving access to insurance, PCPs, and routine preventative care services may be critical to efforts aimed at reducing vaccine hesitancy.

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Data Availability *The deidentified data underlying the results presented in this study may be made available upon request from the corresponding author, Dr. Pearl A. McElfish, at pamcelfish@uams.edu. The data are not publicly available in accordance with funding requirements and participant privacy.*

Declarations:

Conflict of Interest: *Dr. Sheena CarlLee reports owning Pfizer stock. The authors declared no other potential conflicts of interest.*

REFERENCES

1. World Health Organization. Ten threats to global health in 2019. 2019. 01/04/2022. Available from: https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019#:~:text=These%20range%20from%20outbreaks%20of,change%20and%20multiple%20humanitarian%20crises.
2. **Troiano G, Nardi A.** Vaccine hesitancy in the era of COVID-19. Public Health. 2021;194:245-51.
3. **Larson HJ, Jarrett C, Eckersberger E, Smith DM, Paterson P.** Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007-2012. Vaccine. 2014;32(19):2150-9.

4. **Kempe A, Saville AW, Albertin C, Zimet G, Breck A, Helmkamp L, et al.** Parental hesitancy about routine childhood and influenza vaccinations: a national survey. Pediatrics. 2020;146(1):e20193852.
5. **Truong J, Bakshi S, Wasim A, Ahmad M, Majid U.** What factors promote vaccine hesitancy or acceptance during pandemics? A systematic review and thematic analysis. Health Promot Int. 2021;37(1):daab105.
6. **Altman D.** The Challenge Of Vaccine Hesitancy In Rural America. 2021. 01/18/2022. Available from: https://www.kff.org/coronavirus-covid-19/perspective/the-challenge-of-vaccine-hesitancy-in-rural-america/.
7. **Cull Weatherer A, Pritzl SL, Kerch S, Li Z, LoConte NK.** Current trends in HPV vaccine uptake: Wisconsin and United States, 2016-2019. Wmj. 2021;120(1):62-5.
8. **Henning-Smith C, Ramirez MR, Hernandes A, Hardeman R, Kozhimannil K.** Differences in Preventive Care Among Rural Residents by Race and Ethnicity. Policy Brief [Internet]. 2019. 01/04/2022. Available from: https://rhrc.umn.edu/publication/differences-in-preventive-care-among-rural-residents-by-race-and-ethnicity/.
9. **Kirzinger A, Sparks G, Brodie M.** KFF COVID-19 Vaccine Monitor- Rural America. 2021. 01/04/2022. Available from: https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-rural-america/.
10. **Lennon RP, Block R, Jr., Schneider EC, Zephrin L, Shah A.** Underserved population acceptance of combination influenza-COVID-19 booster vaccines. Vaccine. 2022;40(4):562-7.
11. **Swiecki-Sikora AL, Henry KA, Kepka D.** HPV vaccination coverage among US teens across the rural-urban continuum. J Rural Health. 2019;35(4):506-17.
12. **Zhai Y, Santibanez TA, Kahn KE, Srivastav A, Walker TY, Singleton JA.** Rural, urban, and suburban differences in influenza vaccination coverage among children. Vaccine. 2020;38(48):7596-602.
13. **Abbas KM, Kang GJ, Chen D, Werre SR, Marathe A.** Demographics, perceptions, and socioeconomic factors affecting influenza vaccination among adults in the United States. PeerJ. 2018;6:e5171.
14. **Applewhite A, Stancampiano FF, Harris DM, Manaois A, Dimuna J, Glenn J, et al.** A retrospective analysis of gender-based difference in adherence to influenza vaccination during the 2018-2019 season. J Prim Care Community Health. 2020;11:2150132720958532.
