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Identifying early adopters of COVID-19 vaccines in Latin America

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Abstract

COVID-19 vaccine hesitancy is currently one of the main obstacles to worldwide herd immunity and socioeconomic recovery. Because vaccine coverage can vary between and within countries, it is important to identify sources of variation so that policies can be tailored to different population groups. In this paper, we analyze the results from a survey designed and implemented in order to identify early adopters and laggers in six big cities located in Argentina, Colombia, Chile, Ecuador, Peru, and Dominican Republic. We find that trust in government and science, accurate knowledge about the value of vaccination and vaccine effects, and perceived risk of getting sick is associated with a higher probability to get vaccinated. We also identify potential laggers such as women and populations with high education but low knowledge about vaccines. We discuss specific strategies to promote vaccination among these population groups as well as more general strategies designed to gain trust. These findings are specific to the context of Latin America insofar as the underlying factors associated with the choice to be vaccinated vary significantly by location and in relation to individual-level factors.

1. Introduction

Containment of the COVID-19 pandemic has become even more urgent as more deadly mutations of the SARS-Cov-2 virus emerge. The common goal is to achieve “herd immunity” in every country as soon as possible. However, the achievement of global herd immunity faces many obstacles: problems with the production and delivery of vaccines, unequal access to vaccines for different countries and/or population groups, and vaccine hesitancy and/or refusal, among others.

In this paper, we focus on vaccine hesitancy, which has been aggravated as a result of the COVID-19 pandemic. As acknowledged by the World Health Organization (WHO), a person’s willingness and motivation to be vaccinated is affected by a variety of thoughts and feelings about vaccines, including varying levels of perceived risk, worry, confidence, and trust, as well as safety concerns. Our purpose is to identify the factors associated with a person’s propensity to get a COVID-19 vaccine across several big cities of Latin America. Knowledge of these factors is especially important for policy purposes because it makes it possible to identify the population groups that are most willing to get vaccinated and thus can be used to increase demand. It also provides information on perceptions of vaccine safety and efficacy that can be used to implement communication campaigns or other strategies tailored to specific populations.

We designed and delivered a survey across citizens of six cities of Latin America with high incidence of COVID-19 (Buenos Aires-Argentina, Santiago-Chile, Bogotá-Colombia, Guayaquil-Ecuador, Lima-Peru, and Santo Domingo-Dominican Republic). The survey took place when the vaccine had not yet arrived to any of these countries (between September and December 2020). The timing of the survey was important, as it allowed us to identify the characteristics of individuals who were likely to become early adopters of the new vaccines before barely any specific information of the vaccine and vaccination process were available. Identifying early adopters, i.e. those individuals who use new products before the majority of people and have an influence on usage, is critical, as these groups can help to spur wider adoption of an innovation, while laggers can have a hindering effect.

Before the current pandemic, vaccine confidence was already decreasing worldwide for cultural, and political reasons. In 2019 vaccine hesitancy was already cited as one of the top ten threats to global health. The current situation may have aggravated the problem, as the use of social media has increased notably during the pandemic and it has been estimated that increased interactions with misleading online news accounts for 17% of...
In the past, the region of Latin America has not been known for vaccine hesitancy, at least toward children’s vaccines or other well-known vaccines among certain age groups such as the seasonal flu. However, previous evidence in the region from the pandemic H1N1 shows that there was some level of distrust regarding safety of the new vaccine; in particular, pregnant women in the region reported a very low rate of vaccination. But according to surveys made in different countries of the region during October and November 2020, it seems that levels of vaccine refusals related to COVID-19 are much higher than before the pandemic. For instance, in countries like Ecuador more than 50% reported an intention to refuse vaccination in October 2020 and around 38.5% in Colombia. Levels of vaccine refusal are lower in countries such as Chile (16%), Perú (10%) and Argentina (10%) but still higher than before the pandemic.

