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Article

COVID-19 Attitudes and Vaccine Hesitancy among an Agricultural Community in Southwest Guatemala: A Cross-Sectional Survey

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Abstract: Despite offering free-of-charge COVID-19 vaccines starting July 2021, Guatemala has one of the lowest vaccination rates in Latin America. During September 28, 2021 to April 11, 2022, we conducted a cross-sectional survey of community members adapting a CDC questionnaire to evaluate COVID-19 vaccine access and hesitancy. Of 233 participants ≥ 12 years, 127 (55%) received ≥ 1 dose of COVID-19 and 4 (2%) reported prior COVID-19 illness. Persons ≥ 12 years old unvaccinated ($n=106$) were more likely to be female (73% vs 41%, $p<0.001$) and homemakers (69% vs 24%, $p<0.01$) compared with vaccinated participants ($n=127$). Among those ≥ 18 years, the main reported motivation for vaccination among vaccinated participants was to protect the health of family/friends (101/117, 86%); 40 (55%) unvaccinated persons reported little/no confidence in public health institutions recommending COVID-19 vaccination. Community- and/or home-based vaccination programs, including vaccination of families through the workplace, may better reach female homemakers and reduce inequities and hesitancy.

Keywords: COVID-19; SARS-CoV-2; hesitancy; access; Guatemala; agricultural worker

Introduction

Despite a significant disease and economic burden of COVID-19 and free-of-charge vaccination, low- and middle-income countries (LMICs) have struggled to achieve high vaccination rates. Limited accessibility to vaccines and increasingly, vaccine hesitancy, fuels repeated waves of community transmission and wastes valuable resources.^{1,2} Guatemala began its COVID-19 vaccination program on February 25, 2021, targeting health workers and individuals with comorbidities; adolescents aged 12 to 17 years were included as of September 22, 2021. Despite the increasing availability of free-of-charge COVID-19 vaccines, coverage in Guatemala remains one of the lowest in Latin America, especially in rural and indigenous communities. As of July 1, 2022, only 46% of the eligible population in Guatemala had received one vaccine dose and 35% had received two doses.^{3,4} By April 2022, 1.47 million doses of U.S.-donated COVID-19 vaccine⁵ and nearly 5 million doses of purchased Sputnik V

vaccine⁶ had expired, presumably because of low accessibility and demand throughout the country. The objectives of this study were to understand the frequency and drivers of COVID-19 vaccination coverage and hesitancy within an agricultural community in rural Guatemala, in order to design an intervention to improve COVID-19 vaccination coverage.

Materials and Methods

We conducted a cross-sectional survey to evaluate knowledge, attitudes, and practices towards COVID-19 illness and freely available vaccines. This survey was embedded in the enrollment visit of a prospective cohort study to characterize asymptomatic and pre-symptomatic SARS-CoV-2 transmission among banana farmworkers' households and workplaces. The study was conducted between September 28, 2021, and April 11, 2022, within two rural communities (Los Encuentros, Quetzaltenango and Chiquirines, San Marcos) in southwest lowland Guatemala, approximately 50 km from the border of Chiapas, Mexico. Inclusion criteria for the parent study and survey were the following: ≥ 1 member of the household employed in the agricultural sector, they must live in the selected communities, $\geq 75\%$ of the people living in the household must consent to participate, and they must be eligible to receive COVID-19 vaccines at the time of the survey (age ≥ 12 years; survey inclusion criteria only). The questionnaire (Appendix 1) included an adapted Spanish language COVID-19 "Vaccine Confidence" survey developed by the Centers for Disease Control and Prevention (CDC),⁷ as well as additional questions on demographics, vaccination status, and knowledge, attitudes, and practices about COVID-19, COVID-19 vaccines, and vaccines in general. The survey was administered verbally to adults and children (accompanied by adults) by trained study nurses at the participants' homes or workplaces and responses were recorded via the REDCap application on a smartphone.