15. **Bennett KJ, Pumkam C, Probst JC.** Rural-urban differences in the location of influenza vaccine administration. Vaccine. 2011;29(35):5970-7.
16. Centers for Disease Control and Prevention. Flu Vaccination Coverage, United States, 2020–21 Influenza Season. 2021. 10/07/2021. Available from: https://www.cdc.gov/flu/fluvaxview/coverage-2021estimates.htm.
17. **Khairat S, Zou B, Adler-Milstein J.** Factors and reasons associated with low COVID-19 vaccine uptake among highly hesitant communities in the US. Am J Infect Control. 2022;50(3):262-267.
18. **Willis DE, Andersen JA, Bryant-Moore K, Selig JP, Long CR, Felix HC, et al.** COVID-19 vaccine hesitancy: race/ethnicity, trust, and fear. Clin Transl Sci. 2021;14(6):2200-2207.
19. **Maurer J, Harris KM, Uscher-Pines L.** Can routine offering of influenza vaccination in office-based settings reduce racial and ethnic disparities in adult influenza vaccination? J Gen Intern Med. 2014;29(12):1624-30.
20. **Daly M, Jones A, Robinson E.** Public trust and willingness to vaccinate against COVID-19 in the US from October 14, 2020 to March 29, 2021. J Am Med Assoc. 2021;325(23):2397.
21. **Siegel M, Critchfield-Jain I, Boykin M, Owens A, Muratore R, Nunn T, et al.** Racial/ethnic disparities in state-level COVID-19 vaccination rates and their association with structural racism. J Racial Ethn Health Disparities. 2021:1-14.
22. **Bleser W, Miranda P, Jean-Jacques M.** Racial/ethnic disparities in influenza vaccination of chronically-ill U.S. adults: the mediating role of perceived discrimination in healthcare. Med Care. 2016;54(6):570-7.
23. **Willis DE, Andersen JA, Montgomery BEE, Selig JP, Shah SK, Zaller N, et al.** COVID-19 vaccine hesitancy and experiences of discrimination among black adults. J Racial Ethn Health Disparities. 2022:1-10.
24. **Savoia E, Piltch-Loeb R, Goldberg B, Miller-Idriss C, Hughes B, Montrond A, et al.** Predictors of COVID-19 vaccine hesitancy: socio-demographics, co-morbidity and past experience of racial discrimination. Vaccines. 2021;9(7):767.
25. **McElfish PA, Willis DE, Shah SK, Bryant-Moore K, Rojo MO, Selig JP.** Sociodemographic determinants of COVID-19 vaccine hesitancy, fear of infection, and protection self-efficacy. J Prim Care Community Health. 2021;12:21501327211040746.
26. **Moore R, Willis DE, Shah SK, Purvis RS, Shields X, McElfish PA.** "The risk seems too high": thoughts and feelings about COVID-19 vaccination. Int J Environ Res Public Health. 2021;18(16):8690.
27. **Luz PM, Johnson RE, Brown HE.** Workplace availability, risk group and perceived barriers predictive of 2016-17 influenza vaccine uptake in the United States: A cross-sectional study. Vaccine. 2017;35(43):5890-6.
28. **Quinn SC, Jamison AM, An J, Hancock GR, Freimuth VS.** Measuring vaccine hesitancy, confidence, trust and flu vaccine uptake: results of a national survey of White and African American adults. Vaccine. 2019;37(9):1168-73.
29. **Brewer N, Chapman G, Rothman A, Leask J, Kempe A.** Increasing vaccination: putting psychological science into action. Psychol Sci Public Interest. 2017;18(3):149-207.
30. **Reiter P, McRee A, Pepper J, Gilkey M, Galbraith K, Brewer N.** Longitudinal predictors of human papillomavirus vaccination among a national sample of adolescent males. Am J Public Health. 2013;103(8):1419-27.
31. **Pandolfi E, Marino M, Carloni E, Romano M, Gesualdo F, Borgia P, et al.** The effect of physician's recommendation on seasonal influenza immunization in children with chronic diseases. BMC Public Health. 2012;12(1):984.
32. **Wiley K, Leask J.** Respiratory vaccine uptake during pregnancy. Lancet Respir Med. 2013;1(1):9-11.
