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Factors associated with not receiving the primary series and booster dose of the COVID-19 vaccine among Venezuelan migrants in Peru: A population-based cross-sectional study

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ABSTRACT

Background: Ensuring broad COVID-19 vaccination coverage among migrants is a global public health concern. Thus, our study aimed to assess the factors associated with not receiving the primary series and booster dose of the COVID-19 vaccine among Venezuelan migrants in Peru.

Methods: This was a cross-sectional study based on secondary data analysis of the 2022 Venezuelan Population Residing in Peru Survey. Our population included Venezuelan migrants and refugees over 18 years old living in Peru with complete information for the variables of interest. Two outcome variables were assessed: not receiving the primary series and not receiving the booster dose of the COVID-19 vaccine. Crude and adjusted prevalences were calculated with 95% confidence intervals.

Results: A total of 7,727 Venezuelan adults were included in our study, of whom 6,511 completed the primary series. The overall COVID-19 vaccination coverage of the primary series was 84.17%, whilst the coverage of the booster dose was 28.06%. Being younger, uninsured, illegally-staying, and having a low educational level were associated with both outcomes.

Conclusion: Several sociodemographic and migration-related variables were associated with both outcomes. Governmental policies prioritizing vaccination among Venezuelan migrants are needed to ensure broad coverage in this vulnerable group.

1. Introduction

Nowadays, there are more than 100 vaccines against COVID-19 and their implementation as the main measure to slow down the pandemic worldwide is a priority in many countries [1,2]. According to the World Health Organization (WHO), as of January 2023, more than 13 billion vaccines have been administered globally, albeit with variations in coverage among countries [3]. Regarding income level, by February 2023, at least three in four people in high-income countries received at least one dose of the COVID-19 vaccine, whereas only one in four people in low-income countries received at least one dose of the vaccine [4]. The emergence of variants and declining immunity [2,5] demanded the application of additional doses [6], the coverage of which has also been unequal. As of 31 January 2023, there were 34.1 booster doses per 100 people globally, but in Italy, for example, there were 79.3 and in India only 15.9 [7].

There are variations in vaccination coverage both between and within countries. In Peru, for example, although in February 2023 there were regions such as Ica, in which 88.48% of the population had received two doses of the vaccine, this percentage dropped to 62.19% in Madre de Dios. Similarly, there are variations in coverage in vulnerable groups such as older patients age and those with co-morbidities [8], as vaccination policies prioritized these groups. Nevertheless, a particularly vulnerable population group in our country are Venezuelan

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immigrants, who live in social, political and economic exclusion, resulting in poverty, homelessness and labor exploitation, which increase the risk of COVID-19 infection [9,10]. In Latin America, COVID-19 vaccination coverage among Venezuelan immigrants is heterogeneous, with several factors limiting access to vaccination. These factors include barriers related to ambiguous national and regional vaccination policies and the widespread stigmatization of migrants [9]. In Peru, Venezuelan migrants are included in the vaccination program, but the program does not mention migrants with irregular status [11]. Nonetheless, irregular migrants are instructed to update their information online through the National Universal Vaccination Register [9]. Due to their increased risk of COVID-19 infection, achieving adequate vaccination coverage should be a public health priority.

In Latin America and Peru, several studies have evaluated the factors associated with receiving a booster dose of the COVID-19 vaccine [12,13]. These studies show education level, employment or food insecurity, which may also be frequent among Venezuelan migrants in our country, as some of the factors associated with receiving a booster dose [9,10].

Ensuring broad COVID-19 vaccination coverage among documented and undocumented migrants is a global public health concern [14,15]. Accordingly, identifying the factors that affect vaccination coverage will enable identifying population characteristics to prioritize our strategies. To the best of our knowledge, no study has analyzed vaccination against COVID-19 in the Venezuelan migrant population residing in Peru, which to date totals more than one million individuals, representing an important community in our country [16]. Therefore, the objective of our study was to assess the factors associated with not receiving the primary series and booster dose of the COVID-19 vaccine among Venezuelan migrants in Peru.

2. Methods

2.1. Study design and data source

This was a cross-sectional study based on secondary data analysis of the 2022 Venezuelan Population Residing in Peru Survey (ENPOVE-2022, the Spanish acronym). It was conducted by the National Institute of Statistics and Informatics (INEI, the Spanish acronym) during February and March 2022 in 8 provincial capitals: Lima and Callao, Arequipa, Chiclayo, Chimbote, Ica, Piura, Tumbes, and Trujillo, as these cities have the highest number of dwellings with Venezuelan migrants and refugees, representing 82.9% of the total dwellings with a Venezuelan population at the national level. The information was obtained through direct interviews conducted by trained interviewers and collected using tablets. The survey addressed several dimensions of the Venezuelan population in Peru such as demographic and socioeconomic characteristics, as well as health status and migratory conditions, among other areas of vulnerability [17].

