**Distribution Agreement**



Signature:

____________________________ ______________

Elizabeth Hanna Schurr Date

Association of COVID-19 Perceived Vaccine Eligibility with Vaccine Guideline Complexity & Correct Determination of Eligibility During Times of Vaccine Scarcity

By

Hanna Schurr
MPH

Department of Epidemiology

Aaron J Siegler, PhD
Committee Chair

Association of COVID-19 Perceived Vaccine Eligibility with Vaccine Guideline Complexity & Correct Determination of Eligibility During Times of Vaccine Scarcity

By

Hanna Schurr

B.S.
Georgia State University
2020

Thesis Committee Chair: Aaron J Siegler, PhD

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
2022

# Abstract

Association of COVID-19 Perceived Vaccine Eligibility with Vaccine Guideline Complexity & Correct Determination of Eligibility During Times of Vaccine Scarcity
By Hanna Schurr

Introduction: The purpose of this study is to assess the relation between perceived COVID-19 vaccine eligibility, vaccine guideline complexity, and correct determination of vaccine eligibility among participants living in six populous states to determine if vaccine guidelines are too complex for individuals. Methods: Logistic regression analysis and sensitivity, specificity, positive predictive value, and negative predictive value analyses were conducted to determine the association between perceived vaccine eligibility, guideline complexity, demographic factors, and determination of vaccine eligibility among those surveyed. Results: Vaccine eligible persons living in states determined to have more complex guidelines had 60% lower odds of correctly determining eligibility status than persons living in states with less complex guidelines. Vaccine eligible persons aged 65+ years had over 21 times higher odds of correctly determining eligibility status than eligible persons aged 45-54 years. Discussion: Too complex vaccine guidelines may hinder an individual from being able to correctly determining their vaccine eligibility status, therefore it is crucial for public health agencies and jurisdictions to simplify vaccine guidelines to ensure appropriate health communication.

Association of COVID-19 Perceived Vaccine Eligibility with Vaccine Guideline Complexity & Correct Determination of Eligibility During Times of Vaccine Scarcity

By

Hanna Schurr
B.S.
Georgia State University
2020

Thesis Committee Chair: Aaron J Siegler, PhD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
2022

Table of Contents

*Introduction*

At the beginning of COVID-19 vaccine rollout, the initial demand for vaccines exceeded the supply, an occurrence that can be expected to continue with future pandemics. Because of supply and demand discrepancies, vaccine prioritization will occur in early periods of supply availability, and it is crucial for at-risk individuals to be able to identify when they qualify to receive a vaccine. Since the United States COVID-19 vaccination rollout began on December 14, 2020, [1] many states created unique guidelines to prioritize the COVID-19 vaccine. The Centers for Disease Control and Prevention (CDC) released guidelines on vaccine prioritization, but states were not required to follow these guidelines [2], allowing for local variance in how the COVID-19 vaccine was initially rolled out, including eligibility determination.

Differences in state-level guidelines for vaccine eligibility allow an opportunity to explore the impact of different guideline characteristics. One potential difference between vaccine eligibility guidelines is complexity, the nuance contained within each guideline providing greater detail regarding eligibility. Although complex eligibility requirements may allow for a more tailored vaccine distribution, too much complexity of vaccine guidelines may impede people's ability to correctly interpret the guidelines and could negatively impact early vaccine distribution.

To our knowledge, there have not been assessments of vaccine eligibility guideline complexity, or of how differences in guideline complexity may impact ability to correctly determine vaccine eligibility during times of vaccine scarcity. However, there is existing literature that addresses public opinions on vaccine prioritization itself [3, 4] . Adults in the United States are generally supportive of prioritizing frontline healthcare workers and adults over the age of 65 years old.

COVIDVu, a national population-based serosurvey, was conducted to examine SARS-CoV-2 prevalence and incidence [5-8]. In addition to providing biological specimens, one person over the age of 18 years per household sampled was randomly selected and asked to complete a questionnaire consisting of demographic information, knowledge about COVID-19, testing history, symptomatic illness history, household illness, social distancing and isolation practices, and perceived vaccine eligibility [5]. Notably, although the COVID-19 vaccine is now widely available in the US, it was scarce during the COVIDVu study period, which coincided with the early stages of vaccine rollout, in April 2021. The purpose of this analysis is to describe COVID-19 vaccine guideline complexity, and to examine its relation with correct determination of vaccine eligibility among persons surveyed in the six highly populated states of Georgia, Florida, Texas, New York, Pennsylvania, and New York.

*Methods*

*Data Collection*

The COVIDVu survey was a national, population-based household sample survey that aimed to collect SARS-CoV-2 seroprevalence data for approximately 4,000 United States participants [5]. The COVIDVu survey consisted of two elements: a self-collection biological specimen kit that included an anterior nares swab for RNA PCR (polymerase chain reaction) and a dried blood spot (DBS) for serology, and a behavioral survey. Each component was completed in three-month intervals. The behavioral survey was a 15–20-minute survey that collected demographic information, knowledge of COVID-19, job history, medical history, SARS-CoV-2 testing history, history of COVID-19 symptoms, household illness, and social distancing and isolation practices, and life changes due to COVID-19.

*Inclusion Criteria*

COVIDVu survey eligibility included those aged 18 years or older [5]. For the present cross-sectional, ecological study, there were a number of additional inclusion criteria. We assessed policy and demographics in states with at least n=85 participants during the survey period of 3 March 2021 to 21 April 2021. Six states were identified to have at least n=85 overall participants; the states include Georgia, Florida, Texas, California, New York, and Pennsylvania. Among all six states, there were 898 survey participants identified as eligible for inclusion in analysis. Participants must have resided in one of six states (CA, FL, GA, PA, NY, TX), self-reported their age and at least one other eligibility criteria (occupation category, health condition, BMI, smoking status, or long-term care facility residence), and have completed the COVIDVu survey between the dates of 3 March 2021 and 21 April 2021 to be included in analysis. Participants with a Body Mass Index (BMI) calculated to be less than 10 kg/$m^2$ or greater 70 kg/$m^2$, were excluded from analysis due to determination that data had been entered incorrectly. To allow for appropriate determination of the outcome of perceived vaccine eligibility, we excluded persons who declined to answer, who answered "unsure" about vaccine eligibility, or who had already been vaccinated.

