

---

# *Original Research Article*

## **Clinical Profile, Comorbidities, and Outcome of the Unvaccinated and Hospitalized for COVID-19 in Northern Brazil: Retrospective Cohort**

**Abstract:** Over the course of the pandemic, COVID-19 affected health, the economy and quality of life in Brazil. The worst years for the country were the first and second. There were delays in vaccine purchases for political reasons at the time. The northern region of the country had a higher mortality rate compared to other regions, associated with local vulnerabilities and fragility of surveillance due to geographic and population characteristics. This study aims to investigate the clinical profile, comorbidities, and outcome of unvaccinated people hospitalized for COVID-19 in the state of Pará in 2022. Retrospective cohort epidemiological study, with data from the national epidemiological surveillance of acute and severe respiratory syndromes. Cases reported in 2022 with vaccinated yes or no field and completed doses were included. Only closed cases cure or death were included. We performed a chi-square test on categorical variables and a Mann-Whitney test on numerical variables. We compared vaccinated VS non-vaccinated; we performed the Odds Ratio in the significant variables. We used the SPSS 20.0 software. The study worked with 2,634 cases of COVID-19 hospitalized in the study period, confirmed by RT-PCR (851/32.30%) and (1,784/67.70%) rapid antigen test. The lethality was (778/29.53%), and those vaccinated with two doses were (1,473/55.90%) and those unvaccinated with no dose (1,162/44.10%). Death represents  $p < 0.001$  (HR 1.306 - CI 1.124/1.517) higher risk of the event occurring in the unvaccinated cases, followed by male sex  $p = 0.004$  (HR 1.188 - CI 1.058/1.334). The first cohort in Brazil and in the north of the country to evaluate the clinical profile, comorbidities, and outcome of COVID-19 in hospitalized patients in this Amazon region, which is a region characterized by local vulnerability factors unique to the other regions of Brazil, showed that the unvaccinated were males, younger, with fewer comorbidities, and that they were associated the deaths.

**Keywords:** COVID-19; Severe acute respiratory syndrome; Hospitalized; Vaccine; Associated Factors; Unvaccinated

---

### **1. Introduction**

COVID-19 devastated Brazil and the world in the first and second years of the pandemic, especially Brazil, one of the reasons was the delay in purchasing the vaccines, for political reasons at the time, which was denounced by the National Health Council (NHC) as a violation of human rights by the conduct of the Bolsonaro government in the pandemic, which even tried to influence the use of drugs without scientific evidence[1].

With 319,119 confirmed cases, the COVID-19 in Brazil in 2020 peaked in July. The number of deaths also reached 7,453 in July 2020. In 2021, the country faced a wave of greater intensity, with a peak of cases in March, with 533,024 confirmed cases and 21,094 deaths in March 2021 alone. It was the worst phase of the disease because we didn't have the vaccine. In 2022, we saw the highest number of cases since the pandemic began, but they were mostly mild and only reached 1,283,024 in January 2022. However, the number of deaths was much lower than in previous years, with 6,658 deaths in January 2022, probably due to vaccination[2].

COVID-19 surveillance in Brazil standardized the molecular test for diagnosis in the first year of the pandemic. This was because surveillance for influenza syndromes was already carried out in sentinel units, and all cases of severe acute respiratory syndrome in

---

hospitalized patients and deaths were screened for respiratory viruses. In the second year of the pandemic, diagnosis was strengthened with the introduction of antigen tests, which were essential tools for rapid diagnosis and isolation of patients and for breaking the chain of transmission. However, molecular testing for respiratory viruses has always been mandatory in severe cases[3].

Vaccination started slowly in Brazil in January 2021, initially for the elderly over 90 years old and health professionals, while we faced the second wave with thousands of deaths. Progress was slow and we were only able to vaccinate the entire adult population with the first dose by the end of 2021. Children were vaccinated in early 2022 and infants were not vaccinated, despite the Fizer baby being approved by the National Health Surveillance Agency (ANVISA). The delay in vaccine procurement and slow vaccination by age group may have influenced the mortality of COVID-19 by the end of 2022[4–9].

Studies conducted from 2020 to 2021 on vaccine use and mortality reduction in other countries that started vaccination before Brazil, showed mortality reduction still in 2021, including a reduction in the elderly[10,11]. A systematic review with meta-analysis with 54 studies, showed the Efficacy of the Pooled Vaccine (EPV) against SARS-COV 2 infection was 71% [odds ratio (OR) = 0.29, 95% confidence interval (CI): 0.23-0.36] at the first dose and 87% (OR = 0.13, 95% CI: 0.08- 0.21) at the second dose. The EPV for preventing hospitalization due to COVID-19 infection was 73% (OR = 0.27, 95% CI: 0.18-0.41) at the first dose and 89% (OR = 0.11, 95% CI: 0.07-0.17) at the second dose. Regarding the type of vaccine, mRNA-1273 and combined studies at the first dose and ChAdOx1 and mRNA-1273 at the second dose showed higher efficacy in preventing infection. Regarding COVID-19-related mortality, EPV was 68% (HR = 0.32, 95% CI: 0.23-0.45) at the first dose and 92% (HR = 0.08, 95% CI: 0.02-0.29) at the second dose[12]. Vaccines are the best strategies to control the pandemic and reduce mortality, especially among the elderly [13].