2.2. Sample and selection criteria

The target population of the ENPOVE-2022 consisted of the Venezuelan population usually residing in the household, including all residents of private and collective dwellings in urban areas. The sample frame was based on information from the National Labour Market Survey and the National Superintendence of Migration. The investigation units consisted of dwellings with a Venezuelan population, households in those dwellings, and Venezuelans residing in dwellings in the study area. However, the sampling units consisted of dwellings grouped into sampling segments, each consisting of 5 geographically arranged dwellings. These segments were selected by simple systematic sampling with random start for each city, until the number of segments required for the sample was reached. The sampling design was probabilistic, stratified, and independent for each city. People over 12 years of age were interviewed, and in the case of the youngest, the survey was answered by the head of the household. The sample size was 3,680 households with Venezuelan population. Further details of the survey are described elsewhere [17].

For the present study, we included Venezuelan migrants and refugees living in Peru over 18 years old (age of majority in Peru) with complete information for the variables of interest.

2.3. Outcome variables

The survey was conducted considering the current context of the COVID-19 pandemic, thus information about vaccination was collected. The Peruvian Ministry of Health approved the administration of four vaccines free of charge, in both public and private settings, regardless of nationality: Sinopharm, Pfizer/BioNTech, Moderna, and Oxford/AstraZeneca. At the time of the survey, the COVID-19 vaccination schedule included three doses, but the 3rd dose started to be administered in the last quarter of 2021. The following questions were asked to the participants: Have you been vaccinated against COVID-19? If yes, the respondent was asked: How many doses did you receive? Hence, our study had two outcome variables.

- Not receiving the primary series: We categorized COVID-19 vaccination as 'receiving the primary series' if the individual had received the 1st and 2nd doses; if 1 dose or no dose was administered, it was categorized as 'Not receiving the primary series'.
- Not receiving the booster dose: We categorized 'receiving the booster dose' when the individual had received the 3rd dose of the COVID-19 vaccine; otherwise, this was categorized as 'Not receiving the booster dose'. This variable was only measured among those who had previously completed the primary series.

2.4. Independent variables

Age was grouped into the following categories: 18–24, 25–34, 35–44, 45–54, 55–64, and 65 years or older. Educational level, attained in Peru or Venezuela, was categorized as no formal education or primary, secondary, and higher. The presence of chronic diseases includes arthritis, hypertension, asthma, rheumatism, diabetes, tuberculosis, hypercholesterolemia, heart disease, lung disease, cancer, mental disease, HIV/AIDS and other sexually transmitted diseases, among others. Individuals were categorized as presenting none, one, or more than one disease. Regarding employment status, a participant was employed if they had worked in the week prior to the interview or if they had a permanent job or owned business to which they would return. Otherwise, the participant was deemed unemployed. The presence of mental or physical disability was defined if the participant reported permanent limitations in moving, walking, seeing (even with the use of glasses), speaking, or communicating (even with the use of sign language or other), hearing (even with the use of hearing aids), understanding and learning. Migratory status was considered illegal if the participant did not hold any migration permit; otherwise, the participant was considered legal. Other variables included were sex (male/female), socioeconomic status (lower/middle/higher), health insurance (uninsured/insured), time residing in Peru (0–6/7–12/more than 12 months), history of COVID-19 infection (yes/no/does not know), and city of residence.

2.5. Statistical analysis

The database of the ENPOVE-2022 was downloaded in *.sav* format from the 'Microdatos' webpage of the INEI, being publicly and freely available [18]. Then, it was imported into Stata 16.0 (Stata Corporation, College Station, TX, USA), where it was further analyzed using the *svy* package. Absolute frequencies and weighted proportions were estimated with their corresponding 95% confidence intervals (95% CI). In the bivariate analysis, the coverage of the primary series and booster dose was calculated for each category of the independent variables, and the chi-squared test with Rao–Scott correction was used to assess potential

associations. Variables with p < 0.2 in the bivariate analysis were included in the multiple regression analysis. Generalized linear models *Poisson* family with log link function were performed to assess the magnitude of the association through crude (cPR) and adjusted prevalence ratios (aPR). Two multiple regression models were performed in which factors associated with not receiving the primary series and the booster dose were evaluated separately. Only participants that completed the primary series were included in the second regression model. Confidence intervals were computed to 95% and p-values <0.05 were deemed statistically significant.

2.6. Ethical considerations

Since our study was based on the secondary data analysis of the ENPOVE-2022, which is publicly available [18], ethical approval was not required.

3. Results

3.1. Characteristics of Venezuelan adults living in Peru

A total of 7,727 Venezuelan adults were included in our study, of whom 6,511 completed the primary series of the COVID-19 vaccine (**Supplementary 1**). The mean age of the participants was 34.42 (standard deviation 11.62) and 51.08% were female. In addition, 46.11% reported having attained a higher educational level, 39.46% had a lower socioeconomic status and 77.66% were employed. Almost one-third had illegal migratory status, 84.55% reported having been in Peru for more than 12 months and most lived in Lima (82.74%). Additionally, 98.02% had no mental or physical disability, 75.85% were uninsured, 85.01% had no chronic diseases and 60.54% reported not having a history of COVID-19 infection (Table 1).