*Determination of Vaccine Eligibility & Guideline Complexity*

To determine participants' eligibility for COVID-19 vaccination, we obtained each state's vaccination eligibility guidelines from official government communication. We developed and enumerated in a table of each state-specific vaccine eligibility rule and applied these to survey data collected in COVIDVu (Appendix A). Survey data was used to classify participants as either eligible for vaccination or ineligible for vaccination based on this table of state-specific guidance, the date of survey completion, the date each state's vaccination guidelines went into effect, and matching of participants' responses of age, occupation, health condition, and long-term care facility residence to vaccine guidelines. If participants met at least one current eligibility criterion at the time of survey completion, they were classified as eligible. If participants did not meet any current eligibility criteria at the time of survey completion, they were classified as ineligible. Vaccine guidelines were categorized into complexity levels: less complex and more complex. Guidelines were classified as either "more complex" or "less complex" based on word count and the number of eligibility criteria of each state's guidelines. More complex guidelines had a word count of >150 and eligibility criteria >30, and less complex guidelines had a word count of ≤150 and eligibility criteria≤30 (Appendix B).

*Data Analysis*

All data analysis was conducted in SAS 9.4. Analysis compared participants' perceived eligibility for the COVID-19 vaccine at time of survey and participants' actual eligibility for the COVID-19 vaccine at time of survey. Sensitivity, specificity, positive predictive value, and negative predictive value of actual vaccine eligibility versus perceived vaccine eligibility were calculated for the entire sample and stratified by vaccine complexity category, and for each individual state. Logistic regression analysis was used to assess the relation between correct vaccine eligibility determination and guideline complexity, sex, race & ethnicity, age, education, income, and insurance. Results are reported in odds ratios. After initial logistic regression analysis was performed, multivariable logistic regression analysis was performed, which included controlling for confounders of sex, race & ethnicity, age, income, insurance, education to assess the relation between guideline complexity and eligibility determination.

Sex and vaccine guideline complexity were analyzed as dichotomous variables. Race & ethnicity, age, education, income, and insurance were categorical. Age was also included as a continuous variable for demographic purposes. For states that included BMI as a vaccine eligibility criterion, weight in pounds was converted to weight in kilograms, height in feet and inches were converted to height in meters, and BMI was calculated using $kg/m^2$. Two separate codings of correct vaccine eligibility determination were made to facilitate interpretability of results, because proper determination among those who ARE vaccine eligible seems most critical in terms of public health ramifications for vaccine seeking. The first coding assessed the proportion of participants correctly determining their eligibility *among participants who were vaccine eligible (e.g., sensitivity)*. The second coding assessed the proportion of participants correctly determining their eligibility *among participants who were **not** vaccine eligible (e.g.*, *specificity*). Logistic regressions were conducted for each of these coding strategies. The model for the eligible participants produced odds ratios that can be interpreted as: 'Odds of eligible participants correctly identifying vaccine eligibility status divided by the odds of eligible participants incorrectly identifying vaccine eligibility status. The model for the ineligible participants can be described as 'Odds of ineligible participants correctly identifying vaccine eligibility status divided by the odds of ineligible participants incorrectly identifying vaccine eligibility status'.

Sensitivity, specificity, positive predictive value, and negative predictive value, and their 95% confidence intervals were calculated using the PROC FREQ procedure with the 'senspec' command in SAS 9.4. Sensitivity was defined as 'the percentage of eligible persons correctly identifying their eligibility status'. Specificity was defined as 'the percentage of ineligible persons correctly identifying their eligibility status'. Positive predictive value was defined as 'The percentage of persons who perceived themselves as eligible for a vaccine and were eligible'. Negative predictive value was defined as 'The percentage of persons who perceived themselves as ineligible for a vaccine and were ineligible'. Analysis also includes the distribution of participants in each jurisdiction of interest—entire catchment area, states with less complex vaccine guidelines, states with more complex vaccine guidelines, and each separate state was analyzed for sensitivity, specificity, positive predictive value, negative predictive value, and distribution of study participants.

*Results*

*Demographic Characteristics*

The total analytic sample size was 898. 535 (59.6%) participants identified their sex as female, and 504 (56.1%) participants identified their race & ethnicity as non-Hispanic White. Participant age ranged from 18 to 89 years (mean=45.4, std dev: 14.5). Demographic characteristics stratified by COVID-19 vaccine eligibility at time of survey are included in Table 1.

*Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Vaccine Eligibility and Actual Vaccine Eligibility*

*Entire Catchment Area*

Sensitivity was 0.72 (95% CI 0.68, 0.76), indicating 72% of those who were eligible for the COVID-19 vaccine perceived themselves to be eligible (Table 2). Specificity was 0.79 (95% CI 0.75, 0.83), indicating 79% of participants who were ineligible for the COVID-19 vaccine perceived themselves as ineligible. Positive predictive value was 0.76 (95% CI 0.72, 0.80), indicating that 76% of people who perceived themselves eligible for the COVID-19 vaccine were eligible. Negative predictive value was 0.75 (95% CI 0.71, 0.79) indicating that 75% of those who perceive themselves ineligible for the COVID-19 vaccine were ineligible. Overall, 34.5% (n=310) of participants perceived themselves as eligible for the COVID-19 vaccine and were eligible, and

41.0% (n=368) of participants perceived themselves as ineligible for the COVID-19 vaccine and were ineligible (Table 3).

*States with Less Complex Vaccine Guidelines (Florida, Georgia, Texas)*

Among states with less complex vaccine guidelines (n=515), sensitivity was 0.78 (95% CI 0.73, 0.83), indicating that 78% of those who were eligible for the COVID-19 perceived themselves to be eligible (Table 4). Specificity was 0.77 (95% CI 0.71, 0.82), indicating 77% of participants who were ineligible for the COVID-19 vaccine perceived themselves to be ineligible. Positive predictive value was 0.80 (95% CI 0.75, 0.85), indicating that 80% of persons who perceived themselves eligible for a COVID-19 vaccine were eligible. Negative predictive value was 0.74 (95% CI, 0.69, 0.80), indicating that 74% of persons who perceived themselves as ineligible for the COVID-19 vaccine were ineligible. 42.3% (n=218) of participants perceived themselves as eligible for the COVID-19 vaccine and were eligible, and 35.0% (n=180) of participants perceived themselves ineligible for the COVID-19 vaccine and were ineligible (Table 5).