The willingness to get vaccinated in Latin America also seems to be lower in other regions of the world. While in Fall 2020 the average level of willingness to get vaccinated was around 73% for a sample of 15 countries around the world, surveys in countries of Latin America in the same period report that only about 40% of Argentines and Chileans were willing to be among the first to be vaccinated, and in Perú around 48% were willing to get vaccinated. The percentage is larger in Colombia (57.7% in October 2020), and Dominican Republic (68%).

Other studies have analyzed the propensity to get vaccinated against COVID-19 either do not focus on early adopters and/or gather data from other countries or regions. Our study is especially relevant to the context of Latin America, as the underlying factors associated with the choice to be vaccinated vary significantly by location and with individual-level factors. This variance can be attributed to complex socio-environmental, psychological, and cultural influences, and indicates the importance of information about vaccination propensity by region/country in order to design policies that target specific populations. Without this information, differences in vaccine coverage between and within countries could potentially delay global control of the pandemic and subsequent recovery. Although data about vaccine coverage is widely collected, no similarly robust monitoring system exists for vaccine confidence.

2. Study data and methods

2.1. Data

Data was collected through the Latinwell survey, an instrument developed by Florida International University and Universidad de Chile to assess the effects of COVID-19 on the subjective wellbeing of residents of Latin American cities and their willingness to get a COVID-19 vaccine. The Latinwell survey was implemented online and distributed to residents aged 25 to 60 from six large cities of Latin America: Buenos Aires (Argentina), Bogota (Colombia), Guayaquil (Ecuador), Lima (Peru), Santiago (Chile), and Santo Domingo (Dominican Republic). The cities were selected based on size (largest cities), language (Spanish speaking), and similar government response to the COVID-19 pandemic (Mexico and Venezuela were excluded). The Latinwell survey focused on large cities rather than countries because of accessibility constraints associated to access to internet that is usually more limited in smaller, rural areas. A non-probability sampling design was implemented through two web-based recruitment platforms. A total of 1,689 respondents were recruited from September 11th to November 8th, 2020 using Facebook’s advertising model to construct samples by age and city of residence. Facebook is a promising platform for survey sampling and recruitment in social science, but its use is still limited in the Latin American region. Additionally, 5,252 respondents were recruited from December 4th to December 13th using the Offerwise opt-in online panel. The Offerwise panel in the Latin American region covers the six countries included in the study with over 1.3 million panelists. Of all respondents, 2,155 completed the survey and were used for the analysis. The final sample included 460 (21.3%) respondents recruited from Facebook, and 1,695 (78.7%) respondents recruited from Offerwise.

The study was approved by the Scientific Ethics Evaluation Committee of the University of Chile, and the Florida International University Office of Research Integrity, IRB protocol 20–0553.

2.2. Measures

Our dependent variable is willingness to get a COVID-19 vaccine. Before any vaccination campaign was rolled out in Latin America, the Latinwell survey asked respondents whether they would be vaccinated if a vaccine against COVID-19 were approved and provided free of charge by the government. Response options were recorded on a 4-point Likert scale, ranging from “I will definitely not get the vaccine” to “I will definitely get it.”

Our variables of interest were chosen based on the WHO Strategic Advisory Group of Experts (SAGE) on vaccine hesitance. These experts grouped vaccine hesitance determinants into three key domains:

1) individual and group influences driven by personal perception of the vaccine or influences of the social/peer environment; ii) contextual influences driven by historic, sociocultural, environmental, health system/institutional, economic or political factors; and iii) specific issues directly related to the vaccine or vaccination process.

In particular, we focused on two of the three domains of the SAGE working group’s model of determinants of vaccine hesitancy: i) individual and group influences, and ii) contextual influences. We did not include specific issues of the vaccine and vaccination process because the survey took place before the vaccines arrived to the cities under analysis. We included 10 types of variables in our analysis following SAGE’s framework (see details in Table 1). Four types of variables fell in the individual and group influence domain: 1) variables that capture the health and economic impact of COVID-19 on individuals or members of their household and, therefore, have the potential to promote vaccination by creating more awareness and perceived need of the vaccine. 2) Knowledge about vaccines, and 3) trust in government and science, as well as beliefs about COVID-19. 4) Perceived compliance with COVID-19 public health policies relative to others, which is expected to capture the role of social norms on immunization. The remaining 6 variables are part of the contextual influence domain: 5) access to COVID-19 public assistance programs, such as monetary support from the government, which can increase trust and awareness and promote immunization.
Socioeconomic and demographic characteristics such as, for instance, income and education that are known to have a significant role on vaccine hesitancy.[20] 7 Pre-existing medical conditions, which can create a perceived need for getting vaccinated.