Table 1
Characteristics of Venezuelan adults living in Peru.

Characteristics	Total		
	Absolute frequency	Weighted proportion	
	n	%	95% CI[a]
Sex			
Male	4,212	48.92	47.99–49.85
Female	4,412	51.08	50.15–52.01
Age (years)			
18–24	1,732	19.34	18.04–20.72
25–34	3,313	40.85	39.27–42.45
35–44	1,780	21.84	20.57–23.16
45–54	921	10.70	9.89–11.57
55–64	442	5.11	4.52–5.78
65 or older	191	2.15	1.76–2.63
Education level			
No formal education or primary	1,022	9.56	8.54–10.68
Secondary	3,445	44.33	42.41–46.28
Higher	3,260	46.11	44.26–47.97
Socioeconomic status			
Lower	3,664	39.46	36.31–42.70
Middle	3,035	36.66	33.52–39.92
Higher	1,925	23.88	21.50–26.43
Mental or physical disability			
Yes	153	1.98	1.60–2.46
No	7,800	98.02	97.54–98.40
Employment status			
Employed	5,936	77.66	76-.40–78.87
Unemployed	1,791	22.34	21.13–23.60
Health insurance			
Uninsured	6,317	75.85	74.09–77.53
Insured	1,636	24.15	22.47–25.91
Chronic diseases			
None	7,289	85.01	83.89–86.08
1	1,143	12.87	11.94–13.86
>1	192	2.12	1.70–2.63
Migratory status			
Legal	5,043	70.41	68.54–72.21
Illegal	2,910	29.59	27.79–31.46
Time residing in Peru (in months)			
0–6	787	9.09	8.17–10.10
7–12	558	6.36	5.61–7.21
More than 12	6,608	84.55	83.32–85.70
Marital status			
Married or living with a partner	5,483	65.03	63.39–66.95
Other	2,896	34.97	33.36–36.61
History of COVID-19 infection			
Yes	2,382	31.89	30.17–33.66
No	4,919	60.54	58.62–62.42
Does not know	652	7.57	6.66–8.60
City of residence			
Arequipa	472	3.37	2.67–4.26
Chiclayo	522	1.65	1.30–2.09
Chimbote	584	1.58	1.20–2.06
Ica	449	2.40	1.80–3.20
Lima and Callao	4,555	82.74	80.66–85.64
Piura	518	2.25	1.72–2.93
Trujillo	950	4.93	3.96–6.12
Tumbes	574	1.08	0.80–1.46

[a] 95% CI: 95% Confidence Interval.

3.2. COVID-19 vaccination coverage of the primary series and booster dose

The overall COVID-19 vaccination coverage of the primary series in Venezuelan adults was 84.17% (95% CI 82.67–85.57), whilst the overall vaccination coverage of the booster dose was 28.06% (95% CI 25.62–29.07). Lima was the city with the highest vaccination coverage of the primary series reaching 85.11%, while, Arequipa had the highest coverage of the booster dose reaching 30.39%. However, when stratifying to those that completed the primary series, only 32.44% had received the booster dose (Fig. 1).

3.3. Bivariate analysis according to not receiving the primary series of the COVID-19 vaccine

Most independent variables showed statistically significant differences with respect to not receiving the primary series of the COVID-19 vaccine, except for employment and marital status. The groups with the lowest coverage of the primary COVID-19 series were males (81.4%), aged between 18 and 24 years (74.61%), with non-formal or primary education (80.52%), without mental or physical disability (84.06%), uninsured (83.32%), without chronic diseases (83.34%), having illegal migratory status (72.27%), had resided in Peru between 0 and 6 months (68.81%), and did not have a history of COVID-19 infection (81.06%) (Table 2).

3.4. Bivariate analysis according to not receiving the booster dose of the COVID-19 vaccine

After restricting the analysis to participants that had completed the primary vaccine series, the majority of the independent variables showed statistically significant differences regarding not receiving the booster dose of the COVID-19 vaccine. The groups with the lowest coverage of the COVID-19 booster dose were females (11.44%), aged between 18–24 years (30.28%), with secondary education (27.66%), absence of mental or physical disability (32.2%), uninsured (27.81%), without chronic diseases (30.26%), with illegal migratory status (18.67), and having resided in Peru for 7–12 months (19.18%) (Table 2).