At the time of the survey, COVID-19 vaccination was offered only at Ministry of Health posts, (usually two days/week), and through workplace vaccination programs by the Institute of Guatemala Social Security system (IGSS), such as the agribusiness that employed at least one member of each household. Vaccines available in Guatemala at the time of the survey included mRNA-1273 (mRNA, Moderna, Cambridge, USA), BNT162b2 (mRNA, Pfizer-BioNTech, New York, USA) ChAdOx1-S (viral vector, AstraZeneca, Cambridge, England), and Gam-COVID-Vac (virus vector, Sputnik V, Russia) All these vaccines require 2 doses in the primary series. In Guatemala, individuals ≥ 12 years of age became eligible to receive COVID-19 vaccine in September, 2021. Vaccination data was obtained directly from the national vaccination registry and verified by self-report of participants.

Data analysis was conducted using SPSS® software (version 25, Chicago, IL, USA). Participants with ≥ 1 dose of the COVID-19 vaccine were considered vaccinated. Descriptive statistics were used to characterize survey responses. The Mann-Whitney U test was used for median comparisons, and Pearson's chi-square/Fischer's exact tests were used for proportions; a p-value < 0.05 was considered statistically significant. The study was approved by the University of Colorado (COMIRB, protocol #21-2551) Universidad del Valle de Guatemala (UVG), and CDC ethics committees; it was funded by CDC (CDCGH002243).

Results

From September 28, 2021, to April 11, 2022, we enrolled 340 individuals (86% of 394 eligible individuals) from 74 households; 233 individuals (69%) were ≥ 12 years old and 190 individuals (56%) were ≥ 18 years old (Table 1). Households and individuals were similar between the Chiquirines and los Encuentros communities in terms of demographics and exposure risks. Overall, median monthly household income was \$379 (standard deviation [SD]=\$135). Of the 340 enrolled subjects, 177 (52%) were female, 323 (95%) were of ladino/mestizo (mixed Spanish/indigenous) ethnicity, and of those > 15 years, 107 (53%) worked outside the home. Median age was 21 years (SD=17, range=0-73 years). No children reported school attendance, as all schools in the community were closed because of the COVID-19 pandemic.

Table 1. Sociodemographic characteristics of enrolled households in two rural communities in the Trifinio Region of Southwest Guatemala, 2021-2022.

Variable	Los Encuentros (n=40)	Chiquirines (n=34)	p-value**
Household			
Persons living at home, median (Q1, Q3)	5 (4,6)	5 (4,6)	0.76
Children living at home, median (Q1, Q3)	1.5 (1,2)	1.5 (1,2)	0.95
Beds at home, Median (Q1, Q3)	3 (2,5)	3 (2,5)	0.89
Monthly household income, \$USD, median (Q1, Q3)*	395 (329,461)	362 (309,487)	0.25
Individual			
Age, median (SD)	21 (17)	20 (16)	
Female, n (%)	95 (52)	82 (52)	0.86
Ethnicity			
Ladino /Mestizo*, n (%)	166 (92)	157 (99)	< 0.01
Indigenous	3 (2)	1 (0.5)	
Do not know	12 (6)	1 (0.5)	
Reports comorbidity, n (%)	33 (18)	20 (13)	0.15
Work outside the home ≥15 years old, n (%)	53/112 (47)	54/90 (60)	0.29
COVID-19 vaccine ≥12 years old, n (%)	67/123 (54)	60/110 (55)	0.99

Abbreviations: Q1 = Quartile 1, Q3= Quartile 3, SD= standard deviation; *Q7.6 = \$USD 1. *Mixed Spanish/indigenous descent. **p-value= the Mann-Whitney U test was used for median comparisons, and Pearson's chi-square/Fischer's exact tests were used for proportions; a p-value <0.05 was considered statistically significant for all comparisons.

At the time of the survey, 4 (2%) respondents reported prior COVID-19 disease; 127 (55%) reported receiving ≥1 dose of a COVID-19 vaccine, which included mRNA-1273 (n=106, 83%), ChAdOx1-S (n=15, 12%), BNT162b2 (n=4, 3%), Gam-COVID-Vac (n=1, 1%) and Cansino (n=1, 1%; administered in nearby Mexico). Only 11 participants (5%) reported having ever refused any vaccine in the past; common reasons for refusal of past vaccines were thinking a vaccine was unnecessary (n=7, 64%), concern about side effects (n=2, 18%), and someone else telling the respondent that the vaccine was unsafe (n=2, 18%), (Table 2).