8) Personality trait dimensions, which may help to understand the psychology of vaccine hesitancy.[22] 9 Because country and health system characteristics are mostly unobserved, we used city fixed effects to capture those factors that are common to all individuals from the same city. 10) Because contextual influences can vary over time, we capture those that are common to all individuals using a weekly time trend (week at which the respondent took the survey) and the weekly number of COVID-19 cases reported in each city (as reported by the Ministry of Health of each country). In this way we are able to determine how changes in willingness to get vaccinated are associated with changes in the magnitude of the epidemic over time. Details of all the variables included in the analysis are provided in Table 1.
2.3. Analytical strategy

We followed two estimation strategies to assess the association between the respondent’s willingness to get a COVID-19 vaccine and our 10 variables. First, we estimated an ordered logit model using the 4-point Likert scale of our dependent variable. While this is the best specification for our data because it captures the full categorical dimension of the dependent variable, the interpretation of coefficient estimates is not straightforward. To facilitate interpretation, we estimate a linear probability model, and we present and discuss our findings in the results and discussion sections, while we report the results of the ordered logit model in the appendix. For the linear probability model, we transformed our dependent variable into a binary outcome \( V_c \) that equals 1 if individual \( i \) living in city \( c \) will definitely or likely get the vaccine and equals 0 otherwise. Then, we assessed the association between each of the 10 variable groups \( X^g \) with the probability of getting the vaccine based on the following specification:

\[
V_c = \beta_1 X^1_{ic} + \beta_2 X^2_{ic} + \ldots + \beta_8 X^8_{ic} + \beta_9 X^9_{ic} + \beta_9 X^9_{ic} + \beta_9 X^9_{ic} + \beta_9 X^9_{ic} + \beta_9 X^9_{ic} + \epsilon_c
\]

Where the coefficient \( \beta_g \) represents the percentage point increase in the probability of getting the vaccine associated to a 1-unit change in variable \( X^g \). Notice that \( X^1 \) and \( X^{10} \) are common to all individuals residing in city \( c \). \( X^g \) is a set of binary variables capturing city fixed effects, using Santo Domingo as city of reference. \( X^{10} \) includes a weekly trend common to all cities and the weekly number of COVID-19 cases reported in each city. Inference was based on robust (heteroskedasticity-consistent) standard errors[23] using the default option in Stata. All estimations were performed in StataMP v.17.

2.4. Limitations

It must be kept in mind that all public surveys of the type reported here are snapshots taken at a particular time. This particular survey was conducted in the context of a highly dynamic and changing landscape, with daily variations in perceived disease threat and COVID-19 vaccine development. Further, reporting one's willingness to be vaccinated might not be a good predictor of acceptance, as vaccine decisions are multifactorial and can change over time. Finally, the Latinwell survey is an observational study whose design imposes some caveats. First, the survey was implemented in large cities, and generalizations to the whole country could be misleading since it did not include rural populations. Second, the survey may introduce biases related to the use Facebook as tool to recruit participants. [17] To reduce this effect, we recruited more participants via the Offerwise opt-in online panel. Third, because the Latinwell survey used a non-probability sample design, it may not represent the population of each city. Overall, the Latinwell sample tends to overrepresent females, older adults, higher educated individuals, and dependent workers, as compared to the Latinobarometer sample.[24] The Latinobarometer is a survey performed annually in multiple countries of Latin America, with a good representation of the large cities populations. A table testing for differences in means for common demographic variables between the Latinobarometer and Latinwell surveys is presented in the appendix. Despite the limitations, the Latinwell survey allowed us to reach out individuals quickly and with timely and relevant questions for our research (just before the arrival of vaccines to LAC), as opposed to the Latinobarometer that has a rigid schedule.