3.5. Factors independently associated with not receiving the primary series of the COVID-19 vaccine

The adjusted regression model showed that several factors were independently associated with not receiving the primary series of the COVID-19 vaccine. Males were more likely to not complete the primary

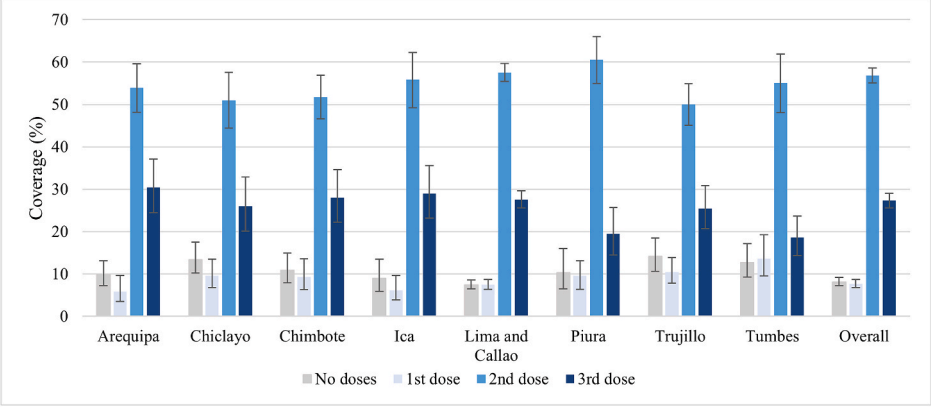

Fig. 1. COVID-19 vaccination coverage of the primary series and booster dose in Venezuelan adults living in Peru.

series than females (aPR = 1.47; 95% CI 1.29–1.68). Participants aged between 18 and 24 years old also had a 3.12-fold greater probability of not receiving the primary series than older adults (aPR = 3.12; 95% CI 1.71–5.70). Regarding education level, having no formal education or primary, or having secondary education, were associated with 1.48 (aPR = 1.48; 95% CI 1.15–1.89) and 1.38-fold (aPR = 1.38; 95% CI 1.14–1.67) greater probability of not completing the primary series, respectively, in comparison with those with higher level. Being uninsured was associated with a 2.03 times higher prevalence of not receiving the primary series, in comparison to being insured (aPR = 2.03; 95% CI 1.50–2.74). Having an illegal migratory status was 2.24 times more likely to not having received the primary series, compared to having legal status. (aPR = 2.24, 95% CI 1.89–2.66). Also, unemployment was associated with a greater probability of not having received the primary series (PR = 1.24; 95% CI 1.05–1.47). Contrarily, belonging to a lower socioeconomic status was inversely associated with not receiving the booster, when compared to a higher socioeconomic status (aPR = 0.79; 95% CI 0.63–0.99). Nevertheless, having a mental or physical disability, suffering from chronic illnesses, the time residing in Peru, and a history of COVID-19 infection were not associated with receiving the primary vaccine series (Table 3).

3.6. Factors independently associated with not receiving the booster dose of the COVID-19 vaccine

When restricting the adjusted regression model to individuals that completed the primary series, several factors were independently associated with not receiving the booster dose of the COVID-19 vaccine. Participants aged between 18 and 24 years old were 3.04 times more likely to not receive the booster dose, in comparison to older adults (aPR = 3.04, 95% CI = 2.27–4.08). In addition, having no formal education or primary was associated with 1.12-fold greater probability of not receiving the booster dose, compared to persons with a higher level (aPR = 1.12, 95% CI = 1.02–1.22). Likewise, being uninsured was associated with a 1.20 times higher prevalence of not receiving the booster dose of the COVID-19 vaccine than insured individuals (aPR = 1.20, 95% CI = 1.14–1.26). Also, participants with an illegal migratory status had a 1.18-fold higher likelihood of not having received the booster dose, compared to those with legal status (aPR = 1.18, 95% CI 1.14–1.21). Contrarily, having resided in Peru for more than 12 months was inversely associated with not receiving the booster, compared to those that resided for 0–6 months (aPR = 0.91; 95% CI 0.86–0.97). Likewise, belonging to a lower or middle socioeconomic status was inversely associated with not receiving the booster dose compared to having a higher socioeconomic status (aPR = 0.94; 95% CI 0.91–0.98 and aPR 0.95; 95% CI 0.91–0.99, respectively). On the other hand, sex, having a mental or physical disability and suffering from chronic diseases were not associated with receiving or not the booster dose (Table 4).

4. Discussion

4.1. Main findings

This study unveils the COVID-19 vaccination coverage of the primary series and booster dose in the Venezuelan migrant population living in Peru, as well as their associated factors. The main results show that eight out of ten participants received the primary series of the COVID-19 vaccine with significant variation across cities, and that three out of ten participants who received the primary series received the booster dose. For the primary series, being male, aged 18–34 years, having a low level of education, not having health insurance, being illegally-residing or unemployed were associated with a higher probability of not completing the scheme. For the booster dose, age between 18 and 54 years, having no formal education or primary education, not having health insurance, and being illegal were associated with a higher likelihood of not receiving the booster dose. However, except for age, the magnitudes of the associations were smaller with respect to not receiving the booster dose. In both cases, the city of residence played a key role, which may be due to the different approaches of the vaccination campaigns. While some of these associations are due to national prioritization plans for COVID-19 vaccination, others represent possible inequities in access to vaccination in the migrant population.