Table 2. COVID-19 vaccination and vaccine hesitancy data from vaccine-eligible survey respondents.

COVID-19 vaccination in participants ≥12 years old.	n (233)
Received COVID-19 vaccine* n (%)	127 (55)
Received 1 dose of COVID-19 vaccine, n (%)	36 (28)
Received 2 doses of COVID-19 vaccine, n (%)	89 (70)
Received 3 doses (booster) of COVID-19 vaccine, n (%)	2 (2)
First dose COVID-19 (n=127)	

Moderna, n (%)	106 (83)
AstraZeneca, n (%)	15 (12)
Pfizer-BioNTech, n (%)	4 (3)
Sputnik V, n (%)	1 (1)
Other (Cansino), n (%)	1 (1)
Second dose COVID-19 (n=91)	
Moderna, n (%)	88 (97)
AstraZeneca, n (%)	2 (2)
Sputnik V, n (%)	1 (1)
Third dose (booster) COVID-19 (n= 2)	
Moderna, n (%)	1 (50)
Pfizer-BioTech, n (%)	1 (50)
Vaccine Hesitancy	
History of COVID-19 (self-report), n (%)	4 (2)
Refused a routine vaccine previously, n (%)	11 (5)
Reasons for vaccine refusal (n=11)**	
I did not think it was necessary, n (%)	7 (63)
I am concerned about side effects, n (%)	2 (18)
Someone else told me vaccine was not safe, n (%)	2 (18)
Other, n (%)	3 (27)
Previously (pre-pandemic) wanted to receive a routine vaccine (any type) but was unable to do so, n (%)	40 (17)
Most common reasons for previously being unable to obtain a routine vaccine despite intent (n=40)	
Vaccine not available at my health clinic or in my community	
I didn't know where to get vaccinated	14 (32)
I didn't know where to get good and reliable information about the vaccine.	7 (16)
	5 (12)
Could not afford the vaccine	1 (2)
It is not possible to leave my work to receive the vaccine during clinic hours.	5 (12)
	11 (26)
Another reason	

* A person with ≥ 1 dose of COVID-19 vaccine was considered as vaccinated. ** may choose more than one answer.

Vaccinated individuals were more likely to be male (59% vs 27%, $p < 0.01$), older (median age = 33 vs 25 years, $p < 0.01$), work outside of the home (69% vs 24%, $p < 0.01$), or work on a farm (70% vs 43%, $p = 0.008$) (Table 3). Of those vaccinated, 4 (3%) reported to have refused another type of vaccination previously (prior to the COVID-19 pandemic) vs. 7 (7%) of those unvaccinated ($p = 0.23$).

Among those aged ≥ 18 years (Table 3), at the time of the survey, vaccinated individuals were more likely to be moderately or very worried about COVID-19 ($n = 36$, 31%) compared to unvaccinated individuals ($n = 13$, 18%; $p = 0.04$). The most reported motivations for COVID-19 vaccination are shown in Table 3 and include protecting the health of the participant, which differed between vaccinated and unvaccinated (24% vs 11%, respectively; $p < 0.01$); there was no difference between motivation

related to protecting their family/friends (68% vs 73%, $p=0.53$) and community (3% vs 3%, $p=0.94$). Compared to vaccinated individuals, unvaccinated individuals were more likely to report little/no confidence in public health institutions (38% vs 55%, $p=0.02$). Among 73 (38%) unvaccinated participants >18 years, 25% reported they would obtain the vaccine as soon as possible, 40% reported they would obtain it but would wait, 11% responded they would not obtain vaccine, and 25% reported they were unsure.

Table 3. Comparison of participants ≥ 12 years old vaccinated and unvaccinated against COVID-19.