*States with More Complex Vaccine Guidelines (California, New York, Pennsylvania)*

Among states with more complex vaccine guidelines, sensitivity was 0.61 (95% CI 0.53, 0.69), indicating that 61% of persons who were eligible for the COVID-19 vaccine perceived themselves to be eligible (Table 6). Specificity was 0.81 (95% CI 0.76, 0.87), indicating that 81% of persons who were eligible for the COVID-19 vaccine perceived themselves to be ineligible. Positive predictive value was 0.68 (95% CI 0.60, 0.76), indicating that 68% of persons who perceived themselves eligible for a COVID-19 vaccine were eligible. Negative predictive value was 0.76 (95% CI 0.71, 0.81), indicating that 76% of persons who perceived themselves ineligible for a COVID-19 vaccine were ineligible. 24.0% (n=92) of participants perceived themselves as eligible for the COVID-19 vaccine and were eligible, and 49.1% (n=188) of participants perceived themselves as ineligible for the COVID-19 vaccine and were ineligible (Table 7).

*Georgia*

Participants residing in Georgia (n=418) were calculated to have a sensitivity of 0.77 (95% CI 0.72, 0.83), indicating that 77% of persons eligible for a vaccine perceived themselves to be eligible (Table 8). Georgia had a specificity of 0.77 (95% CI 0.71, 0.83), showing that 77% of persons ineligible for a vaccine perceived themselves as ineligible. Georgia had a positive predictive value of 0.82 (95% CI 0.77, 0.87), indicating that 82% of people that perceived themselves eligible for a vaccine were in fact eligible. The negative predictive value was 0.73 (95% CI 0.66, 0.79), indicating that 73% of people that perceived themselves as ineligible were in fact ineligible to receive a vaccine. 44.0% (n=184) of Georgia participants perceived themselves eligible for the COVID-19 vaccine and were eligible, and 33.5% (n=140) of Georgia participants perceived themselves ineligible for vaccination and were ineligible (Table 9).

*California*

Participants residing in California (n=295) had a sensitivity of 0.60 (95% CI 0.50, 0.70), indicating that 60% of persons who were eligible for a vaccine perceived themselves as eligible

(Table 10). California had a specificity of 0.82 (95% CI 0.77, 0.88), indicating that 82% of persons who were ineligible for a vaccine perceived themselves to be ineligible. The positive predictive value was 0.61 (95% CI 0.51, 0.71), showing that 61% of persons perceived themselves as eligible for a vaccine and were eligible. The negative predictive value was 0.81 (95% CI 0.76, 0.87), showing that 81% of people who perceived themselves as ineligible for a vaccine were ineligible. 19.0% (n=56) of participants perceived themselves eligible for vaccination and were eligible, and 55.9% (n=165) of participants perceived themselves ineligible for vaccination and were ineligible (Table 11).

*New York*

Participants residing in New York (n=49) had a sensitivity of 0.71 (95% CI 0.55, 0.88), indicating that 71% of persons who were eligible for a vaccine perceived themselves as eligible (Table 12). New York had a specificity of 0.76 (95% CI 0.58, 0.94), meaning that 76% of persons who were ineligible for a vaccine perceived themselves as ineligible. The positive predictive value was 0.80 (95% CI 0.64, 0.96), indicating that 80% of people who perceived themselves to be eligible for a vaccine were eligible. The negative predictive value was 0.67 (95% CI 0.48, 0.86), meaning that 67% of people who perceived themselves as ineligible for a vaccine were ineligible. 40.8% (n=20) of participants perceived themselves to be eligible for vaccination and were eligible, and 32.6% (n=16) of participants perceived themselves to be ineligible for vaccination and were ineligible (Table 13).

*Pennsylvania*

Participants residing in Pennsylvania (n=39) had a sensitivity calculated to be 0.55 (95% CI 0.37, 0.73), meaning that 55% of persons who were eligible for a vaccine perceived themselves to be eligible (Table 14). The specificity was 0.70 (95% CI 0.42, 0.98), indicating that 70% of ineligible persons perceived themselves to be ineligible. Pennsylvania returned a positive predictive value of 0.84 (95% CI 0.68, 1.00), indicating that 84% of persons who perceived themselves eligible were eligible. The negative predictive value was 0.35 (95% CI 0.14, 0.56), showing that 35% of persons who perceived themselves as ineligible were ineligible. 41.0% (n=16) of participants perceived themselves to be eligible for vaccination and were eligible, and 17.9% (n=7) of participants perceived themselves to be ineligible for vaccine and were ineligible (Table 15).

*Texas*

Participants residing in Texas (n=46) had a sensitivity of 0.80 (95% CI 0.66, 0.94), indicating that 80% of persons who were eligible for a vaccine perceived themselves to be eligible (Table 16). The specificity was 0.69 (95% CI 0.46, 0.91), showing that 69% of persons who were ineligible for a vaccine perceived themselves to be ineligible. The positive predictive value was 0.83 (95% CI 0.69, 0.97), indicating that 83% of persons who perceived themselves to be eligible were eligible. The negative predictive value was 0.65 (95% CI 0.42, 0.87), meaning that 65% of persons who perceived themselves ineligible were ineligible. 52.2% (n=24) of participants perceived themselves to be eligible for vaccination and were eligible, and 23.9%

(n=11) of participants perceived themselves to be ineligible for vaccination and were ineligible (Table 17).