2.5. Results

Descriptive statistics of the Latinwell data are presented in Table 2 by city. The willingness to get the vaccine, which range from 1 to 4 (highest willingness), is similar across cities, with Santo Domingo and Guayaquil having the lowest levels among the cities studied.

It is worth highlighting that Lima and Guayaquil are the cities with the largest fraction of individuals with COVID-19 diagnosis (see Table 2). In addition, in most of the analyzed cities, about one-third of individuals lost their employment due to the pandemic, and one-half had salary cuts. Monetary assistance from governments was received by around 20% of individuals on average with a large variation between cities. Nearly 37% of Santiago residents who responded to the survey received monetary assistance compared to only 5.7% of residents of Guayaquil.

Table 3 presents the results of our linear probability model. The significance levels and the direction of the associations of most variables with the willingness to accept the vaccine are similar to those obtained using the ordered logistic regression analysis (see appendix for results of the ordered logistic model and its comparison with the linear probability model). The first model assesses the association between willingness to get the vaccine and all 10 variable groups as specified in equation (1). The second and third models add interaction effects to explore the association of education and vaccine knowledge, and agreeableness and trust on government respectively.

Results from the first model shows that within the category of individual and group influences, vaccine knowledge and trust in government and science were the variables more associated with COVID-19 vaccine hesitancy. General knowledge about vaccination is associated with a 5 to 7 percentage-point (ppt) increase in willingness to accept the COVID-19 vaccine. Trust in government and science are associated with an increase of 5 ppt in willingness. Among different types of cases of COVID-19, only the death of a close person had a statistically significant association with an increase of 5 ppt in willingness. Social comparison of compliance with COVID-19 public health policies did not show a significant association with vaccination, except when people perceived that their compliance with physical distancing was higher than others in their community (associated with a 9 ppt increase in willingness).

Model 1 also assesses the association of contextual influences on vaccination. Here sociocultural and health system characteristics common to all individuals residing in a city, and captured by city fixed effects, are the most relevant. Interviewed individuals from Bogotá have 23 ppt greater probability to accept the vaccine than respondents from Santo Domingo (city of reference), followed by Santiago (13 ppt more), Lima (13 ppt more), Guayaquil (12 ppt), and Buenos Aires (9 ppt, but not statistically significant). Having received public assistance related to COVID-19 is not statistically associated with willingness to get the vaccine. Having a medical condition is not associated with vaccination except for obesity, where having the disease is associated to a 5 ppt increase in willingness. Among multiple individual characteristics, only gender, education and living alone showed to be statistically significant, being females 5 ppt more hesitant to get the vaccine and those living alone 7 ppt more willing to get it. Our results also show that more education is negatively associated with vaccination. Model 2 (see second column in Table 3) provides a more in-depth analyses of the role of education and its interaction with general knowledge about vaccines. Model 2 shows that respondents with more education are less likely to accept a COVID-19 vaccine when their general knowledge about vaccines is more limited. Regarding personality traits, we also found that extraverts have a 2 ppt higher probability of accepting the vaccine, but, contrary to what we
### Table 2
Descriptive statistics by city.

#### Willingness to get a COVID-19 vaccine
- **4-point Likert scale (no = 1 - yes = 4, average)**
  - Buenos Aires: 2.9
  - Santiago: 2.9
  - Bogota: 3.0
  - Santo Domingo: 2.6
  - Guayaquil: 2.6
  - Lima: 2.9
  - All cities: 2.9
- **Binary outcome (yes = 1, in %)**
  - Buenos Aires: 72.3
  - Santiago: 70.5
  - Bogota: 75.1
  - Santo Domingo: 60.2
  - Guayaquil: 60.5
  - Lima: 73.8
  - All cities: 69.5