Variable	Vaccinated n=127 (%)	Not vaccinated n=106 (%)	p- value
Age, median (SD)	33 (13)	25 (15)	<0.01
12 – 17	10 (8)	33 (31)	<0.01
18 – 30	44 (35)	37 (35)	0.96
31 – 40	42 (33)	19 (18)	<0.01
≥ 41	31 (24)	17 (16)	0.11
Female, n (%)	52 (41)	77 (73)	<0.01
Ladino/mestizo, n (%)	122 (96)	98 (93)	0.45
work outside the home, n (%)	87 (69)	25 (24)	<0.01
Comorbidity present, n (%)*	30 (24)	17 (16)	0.15
Refused a vaccine previously? n (%)	4 (3)	7 (7)	0.23
<i>Reasons for vaccine refusal (may select ≥ 1)</i>	n=4	n=7	
I did not think it was necessary	2 (50)	5 (71)	0.57
I did not know where to get reliable information	1 (25)	0 (0)	n/a
I was concerned about side effects	0 (0)	2 (29)	n/a
Someone else told me that the vaccine was not safe	0 (0)	2 (29)	n/a
Fear of needles	0 (0)	1 (14)	n/a
I was not able to leave my job/house to go to get vaccinated	1 (25)	0 (0)	n/a
Previously (pre-pandemic) wanted to obtain a vaccine (any type), but was unable to do so	19 (15)	21 (20)	0.32
<i>Reasons why you were unable to be vaccinated (pre-pandemic, may select ≥ 1)</i>	n=19	n=21	
Vaccine not available at my health clinic or in my community	5 (26)	9 (43)	0.27
I didn't know where to get vaccinated	3 (16)	4 (19)	1.00
I didn't know where to get good and reliable information about the vaccine	2 (11)	3 (14)	1.00
Could not afford the vaccine	1 (5)	0 (0)	n/a
It is not possible to leave my work to receive the vaccine during clinic hours	4 (21)	1 (5)	0.17
Another barrier to receiving the vaccine	4 (21)	7 (33)	0.48
Participants ≥ 18 years old	n= 117 (%)	n=73 (%)	

How concerned are you or were you about contracting COVID-19?

Not at all worried	35 (30)	33 (45)	0.32
Somewhat concerned	46 (39)	27 (37)	0.74
Moderately Concerned	14 (12)	7 (10)	0.61
Very concerned	22 (19)	6 (8)	0.04
<i>Primary motivation to be vaccinated against COVID-19</i>			
Protecting my health	28 (24)	8 (11)	0.02
Protect the health of my family and friends	80 (68)	53 (73)	0.53
Protecting the health of my community	3 (2.5)	2 (3)	0.94
Back to work or school	3 (2.5)	0 (0)	n/a
Because others encouraged me to get vaccinated.	2 (2)	0 (0)	n/a
Other	1 (1)	0 (0)	n/a
Not sure	0 (0)	10 (13)	n/a
No or little confidence in the public health institutions that recommend vaccination	44 (38)	40 (55)	0.02
Saw or heard information about COVID-19 vaccines (news, social networks, friends and family)	92 (79)	50 (69)	0.25
Not receiving enough information about COVID-19 vaccines.	14 (12)	21 (29)	0.01
Knows where to get accurate and timely information on COVID-19 vaccines	80 (68)	42 (57)	0.25

* Comorbidity refers to participants who reported at least one of the following medical condition present: asthma, pulmonary disease, kidney disease, heart disease, diabetes, anemia, neurological disease and liver disease. ** Value p: the Mann-Whitney U test was used for median comparisons, and Pearson's chi-square/Fischer's exact tests were used for proportions; a p-value <0.05 was considered statistically significant for all comparisons.

Discussion

This cross-sectional survey shows that although vaccine refusal prior to the COVID-19 pandemic was rare (5%), in these two agricultural communities in Guatemala, nearly half (45%) of vaccine-eligible participants remained unvaccinated against COVID-19 (with any dose) one year following COVID-19 vaccine availability. This raises the question of how COVID-19 vaccine distribution and information may have differed in this community compared to previous vaccine programs, potentially contributing to lower uptake and confidence.

The majority of respondents not yet vaccinated were female homemakers. Many of the adult males in these communities were employed at large agribusinesses that offered recommended COVID-19 vaccination through the workplace, suggesting that greater access to vaccine (through the workplace) may improve vaccination coverage. Extending workplace programs to family members of employees and implementing home- or community-based (places of worship, community gathering places) interventions may increase access to those who remain unvaccinated.