4.2. Comparison with previous studies

There were variations in primary series and booster dose coverage between the general population and ENPOVE-2022 participants. By February 6, 2022, for instance, 80.7% of the general population had completed the primary series and 42.19% had received the booster dose in the region of Lima [8]. While these data are not comparable because the information collected by ENPOVE-2022 covered February and March 2022 [17] and the data provided by MINSA includes all age groups [8], in the general population the coverage of the primary series was higher than that of the booster dose. Regardless of these values, in the general population, vaccination coverage of the primary series and booster dose were still suboptimal, especially the latter. However, these figures are dynamic and are constantly increasing [8]. These variations could be influenced by factors associated with not receiving the COVID-19 vaccine found in our study, which in some cases are related to factors found in the general population of Peru and Latin America [12, 13]. Although to our knowledge there are only studies that assessed the intention to vaccinate with the primary series in Peru [19] and others have analyzed receipt of the booster dose in Peru and Latin America [12, 13], no study has determined the factors associated with receiving the primary series and the booster doses in the Peruvian context.

Table 2
Characteristics of Venezuelan adults according to vaccination status.

Characteristics	Primary series			Booster dose[b]		
	Complete	Incomplete	p-value[a]	Complete	Incomplete	p-value[a]
	%	%		%	%	
Sex			<0.001			0.001
Male	81.4	18.6		30.28	69.72	
Female	86.78	13.22		34.36	65.64	
Age (years)			<0.001			<0.001
18–24	74.61	25.39		11.44	88.56	
25–34	86.37	13.63		24.36	75.64	
35–44	92	8		41.45	58.55	
45–54	93.83	6.17		53.42	46.58	
55–64	92.26	7.74		65.35	34.65	
65 or older	92.04	7.96		72	28	
Education level			<0.001			<0.001
No formal education or primary	80.52	19.48		31.15	68.85	
Secondary	82.28	17.72		27.66	72.34	
Higher	91.66	8.34		36.81	63.19	
Socioeconomic status			<0.001			0.002
Lower	87.26	12.74		35.18	64.82	
Middle	83.31	16.69		32.21	67.79	
Higher	80.39	19.61		27.9	72.1	
Employment status			0.052			0.445
Employed	86.94	13.06		32.74	67.26	
Unemployed	84.66	15.34		31.38	68.62	
Mental or physical disability			0.034			0.018
Yes	89.84	10.16		43.81	56.19	
No	84.06	15.94		32.2	67.8	
Health insurance			0.005			<0.001
Uninsured	83.32	16.68		27.81	72.19	
Insured	86.85	13.15		46.4	53.6	
Chronic diseases			0.001			<0.001
None	83.34	16.66		30.26	69.74	
1	88.39	11.61		41.58	58.42	
>1	89.1	10.9		52.56	47.44	
Migratory status			<0.001			<0.001
Legal	89.17	10.83		37.14	62.86	
Illegal	72.27	27.73		18.67	81.33	
Time residing in Peru (in months)			<0.001			<0.001
0–6	68.81	31.19		21.46	78.54	
7–12	64.35	35.65		19.18	80.82	
More than 12	87.31	12.69		34.11	65.89	
Marital status			0.342			0.778
Married or living with a partner	86.79	13.21		32.28	67.72	
Other	85.8	14.2		32.74	67.26	
History of COVID-19 infection			<0.001			<0.001
Yes	89.84	10.16		35.93	64.07	
No	81.06	18.94		31.6	68.4	
Does not know	85.19	14.81		23.43	76.57	
City of residence			<0.001			0.135
Arequipa	84.3	15.7		36.04	63.96	
Chiclayo	76.98	23.02		33.77	66.23	
Chimbote	79.75	20.25		35.09	64.91	
Ica	84.85	15.15		34.2	65.8	
Lima and Callao	85.11	14.89		32.38	67.62	
Piura	80.06	19.94		24.3	75.7	
Trujillo	75.41	24.59		33.74	66.26	
Tumbes	73.67	26.33		25.23	74.77	

[a] Chi-squared test with Rao-Scott correction.
[b] Only people who completed the primary series were included.

Nevertheless, there are some explanations for our results.

4.3. Plausibility of the results

The primary series and booster dose in the national vaccination schedule were prioritized among high-risk groups for COVID-19 disease [20,21]. This strategy would explain why young people were more likely to not receive the primary series or the booster dose, and why older adults were more likely to be vaccinated, taking into account that age is a known predictor of poorer prognosis among infected patients [22]. In the general population, these factors were also associated with not receiving a booster dose in our country, presumably for the same reason [12]. Overall, these differences constitute an inequality rather than an inequity.