The northern region of the country had a higher mortality rate compared to other regions, associated with local vulnerabilities and fragility of surveillance due to geographic and population characteristics. One study described the predictors of deaths in the state of Pará in the first year of the pandemic, and showed that the predictors of lethality were invasive ventilation (OR 6,627; CI 5,780-7,597), other pneumopathy (OR 1.901; CI 1.439-2.510), dyspnea (OR 1.899; CI 1.737-2.076), immunodeficiency (OR 1.905; CI 1.493-2.431), hospitalized in ICU (OR 1.764; CI 1.588-1.959), chronic kidney disease (OR 1.753; CI 1.396-2.203), diabetes mellitus (OR 1.210; CI 1.108-1.321), and male gender (OR 1.198; CI 1.111-1.293). And it showed that those vaccinated against influenza were associated with survivors[14].

No study has evaluated the profile of those hospitalized for COVID-19 in the third year of the pandemic in this region of Brazil, because it is worth noting that denialism greatly influenced non-adherence to COVID-19 vaccines. Assessing the factors associated with non-vaccination in hospitalized cases will guide public health to more effective strategies for COVID-19 vaccine campaigns and improve the immunization scenario and reduce severe cases and deaths in this region. Thus, we question: What are the clinical profile, comorbidities, and outcomes of unvaccinated people hospitalized for COVID-19 in the state of Pará in 2022?

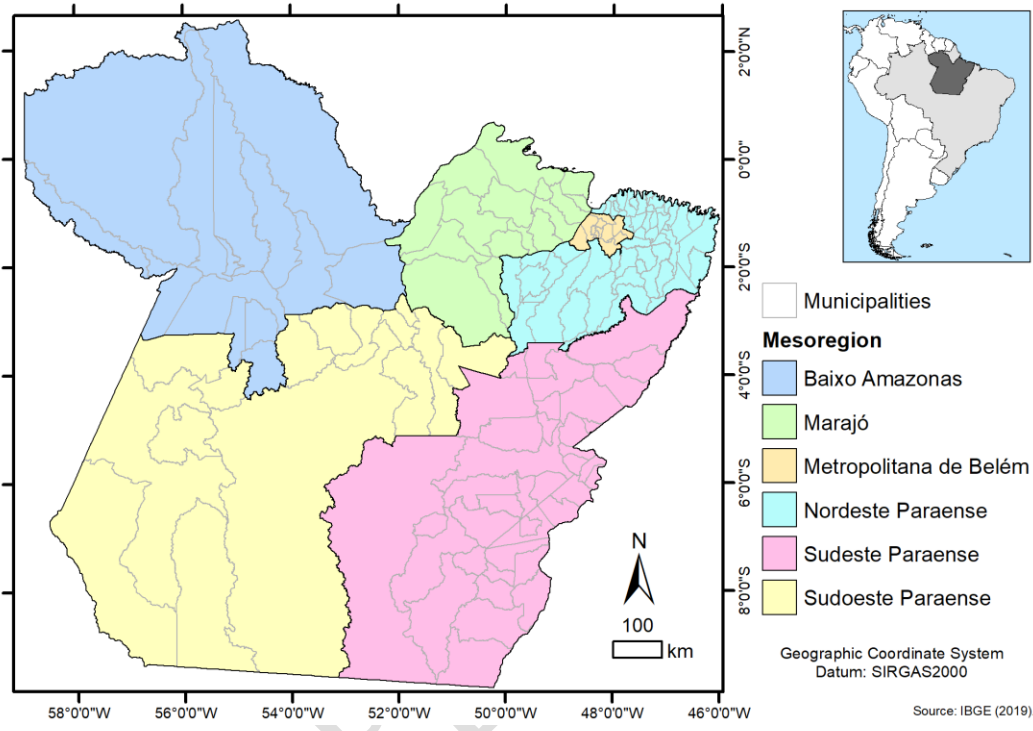
## 2. Materials and Methods

### 2.1. Type of study

The present study is a retrospective cohort with regional data from the surveillance of acute and severe respiratory syndromes in the state of Pará, Brazil. It was carried out in the year 2022. According to the guidelines of the Strengthening the reporting of observational studies in epidemiology (STROBE) [15].

### 2.2. Study location

98 The study was conducted in the state of Pará, which is located in the northern region  
 99 of Brazil (figure 1). Pará is the second largest state in the country in territorial extension,  
 100 with an area of 1,245,870.798 km<sup>2</sup>, has an estimated population for 2020 of 8,690,745 in-  
 101 habitants, and presents a Human Development Index (HDI) of 0.646. The state has six  
 102 Mesoregions comprised of 22 Microregions, in a total of 144 municipalities, and has the  
 103 city of Belém as its capital. The territory of Pará is composed of the largest tropical forest  
 104 in the world, the Amazon. The relief is low and flat; 58% of the territory is below 200  
 105 meters. Altitudes above 500 meters are found in the following mountain ranges: Serra  
 106 dos Carajás, Serra do Cachimbo, and Serra do Acari. [16].