#### Individual and group influences of vaccine hesitancy
**COVID-19 impact (yes = 1, in %)**
- Diagnosed with COVID-19: 4.1
- Death of a close person: 25.3
- Lost employment due to COVID-19: 19.3
- Other member lost employment due to COVID-19: 7.4
- Lost income due to COVID: 42.9
- Other member lost income due to COVID-19: 10.5
- Knowledge about vaccines (lowest = 1 - highest = 4, averages)
  - Vaccine knowledge - general: 3.5
  - Vaccines vs Natural immunity: 3.0
  - Vaccines and toxins: 3.0
  - Vaccines and excessive health risk: 3.5
  - Vaccines and infection: 3.1
  - Vaccines and herd immunity: 3.4
- Trust and believes about COVID-19 (averages)
  - Trust on government (lowest = 1 - highest = 7): 3.6
  - Trust on science (lowest = 1 - highest = 7): 4.4
  - Rejects COVID-19 conspiracy (lowest = 1 - highest = 4): 2.8
- Social comparison of compliance with COVID-19 public health policies (individual compliance better than community compliance = 1, in %)
  - Stay at home: 94.6
  - Washing hands: 94.6
  - Surface disinfection: 88.2
  - Mask use: 96.0
  - Physical distancing: 97.3
  - Public transportation use: 87.5
  - Social activities (restaurants/bars/theaters): 97.0
  - Family activities (family reunions): 99.7
- Contextual influences of vaccine hesitancy
  - Received monetary assistance: 21.6
  - Other member received monetary assistance: 5.7
  - Received non-monetary assistance: 10.5
  - Other member received non-monetary assistance: 3.0
  - Age (in years, average): 46.4
  - Married: 15.9
  - Divorced: 23.3
  - Single (reference group): 21.3
  - Living alone: 15.9
  - Female: 75.3
  - Catholic religion: 46.6
  - Evangelic religion: 2.4
  - No religion: 7.5
  - Other religions (reference group): 40.9
  - Education (level 1 to 10): 62.0
  - Mestizo race: 15.5
  - Black race: 1.7
  - Other race no-white: 5.1
  - White (reference group): 77.7
  - Independent worker: 24.7
  - Dependent worker: 44.6
  - Homemaking: 10.1
  - Retired: 4.7
  - Student: 3.0
  - Unemployed (reference group): 17.2
  - Income (in US dollars): 633.3
  - Medical conditions (in %)
    - Pregnant: 0.0
    - Hypertension: 17.2
    - High cholesterol: 11.8
    - Diabetes: 7.1
    - Cancer: 3.0
    - Asthma: 7.1
    - Obesity: 16.2
    - Depression: 12.8
    - Anxiety: 19.3
    - Other illness: 17.6
expect, those who are more agreeable and those more open to experiences are more hesitant. A more in-depth analysis to explore the interaction of being agreeable with trust in the information provided by the government about COVID-19 is presented in model 3 (see third column in Table 3). We found that those who are more agreeable are less likely to accept the vaccine when their trust in the government is lower. This is not the case, however, when the agreeable people trust the government. When these interaction effects are included, the significant effect of openness to experiences vanishes. Finally, neither model was able to find a statistical association between willingness to get the vaccine and trends in either the number of COVID-19 cases or the week of the year.

Results from the linear probability model are fairly similar to the results from the ordered logit model. In the Appendix we highlight the differences in the results obtained from the estimation of both models. We also explore whether those differences are due to the model specification (logistic estimation) or the transformation of the outcome variable from 4 to 2 categories. We observe that six variables (lost employment due to COVID, other members received monetary assistance, age, female, retired and student) are not statistically significant when using the Linear Probability Model, and that these differences are mostly driven by the transformation of the outcome variable (see notes for Table A2).

2.6. Discussion and policy implications

This study explores the willingness to be vaccinated against COVID-19 in a sample of population from six main cities of Latin America (LAC). The survey was made during the fall of 2020, before vaccines were available, with the purpose of identifying potential groups of early adopters who might help to promote willingness to vaccinate among the wider population. Because individuals learn about social norms in part by observing others, early adopters of the COVID-19 vaccine can be given badges or ribbons that display their pro-vaccination choice.[25] In addition, the survey also allows us to identify which population groups can hinder vaccination now that vaccination is taking off in LAC.