*Florida*

Participants residing in Florida (n=51) had a sensitivity of 0.77 (95% CI 0.54, 1.00), indicating that 77% of eligible persons perceived themselves as eligible for a vaccine (Table 18). Florida had a specificity of 0.76 (95% CI 0.63, 0.90), meaning that 76% of ineligible persons perceived themselves as ineligible for a vaccine. The positive predictive value was 0.53 (95% CI 0.30, 0.75), showing that 53% of people who perceived themselves eligible for a vaccine were eligible. The negative predictive value was 0.91 (95% CI 0.81, 1.00), indicating that 91% of persons who perceived themselves ineligible were ineligible. 19.6% (n=10) of participants perceived themselves to be eligible for vaccination and were eligible, and 56.9% (n=29) of participants perceived themselves to be ineligible for vaccination and were ineligible (Table 19).

Logistic Regression Analysis

*Part 1: Determination of positive COVID-19 vaccine eligibility status*

*Logistic Regression Analysis- Controlling for Significant Variables*

Females had over two times higher odds of correctly determining positive eligibility status than males (aOR: 2.48, 95% CI 1.52, 4.05) (Table 21). Participants aged 65 and over had over 21 times higher odds of correctly determining positive eligibility status than those aged 45-54 (aOR: 21.04, 95% CI 4.33, 102.23). The odds of participants living in a state with more complex vaccine guidelines were 0.40 times the odds of participants living in states with less complex guidelines of correctly determining positive eligibility status (aOR: 0.40, 95% CI 0.24, 0.66). After adjusting for confounders, the variables of Race & Ethnicity, Income, and Insurance did not have an association with ability to correctly determining positive eligibility status. Results from unadjusted analyses can be found in Table 20.

*Part 2: Determination of negative COVID-19 vaccine eligibility status*

*Logistic Regression Analysis- Controlling for Significant Variables*

The odds of females were 0.54 times the odds of males in correctly determining negative eligibility status (aOR: 0.54, 95% CI 0.33, 0.88). Participants aged 35-44 had three times higher odds of participants aged 45-54 in correctly determining negative eligibility status (aOR: 3.30, 95% CI 1.43, 7.62). The odds of participants whose highest level of education is a high school diploma or GED was 0.29 times the odds of those with a bachelor's degree in correctly determining negative eligibility status (aOR: 0.29, 95% CI 0.13, 0.61). The odds of participants whose highest level of education completed is 'some college' was 0.49 times the odds of those with a bachelor's degree in correctly determining negative eligibility status (aOR: 0.49, 95% CI 0.26, 0.93). The odds of participants with an associate degree were 0.30 times the odds of those with a bachelor's degree in correctly determining negative eligibility status (aOR: 0.30, 95% CI 0.13, 0.71). The variable of Race & Ethnicity becomes insignificant after controlling for significant variables (Table 23). Results from unadjusted analyses can be found in Table 22.

*Discussion*

To our knowledge, this is the first study to assess the relation between COVID-19 vaccine guideline complexity and ability to determine eligibility for a COVID-19 vaccine. Previous research has explored how vaccinations are prioritized during a pandemic, with high-risk and elderly populations generally being identified as the populations that by consensus should be prioritized [9, 10], yet little has been done to understand the impact of highly variable guideline complexity. At the beginning of COVID-19 vaccine rollout, Centers for Disease Control and Prevention released suggested vaccine guidelines. However, individual states were not required to use the CDC guidelines. Many states developed unique guidelines, which varied in complexity. We found that eligible persons who live in states with less complex vaccine guidelines were better able to correctly determine their positive eligibility status than eligible persons who live in states with more complex vaccine guidelines. In other words, there is an inverse association between guideline complexity and ability to correctly determine positive vaccine eligibility status. In states with less complex vaccine guidelines, 78% of vaccine eligible participants identified that they were eligible for a vaccine. In states with more complex vaccine guidelines, only 61% of vaccine eligible participants identified that they were eligible for a vaccine. These findings have implications for health communications more broadly than vaccination. There is a tradeoff between health communications complexity and interpretability. In a time where individuals are inundated with health information, health literacy is important so that individuals can understand information being presented to them. Many individuals are unable to understand health terminology and interpret research, and without simplified health communication, it will be difficult for an individual to understand their health status, including vaccine eligibility status. It is crucial to balance precision and simplicity in creating vaccine guidance, it is important to not overcomplicate guidance so that individuals are able to identify their eligibility.

This study also found that adults aged 65 years and older were much better able to correctly identify their positive vaccine eligibility status than adults aged 45 to 54 years. The odds of correctly determining positive eligibility status among those aged 65 years and older was over 21 times higher than the odds of correctly determining positive eligibility status of participants aged 45-54 years (aOR: 21.04, 95% CI 4.33, 102.23). Almost every single adult over the age of 65 that was eligible at time of survey was able to correctly identify that they were eligible for a vaccine. Throughout the entire pandemic, those over the age of 65 years were considered high risk for serious COVID-19 infection, or death. Generally, the public decided that elderly people should be among the first prioritized for a COVID-19 vaccine along with persons with disabilities and persons working in healthcare [9]. In addition to the public's opinion on vaccine prioritization, studies using mathematical models to determine how the COVID-19 vaccine should be prioritized have been conducted. Research suggests that, after examining five different mathematical models, those over the age of 60 years old should be prioritized to reduce mortality and years of life lost [10]. The vaccine guidelines for those 65 years of age and older were very consistent across the states included in analysis—each guideline only mentioned age and had no other qualifiers. Thus, the simplicity of the vaccine guidelines for those 65 years of age or older were useful in allowing people to correctly identify their eligibility status.  Many elderly people have health conditions that may make them eligible for a vaccine, but they will know they are eligible because of their age and not have to navigate the guidelines that include health conditions, such as cancer, heart disease, or diabetes. Overall, this supports our overall findings regarding less complex guidelines leading to better performance of individuals in determining their eligibility.