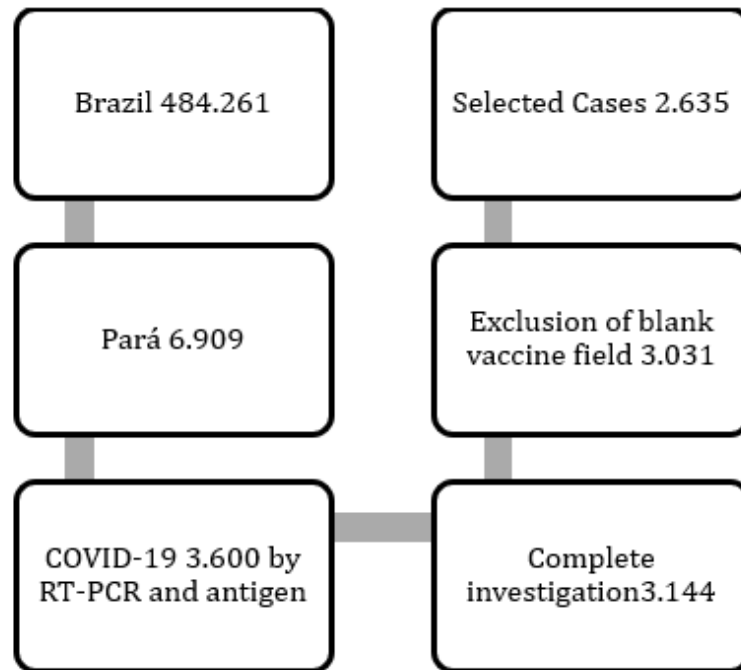


**Figure 1.** – Geographic location of the state of Pará and its mesoregions.

Source: Sardinha, [17].

## 2.2. Study population and source

The study population was all cases reported and confirmed by RT-PCR and rapid antigen testing for COVID-19 in the Influenza Epidemiological Surveillance Information System platform SIVEP-GRIPE (<https://sivepgripe.saude.gov.br/sivepgripe/login.html?1>). In the period January 01, 2022, to November 09, 2022. The following flow details the selection of participants.



**Figure 2** – Selection of participants.

Source: Authors' research.

### 2.3. Inclusion Criteria

All confirmed cases, with the vaccination field of COVID-19 filled in, the cases that had yes in the vaccine field should have the dates of the first and second dose, final classification, and evolution filled in.

### 2.4. Exclusion Criteria

Cases with only one vaccine dose completed and no vaccine date.

### 2.5. Case Definition

Severe Acute Respiratory Syndrome (SARS) is defined as individuals with Influenza Syndrome (RSS) who have: dyspnea/respiratory distress or persistent chest pressure or O<sub>2</sub> saturation less than 95% on room air or bluish coloration of the lips or face. (SG: Individual with an acute respiratory condition characterized by at least two (2) of the following signs and symptoms: fever (even if referred), chills, sore throat, headache, cough, runny nose, smell or taste disturbances). For notification in SIVEP-GRIPE, should be considered the cases of SARS hospitalized or deaths by SARS independent of hospitalization[18].

The dependent variable of this cohort was cases of unvaccinated (1,162 exposed) and vaccinated (1,473 unexposed) SARS due to COVID-19. A comparison of the clinical, comorbidity, and outcome variables of COVID-19 SARS in the exposed (unvaccinated) and unexposed (vaccinated) groups was performed.

### 2.6. Data Analysis

The database was made available in Excel 2019 format with the variables corresponding to the SIVEP-GRIPE notification form, which is composed of 80 variables, referring to sociodemographic and clinical-epidemiological data. The variables worked and extracted according to the form were: gender (item 8), age (item 10), signs and symptoms (item 35), risk factors/comorbidities (item 36), admitted to ICU (item 47), used ventilatory support (item 50) and evolution (item 74). SIVEP-GRIPE notification form[18].

---

145 For the statistics, the absolute and relative frequencies of all cases were calculated,  
146 and to investigate the predictor variables in unvaccinated cases, the comparison in a  
147 univariate model was performed in the categorical variables by 2x2 table and the  
148 Chi-square test between vaccinated and unvaccinated cases, in values less than <5 the  
149 Fisher's exact test was performed, and in significant cases, the Odds Ratio (OR) was also  
150 performed.

151 For the numerical variable age, a normality test was performed, the Kolmogorov-Smirnov  
152 test, which was significant (<0.001), thus the Mann-Whitney test was applied to age,  
153 to compare the median of the unvaccinated and vaccinated.

154 We performed COX regression, univariate and multivariate a final model with only  
155 the variables that were significant. Cox regression builds a predictive model for  
156 time-to-event data. The model produces a survival function that predicts the probability  
157 that the event of interest has occurred at a given time t for given values of the predictor  
158 variables. The form of the survival function and the regression coefficients for the pre-  
159 dictors are estimated from observed subjects; the model can then be applied to new cases  
160 that have measures for the predictor variables. Note that information from censored  
161 subjects, that is, those who do not experience the event of interest during the observation  
162 time, makes a useful contribution to model estimation. The time variable was the day's  
163 counting from the date of notification until the outcome, cure or death. We performed  
164 with the dependent variable not vaccinated against COVID-19, and set up with the re-  
165 maining independent variables, referring to the epidemiological, clinical profile, comor-  
166 bidities, and disease outcome. For all statistical analyses we used the Statistical Package  
167 for the Social Sciences (SPSS) version 26.0. The alpha level of significance for all analyses  
168 was <0.05.

### 169 2.7. Ethical Aspects

170 And to meet the ethical aspects from Resolution No. 466 of 12 December 2012 that  
171 directs the study in the principles of bioethics, emphasizing respect for human dignity,  
172 freedom, and autonomy of the human being, also integrating non-maleficence, benefi-  
173 cence, justice, and equity among others, to ensure rights and duties to all involved in re-  
174 search. The project was approved on 11/16/2020 by the Ethics and Research Committee of  
175 the Marco School Health Center of the Universidade do Estado do Pará - UEPA. Con-  
176 substantiated Opinion No. 4.399.970. Which is part of this multicenter project "SOCIAL,  
177 EPIDEMIOLOGICAL AND SPACIAL ANALYSIS OF COVID-19 IN THE STATE OF  
178 PARÁ DURING THE PANDEMIA" of the postgraduate program in Parasite Biology in  
179 the Amazon of the University of Pará State and the Evandro Chagas Institute (UE-  
180 PA-IEC).