There were significant differences in the uptake of the COVID-19 vaccine according to sex, education level, and socioeconomic status. Male sex was associated with a higher intention to be vaccinated in the primary series in the general population [19], which is in line with our results. This could be explained by the fact that prior to the vaccination campaign for primary series, some studies showed that women were more fearful of the adverse effects of the vaccine [23]. Furthermore, having a lower education level was associated with not receiving the primary series or the booster dose. Indeed, two systematic reviews reported that people with a higher education were more likely to accept

Table 3
Factors associated with not receiving the primary series of the COVID-19 vaccine.

Characteristics	Crude model[a]			Adjusted model[b]		
	cPR[c]	95% CI[d]	p-value	aPR[e]	95% CI[d]	p-value
Sex						
Male	1.40	1.27–1.55	<0.001	1.47	1.29–1.68	<0.001
Female	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Age (years)						
18–24	3.18	1.98–5.10	<0.001	3.12	1.71–5.70	<0.001
25–34	1.71	1.08–2.68	0.020	2.26	1.23–4.15	0.008
35–44	1.00	0.62–1.61	0.984	1.42	0.78–2.59	0.244
45–54	0.77	0.46–1.29	0.326	0.97	0.50–1.86	0.933
55–64	0.97	0.53–1.76	0.925	1.07	0.53–2.14	0.844
65 or older	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Education level						
No formal education or primary	2.33	1.87–2.91	<0.001	1.48	1.15–1.89	0.002
Secondary	2.12	1.88–2.40	<0.001	1.38	1.14–1.67	0.001
Higher	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Socioeconomic status						
Lower	0.64	0.52–0.80	<0.001	0.79	0.63–0.99	0.042
Middle	0.85	0.72–0.99	0.040	0.94	0.75–1.17	0.612
Higher	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Employment status						
Employed	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Unemployed	1.17	0.99–1.38	0.050	1.24	1.05–1.47	0.008
Mental or physical disability						
Yes	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
No	1.56	1.01–2.42	0.043	1.32	0.80–2.19	0.272
Health insurance						
Uninsured	1.26	1.07–1.49	0.005	2.03	1.50–2.74	<0.001
Insured	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Chronic diseases						
None	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1	0.69	0.56–.86	0.001	1.05	0.86–1.29	0.590
>1	0.65	0.41–1.03	0.072	1.59	0.80–3.16	0.177
Migratory status						
Legal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Illegal	2.56	2.13–3.07	<0.001	2.24	1.89–2.66	<0.001
Time residing in Peru (in months)						
0–6	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
7–12	1.14	0.91–1.42	0.231	0.89	0.64–1.25	0.532
More than 12	0.40	0.31–0.52	<0.001	1.06	0.86–1.30	0.577
History of COVID-19 infection						
Yes	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
No	1.86	1.50–2.30	<0.001	1.16	0.95–1.42	0.121
Does not know	1.45	1.06–1.99	0.018	1.14	0.83–1.58	0.403
City of residence						
Arequipa	1.05	0.74–1.48	0.762	1.12	0.80–1.56	0.507
Chiclayo	1.54	1.11–2.14	0.009	1.24	0.95–1.63	0.105
Chimbote	1.36	1.06–1.73	0.013	0.86	0.62–1.19	0.375
Ica	1.01	0.69–1.49	0.927	0.70	0.47–1.04	0.079
Lima and Callao	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Piura	1.33	0.93–1.91	0.107	1.14	0.85–1.54	0.362
Trujillo	1.65	1.24–2.18	0.001	1.37	1.09–1.73	0.006
Tumbes	1.76	1.32–2.35	<0.001	1.16	0.90–1.50	0.247

[a] Poisson regression.
[b] Poisson regression adjusted per all model variables.
[c] cPR: crude Prevalence Ratio.
[d] 95% CI: 95% Confidence Interval.
[e] aPR: adjusted Prevalence Ratio.

Table 4
Factors associated with not receiving the booster dose of the COVID-19 vaccine.

