Research Article

Understanding COVID-19 Vaccine Hesitancy Among Brazilian Immigrants: Prevalence, Determinants, and Global Health Implications

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Abstract

Background: Vaccine hesitancy extends beyond simple refusal to receive immunizations, encompassing psychological, cultural, and sociodemographic factors that influence individuals' perceptions and decision-making regarding vaccines.

Objectives: This study aimed to determine the prevalence and factors influencing COVID-19 vaccine hesitancy among Brazilian immigrants.

Methods: A survey targeting Brazilian immigrants in Portugal was conducted from May to August 2020, involving 598 participants. The study explored the relationship between vaccine hesitancy and non-compliance with social distancing measures using a Poisson regression model with robust variance to calculate prevalence ratios (PRs).

Results: The study identified a vaccine hesitancy rate of 15.1% among Brazilian immigrants. Older individuals (aged 50 and above) exhibited a significantly higher hesitancy, with an adjusted prevalence ratio (aPR) of 10.0 (95% CI: 1.8 - 13.6). Those adhering to a religion were 2.3 times more likely to hesitate (95% CI: 1.4 - 3.4), and a reluctance to follow social distancing measures was associated with a 10.4 times higher hesitancy rate (95% CI: 4.2 - 15.4). Highlighting these correlations is vital for developing strategies to enhance vaccine acceptance and tackle public health challenges.

Conclusions: There is a notable rate of COVID-19 vaccine hesitancy among Brazilian immigrants in Portugal, significantly influenced by age, religious practice, and non-adherence to social distancing measures. Implementing targeted educational and awareness programs is recommended to reduce hesitancy and improve vaccine coverage within this community and in similar settings.

Keywords: Immigrants, COVID-19, Vaccine, Vaccine Hesitancy, Global Health

1. Background

Attitudes toward vaccines range from enthusiastic acceptance to outright refusal and can fluctuate based on time, location, and vaccine type (1). Vaccine Hesitancy (VH) represents a midpoint on this spectrum, characterized by reluctance or delay in accepting vaccines available through healthcare systems. The concept of VH, while longstanding since the introduction of the first vaccines, has gained particular prominence during the global COVID-19 pandemic, exacerbated by a pervasive infodemic (2).

The swift spread of often contradictory and misleading information across various media has fostered an environment filled with uncertainty and skepticism about vaccines (3). This has positioned VH as a major impediment to public health efforts, compromising the effectiveness of vaccination campaigns and pandemic control (4).

Historically, approaches to counter VH have been grounded in systematic principles. However, there has been a shift towards utilizing content through social media platforms more recently (3). Despite these changes, the engagement tactics of VH proponents have remained notably consistent over the past two centuries (5).

Variations in VH prevalence, influencing behaviors, and associated factors differ widely across different populations and countries (5-8). Recent research has shown a heightened prevalence of VH among immigrants, particularly those without official documentation or limited language proficiency in their new country (8-10).

A significant VH prevalence can lead to lower vaccination rates compared to other vaccines within immigrant communities. A meta-analysis revealed that in the United States, immigrants' vaccination rates are notably lower than those of the general population: HPV vaccination rates are 38% lower, influenza rates are 25% lower, hepatitis B rates are 41% lower, and pneumococcal vaccination rates are 34% lower (8).

Other reasons for vaccine hesitancy include fear of deportation, difficulty accessing accurate information due to language barriers, and the influence of cultural views from their countries of origin, especially in areas with strong opposition to vaccines. Addressing these factors is essential for crafting effective and inclusive vaccination strategies that cater to the nuances of all population segments (6-8).

Brazilians form a significant global migrant community, with migration to European nations like Portugal increasing significantly, largely due to shared language and cultural ties. However, it is crucial to recognize that many of these migrations occur illegally, presenting numerous challenges for the migrants, such as restricted access to healthcare services. The absence of stable immigration status often hinders direct access to these services, leaving Brazilian migrants susceptible to poor health conditions and limiting their access to necessary medical treatments, including vaccinations.

Despite extensive documentation of these challenges by official bodies, research on the frequency and causes of vaccine hesitancy in this population remains limited (11, 12). Consequently, investigating vaccine hesitancy among Brazilian immigrants could yield insights that inform policies and initiatives to improve vaccine compliance within this demographic (13, 14).