## 181 3. Results

182 The study worked with 2,634 cases of COVID-19 hospitalized in the study period,  
183 confirmed by RT-PCR (851/32.30%) and (1,784/67.70%) rapid antigen test. The lethality  
184 was (778/29.53%), and those vaccinated with two doses were (1,473/55.90%) and those  
185 unvaccinated with no dose (1,162/44.10%).

186 We present the first and second doses of the vaccine by production laboratory,  
187 which were used in Brazil. AstraZeneca was the most frequent in hospitalized patients, in  
188 the 1st dose with 52.61% and 2nd with 52.31 (table1). About the outcomes of cure and  
189 death, CoronaVac presented the highest lethality with 33.80%(table 2). About Janssen  
190 and those hospitalized were lower in number, which may be associated with the start of  
191 vaccination with Janssen only in June 2021 and prioritizing the most distant regions of  
192 the state.

193 The median age overall was 56 years, of those vaccinated 65 and of those not vacci-  
194 nated 45, a lower median age was associated with the unvaccinated cases (p-<0.001).  
195 About the sex, the male was associated with the unvaccinated (p-0.011- OR 1.202- 95%  
196 CI 1.030/1.402).. Fever was associated with the unvaccinated (p-0.013- OR 1.202- 95% CI

1.025/1.408), and vomiting (p=0.021- OR 1.277- 95% CI- 1.016/1.607). Other signs and symptoms had an association with that vaccinated, dyspnea (p=0.001- OR 0.785- 95% CI 0.671/0.918) and O2 saturation <95% (p=0.007- OR 0.819- 95% CI 0.701/0.957). When comparing comorbidities between vaccinated and unvaccinated, significance was associated with vaccinated, showing that individuals with comorbidities are vaccinated for COVID-19, such as in chronic cardiovascular disease (p<0.001- OR 0.476- 95% CI 0.396/0.573), chronic liver disease (p=0.049- OR 0.315- 95% CI 0.089/1.119), asthma (p=0.014- OR 0.418- 95% CI 0.196/0.892), diabetes mellitus (p<0.001- OR 0.515- 95% CI 0.418/0.635), chronic neurological disease (p=0.014- OR 0.579- 95% CI 0.361/0.928), chronic kidney disease (p=0.001- OR 0.480- 95% CI 0.303/0.760). At outcome, ICU admission (p=0.009-OR 1.494-CI 1.105-2.019) and death (p=0.046-OR 1.442-CI 1.163-1.788) were associated with those not vaccinated against COVID-19.(table 3).

**Table 1** – First and second doses of the COVID-19 vaccine by production laboratory, of vaccinees hospitalized in the state of Pará in 2022.

Vaccine Laboratory	1st dose %	2st dose %
AstraZeneca	52.61	52.31
CoronaVac	38.82	38.40
Janssen	0.24	0.12
Pfizer/Biontech	8.32	9.17
<b>Total</b>	<b>100.00</b>	<b>100.00</b>

Source: SIVEP-GRIPE.

**Table 2** – First and second doses of the COVID-19 vaccine by laboratory and outcome, of vaccinees hospitalized in the state of Pará in 2022.

1st dose	Survivor %	Death %	Total %
AstraZeneca	71.25	28.75	52.61
CoronaVac	66.20	33.80	38.82
Janssen	100.00	0.00	0.24
Pfizer/Biontech	81.02	18.98	8.32
<b>Total</b>	<b>70.17</b>	<b>29.83</b>	<b>100.00</b>
2nd dose	Survivor %	Death %	Total %
AstraZeneca	71.43	28.57	52.31
CoronaVac	66.77	33.23	38.40
Janssen	100.00	0.00	0.12
Pfizer/Biontech	76.82	23.18	9.17
<b>Total</b>	<b>70.17</b>	<b>29.83</b>	<b>100.00</b>

Source: SIVEP-GRIPE.

**Table 3** – Epidemiological, clinical characteristics, comorbidities, and outcome associated with unvaccinated people hospitalized for COVID-19 in Pará State in 2022.

Characteristics	Vaccinate d (1,473)	%	Not vaccinated (1,162)	%	Total (2,634)	%	p-value	OR	CI (95%)
<b>Age</b>							<0.001*		
Minimum	0		0		0				
Mean	65		45		56				
Maximum	109		108		109				
<b>Sex</b>							0,011	1,202	1,030 1,402
Male	726	49.29	626	53.87	1.352	51.31			
Female	747	50.71	536	46.13	1.283	48.69			