The use of proper public health communication is crucial in ensuring COVID-19 vaccine guidelines are understood by individuals. Appropriate, accessible, and accurate public health messaging is essential for health behavior uptake. Therefore, if vaccine guidelines are not made to be widely understandable, individuals may not be able to identify their eligibility for a vaccine. It is also important to ensure that vaccine guideline communications are culturally and socially responsive, meaning that communications should include non-stigmatizing language and promote health equity [11]. Public health communication should be precise and not include jargon so that it can be widely understood. Vaccine guidelines for each state included in this study were found online, with varying degrees of difficulty. If individuals cannot access vaccine eligibility in a simple manner, they may not be able to determine their eligibility for a vaccination. It is also important to note that websites can be edited and archived, so there is room for error to occur and for information to be moved or deleted, which may result in inaccessibility of data. The results from this analysis underscore the need for simple vaccine eligibility guidelines—and show that if guidelines are too complex, there may be differences in eligibility identification between jurisdictions.

*Limitations*

This study has several limitations. First, there is potential misclassification of vaccine eligibility due to self-reported survey data. We do not have reason to believe that any misclassification of data is differential, as there is no pattern between those who perceive themselves eligible for vaccination and those who perceive themselves ineligible for vaccination. Second, this study is limited because of its cross-sectional and ecological design. Due to this being a state level analysis, it is important to exercise caution in applying these results to an individual scenario.

*Conclusion*

This study found that increased vaccine guideline complexity is negatively associated with ability to correctly identify positive COVID-19 vaccine eligibility. Where vaccine guidelines were simple across the board, such as vaccine guidelines for those 65 years of age or older, participants were more able to correctly identify their vaccine eligibility. Public health agencies and jurisdictions may take this into consideration when determining future vaccine eligibility guidelines. More precision in guidelines leads to more complexity, which has shown lower guideline comprehension among the study population. To reach as many persons as possible and maximize vaccination for COVID-19, simple vaccine eligibility guidelines that include proper public health communication should be adopted. Future research may include states other than those included in this analysis, analysis on political affiliation and perceived vaccine eligibility, and analysis on if willingness to receive a COVID-19 vaccine is associated with perceived vaccine eligibility.

*References*


1. Diesel, J., et al., *COVID-19 Vaccination Coverage Among Adults - United States, December 14, 2020-May 22, 2021.* MMWR Morb Mortal Wkly Rep, 2021. **70**(25): p. 922-927.
2. Gunder, J.R. and L. Ballenger, *COVID-19 Vaccine Scarcity and Prioritization.* Available at SSRN 3908231, 2021.
3. Persad, G., et al., *Public Perspectives on COVID-19 Vaccine Prioritization.* JAMA Netw Open, 2021. **4**(4): p. e217943.
4. Gollust, S.E., et al., *US adults' preferences for public allocation of a vaccine for coronavirus disease 2019.* JAMA network open, 2020. **3**(9): p. e2023020-e2023020.
5. Siegler, A.J., et al., *Protocol for a national probability survey using home specimen collection methods to assess prevalence and incidence of SARS-CoV-2 infection and antibody response.* Annals of epidemiology, 2020. **49**: p. 50-60.
6. Siegler, A.J., et al., *Trajectory of COVID-19 Vaccine Hesitancy Over Time and Association of Initial Vaccine Hesitancy with Subsequent Vaccination.* JAMA Network Open, 2021. **4**(9): p. e2126882-e2126882.
7. Lamba, K., et al. *SARS-CoV-2 Cumulative Incidence and Period Seroprevalence: Results From a Statewide Population-Based Serosurvey in California*. in *Open Forum Infectious Diseases*. 2021. Oxford University Press US.
8. Chamberlain, A.T., et al., *Cumulative incidence of SARS-CoV-2 infections among adults in Georgia, United States, August to December 2020.* The Journal of infectious diseases, 2022. **225**(3): p. 396-403.
9. Matrajt, L., et al., *Vaccine optimization for COVID-19: Who to vaccinate first?* Sci Adv, 2020. **7**(6).
10. Bubar, K.M., et al., *Model-informed COVID-19 vaccine prioritization strategies by age and serostatus.* Science, 2021. **371**(6532): p. 916-921.
11. Centers for Disease Control and Prevention. *CDC's Health Equity Guiding Principle for Inclusive Communication*. 2021 [cited 2022 April 6]; Available from: https://www.cdc.gov/healthcommunication/Comm_Dev.html.

*Tables*

Table 1. Demographic Characteristics of Participants (n=898) Stratified on COVID-19 Vaccine Eligibility at time of Survey (3 March 2021 to 21 April 2021)

| Characteristic | Total n(%) | Eligible for COVID-19 Vaccine | | Ineligible for COVID-19 Vaccine | |
|---|---|---|---|---|---|
| | | Perceived Eligible n(%) | Perceived Ineligible n(%) | Perceived Eligible n(%) | Perceived Ineligible n(%) |
| **Sex** | | | | | |
| Male | 363 (40.4%) | 101 (27.8%) | 59 (16.3%) | 32 (8.8%) | 171 (47.1%) |
| Female | 535 (59.6%) | 209 (39.1%) | 62 (11.6%) | 67 (12.5%) | 197 (36.8%) |
| **Race & Ethnicity** | | | | | |
| Hispanic | 152 (16.9%) | 35 (23.0%) | 18 (11.8%) | 19 (12.5%) | 80 (52.6%) |
| Non-Hispanic White | 504 (56.1%) | 182 (36.1%) | 70 (13.9%) | 51 (10.1%) | 201 (39.9%) |
| Non-Hispanic Black | 178 (19.8%) | 80 (44.5%) | 18 (10.1%) | 25 (14.0%) | 55 (30.9%) |
| Non-Hispanic Asian | 49 (5.5%) | 8 (16.3%) | 11 (22.5%) | 2 (4.1%) | 28 (57.1%) |
| Non-Hispanic Other | 15 (1.7%) | 5 (33.3%) | 4 (26.7%) | 2 (13.3%) | 4 (26.7%) |
| **Age** | | | | | |
| (Mean, SD) | 45.4 (14.5) | | | | |
| **Age** | | | | | |
| 18-24 | 66 (7.3%) | 16 (24.2%) | 8 (12.1%) | 8 (12.1%) | 34 (51.5%) |
| 25-34 | 185 (20.6%) | 52 (28.1%) | 22 (11.9%) | 21 (11.4%) | 90 (48.5%) |
| 35-44 | 170 (18.9%) | 44 (25.9%) | 36 (21.2%) | 9 (5.3%) | 81 (47.7%) |
| 45-54 | 189 (21.0%) | 47 (24.9%) | 27 (14.3%) | 30 (15.9%) | 85 (45.0%) |
| 55-64 | 217 (24.1%) | 82 (37.8%) | 26 (12.0%) | 31 (14.3%) | 78 (35.9%) |
| 65+ | 71 (8.1%) | 69 (97.2%) | 2 (2.82%) | 0 (0.0%) | 0 (0.0%) |