2. Objectives

To evaluate the prevalence and determinants influencing Brazilian immigrants' hesitancy to receive the COVID-19 vaccine.

3. Methods

This observational and cross-sectional study was carried out via an online survey exclusively targeting Brazilian immigrants in Portugal from May to August 2020.

3.1. Sample, Sampling, and Eligibility Criteria

The sample size was estimated using G Power software, factoring in the size of the migrant population in Portugal, an assumed incidence rate of the phenomenon of 50% (due to the lack of prior studies on this population), a tolerable error of 3%, a sample design effect correction of 2, a 95% confidence level, and an additional 20% to accommodate potential losses and refusals. The minimum required sample size was determined to be 412 participants.

To recruit participants, we employed a two-stage snowball sampling method adapted to the virtual environment:

(1) Initially, 30 migrants (referred to as "seeds") were randomly selected from a database of previous studies conducted in Portugal. These seeds were chosen to ensure diversity in location (regions), origin (native or immigrant), race/color (white and non-white), age (young, adult, and older adult), and education level (elementary/high school, university, and graduate education).

(2) Subsequently, each seed was asked to recruit additional participants within the same category as themselves via their digital social networks. Facebook® was also used for participant recruitment.

Ineligible participants included migrants residing outside of Portugal, individuals under 18 years of age,

and those who failed to complete more than 50% of the mandatory survey questions.

3.2. Instruments Used and Data Collection

Our research utilized a structured online questionnaire developed by the authors and based on international scientific literature. Although the questionnaire was not based on a validated scale, it underwent a validation process for face and content validity conducted by experts in the subject area, as supported by recent publications ([6], [15]). The questionnaire included various thematic sections:

- Demographic Information: This section collected essential demographic data such as age, gender, education level, occupation, and duration of residency in Portugal ([6]).

- Knowledge and Attitudes Towards Vaccines: This part explored participants' understanding and opinions regarding COVID-19 vaccines, focusing on their efficacy, safety, and perceived benefits ([6]).

- Vaccine Hesitancy: This segment assessed the level of vaccine hesitancy among participants, including factors contributing to hesitancy such as concerns about potential adverse effects, distrust in vaccine manufacturers, and exposure to misinformation ([6]).

Each thematic section contained specific questions or scales designed to comprehensively measure the relevant constructs. The items in the questionnaire were carefully formulated to be clear, concise, and culturally sensitive, ensuring their applicability and understandability to the Brazilian immigrant population residing in Portugal.

The reliability and validity of the questionnaire were rigorously evaluated through a detailed validation process by a panel of experts. This process included face and content validation, which involved calculating the Content Validity Index (CVI) for each question. The overall CVI for the questionnaire was 0.97, indicating a strong consensus among experts regarding the relevance and adequacy of the items. The CVI measures the extent to which the questionnaire accurately represents the intended content, taking into account cultural and linguistic factors as well as construct validity.

The dependent variable, Vaccine Hesitancy (VH), was measured with the question: "Will you accept the COVID-19 vaccine when it becomes accessible to the general public?" Participants responded on a binary scale with options "yes" or "no."

3.3. Data Analysis

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 24.0 (SPSS Inc., Chicago, IL, USA). Both absolute and relative frequencies were computed. Unadjusted associations were evaluated using prevalence ratios. Statistical significance was assessed with the Pearson chi-square test and the Monte Carlo method, setting a significance threshold at $P \leq 0.05$ and establishing 95% confidence intervals.

Before proceeding, all variables were checked for multicollinearity using tolerance coefficients and variance inflation factors (VIF).

Due to the high frequency of our reference outcome, vaccine hesitancy exceeding 10%, using the logistic regression model with odds ratios (OR) could potentially lead to overestimated associations. Therefore, we opted for the Poisson regression model with robust variance estimation, utilizing a covariance matrix (a generalized linear model) to estimate the prevalence ratio (PR). This approach is more appropriate for cross-sectional studies. A logarithmic link function was utilized, and 95% confidence intervals were established.