<b>Signs and symptoms</b>										
Fever	878	59.61	743	63.94	1.621	61.52	0,013	1,202	1,025	1,408
Cough	1,075	72.98	819	70.48	1.894	71.88	0,085			
Sore throat	470	31.91	355	30.55	825	31.31	0,241			
Dyspnoea	909	61.71	649	55.85	1.558	59.13	0,001	0,785	0,671	0,918
Respiratory distress	744	50.51	598	51.46	1.342	50.93	0,327			
O2 saturation <95%	660	44.81	464	39.93	1.124	42.66	0,007	0,819	0,701	0,957
Diarrhoea	169	11.47	133	11.45	302	11.46	0,517			
Vomiting	170	11.54	166	14.29	336	12.75	0,021	1,277	1,016	1,607
<b>Comorbidities</b>										
Chronic cardiovascular disease	468	31.77	211	18.16	679	25.77	<0.001	0,476	0,396	0,573
Chronic hematological disease	13	0.88	4	0.34	17	0.65	0,068			
Down syndrome	5	0.34	3	0.26	8	0.30	0,498			
Chronic liver disease	12	0.81	3	0.26	15	0.57	0,049	0,315	0,089	1,119
Asthma	27	1.83	9	0.77	36	1.37	0,014	0,418	0,196	0,892
Diabetes mellitus	333	22.61	152	13.08	485	18.41	<0.001	0,515	0,418	0,635
Chronic neurological disease	56	3.80	26	2.24	82	3.11	0,014	0,579	0,361	0,928
Another chronic lung disease	30	2.04	16	1.38	46	1.75	0,128			
Immunodeficiency/immunosuppression	48	3.26	44	3.79	92	3.49	0,265			
Chronic kidney disease	67	4.55	26	2.24	93	3.53	0,001	0,480	0,303	0,760
Obesity	30	2.04	15	1.29	45	1.71	0,093			
<b>Outcomes</b>										
Intensive care unit	329	22.34	259	22.29	588	22.31	0,009	1,494	1,105	2,019
Invasive ventilation	207	14.05	145	12.48	353	13.40	0,131			
Death	455	30.89	323	27.80	778	29.53	0,046	1,442	1,163	1,788

Source: SIVEP-GRIPE. OR (Odds Ratio), CI (confidence interval) \* Mann-Whitney test. Chi-square test and for values <5 the Fisher's exact test.

In the final multivariate survival model, by COX regression, we identified the hazard ratio in the variables that form significant for the dependent variable unvaccinated against COVID-19. Death represents p- <0.001 (HR 1.306 - CI 1.124/1.517) higher risk of the event occurring in the unvaccinated cases, followed by male sex p-0.004 (HR 1.188 - CI 1.058/1.334). The other significant variables in the multivariate model were negatively associated, i.e., those vaccinated were associated with older age, having comorbidities and fever, cough and invasive ventilation, showing that those vaccinated have older age, more comorbidities, fever and cough symptoms, and higher rates of invasive ventilation. The non-vaccinated are young, male and have fewer comorbidities, and a higher risk of death (Table 4).

**Table 4** - Final multivariate survival model, COX regression, hazard ratio for unvaccinated COVID-19 in hospitalized patients in the northern region of Brazil in 2022.

Variables	Univariate		95,0% CI		Multivariate		95,0% CI	
	p-valor	HR adjusted	Lower	Upper	p-valor	HR adjusted	Lower	Upper
<b>Death</b>	<0,001	1,317	1,128	1,538	<0,001	1,306	1,124	1,517
<b>UCI</b>	0,650	0,954	0,777	1,170				
<b>Invasive ventilation</b>	0,111	0,815	0,634	1,048	0,008	0,773	0,639	0,936
<b>Fever</b>	0,097	0,892	0,779	1,021	0,033	0,867	0,761	0,988

<b>Cough</b>	0,102	0,890	0,774	1,023	0,030	0,861	0,753	0,985
<b>Sorethroat</b>	0,267	0,925	0,805	1,062				
<b>Dyspnoea</b>	0,302	0,931	0,813	1,066				
<b>Respiratory distress</b>	0,291	0,931	0,816	1,063				
<b>O2 saturation 95%</b>	0,746	1,024	0,888	1,180				
<b>Diarrhoea</b>	0,665	0,958	0,789	1,163				
<b>Vomiting</b>	0,745	0,971	0,814	1,159				
<b>Male</b>	0,006	1,180	1,049	1,326	0,004	1,188	1,058	1,334
<b>Age</b>	<0,001	0,985	0,983	0,987	<0,001	0,985	0,982	0,987
<b>Chronic cardiovascular disease</b>	0,271	0,910	0,769	1,077	0,016	0,892	0,759	1,048
<b>Chronic hematological disease</b>	0,266	0,571	0,213	1,534				
<b>Down syndrome</b>	0,496	1,486	0,475	4,647				
<b>Chronic liver disease</b>	0,559	0,712	0,228	2,225				
<b>Asthma</b>	0,348	0,728	0,375	1,413				
<b>Diabetes mellitus</b>	0,376	0,919	0,763	1,108				
<b>Chronic neurological disease</b>	0,773	0,944	0,639	1,396				
<b>Another chronic lung disease</b>	0,651	0,890	0,538	1,472				
<b>Immunodeficiency/immunosuppression</b>	0,056	0,739	0,542	1,007	0,035	0,719	0,528	0,978
<b>Chronic kidney disease</b>	0,011	0,599	0,404	0,888	0,008	0,587	0,396	0,868
<b>Obesity</b>	0,529	0,847	0,506	1,420				

234 Source: SIVEP-GRIPE. HR (Hazard Ratio), CI (Confidence Interval).

235

236

#### 4. Discussion

237

238

239

240

241

242

243

244

245

246

247

248

249

This study analyzed the epidemiological profile factors, comorbidities, and the outcome of COVID-19 in vaccinated and unvaccinated hospitalized patients by COVID-19. To our knowledge, it is the first cohort in the northern region of Brazil with the dependent variable unvaccinated. We show that overall lethality was 29.53%, lower than a study that analyzed lethality in the first year of the pandemic before vaccination in the state of Pará, which was 42.47%. [14]. Evidence that the vaccine reduced the lethality rate in the 2022 period when compared to 2020.