Table 2. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Eligibility versus Actual Eligibility for COVID-19 Vaccines for Overall Catchment Area (n=898) at time of Survey (3 March 2021 to 21 April 2021)

| Statistic | Estimate | 95% Confidence Intervals |
|---|---|---|
| Sensitivity | 0.72 | 0.68, 0.76 |
| Specificity | 0.79 | 0.75, 0.83 |
| Positive Predictive Value | 0.76 | 0.72, 0.80 |
| Negative Predictive Value | 0.75 | 0.71, 0.79 |

Table 3. Frequency of Perceived Eligibility and Actual Eligibility for COVID-19 Vaccines for Overall Catchment Area (n=898) at time of Survey (3 March 2021 to 21 April 2021)

| | Perceived ineligible | Perceived eligible | Total |
|---|---|---|---|
| Ineligible for vaccine | 368 (41.0%) | 99 (11.0%) | 467 |
| Eligible for Vaccine | 121 (13.5%) | 310 (34.5%) | 431 |
| Total | 489 | 409 | 898 |

Table 4. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Eligibility versus Actual Eligibility for COVID-19 Vaccines for States with Less Complex Guidelines (n=515) at time of Survey (3 March 2021 to 21 April 2021)

| Statistic | Estimate | 95% Confidence Limits |
|---|---|---|
| Sensitivity | 0.78 | 0.73, 0.83 |
| Specificity | 0.77 | 0.71, 0.82 |
| Positive Predictive Value | 0.80 | 0.75, 0.85 |
| Negative Predictive Value | 0.74 | 0.69, 0.80 |

Table 5. Frequency of Perceived Eligibility and Actual Eligibility for COVID-19 Vaccines for States with Less Complex Guidelines (n=515) at time of Survey (3 March 2021 to 21 April 2021)

| | Perceived ineligible | Perceived eligible | Total |
|---|---|---|---|
| Ineligible for vaccine | 180 (35.0%) | 55 (10.7%) | 235 |
| Eligible for Vaccine | 62 (12.0%) | 218 (42.3%) | 280 |
| Total | 242 | 273 | 515 |

Table 6. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Eligibility versus Actual Eligibility for COVID-19 Vaccines for States with More Complex Guidelines (n=383) at time of Survey (3 March 2021 to 21 April 2021)

| Statistic | Estimate | 95% Confidence Interval |
|---|---|---|
| Sensitivity | 0.61 | 0.53, 0.69 |
| Specificity | 0.81 | 0.76, 0.87 |
| Positive Predictive Value | 0.68 | 0.60, 0.76 |
| Negative Predictive Value | 0.76 | 0.71, 0.81 |

Table 7. Frequency of Perceived Eligibility and Actual Eligibility for COVID-19 Vaccines for States with More Complex Guidelines (n=383) at time of Survey (3 March 2021 to 21 April 2021)

| | Perceived ineligible | Perceived eligible | Total |
|---|---|---|---|
| Ineligible for vaccine | 188 (49.1%) | 44 (11.5%) | 232 |
| Eligible for Vaccine | 59 (15.4%) | 92 (24.0%) | 151 |
| Total | 247 | 136 | 383 |

Table 8. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Eligibility versus Actual Eligibility for COVID-19 Vaccines for Georgia (n=418) at time of Survey (3 March 2021 to 21 April 2021)

| Statistic | Estimate | 95% Confidence Interval |
|---|---|---|
| Sensitivity | 0.78 | 0.72, 0.83 |
| Specificity | 0.77 | 0.71, 0.83 |
| Positive Predictive Value | 0.82 | 0.77, 0.87 |
| Negative Predictive Value | 0.73 | 0.66, 0.79 |

Table 9. Frequency of Perceived Eligibility and Actual Eligibility for COVID-19 Vaccines for Georgia (n=418) at time of Survey (3 March 2021 to 21 April 2021)

| | Perceived ineligible | Perceived eligible | Total |
|---|---|---|---|
| Ineligible for vaccine | 140 (33.5%) | 41 (9.8%) | 181 |

| | | | |
|---|---|---|---|
| Eligible for Vaccine | 53 (12.7%) | 184 (44.0%) | 237 |
| Total | 193 | 225 | 418 |

Table 10. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Eligibility versus Actual Eligibility for COVID-19 Vaccines for California (n=295) at time of Survey (3 March 2021 to 21 April 2021)

| Statistic | Estimate | 95% Confidence Limits |
|---|---|---|
| Sensitivity | 0.60 | 0.50, 0.70 |
| Specificity | 0.82 | 0.77, 0.87 |
| Positive Predictive Value | 0.61 | 0.51, 0.71 |
| Negative Predictive Value | 0.81 | 0.76, 0.87 |

Table 11. Frequency of Perceived and Actual Eligibility for COVID-19 Vaccine for California (n=295) at time of Survey (3 March 2021 to 21 April 2021)

| | Perceived ineligible | Perceived eligible | Total |
|---|---|---|---|
| Ineligible for vaccine | 165 (55.9%) | 36 (12.2%) | 203 |
| Eligible for Vaccine | 38 (12.9%) | 56 (19.0%) | 92 |
| Total | 201 | 94 | 295 |

Table 12. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Eligibility versus Actual Eligibility for COVID-19 Vaccines for New York (n=49) at time of Survey (3 March 2021 to 21 April 2021)

| Statistic | Estimate | 95% Confidence Intervals |
|---|---|---|
| Sensitivity | 0.71 | 0.55, 0.88 |
| Specificity | 0.76 | 0.58, 0.94 |
| Positive Predictive Value | 0.80 | 0.64, 0.96 |
| Negative Predictive Value | 0.67 | 0.48, 0.86 |