We find, for instance, that, after controlling for multiple factors, individuals with an agreeable personality who do not trust the government are less likely to be vaccinated against COVID-19, probably because they are more likely to trust unreliable sources of information. Arguably, trust is an essential component of a successful vaccination campaign, but fortunately it is also potentially modifiable. For instance, after early stumbles in the management of the pandemic caused the British government to lose the trust of the population, this trust was recovered thanks to the effective design and deployment of an anti-COVID-19 vaccination strategy. [26] Our findings show that trust in government is strongly associated with vaccine acceptance and can contribute to public compliance with recommended actions. Trust in government has been consistently shown as a factor that can lead to higher rates of vaccination.[27] Lessons learned from previous infectious disease outbreaks and public health emergencies, including HIV, H1N1, SARS, MERS and Ebola, remind us that trusted sources of information and guidance are fundamental to disease control.[28]

In addition, our study shows that trust in science also leads to higher willingness to be vaccinated. Unfortunately, it seems that distrust in science and politics has grown during the current pandemic.[29] As the relationship between science and politics continues to break down, it is clear that evidence-based arguments are not enough.[29] In the face of this challenge, it is important to evaluate the effectiveness of communication strategies and other interventions. For instance, the communication strategy for publicizing the safety of Astrazeneca vaccine is an example of a bad communication strategy. Hesitancy against this vaccine has increased, which delayed the vaccination process in European countries and might be delaying it in Latin American countries where this vaccine is also being distributed and offered. What is evident is that a substantial number of health officials, national governments, news organizations, non-governmental organizations, and social media platforms are propagating confusing and contradictory messages about COVID-19 and available vaccines. This global “infodemic” undermines the public trust on which successful public health programs depend. Insofar as effective communication strategies are essential to building public trust, governments need to find alternative ways to communicate, providing information that is clear, objective, and understandable by different target groups. For instance, in the past celebrities and respected public figures have proved successful in improving public attitudes, trust, and uptake of health interventions, including vaccines.[3].

In addition to trust, citizens need to access to reliable sources of information. Our results indicate that, after controlling for multiple factors, higher levels of accurate knowledge about vaccination are linked to increased willingness to be vaccinated, while those who believe that COVID-19 pandemic is just a conspiracy are less likely to get vaccinated. It is worrisome to find that 54 % of the surveyed population believe the conspiracy theory is definitively true or probable, even if among those only 10.6 % think it is definitively true. And although having more or less years of education is relevant, we find that those individuals with higher levels of education but whose general knowledge of vaccine effectiveness is low are still reluctant to be vaccinated. This does not happen for those with higher levels of education and accurate general knowledge about vaccines. This result is aligned with previous findings in the literature (see 18 and 19) that indicate that education and socioeconomic status do not influence vaccine hesitancy in only one direction (as is generally the case with education and health outcomes). That is to say, our results confirm that higher education can be associated with both lower and higher levels of vaccine acceptance. By including this interaction effect between education and vaccine knowledge we contribute to this literature.
Table 3
Factors associated with willingness to get a COVID-19 vaccine.