A study in the United States estimated the risk of hospitalizations among vaccinated and unvaccinated patients from a national database and showed that the rates of hospitalizations in unvaccinated cases for COVID-19 among the infected were 10 times higher than among vaccinated patients, and the study underscored the importance of full-dose and booster vaccination for reducing hospitalization and deaths. [19]. In our cohort, we did not measure the risk of hospitalizations, because we only analyzed those who were

250 hospitalized. Other research has associated the lower risk of mortality from  
251 non-COVID-19 causes in those vaccinated for COVID-19 and has emphasized the safety  
252 of COVID-19 vaccines [20].

253 An analysis of vaccinated and unvaccinated healthcare professionals specifically  
254 infected with the gamma variant in early 2021 in a tertiary care hospital in São Paulo,  
255 Brazil, showed that the most common symptoms in vaccinated patients on multivariate  
256 after adjustment for multiple comparisons, hyposmia/anosmia (OR = 0.304, adj p < 0.001)  
257 and dysgeusia (OR = 0.385, adj p = 0.011) were the only symptoms significantly associated  
258 with the gamma variant [21]. However, in our study, we analyzed hospitalized severe  
259 cases in the year 2022, when the variant of SARS-CoV-2 in the reported cases was not  
260 known in the database.

261 A cohort in Italy compared COVID-19 waves before and after the vaccine and found  
262 that the vaccinated group was older and had comorbidities [22]. Another cohort at Aga  
263 Khan University Hospital (AKUH) of 434 patients. For unvaccinated patients, there was a  
264 significant increase in the number of intensive care admissions (p-value 0.043). The un-  
265 vaccinated patients had significantly higher serum levels of procalcitonin, ferritin, LDH,  
266 and D-dimer. About 5.3% (n = 23) of patients required invasive ventilation, which was  
267 more common in unvaccinated patients (p-value 0.04). Overall, the mortality rate was  
268 12.2% (n = 53) and was higher (16.2%, n = 39) in unvaccinated patients compared with  
269 fully vaccinated patients (6.1%, n = 10, p-value 0.006)[23]. Another survey of hospitalized  
270 patients showed that unvaccinated patients required mechanical ventilation more fre-  
271 quently (8.5%) than vaccinated patients, in whom the likelihood of mechanical ventila-  
272 tion decreased with increasing doses (8.7%, 2.8%, 0%)[24]. This is similar to our results on  
273 the association of deaths in unvaccinated cases.

274 A survey that evaluated in-hospital mortality of COVID-19 patients by vaccination  
275 status using a retrospective cohort study, in Northern California. Of the 7,305 patients,  
276 1,463 (20.0%) were complete, 138 (1.9%) were partial, and 5,704 (78.1%) were unvacci-  
277 nated. The fully vaccinated were older than the partial or unvaccinated (71.0, 63.0, and  
278 54.0 years, respectively, p < 0.001) with more comorbidities (Comorbidity Scores 33.0,  
279 22.0, and 10.0, p < 0.001) and immunosuppressants (11.5%, 8.7%, and 3.0%, p < 0.001) or  
280 chemotherapy exposure (2.8%, 0.7%, and 0.4%, p < 0.001). Fewer fully vaccinated patients  
281 died compared to the corresponding unvaccinated patients (9.0% vs. 16.3%, p < 0.0001).  
282 Fully vaccinated patients were less likely to die compared with unvaccinated patients  
283 [25]. Another survey identified that those vaccinated with the full regimen were older  
284 with comorbidities [26]. Similar to our results, however, we showed higher lethality.

285 Research has shown vaccine benefits also in fully vaccinated pregnant women in-  
286 fected with SARS-CoV-2 during the Omicron wave had a milder disease and were less  
287 likely to require oxygen supplementation and intensive care compared with their un-  
288 vaccinated counterparts [27].

289 Our results associated older age with those vaccinated against COVID-19, but when  
290 adjusting for age and sex, deaths were associated with those unvaccinated, highlighted in  
291 a survey in Spain that analyzed vaccinated and unvaccinated elderly >85 who were hos-  
292 pitalized for COVID-19 and showed a reduction in mortality in this age group in vacci-  
293 nated cases. This decline may be explained by the greater availability of hospital re-  
294 sources and more effective treatments as the pandemic progressed, although other fac-  
295 tors, such as changes in the virulence of SARS-CoV-2, cannot be ruled out [28]. A study  
296 analyzed hospitalizations for COVID-19 in the Delta variant period (Jan to Aug 2021) in  
297 the United States and concluded that lower vaccination coverage in adults aged 18 to 49  
298 likely contributed to the increase in hospitalized patients during the Delta period. Vac-  
299 cination against COVID-19 is critical for all eligible adults, including adults under age 50  
300 who have relatively low vaccination rates compared to older adults[29].

301 We did not delve into the analysis by vaccine type due to the high risk of bias be-  
302 cause it is surveillance data, however Pfizer/Biotenck in the two doses had the lowest  
303 lethality in the hospitalized cohort, we did not include booster doses. One study eva-  
304 luated Pfizer/Biotenck vaccine booster doses and found that at least 5 months after a

---

305 second dose had 90% lower mortality due to COVID-19 than participants who did not  
306 receive a booster [30]. The low numbers vaccinated with Janssen may be associated with  
307 the vaccine only starting in June 2021 in the state of Pará, which started with the muni-  
308 cipalities farthest from the metropolitan region[31].