Variable selection for the multivariate model was guided by the results of bivariate analyses, taking into account statistical significance (P-value ≤ 0.05), theoretical relevance, and conditions that provided the best model fit. Model performance was evaluated using the Akaike information criterion (AIC), likelihood ratios, omnibus tests, and type III effect tests.

To calculate the adjusted Prevalence Ratios (PR) and their 95% Confidence Intervals (CI), we utilized a hybrid method of parameter estimation, a robust variance estimator, and Type III analysis to evaluate the effects of the model. We conducted an omnibus test to assess the hypothesis that the final multivariate model would better explain the prevalence of COVID-19 vaccine hesitancy compared to a model with only the intercept, setting the statistical significance level at 5% (P-value < 0.05). The model's fit was appraised using Akaike's Information Criterion (AIC), deviation, and log-likelihood, with lower values indicating a better fit. The significance of the adjusted RPs for variables in the final

Table 1. Social and Demographic Characteristics of Brazilian Immigrants During the COVID-19 Pandemic (n = 598), Brazil, 2020

Characteristics	Values [a]
Age group	
18 - 29	134 (22.4)
30 - 49	365 (61)
50 or older	99 (16.6)
Gender	
Male	246 (41.1)
Female	352 (58.9)
Marital Status	
Single	380 (63.5)
In a relationship	218 (36.5)
How many peoples reside with you in your household?	
1 - 3	323 (53.9)
4 - 5	182 (30.4)
More than 6	93 (15.6)
Education	
12 years or less of education	297 (49.6)
12 or more years of education	295 (49.3)
Prefer not to answer	6 (1.0)
How long have you currently been residing in this country?	
More than 12 months	508 (84.9)
Less than 12 months	90 (15.1)
None/Not practicing	410 (68.6)
Catholic	99 (16.6)
Protestant/Evangelical	58 (9.7)
African Traditional Religions	2 (0.3)
Other	29 (4.8)

[a] Values are expressed as No. (%).

model was assessed using the Wald chi-square test. Variables with a p-value less than 0.05 were considered significant.

3.4. Ethical and Legal Considerations

The study adhered to ethical research standards of the two participating countries. It was approved in Brazil by the Research Ethics Committee - CONEP under opinion 4,950,793 in 2020 and conformed to the Declaration of Helsinki and relevant legislation in each country, including Resolution 466/12. All participants provided consent through an online form.

4. Results

4.1. Sociodemographic Data

The sample included 598 participants, predominantly female (58.9%) and aged between 30 to 49 years (61%). Approximately half of the sample had 12 years or less of schooling (49.6%). A majority were in a relationship (63.5%) (Table 1).

Most participants expressed concern about the pandemic's impact on their lives (74.9%), with 74.4% supporting government pandemic response strategies. Furthermore, 88.4% felt the effects of social distancing on their lives and routines, with 42.1% partially isolated. The majority had not been tested for COVID-19 (60.9%), did not know anyone who had died from the disease (92.5%), and had not been hospitalized for COVID-19 (99.7%) (Table 2).

The sample showed a vaccine hesitancy prevalence of 15.1%, indicating that 90 out of 598 Brazilians were hesitant to receive vaccines.

Table 2. COVID-19 Experiences Among Brazilian Immigrants (n = 598), Brazil, 2020

Characteristics	Values [a]
Since the beginning of the pandemic in your country, how long have you been in isolation up to now?	
I am not in isolation	181 (30.27)
60 days or less	104 (17.39)
Between 61 and 90 days	75 (12.54)
More than 90 days	238 (39.80)
What is your gender identity?	
Male	246 (41.14)
Female	352 (58.86)
Do you practice any religion?	
Yes	188 (31.44)
No	410 (68.56)
What is your marital status?	
In a relationship	380 (63.55)
Single	218 (36.45)
Could you endorse the approaches implemented by your municipal authorities in response to the pandemic?	
Agree	445 (74.41)
Disagree	153 (25.59)
Regarding the COVID-19 pandemic, would you say that you:	
Fear the repercussions of the COVID-19 pandemic in your life.	448 (74.92)
Do not fear the repercussions of the COVID-19 pandemic in your life	117 (19.57)
Prefer not to answer	33 (5.52)
How do you perceive the impact that social distancing has had on your life and routine?	
Little impact	60 (10.03)
I see the impact	529 (88.46)
I can't answer	9 (1.51)
Are you (currently - at the time of the survey) in social isolation/social distancing/quarantine?	
Yes, in complete isolation	166 (27.76)
No	180 (30.10)
In partial isolation (I go out for extremely necessary activities but take necessary precautions)	252 (42.14)
Have you been tested for COVID-19?	
Yes	234 (39.13)
No	364 (60.87)
Do you know someone who has had COVID-19?	
Yes	259 (43.31)
No	339 (56.69)
Are you acquainted with anyone who has passed away due to COVID-19?	
Yes	45 (7.53)
No	553 (92.47)
Have you been hospitalized for COVID-19?	
Yes	2 (0.33)
No	596 (99.67)