| Variable | Model 1 | Model 2 | Model 3 |
|----------|---------|---------|---------|
| **Individual and group influences of vaccine hesitancy** | | | |
| COVID-19 impact | | | |
| Diagnosed with COVID-19 | −0.02 | −0.02 | −0.02 |
| Death of a close person | 0.05 | 0.04* | 0.04* |
| Lost employment due to COVID-19 | 0.02 | 0.02 | 0.03 |
| Other member lost employment due to COVID-19 | 0.02 | 0.02 | 0.02 |
| Lost income due to COVID | −0.01 | −0.01 | −0.01 |
| Other member lost income due to COVID-19 | 0.01 | 0.02 | 0.01 |
| Knowledge about vaccines | | | |
| Vaccine knowledge - general | 0.05*** | 0.05*** | 0.05*** |
| Vaccines vs Natural immunity | −0.01 | −0.01 | −0.01 |
| Vaccines and toxins | 0.02 | 0.02 | 0.02 |
| Vaccines and excessive health risk | 0.07*** | 0.07*** | 0.06*** |
| Vaccines and infection | 0.00 | 0.00 | 0.00 |
| Vaccines and herd immunity | 0.07*** | 0.07*** | 0.07*** |
| Trust and believes about COVID-19 | | | |
| Trust on government | 0.05*** | 0.05*** | 0.05*** |
| Trust on science | 0.05*** | 0.05*** | 0.05*** |
| COVID-19 conspiracy | 0.00 | 0.01 | 0.01 |
| Social comparison of compliance with COVID-19 public health policies | | | |
| Stay at home | 0.04 | 0.03 | 0.03 |
| Washing hands | −0.01 | −0.01 | −0.01 |
| Surface disinfection | 0.01 | 0.01 | 0.02 |
| Mask use | 0.04 | 0.04 | 0.04 |
| Physical distancing | 0.02* | 0.09* | 0.08 |
| Public transportation use | 0.01 | 0.01 | 0.01 |
| Social activities (restaurants/bars/theaters) | 0.04 | 0.04 | 0.03 |
| Family activities (family reunions) | −0.01 | 0.01 | 0.00 |
| **Contextual influences of vaccine hesitancy** | | | |
| COVID-19 public assistance | | | |
| Received monetary assistance | 0.01 | 0.01 | 0.02 |
| Other member received monetary assistance | 0.03 | 0.03 | 0.03 |
| Received non-monetary assistance | 0.00 | 0.00 | 0.01 |
| Other member received non-monetary assistance | 0.05 | 0.05 | 0.04 |
| Socioeconomic and demographic control variables | | | |
| Age | 0.00 | 0.00 | 0.00 |
| Age 20 to 34 years old | −0.04 | −0.04 | −0.03 |
| Married | −0.01 | −0.01 | −0.01 |
| Divorced | −0.03 | −0.03 | −0.03 |
| Living alone | 0.08* | 0.07* | 0.07* |
| Female | −0.05* | −0.05* | −0.05* |
| Catholic religion | 0.03 | 0.04 | 0.03 |
| Evangelic religion | 0.00 | 0.01 | 0.00 |
| No religion | −0.02 | −0.02 | −0.02 |
| Education | −0.01 | −0.04*** | −0.04*** |
| Education × Vaccine knowledge = 1 | −0.04 | −0.04 | −0.03 |
| Education × Vaccine knowledge = 2 | −0.02 | −0.02 | −0.02 |
| Education × Vaccine knowledge = 3 | −0.01 | −0.01 | −0.01 |
| Education × Vaccine knowledge = 4 | −0.01 | −0.01 | −0.01 |
| Mestizo race | 0.00 | 0.00 | 0.00 |
| Black race | 0.02 | 0.02 | 0.02 |
| Other race no-white | −0.01 | −0.01 | −0.01 |
| Independent worker | −0.01 | −0.01 | −0.01 |
| Dependent worker | 0.03 | 0.03 | 0.03 |
| Homemaking | −0.02 | −0.02 | −0.02 |
| Retired | 0.10 | 0.11 | 0.10 |
| Student | 0.06 | 0.07 | 0.07 |
| Income | 0.00 | 0.00 | 0.00 |
| Medical conditions | | | |
| Pregnant | 0.03 | 0.02 | 0.04 |
| Hypertension | −0.03 | −0.03 | −0.03 |
| High cholesterol | −0.01 | −0.01 | −0.01 |
| Diabetes | −0.04 | −0.04 | −0.04 |
| Cancer | −0.01 | 0.00 | 0.01 |
| Asthma | −0.02 | −0.02 | −0.02 |
| Obesity | 0.05* | 0.05* | 0.06* |
| Depression | −0.03 | −0.03 | −0.03 |
| Anxiety | 0.02 | 0.02 | 0.02 |
| Other illness | 0.03 | 0.03 | 0.03 |
| Personality dimensions | | | |
| Extraversion | 0.02* | 0.02* | 0.02* |
| Agreeableness | −0.02* | −0.02* | −0.02* |
| Agreeableness × Trust on government = 1 | | | |
| Agreeableness × Trust on government = 2 | | | |
Another relevant factor is the perceived risk of illness related to voting to attract younger populations. In previous studies, onsite vaccination in the workplace has also been identified as a key lever. Related to perceived risk, we find that individuals who believe that they could be part of a successful collective effort or who believe that they are more likely to accept a COVID-19 vaccine than men. This finding has special importance because women are often the primary healthcare decision-makers for their families. Accordingly, to lower overall levels of vaccine hesitancy an effective strategy may be to design and disseminate messages that target the more hesitant female audience in these countries of Latin America. In the US, famous scientists such as Kissmekia Corbett (lead developer of the Moderna vaccine) are helping to combat vaccine hesitancy by talking about COVID-19 science in communities of color. Corbett is one of many black scientists and doctors who are engaged in outreach activities, often virtually, in their free time. Researchers say that outreach is necessary to make scientific knowledge more accessible to the public and to ease health disparities, including varying attitudes toward vaccination, among minorities. Although we do not find race disparities in our sample, the example of Corbett indicates a promising strategy for influencing women in Latin America: using women scientists and other trusted women as messengers who promote the importance of vaccination. The inspiring example of Dolly Parton in the US getting her first shot of Moderna while singing an adapted version of her famous song "Jolene" ("vaccine, vaccine, vaccine, vaccine, I am begging of you, please, do not hesitate") could be reproduced in LAC with famous singers or artists of the region.