Table 13. Frequency of Perceived and Actual Eligibility for COVID-19 Vaccine for New York (n=49) at time of Survey (3 March 2021 to 21 April 2021)

| | Perceived ineligible | Perceived eligible | Total |
|---|---|---|---|
| Ineligible for vaccine | 16 (32.6%) | 5 (10.2%) | 21 |
| Eligible for Vaccine | 8 (16.3%) | 20 (40.8%) | 28 |
| Total | 24 | 25 | 49 |

Table 14. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Eligibility versus Actual Eligibility for COVID-19 Vaccines for Pennsylvania (n=39) at time of Survey (3 March 2021 to 21 April 2021)

| Statistic | Estimate | 95% Confidence Limits |
|---|---|---|
| Sensitivity | 0.55 | 0.37, 0.73 |
| Specificity | 0.70 | 0.42, 0.98 |
| Positive Predictive Value | 0.84 | 0.68, 1.00 |
| Negative Predictive Value | 0.35 | 0.14, 0.56 |

Table 15. Frequency of Perceived and Actual Eligibility for COVID-19 Vaccine for Pennsylvania (n=39) at time of Survey (3 March 2021 to 21 April 2021)

| | Perceived ineligible | Perceived eligible | Total |
|---|---|---|---|
| Ineligible for vaccine | 7 (17.9%) | 3 (7.7%) | 14 |
| Eligible for Vaccine | 13 (33.3%) | 16 (41.0%) | 35 |
| Total | 20 | 19 | 39 |

Table 16. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Eligibility versus Actual Eligibility for COVID-19 Vaccines for Texas (n=46) at time of Survey (3 March 2021 to 21 April 2021)

| Statistic | Estimate | 95% Confidence Limits |
|---|---|---|
| Sensitivity | 0.80 | 0.66, 0.94 |
| Specificity | 0.69 | 0.46, 0.91 |
| Positive Predictive Value | 0.83 | 0.69, 0.97 |
| Negative Predictive Value | 0.65 | 0.42, 0.87 |

Table 17. Frequency of Perceived and Actual Eligibility for COVID-19 Vaccine for Texas (n=46) at time of Survey (3 March 2021 to 21 April 2021)

| | Perceived ineligible | Perceived eligible | Total |
|---|---|---|---|
| Ineligible for vaccine | 11 (23.9%) | 5 (10.9%) | 16 |
| Eligible for Vaccine | 6 (13.0%) | 24 (52.2%) | 30 |
| Total | 17 | 29 | 46 |

Table 18. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of Perceived Eligibility versus Actual Eligibility for COVID-19 Vaccines for Florida (n=51) at time of Survey (3 March 2021 to 21 April 2021)

| Statistic | Estimate | 95% Confidence Limits |
|---|---|---|
| Sensitivity | 0.77 | 0.54, 1.00 |
| Specificity | 0.76 | 0.63, 0.90 |
| Positive Predictive Value | 0.53 | 0.30, 0.75 |
| Negative Predictive Value | 0.91 | 0.81, 1.00 |

Table 19. Frequency of Perceived and Actual Eligibility for COVID-19 Vaccine for Florida (n=51) at time of Survey (3 March 2021 to 21 April 2021)

| | Perceived ineligible | Perceived eligible | Total |
|---|---|---|---|
| Ineligible for vaccine | 29 (56.9%) | 9 (17.6%) | 38 |
| Eligible for Vaccine | 3 (5.9%) | 10 (19.6%) | 13 |
| Total | 32 | 19 | 51 |

Table 20. Bivariate Logistic Regression Analysis of Determination of Correct Positive COVID-19 Vaccine Eligibility Status

| Characteristic | Odds Ratio | 95% CI | P-value |
|---|---|---|---|
| **Sex** | | | |
| Male | Reference | -- | -- |
| Female | 1.97 | 1.28, 3.02 | 0.0019 |

| | | | |
|---|---|---|---|
| **Race & Ethnicity** | | | |
| Hispanic | 0.75 | 0.40, 1.41 | 0.3674 |
| Non-Hispanic White | Reference | -- | -- |
| Non-Hispanic Black | 1.71 | 0.97, 3.10 | 0.0704 |
| Non-Hispanic Asian | 0.28 | 0.11, 0.72 | 0.0087 |
| Non-Hispanic Other | 0.48 | 0.13, 1.84 | 0.2853 |
| **Age** | | | |
| 18-24 | 1.149 | 0.435, 3.036 | 0.7795 |
| 25-34 | 1.358 | 0.683, 2.700 | 0.3831 |
| 35-44 | 0.665 | 0.350, 1.264 | 0.2134 |
| 45-54 | Reference | -- | -- |
| 55-64 | 1.787 | 0.941, 3.396 | 0.0762 |
| 65+ | 19.819 | 4.496, 87.356 | <0.0001 |
| **Education** | | | |
| High School/GED | 1.68 | 0.82, 3.42 | 0.1560 |
| Some college | 1.39 | 0.78, 2.50 | 0.2688 |
| Associate degree | 1.24 | 0.61, 2.54 | 0.5478 |
| Bachelor's degree | Reference | -- | -- |
| Master's degree or higher | 1.30 | 0.73, 2.32 | 0.3807 |
| **Income** | | | |
| $0-$49,999 | Reference | -- | -- |
| $50,000-$99,999 | 0.653 | 0.39, 1.10 | 0.1048 |
| $100,000+ | 0.495 | 0.30, 0.83 | 0.0075 |
| **Insurance** | | | |
| No health insurance | 1.16 | 0.51, 2.63 | 0.7258 |
| Medicare/Medicaid/other govt plan | 2.22 | 1.30, 3.77 | 0.0033 |
| Private insurance/parent's plan | Reference | -- | -- |
| Don't know | 0.74 | 0.31, 1.77 | 0.4955 |
| **Policy Complexity** | | | |
| More complex | 0.44 | 0.29, 0.68 | 0.0002 |
| Less complex | Reference | -- | -- |