Characteristics	Crude model[af]			Adjusted model[bf]		
	cPR[c]	95% CI[d]	p-value	aPR[e]	95% CI[d]	p-value
Sex						
Male	1.06	1.02–1.10	0.002	1.03	0.99–1.06	0.086
Female	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Age (years)						
18–24	3.16	2.31–4.32	<0.001	3.04	2.27–4.08	<0.001
25–34	2.70	1.96–3.72	<0.001	2.79	2.05–3.81	<0.001
35–44	2.09	1.53–2.85	<0.001	2.18	1.61–2.94	<0.001
45–54	1.66	1.25–2.19	<0.001	1.68	1.29–2.19	<0.001
55–64	1.23	0.89–1.71	0.198	1.22	0.89–1.66	0.205
65 or older	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Education level						
No formal education or primary	1.08	1.00–1.18	0.050	1.12	1.02–1.22	0.010
Secondary	1.14	1.05–1.23	0.001	1.05	0.98–1.13	0.127
Higher	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Socioeconomic status						
Lower	0.89	0.85–0.95	<0.001	0.94	0.91–0.98	0.007
Middle	0.94	0.89–0.98	0.011	0.95	0.91–0.99	0.044
Higher	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Mental or physical disability						
Yes	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
No	1.20	1.00–1.44	0.044	0.98	0.84–1.15	0.857
Health insurance						
Uninsured	1.34	1.26–1.43	<0.001	1.20	1.14–1.26	<0.001
Insured	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Chronic diseases						
None	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1	0.83	0.79–0.88	<0.001	0.97	0.91–1.03	0.463
>1	0.68	0.55–0.82	<0.001	1.06	0.87–1.29	0.518
Migratory status						
Legal	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Illegal	1.29	1.24–1.34	<0.001	1.18	1.14–1.21	<0.001
Time residing in Peru (in months)						
0–6	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
7–12	1.02	0.96–1.10	0.400	1.01	0.94–1.09	0.681
More than 12	0.83	0.79–0.88	<0.001	0.91	0.86–0.97	0.005
History of COVID-19 infection						
Yes	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
No	1.06	1.01–1.12	0.011	1.02	0.97–1.06	0.293
Does not know	1.19	1.12–1.27	<0.001	1.14	1.06–1.22	<0.001
City of residence						
Arequipa	0.94	0.85–1.04	0.267	0.94	0.85–1.03	0.224
Chiclayo	0.97	0.84–1.13	0.784	0.93	0.81–1.06	0.293
Chimbote	0.96	0.86–1.06	0.425	0.86	0.77–0.96	0.008
Ica	0.97	0.87–1.08	0.611	0.88	0.81–0.97	0.011
Lima and Callao	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Piura	1.11	1.05–1.18	<0.001	1.05	0.99–1.11	0.053
Trujillo	0.97	0.90–1.05	0.596	0.94	0.89–0.99	0.037
Tumbes	1.10	1.03–1.18	0.004	0.98	0.91–1.05	0.615

[a] Poisson regression.
[b] Poisson regression adjusted per all model variables.
[c] cPR: crude Prevalence Ratio.
[d] 95% CI: 95% confidence interval.
[e] aPR: adjusted Prevalence Ratio.
[f] Only people who completed the primary series were included.

COVID-19 vaccination [24,25]. In the Peruvian general population, having a lower level of education was independently associated with not receiving the booster dose compared to people with a postgraduate education [12]. Nevertheless, having a lower socioeconomic status was associated with lower likelihood of not receiving the primary series or booster dose. One potential explanation for this finding is that, in our sample, many people with a low socioeconomic status actually had a higher education status (63.09%) but were presumably working in low-paying jobs or were unemployed. In the Peruvian population, economic insecurity was associated with a greater intention to be vaccinated, presumably for fear that the infection and its consequences would further affect their ability to work and worsen their insecurity [19]. Something similar may be happening in migrants, both for the primary series and for the booster dose, i.e., even if they are unemployed, they consider a vaccine-preventable disease to be an unnecessary risk.

Some problems associated with the migrant status could also affect their receipt of the primary series and booster dose. In fact, being unemployed, uninsured, and an illegal immigrant were strongly associated with not receiving the primary series, whereas the last two were

associated with not receiving the booster dose. Almost one third of Venezuelan migrants have illegal status and even though almost half of the participants in our study had higher education, nearly 8 out of 10 were unemployed. These factors may also explain some of the constraints limiting access to health services in the countries that host them. These constraints are of a legal, financial and discrimination-related nature, which, during the pandemic, were also barriers that affected their capacity to cover the costs of basic needs [10]. Given this scenario, alternative forms of care have emerged, such as telemedicine, self-medication in pharmacies and unsafe care networks [10]. However, employed people were more prone to be vaccinated because the Peruvian government made it obligatory to present a vaccination card to enter closed spaces in which economic or religious activities are carried out. Moreover, discrimination against the migrant population should be considered as a barrier limiting effective access to vaccination posts. A survey in Peruvian adults showed that 70% consider that Venezuelan displacement has a negative impact on Peru, emphasizing the increase in citizen insecurity and crime and a higher level of informality and fewer jobs in the country [26]. In the case of illegal migrants, this discrimination would increase distrust of governments or fear of detention and deportation if medical care is sought [27]. Therefore, in addition to administering the COVID-19 vaccine free of charge, governments must provide the necessary guarantees for persons with illegal status to be vaccinated and duly informed.

Even though the coverage of the booster dose was still low, it should have increased over the subsequent months. Nonetheless, this coverage would not have been as high as in the primary series, as was the case in the general population in Peru [8]. One explanation for this may be aspects related to hesitancy to receive the vaccine, as occurred in the general population [28]. Despite a high intention to being vaccinated, the percentage that actually receives the vaccine was low [29], usually because of fear of adverse reactions and discomfort experienced after previous doses of the vaccine and concern about serious adverse reactions to booster doses [30]. To ensure high adherence to the vaccination schedule, it is important to conduct a comprehensive information campaign in addition to the corresponding support in case of adverse events.