33. **Biasio L.** Vaccine hesitancy and health literacy. Hum Vaccin Immunother. 2017:13(3):701-702.
34. **Ratzan S.** Health literacy: communication for the public good. Health Promot Int. 2001;16(2):207-14.
35. **Castro-Sánchez E, Chang P, Vila-Candel R, Escobedo A, Holmes A.** Health literacy and infectious diseases: why does it matter? Int J Infect Dis. 2016;43:103-10.
36. **Donadio G, Choudhary M, Lindemer E, Pawlowski C, Soundararajan V.** Counties with lower insurance coverage and housing problems are associated with both slower vaccine rollout and higher COVID-19 incidence. Vaccines (Basel). 2021;9(9):973.
37. **Lu P, O'Halloran A, Williams W.** Impact of health insurance status on vaccination coverage among adult populations. Am J Prev Med. 2015;48(6):647-61.
38. **Benin A, Wisler-Scher D, Colson E, Shapiro E, Holmboe E.** Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust. Pediatrics. 2006;117(5):1532-41.
39. United States Department of Agriculture Economic Research Service. Rural-Urban Continuum Codes 2013. 01/04/2022. Available from: https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/documentation/.
40. **Jain A, van Hoek AJ, Boccia D, Thomas SL.** Lower vaccine uptake amongst older individuals living alone: a systematic review and meta-analysis of social determinants of vaccine uptake. Vaccine. 2017;35(18):2315-28.
41. **Nguyen K, Yankey D, Lu P, Kriss J, Brewer N, Razzaghi H, et al.** Report of Health Care Provider Recommendation for COVID-19 vaccination among adults, by recipient COVID-19 vaccination status and attitudes - United States, April-September 2021. MMWR Morb Mortal Wkly Rep. 2021;70(50):1723-30.
42. **Shen S, Dubey V.** Addressing vaccine hesitancy: clinical guidance for primary care physicians working with parents. Can Fam Physician. 2019;65(3):175-81.
43. **Winston CA, Wortley PM, Lees KA.** Factors associated with vaccination of Medicare beneficiaries in five U.S. communities: results from the racial and ethnic adult disparities in immunization initiative survey, 2003. J Am Geriatr Soc. 2006;54(2):303-10.
44. **Bhanu C, Gopal DP, Walters K, Chaudhry UAR.** Vaccination uptake amongst older adults from minority ethnic backgrounds: a systematic review. PLoS Med. 2021;18(11):e1003826.
45. National Adult and Influenza Immunization Summit. Call to Action to Protect All Adults from Vaccine-Preventable Disease and Disability. 2021. 01/04/2021. Available from: https://www.izsummitpartners.org/call-to-action-adult-immunizations/.
46. **Keisler-Starkey K, Bunch L.** Health Insurance Coverage in the United States: 2019. United States Census Bureau; 2020. Contract No.: P60-271.

47. **Beleche T, Ruhter J, Kolbe A, Marus J, Bush L, Sommers B.** COVID-19 vaccine hesitancy: demographic factors, geographic patterns, and changes over time. Washington, DC: Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services; 2021.
48. **Karpman M, Kenney G, Zuckerman S, Gonzalez D, Courtot B.** Confronting COVID-19 vaccine hesitancy among nonelderly adults: findings from the December 2020 well-being and basic needs survey. Urban Institute; 2021.
49. **Hill H, Elam-Evans L, Yankey D, Singleton J, Kang Y.** Vaccination coverage among children aged 19-35 months - United States, 2017. MMWR Morb Mortal Wkly Rep. 2018;67(40):1123-8.
50. **Lama Y, Hancock G, Freimuth V, Jamison A, Quinn S.** Using classification and regression tree analysis to explore parental influenza vaccine decisions. Vaccine. 2020;38(5):1032-9.