Table 21. Logistic Regression Analysis for Determination of Correct Positive COVID-19 Eligibility Status- Controlling for Significant Variables

| Characteristic | Odds Ratio | 95% CI | P-value |
|---|---|---|---|
| **Sex** | | | |

| | | | |
|---|---|---|---|
| Male | Reference | -- | -- |
| Female | 2.482 | 1.522, 4.047 | 0.0003 |
| **Race & Ethnicity** | | | |
| Hispanic | 1.02 | 0.51, 2.05 | 0.9549 |
| Non-Hispanic White | Reference | -- | -- |
| Non-Hispanic Black | 1.01 | 0.51, 1.96 | 0.9895 |
| Non-Hispanic Asian | 0.40 | 0.14, 1.15 | 0.0890 |
| Non-Hispanic Other | 0.39 | 0.09, 1.72 | 0.2135 |
| **Age** | | | |
| 18-24 | 0.89 | 0.31, 2.60 | 0.8358 |
| 25-34 | 1.18 | 0.56, 2.46 | 0.6631 |
| 35-44 | 0.58 | 0.29, 1.17 | 0.1268 |
| 45-54 | Reference | -- | -- |
| 55-64 | 1.80 | 0.89, 3.65 | 0.1031 |
| 65+ | 21.04 | 4.33, 102.23 | 0.0002 |
| **Income** | | | |
| $0-$49,999 | Reference | -- | -- |
| $50,000-$99,999 | 0.76 | 0.41, 1.41 | 0.3841 |
| $100,000+ | 0.53 | 0.28, 1.02 | 0.0555 |
| **Insurance** | | | |
| No health insurance | 0.53 | 0.21, 1.38 | 0.1929 |
| Medicare/Medicaid/other govt plan | 0.88 | 0.45, 1.72 | 0.7153 |
| Private insurance/parent's plan | Reference | -- | -- |
| Don't know | 0.65 | 0.24, 1.75 | 0.3978 |
| **Vaccine Guideline Complexity** | | | |
| More complex | 0.40 | 0.24, 0.66 | 0.0004 |
| Less complex | Reference | -- | -- |

Table 22. Bivariate Logistic Regression Analysis of Determination of Correct Negative COVID-19 Vaccine Eligibility Status

| Characteristic | Odds Ratio | 95% CI | P-value |
|---|---|---|---|
| **Sex** | | | |
| Male | Reference | -- | -- |
| Female | 0.55 | 0.34, 0.88 | 0.0124 |

| | | | |
|---|---|---|---|
| **Race & Ethnicity** | | | |
| Hispanic | 1.07 | 0.59, 1.92 | 0.83 |
| Non-Hispanic White | Reference | -- | -- |
| Non-Hispanic Black | 0.56 | 0.32, 0.98 | 0.0427 |
| Non-Hispanic Asian | 3.55 | 0.82, 15.41 | 0.0904 |
| Non-Hispanic Other | 0.51 | 0.09, 2.85 | 0.4409 |
| **Age** | | | |
| 18-24 | 1.500 | 0.625, 3.600 | 0.3640 |
| 25-34 | 1.513 | 0.804, 2.844 | 0.1990 |
| 35-44 | 3.098 | 1.384, 6.932 | 0.0059 |
| 45-54 | Reference | -- | -- |
| 55-64 | 0.937 | 0.516, 1.701 | 0.8310 |
| **Education** | | | |
| High School/GED | 0.32 | 0.16, 0.65 | 0.0017 |
| Some college | 0.51 | 0.28, 0.93 | 0.0376 |
| Associate degree | 0.35 | 0.16, 0.76 | 0.0084 |
| Bachelor's degree | Reference | -- | -- |
| Master's degree or higher | 1.13 | 0.56, 2.31 | 0.7308 |
| **Income** | | | |
| $0-$49,999 | Reference | -- | -- |
| $50,000-$99,999 | 1.17 | 0.68, 2.02 | 0.5604 |
| $100,000+ | 1.38 | 0.80, 2.36 | 0.2485 |
| **Insurance** | | | |
| No health insurance | 1.28 | 0.51, 3.20 | 0.5985 |
| Medicare/Medicaid/other govt plan | 0.85 | 0.43, 1.64 | 0.6281 |
| Private insurance/parent's plan | Reference | -- | -- |
| Don't know | 0.83 | 0.34, 2.02 | 0.6851 |
| **Policy Complexity** | | | |
| More complex | 1.31 | 0.84, 2.04 | 0.2413 |
| Less complex | Reference | -- | -- |

Table 23. Logistic Regression Analysis for Determination of Correct Negative COVID-19 Eligibility Status- Controlling for Significant Variables

| Characteristic | Odds Ratio | 95% CI | P-value |
|---|---|---|---|
| **Sex** | | | |
| Male | Reference | -- | -- |
| Female | 0.54 | 0.33, 0.88 | 0.0141 |

| | | | |
|---|---|---|---|
| **Race & Ethnicity** | | | |
| Hispanic | 1.46 | 0.77, 2.79 | 0.2476 |
| Non-Hispanic White | Reference | -- | -- |
| Non-Hispanic Black | 0.72 | 0.39, 1.31 | 0.2765 |
| Non-Hispanic Asian | 3.22 | 0.72, 14.31 | 0.1250 |
| Non-Hispanic Other | 0.49 | 0.08, 3.05 | 0.4401 |
| **Age** | | | |
| 18-24 | 2.14 | 0.84, 5.46 | 0.1107 |
| 25-34 | 1.45 | 0.74, 2.82 | 0.2808 |
| 35-44 | 3.30 | 1.43, 7.62 | 0.0052 |
| 45-54 | Reference | -- | -- |
| 55-64 | 1.13 | 0.60, 2.11 | 0.7083 |
| **Education** | | | |
| High School/GED | 0.29 | 0.13, 0.61 | 0.0013 |
| Some college | 0.49 | 0.26, 0.93 | 0.0291 |
| Associate degree | 0.30 | 0.13, 0.71 | 0.0056 |
| Bachelor’s degree | Reference | -- | -- |
| Master’s degree or higher | 0.994 | 0.48, 2.08 | 0.9873 |