4.4. Public health relevance and recommendations

Vaccination for all is a shared public health task and in order to promote a comprehensive response to the pandemic, some organizations have made some suggestions regarding the vaccination of Venezuelan migrants. The Regional Interagency Coordination Platform for Refugees and Migrants of Venezuela has some recommendations that are applicable to the Peruvian context [31]. First, refugees and migrants should be included in national COVID-19 vaccination plans, regardless of their nationality and legal status. Second, refugees and migrants should be considered as priority groups identified by health authorities in their distribution plans. Third, special attention should be given to populations at significantly elevated risk of infection, such as refugees and migrants in vulnerable situations, for the allocation and prioritization of COVID-19 vaccination. Fourth, the inclusion of refugees and migrants in vaccine information campaigns should be ensured, with the objective of providing full access to information on vaccination schedules, without fear of negative consequences related to their stay in the national territory [31]. It is therefore paramount that governments facilitate migration processes and the legalization of migrants. Furthermore, regionally coordinated actions are urgently required to cope with these fluxes and offer proper migratory and sanitary conditions to Venezuelan migrants. These considerations should be taken into account by policy makers in order to ensure broad coverage of the COVID-19 vaccine in the migrant population.

The variations in vaccination coverage between cities should be deemed when designing public policies. Although the government designed policies to improve vaccination coverage against COVID-19 in migrants [11], some factors would affected this coverage. According to our findings, those migrants residing in Trujillo were more likely to not receive the primary series, whereas those residing in Chimbote, Ica, or Trujillo were more less to not receive the booster those, both compared to those migrants living in Lima and regardless of the effect of several potential confounders. This stresses the need for individualised strategies tailored to the health conditions and perceptions of vaccines in each city.

All in all, inequalities in COVID-19 vaccination reflect existing inequities in health services worldwide [32]. This is especially notable in Peru, in which the health system is fragmented, segmented and partially decentralized [33,34]. Indeed, there are also wide socioeconomic and spatial inequalities in the vaccination coverage of Peruvian children [35,36]. Further efforts to reduce such disparities are needed to protect vulnerable populations such as migrants and, by extension, the general population.

4.5. Strengths and limitations

Our study should be interpreted considering its limitations. First, due to the cross-sectional design of this study, causality cannot be determined. Nonetheless, given the nature of the outcome and independent variables, reverse causality is unlikely. Second, the vaccination coverage of the primary series and booster dose of the COVID-19 vaccine is representative of the time at which the survey was carried out (February and March 2022). Although our study assessed three doses of the COVID-19 vaccine, nowadays the MINSA is administering the fourth dose and the bivalent COVID-19 vaccine (Pfizer or AstraZeneca). It is also important to note that the perception of the need for vaccination may vary between and within individuals depending on the context of the pandemic. Third, as information about COVID-19 vaccination status was self-reported, social desirability bias and memory bias may arise. Nonetheless, a recent study showed that self-reported COVID-19 vaccination details can be a good surrogate in the absence of medical records [37]. Fourth, as our study was based on a secondary data analysis, we were subject to the variables measured in the survey. Then, it would be of great interest to evaluate the reasons for not receiving the primary series or booster dose. Despite these limitations, we believe that our findings provide a general overview of the factors that influence the receipt of the COVID-19 vaccination schedule in our country, and allows the identification of the population groups on which to focus health strategies. Also, it was based on a large sample representative of most of the Venezuelan migrant population residing in Peru. To the best of our knowledge, this is the first study to assess COVID-19 vaccination status among Venezuelan migrants in a Latin American country.

5. Conclusion

The Venezuelan migrant population is subjected to several hurdles that hinder COVID-19 vaccine uptake. Eight out of ten participants received the primary series of the COVID-19 vaccine, and three out of ten participants who received the primary series received the booster dose. Several sociodemographic and migration-related variables were associated with not receiving the primary series and the booster dose of the COVID-19 vaccine. Governmental policies prioritizing vaccination among Venezuelan migrants are needed to ensure broad coverage of this vulnerable group.

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Data statement

Data are available in a public open-access repository. The database is

freely accessible from the website of the National Institute of Statistics and Informatics (http://iinei.inei.gob.pe/microdatos/).

CRediT authorship contribution statement

Ali Al-kassab-Córdova: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft. **Claudia Silva-Perez:** Investigation, Writing – original draft. **Carolina Mendez-Guerra:** Investigation, Writing – original draft. **Percy Herrera-Añazco:** Investigation, Writing – original draft. **Vicente A. Benites-Zapata:** Conceptualization, Methodology, Validation, Investigation, Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

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