309 One study has already shown that seropositivity for SARS-CoV-2 in unvaccinated  
310 individuals has an impact on the reduction of severity and death from COVID-19 infec-  
311 tion[32]. Another study found no severe symptoms in patients who were previously se-  
312 ropositive for SARS-CoV-2 in COVID-19[33]. This could be a protective factor in patients  
313 who are not vaccinated. However, in our study, the epidemiological surveillance data-  
314 base does not contain information on pre-existing seropositivity in unvaccinated cases.

315 Vaccination is the main strategy to fight infectious diseases, and it is no different in  
316 COVID-19; several studies have shown a reduction in hospitalization and death from the  
317 disease [34–36]. Thus, promoting vaccination is the best choice for countries to reduce the  
318 impacts of COVID-19.

319 This study warns that despite being younger and with fewer comorbidities, CO-  
320 VID-19 has worse outcomes in these cases, increasing the risk of death. Thus, vaccination  
321 is the best strategy to reduce hospitalizations and deaths from COVID-19, and effective  
322 strategies for vaccine adherence must be developed because the current challenge is the  
323 fake news and negationist, political, and even religious positioning[37–39].

324 We highlight the limitation of the study and the risk of bias because we are dealing  
325 with secondary data from the national SARS surveillance database; however, the data in  
326 2022 are much better regarding the quality of the information when compared to the first  
327 year of the pandemic, since there were fewer cases and the teams were already trained in  
328 the notification and investigation of SARS in the surveillance system. Another limitation  
329 was the lack of information on the dominant variants because the laboratory analysis of  
330 surveillance in Brazil is limited only to molecular testing, without information on geno-  
331 typing. The high number of multiple vaccinations, which makes it difficult to interpret  
332 the overall benefit, is another limitation of the study.

333 We also highlight as a limitation of a retrospective cohort study with secondary data  
334 from epidemiological surveillance, firstly there may be divergence in data collection by  
335 region and state of the country, because the quality of data depends directly on local  
336 surveillance and health institutions, our region is already considered vulnerable and dif-  
337 ficult area to perform surveillance by geographical characteristics. Another point is the  
338 socioeconomic differences between the states of the country, since states with better fi-  
339 nancial conditions have better access to health care services with higher quality, which  
340 can influence the outcome healing or death, and vaccination. Third point is the results do  
341 not apply to long-term protection against COVID-19 in vaccinated patients, other studies  
342 should be conducted in the long term to verify the benefits of the vaccine and even the  
343 need for doses in campaigns per year.

344 Discussing the profile of the unvaccinated allows alerting vaccine campaigns to be  
345 directed to this population with greater effectiveness regarding acceptance since the state  
346 of Pará continues vaccinating in all health posts in the region. The study is also a warning  
347 because it associates deaths with the unvaccinated, although the clinical management in  
348 2022 is already better directed to the severe cases of COVID-19. Vaccination is our best  
349 strategy to fight the pandemic by COVID-19.

## 350 5. Conclusions

351 The first cohort in Brazil and in the north of the country to evaluate the clinical pro-  
352 file, comorbidities, and outcome of COVID-19 in hospitalized patients in this Amazon  
353 region, which is a region characterized by local vulnerability factors unique to the other  
354 regions of Brazil, showed that the unvaccinated were men, younger, with fewer comor-  
355 bidities, and that they were associated the deaths.

356 We show that hospitalized people unvaccinated for COVID-19, die more from CO-  
357 VID-19 than people vaccinated with two doses, despite advances in clinical management

of the disease in 2022, which reinforces the importance of COVID-19 vaccines as an international public health strategy for pandemic control.

**Institutional Review Board Statement:** To meet the ethical aspects from Resolution No. 466 of 12 December 2012 that directs the study in the principles of bioethics, emphasizing respect for human dignity, freedom, and autonomy of the human being, also integrating non-maleficence, beneficence, justice, equity among others, to ensure rights and duties to all involved in research. The project was approved on 11/16/2020 by the Ethics and Research Committee of the Marco School Health Center of the Universidade do Estado do Pará - UEPA. Consubstantiated Opinion No. 4.399.970. Which is part of this multicenter project "SOCIAL, EPIDEMIOLOGICAL AND SPACIAL ANALYSIS OF COVID-19 IN THE STATE OF PARÁ DURING THE PANDEMIA" of the postgraduate program in Parasite Biology in the Amazon of the University of Pará State and the Evandro Chagas Institute (UEPA-IEC).

**Informed Consent Statement:** Informed Consent Statement: Patient consent was waived due to REASON (retrospective data from regional epidemiological surveillance, whereby personal patient information such as name, phone number, and address was excluded).