Another relevant factor is the perceived risk of illness related to COVID-19. Those who have a condition (e.g., obesity) that increases the risk of a severe case of COVID-19 or who know someone within their circle of close family and friends who has died from COVID-19 are likely to be more willing to be vaccinated. This finding is consistent with studies in other countries: in Italy, for example, the perceived risk of contagion increased during the lockdown (in comparison to before lockdown) as did the willingness to be vaccinated. Related to perceived risk, we find that individuals who perceive that their compliance with the rules is higher than the general level of compliance in their environment or society have a higher willingness to get vaccinated. Also, previous studies of barriers to vaccination in Latin America indicate that other environmental factors such as individual/group influences and contextual influences are relevant. Moreover, a recent study finds that vaccine hesitancy can be reduced by encouraging individuals to believe that they could be part of a successful collective effort to achieve herd immunity and harnessing the expected reputational benefits of vaccination. Communication strategies that take these social factors into account may be more successful in promoting vaccination, but governments can go even further by offering incentives or "nudges" that facilitate the decision to be vaccinated. For instance, in the US now that willingness to be vaccinated is dropping, free baseball tickets or drinks are being offered at vaccine locations. Similar strategies are being fine-tuned to target specific groups in rural and conservative populations at county fairs and rodeos. In Israel, bars offer a free drink or pizza along with vaccination to attract younger populations. In previous studies, onsite vaccination in the workplace has also been identified as a key lever.

This study represents an initial effort to delineate the diversity and extent of the challenges to vaccination in six Latin American big cities. It would be interesting to study not only urban population willingness to get vaccination but also rural population. The results we find in our study are not transferable to the rural populations of the countries where those big cities are located. Regarding basic vaccination (for children), rural populations of many countries in Latin America do not get vaccinated due to barriers of access of different nature: cultural barriers, long distances,
absenteeism of health care providers among other factors. The situation in rural areas regarding basic vaccination is completely different to the situation in urban population. This extends to the vaccination related to COVID-19, but obviously it would be very interesting that future research analyzes the attitude of rural populations regarding COVID-19 vaccination as well as what has happened with the coverage of regular vaccines in these areas.

Results from our study underscores that "one size will not fit all" when it comes to building public trust in a COVID-19 vaccine. The recently discovered side effects of certain COVID-19 vaccines [6–8] have increased vaccine hesitancy even among those who believe in the value of vaccination and would normally follow the early adopters.[36] Our survey did not include questions about different types of vaccines as these issues had not emerged at the time of the survey. However, it would be interesting to explore how willingness to be vaccinated varies according to the types of vaccine available in each country. This would also offer lessons on how different communication strategies about different vaccines are reaching different segments of the population.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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