[a] Values are expressed as No. (%).

4.2. Factors Influencing Hesitancy Towards the COVID-19 Vaccine

Bivariate analysis (Table 3) identified several factors associated with vaccine hesitancy among Brazilian migrants. These factors include marital status, education level, religious practice, agreement with the need for social distancing/quarantine, endorsement of government pandemic strategies, feelings of unmotivation/stress during the pandemic, fear of the

pandemic's repercussions, current participation in isolation/social distancing/quarantine, and a medium to high impact of social distancing on their lives and routines, all with significant P-values of 0.001, except for the last which was 0.004.

Table 3. Association of the Intention to Vaccinate Against COVID-19 with Social, Demographic Characteristics, and Participant Experiences (n = 598), Brazil, 2020 [a]

Factors of Interest	Intends to Voluntarily Get Vaccinated Against COVID-19?			
	Yes	No	Total	P-Value
Marital status				0.001
In a relationship	308 (60.6)	72 (80.0)	380 (63.5)	
Single	200 (39.4)	18 (20.0)	218 (36.5)	
What is your gender identity?				0.064
Male	207 (40.7)	39 (43.3)	246 (41.1)	
Female	301 (59.3)	51 (56.7)	352 (58.9)	
Education				0.001
High school or secondary education	117 (23.0)	4 (4.4)	121 (20.2)	
Higher education (Bachelor's or teaching degree)	172 (33.9)	4 (4.4)	176 (29.4)	
Postgraduate, Master's, or PhD	213 (41.9)	82 (91.1)	295 (49.3)	
I prefer not to answer	6 (1.2)	0 (0.0)	6 (1.0)	
Do you practice any religion?				0.001
Yes	98 (19.3)	90 (100.0)	188 (31.4)	
No	410 (80.7)	0 (0.0)	410 (68.6)	
Do you support the necessity of implementing social distancing or quarantine measures?				0.001
Agree	114 (22.4)	60 (66.7)	174 (29.1)	
Strongly agree	382 (75.2)	29 (32.2)	411 (68.7)	
Indifferent (I neither agree nor disagree)	12 (2.4)	1 (1.1)	13 (2.2)	
Do you endorse the measures implemented by your local government in response to the pandemic?				0.001
Agree	251 (49.4)	36 (40.0)	287 (48.0)	
Strongly agree	147 (28.9)	11 (12.2)	158 (26.4)	
Disagree	41 (8.1)	35 (38.9)	76 (12.7)	
Strongly disagree	3 (0.6)	3 (3.3)	6 (1.0)	
Indifferent (I neither agree nor disagree)	66 (13.0)	5 (5.6)	71 (11.9)	
Did you feel demotivated or stressed during the pandemic?				0.001
Yes	376 (74.0)	41 (45.6)	417 (69.7)	
No	132 (26.0)	49 (54.4)	181 (30.3)	
Regarding the COVID-19 pandemic. would you say that:				0.001