We also found evidence of vaccine hesitancy. Unvaccinated individuals reported lower confidence in public health institutions, not receiving enough information about vaccines, and inability to find accurate and timely information about COVID-19 vaccines. These data suggest a need for improved and more effective public health messaging in this community and similar rural areas. Indeed, this need is only compounded by the ongoing "infodemic" of misinformation from other sources, which has been associated with increased vaccine hesitancy.^{2, 9, 10, 11} It is possible that delays in achieving vaccine access in these rural communities may have served to undermine vaccine

acceptance and “opened the door” to increased misinformation, contributing to greater hesitancy and decreased acceptance once the vaccine became more widely available. Future studies will help clarify this question.

This study is limited in that it was carried out during the enrollment visit of a SARS-CoV-2 household transmission study, and it was restricted to households of workers employed at a large agribusiness, thus limiting generalizability. However, agricultural workers comprise 35% of the overall labor force in Guatemala and thus represent an important subpopulation in which to study vaccine access and hesitancy. The survey was also carried out at a single timepoint and may not reflect changing vaccine attitudes, though we aim to address this limitation with follow-up surveys.

Conclusion

These findings provide an opportunity to implement improved evidence-based public health messaging and access strategies in the community. Building on the need to communicate at the household level and to increase community engagement and information sharing, we are designing a public health messaging strategy that involves a cadre of respected community leaders (members of the Community Development Council - COCODE, nurses from the health posts, midwives, teachers, and religious leaders, among others) who will be trained to provide COVID-19 vaccine information in the community. In parallel, health posts in the community are implementing a house-to-house vaccination program by public health nurses, which may reach the population that has not been vaccinated through their workplaces. After this process, this survey will be conducted again to identify changes in vaccine hesitancy and uptake.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org. Document S1: Spanish-translated manuscript.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of the University of Colorado (COMIRB, protocol #21-2551) Universidad del Valle de Guatemala (UVG), and CDC ethics committees; it was funded by CDC (CDCGH002243).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. Re-striptions apply to the availability of some of the data and therefore it has not been made publicly available.

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References

1. Marcela Vélez C, 2021. UNESCO Office Montevideo and Regional Bureau for Science in Latin America and the Caribbean United Nations Educational, Scientific and Cultural Organization (UNESCO).

2. Lazarus JV, Wyka K, White TM, Picchio CA, Rabin K, Ratzan SC, Parsons Leigh J, Hu J, El-Mohandes A, 2022. Revisiting COVID-19 vaccine hesitancy around the world using data from 23 countries in 2021. *Nat Commun* 13: 3801.
3. 2022. Situación de COVID-19 en Guatemala: Ministerio de Salud Pública y Asistencia Social.
4. Taylor L, 2022. Guatemala's COVID vaccine roll-out failed: here's what researchers know. *Nature*.
5. J V, 2022. Vence último lote de Moderna en Guatemala; 930 mil aún carecen de segunda dosis. *La Hora*. Guatemala City, Guatemala.
6. AL O, 2022. Se vencen las últimas dosis de Sputnik V, ¿cuántas dosis de otras vacunas nos quedan? *Prensa Libre*. Guatemala City, Guatemala.
7. 2021. Confianza en la vacuna contra el COVID-19 Guía para la evaluación rápida de la comunidad: Center for Disease Control and Prevention.
8. Urrunaga-Pastor D, Bendezu-Quispe G, Herrera-Anazco P, Uyen-Cateriano A, Toro-Huamanchumo CJ, Rodriguez-Morales AJ, Hernandez AV, Benites-Zapata VA, 2021. Cross-sectional analysis of COVID-19 vaccine intention, perceptions and hesitancy across Latin America and the Caribbean. *Travel Med Infect Dis* 41: 102059.
9. Rodriguez-Morales AJ, Franco OH, 2021. Public trust, misinformation and COVID-19 vaccination willingness in Latin America and the Caribbean: today's key challenges. *Lancet Reg Health Am* 3: 100073.
10. Zarocostas J, 2020. How to fight an infodemic. *Lancet* 395: 676.
11. Pierri F, Perry BL, DeVerna MR, Yang KC, Flammini A, Menczer F, Bryden J, 2022. Online misinformation is linked to early COVID-19 vaccination hesitancy and refusal. *Sci Rep* 12: 5966.

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