Factors of Interest	Intends to Voluntarily Get Vaccinated Against COVID-19?			
	Yes	No	Total	P-Value
Fear the repercussions of the COVID-19 pandemic on your life	361 (71.1)	87 (96.7)	448 (74.9)	
Do not fear the repercussions of the COVID-19 pandemic on your life	114 (22.4)	3 (3.3)	117 (19.6)	
Are you (currently) in social isolation/social distancing/quarantine?				0.001
Yes, in total isolation	122 (24.0)	44 (48.9)	166 (27.8)	
No	139 (27.4)	41 (45.6)	180 (30.1)	
In partial isolation (I go out for extremely necessary activities but take necessary precautions)	247 (48.6)	5 (5.6)	252 (42.1)	
How do you perceive the impact that social distancing has had on your life and routine?				0.004
Little impact	57 (11.2)	3 (3.3)	60 (10.0)	
Moderate impact	145 (28.5)	40 (44.4)	185 (30.9)	
Significant impact	297 (58.5)	47 (52.2)	344 (57.5)	
I cannot answer	9 (1.8)	0 (0.0)	9 (1.5)	
Do you know anyone who has had COVID-19?				0.641
Yes	218 (42.9)	41 (45.6)	259 (43.3)	
No	290 (57.1)	49 (54.4)	339 (56.7)	
Do you know anyone who has died from COVID-19?				0.001
Yes	25 (4.9)	20 (22.2)	45 (7.5)	
No	483 (95.1)	70 (77.8)	553 (92.5)	
Have you been hospitalized for COVID-19?				0.166
Yes	1 (0.2)	1 (1.1)	2 (0.3)	
No	507 (99.8)	89 (98.9)	596 (99.7)	
Have you ever taken any preventive measures for COVID-19 (such as medications or treatments) without knowing their real effectiveness, only because they were recommended by friends/relatives/acquaintances?				0.011
Never	395 (77.8)	65 (72.2)	460 (76.9)	
Rarely	33 (6.5)	6 (6.7)	39 (6.5)	
Sometimes	60 (11.8)	10 (11.1)	70 (11.7)	
Often	19 (3.7)	6 (6.7)	25 (4.2)	
Have you made any decisions during the COVID-19 pandemic based on information that was not covered in newspapers or widely reported by major media outlets?				0.001
Never	436 (85.8)	62 (68.9)	498 (83.3)	
Yes. at least once	60 (11.8)	19 (21.1)	79 (13.2)	
Yes. more than once	12 (2.4)	9 (10.0)	21 (3.5)	

Multivariate analysis, as shown in Table 4, indicates that adults aged 30 to 49 years exhibit a significantly increased vaccine hesitancy prevalence, with an adjusted prevalence ratio (aPR) of 12.1 (95% CI: 1.2 - 4.37). Similarly, older adults aged 50 years or more also demonstrate higher vaccine hesitancy, with an aPR of 10.0 (95% CI: 1.8 - 13.6), both compared to the younger group (18 - 29 years). The influence of religious activities on vaccine hesitancy is significant, as individuals who engage in religious practices are 2.3 times more likely to exhibit hesitancy towards the vaccine (95% CI: 1.4 - 3.4). The reluctance or refusal to support/adhere to social distancing measures is strongly associated with a notably higher occurrence of vaccine hesitancy, with an aPR of 10.4 (95% CI: 4.2 - 15.4).

Table 4. Multivariate Analysis of Factors Associated with Vaccine Hesitancy in Brazilian Migrants. (n = 598), Brazil, 2020 [a]

Parameter	aPR	95% CI	PR	95%CI	P-Value
Age group (y)					0.001
18 - 29			1		
30 - 49	8.3	3.2 - 14.0	12.1	1.2 - 4.37	
50 years or older	6.4	2.8 - 9.3	10.0	1.8 - 13.6	
Educational level					
Completed up to 12 years of schooling	1				
Completed more than 12 years of schooling	0.17	0.19 - 2.4			
Practice any religion?					0.002
No	1				
Yes	1.7	1.1 - 3.4	2.3	1.4 - 3.4	
Impact of the pandemic					
Little impact	1				
High impact	0.8	0.4 - 1.8			
Agree with the need for social distancing?					
Yes	1				
No	7.6	3.8 - 13.6	10.4	4.2 - 15.4	< 0.001
Fear the impact of COVID on life and well-being?					
Yes	1				
No	1.7	0.4 - 1.9			
Have you adopted any COVID-19 prevention measures without knowing their real effectiveness?					
Yes	1				
No	0.17	0.19 - 1.5			

Abbreviations: PR, prevalence ratio; aPR, adjusted prevalence ratio; 95% CI: 95% confidence interval.

[a] Adjusted by marital status; deviance: 2,531.10; AIC: 4,895.16; log-likelihood: -2,436.55; Omnibus test: [χ² (10) = 460.73; P-value < 0.001].

5. Discussion

We observed a significant prevalence of vaccine hesitancy among Brazilian immigrants at 15.1%, which merits comparison with other studies. For instance, research within the general Brazilian population indicated a slightly higher vaccine hesitancy rate of 17.3% [16], whereas Portuguese-speaking populations in other countries showed an even higher rate of 21.1% [6]. The lack of studies specifically focusing on Brazilian migrants highlights the novelty and importance of this research, emphasizing the need to understand COVID-19 vaccine hesitancy in immigrant communities across various contexts.

Examining similar studies conducted among immigrant populations in countries like the United States and the United Kingdom offers valuable perspectives. For example, research in the United States among Black and African American communities reported a hesitancy rate close to 14%, underscoring the complex dynamics within marginalized groups [17-20]. Moreover, studies have shown varying levels of vaccine acceptance across different racial and ethnic groups, with Asian communities demonstrating higher acceptance rates in certain scenarios.

The discrepancies in vaccine hesitancy rates call for more detailed investigations, particularly regarding differences in research methodologies, sample characteristics, and the cultural, political, and social environments of the studies. A comprehensive analysis that considers these multifaceted factors is crucial. Identifying the primary socioeconomic factors driving vaccine hesitancy among immigrant groups is key to effectively addressing this challenge. By pinpointing these underlying causes, tailored interventions can be developed to increase vaccine uptake.

Our analysis highlights the profound influence of social factors such as marital status, education level, religious involvement (P = 0.001), the impacts of COVID-19, and pandemic-related stress on vaccination decisions among Brazilian immigrants in Portugal. Immigrant communities face distinct challenges, including language barriers, restricted healthcare access, and socioeconomic inequalities, which can exacerbate vaccine hesitancy. Our findings stress the need for targeted interventions and policies that address these

vulnerabilities and promote health equity within immigrant populations.

Our research highlights a significant disparity in vaccine hesitancy across different age groups, with individuals aged 50 and older exhibiting a level of hesitancy ten times greater than that of younger age groups (18 - 29 and 30 - 49 years). This finding aligns with the existing literature, which points to several factors more prevalent among older age groups influencing this trend (20). Commonly cited issues include language barriers, limited access to high-quality healthcare, and reduced trust in the healthcare system of the host country (16, 17, 21). Additionally, some older recent immigrants might have been vaccinated with different vaccines in their countries of origin, contributing to hesitancy towards the vaccines offered in their new country of residence.

As individuals age, their awareness of potential vaccine risks, especially among those with pre-existing health conditions, tends to heighten. A historical distrust, rooted in the experiences of previous generations for whom preventive medicine was not as emphasized, exacerbates this issue. Recent studies by Fabiani et al. (22) and Bhanu et al. (23) have further highlighted the lower vaccination rates among older immigrant populations, particularly against common infectious diseases such as influenza and pneumonia. Moreover, older immigrants might not fully understand the benefits of vaccination and may harbor safety concerns about the vaccines available in their new environment. Negative experiences with the healthcare system and the lack of culturally and linguistically appropriate information intensify vaccine hesitancy among this demographic group (24).

In our study, participants who practiced a religion were found to be 2.3 times more likely to exhibit vaccine hesitancy, a finding that aligns with previous research (6, 25, 26). This association may arise from the intertwining of religious beliefs with notions of health and healing and skepticism towards conventional medicine within certain religious communities. Influential figures such as preachers, priests, and pastors often play a crucial role in disseminating information and shaping opinions within these communities, sometimes perpetuating vaccine-related misinformation and rumors, or influencing vaccination decisions.

A variety of religious leaders and groups have supported and actively promoted vaccination efforts, recognizing their crucial role in protecting public health. For instance, Pope Francis has urged Catholics to get vaccinated, describing it as an "act of love" towards oneself and others (27). Conversely, there have been instances where priests, imams, rabbis, and swamis in the United States have advised their followers against receiving vaccines (28).

Research in the United States has identified a link between higher religious conservatism and a decrease in trust towards traditional authority, as well as a reduced acceptance of vaccines, resulting in significant levels of vaccine hesitancy (9, 27).

Participants who expressed reluctance to adhere to social distancing measures exhibited a 10.4-fold increase in the likelihood of hesitating to receive the vaccine. These individuals may have differing views on the severity of the pandemic, which in turn could lead to a perception that vaccination is not an immediate or necessary protective measure. The enforcement of social distancing was essential to curb the transmission of COVID-19, especially given that many infected individuals were asymptomatic carriers capable of spreading the virus. Additionally, social distancing helped to reduce the burden on healthcare systems, which faced overwhelming challenges due to the influx of patients and increasing mortality rates. Throughout the pandemic, maintaining social distance has been a critical measure to safeguard oneself and others (2, 4, 6, 29, 30).

In the contemporary setting, our study illuminates the changing dynamics of vaccine hesitancy related to COVID-19, signifying a substantial transition from initial uncertainty to the availability of numerous vaccine options (31). As the pandemic has unfolded, the initial apprehensions due to the unknown have gradually shifted towards broader acceptance, especially with the enhanced availability of vaccines compared to the early crisis stages (32). This shift underscores the global community's capacity to adapt and respond to emerging health challenges. Nonetheless, amidst this advancement, new challenges have surfaced, necessitating tailored approaches to sustain vaccine acceptance and address evolving obstacles in public health crises beyond COVID-19 (33, 34).

The data gathered during the pandemic provide valuable insights for developing strategies to promote

the continued adoption of vaccines and address future public health issues. Prominent examples include international initiatives like COVAX, spearheaded by GAVI, the Coalition for Epidemic Preparedness Innovations (CEPI), and the World Health Organization (WHO), which strive to ensure equitable distribution of COVID-19 vaccines.

Additionally, instances of knowledge and technology exchanges among countries and organizations, such as technology transfer agreements for local vaccine production and the implementation of evidence-based public policies discussed in international forums, underscore the importance of cross-border cooperation in overcoming pandemic-related challenges (4, 30, 31, 33-35).

As COVID-19 transmission rates decline, maintaining high vaccination rates is essential to achieve herd immunity and prevent a resurgence. However, the mere availability of vaccines does not guarantee widespread acceptance, highlighting the need to address specific factors that contribute to hesitancy. This transitional phase presents a crucial opportunity to leverage lessons learned and enhance communication and outreach strategies to strengthen confidence in vaccination efforts (6, 33, 35).

5.1. Limitations

There are several limitations to consider in this research. Initially, participant selection was not random, which may have introduced selection bias. Furthermore, although participation in surveys is voluntary in Portugal, this might create disparities between those who choose to participate and those who do not, particularly among older immigrants.

It is also crucial to acknowledge that self-reported data can introduce response bias, as participants' responses might be influenced by their desire to provide socially acceptable answers. Researchers took deliberate measures to mitigate these biases, such as clarifying survey questions and maintaining participant confidentiality.

The limitations inherent to the cross-sectional nature of the study design also merit attention, as this design prevents the establishment of causal relationships or the observation of changes over time. Finally, despite efforts to recruit a diverse sample, this study might not have included enough participants from certain demographic groups, potentially limiting the reflection of the broader population of Brazilian immigrants in Portugal.

5.2. Conclusions

Vaccine hesitancy presents a significant challenge to global public health, especially among immigrant populations and ethnic minorities. Therefore, it is crucial to address this hesitancy within the context of the COVID-19 pandemic by implementing personalized approaches that effectively address vaccine hesitancy in these groups. Adopting a focused and culturally sensitive strategy that considers the unique cultural, social, and political factors influencing vaccination decisions is essential.

Addressing linguistic barriers, religious beliefs, and the impact of social networks and misinformation is vital. Each of these factors significantly influences attitudes and behaviors towards vaccination. In conclusion, efforts to promote immunization should prioritize the needs and concerns of immigrant populations, ensuring that interventions are accessible, comprehensive, and reflective of diverse cultural perspectives.

Footnotes

to the Declaration of Helsinki and relevant national legislation, including Resolution 466/12. All participants provided informed consent online.

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Informed Consent: The consent to participate in the research was signed online by all participants.

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