**Data Availability Statement:** Only by e-mail request from the corresponding author.

## References

- [1] Brasil M da S. Conselho Nacional de Saúde - CNS denuncia internacionalmente governo brasileiro por violação de direitos humanos durante pandemia. ConselhoSaudeGovBr 2021. <http://conselho.saude.gov.br/ultimas-noticias-cns/2071-cns-denuncia-internacionalmente-governo-brasileiro-por-violacao-d-e-direitos-humanos-durante-pandemia> (accessed January 23, 2023).
- [2] WHO WHO. Brazil: WHO Coronavirus Disease (COVID-19) Dashboard With Vaccination Data | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data. Covid-19WhoInt 2023. <https://covid19.who.int/region/amro/country/br> (accessed March 26, 2023).
- [3] Ministério da Saúde (BR). Guia de vigilância epidemiológica : emergência de saúde pública de importância nacional pela doença pelo coronavírus 2019 – covid-19. Brasília - DF: Secretaria de Vigilância em Saúde - Ministério da Saúde do Brasil; 2022.
- [4] El País. Ritmo lento na vacinação contra a covid-19 no Brasil favorece novas cepas do vírus | Atualidade | EL PAÍS Brasil. El País Bras 2021. <https://brasil.elpais.com/brasil/2021-02-03/ritmo-lento-na-vacinacao-contra-a-covid-19-no-brasil-favorece-novas-cepas-do-virus.html> (accessed January 23, 2023).
- [5] Fiocruz FOC. Brasil celebra um ano da vacina contra a Covid-19. PortalFiocruz 2022. <https://portal.fiocruz.br/noticia/brasil-celebra-um-ano-da-vacina-contra-covid-19> (accessed January 23, 2023).
- [6] OPAS OP-A de SB. Controle da COVID-19 nas Américas levará anos se vacinação continuar em ritmo lento, afirma diretora da OPAS. PahoOrg 2021. <https://www.paho.org/pt/noticias/9-6-2021-controle-da-covid-19-nas-americas-levara-anos-se-vacinacao-continuar-em-ritmo> (accessed January 23, 2023).
- [7] Lopes N. Bolsonaro é maior responsável por demora na vacinação para 49% diz CNT/MDA. UOL 2021. <https://www.uol.com.br/vivabem/noticias/redacao/2021/07/06/covid-19-vacinacao-bolsonaro.htm> (accessed January 23, 2023).
- [8] BBB News Brasil. Covid-19: atraso em vacinação de bebês e crianças preocupa pais em meio a temor de alta de casos - BBC News Brasil. BbcCom 2022. <https://www.bbc.com/portuguese/brasil-63551031> (accessed January 23, 2023).
- [9] Cofen CF de E. Atraso vacinal leva a aumento das internações de bebês por covid Conselho Federal de Enfermagem - Brasil.

[http://www.cofen.gov.br/atraso-na-vacinal-leva-a-aumento-das-internacoes-de-bebes-por-covid\\_104875.html](http://www.cofen.gov.br/atraso-na-vacinal-leva-a-aumento-das-internacoes-de-bebes-por-covid_104875.html) (accessed January 23, 2023).

- [10] Jabłońska K, Aballéa S, Toumi M. The real-life impact of vaccination on COVID-19 mortality in Europe and Israel. *Public Health* 2021;198:230–7. <https://doi.org/10.1016/j.puhe.2021.07.037>.
- [11] Pastorino R, Pezzullo AM, Villani L, Causio FA, Axfors C, Contopoulos-Ioannidis DG, et al. Change in age distribution of COVID-19 deaths with the introduction of COVID-19 vaccination. *Environ Res* 2022;204:112342. <https://doi.org/10.1016/j.envres.2021.112342>.
- [12] Rahmani K, Shavaleh R, Forouhi M, Disfani HF, Kamandi M, Oskooi RK, et al. The effectiveness of COVID-19 vaccines in reducing the incidence, hospitalization, and mortality from COVID-19: A systematic review and meta-analysis. *Front Public Heal* 2022;10. <https://doi.org/10.3389/fpubh.2022.873596>.
- [13] Sadarangani M, Abu Raya B, Conway JM, Iyaniwura SA, Falcao RC, Colijn C, et al. Importance of COVID-19 vaccine efficacy in older age groups. *Vaccine* 2021;39:2020–3. <https://doi.org/10.1016/j.vaccine.2021.03.020>.
- [14] Sardinha DM, Corrêa Rodrigues Y, Lúcia da Silva Ferreira A, Valéria Batista Lima K, José de Paula Souza Guimarães R, Nepomuceno Gondim Costa Lima L. Predictors of Death for Hospitalized Patients with COVID-19 in the First Year of the Pandemic in Northern Brazil - A Retrospective Study 2022;627. <https://doi.org/10.21203/RS.3.RS-1559612/V1>.
- [15] von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *PLoS Med* 2007;4:e296. <https://doi.org/10.1371/journal.pmed.0040296>.
- [16] IBGE IB de G e E. IBGE | Cidades@ | Pará | Belém | Panorama 2022:1. <https://www.ibge.gov.br/cidades-e-estados/pa/belem.html> (accessed January 19, 2020).
- [17] Sardinha DM, do Socorro Pompeu de Loiola R, Ferreira AL da S, de Sá CAF, Rodrigues YC, Lima KVB, et al. Risk factors associated with the severity of COVID-19 in a region of the Brazilian Amazon. *Sci Rep* 2021;11:20569. <https://doi.org/10.1038/s41598-021-00009-y>.
- [18] Brasil M da S. Ficha de notificação SIVEP-GRIPE. *OpenDataSUS* 2020:1–2. [https://opendatasus.saude.gov.br/dataset/ae90fa8f-3e94-467e-a33f-94adbb66edf8/resource/54a46c6d-e0b5-40b7-8b74-85450d22ace3/download/ficha-srag-final-27.07.2020\\_final.pdf](https://opendatasus.saude.gov.br/dataset/ae90fa8f-3e94-467e-a33f-94adbb66edf8/resource/54a46c6d-e0b5-40b7-8b74-85450d22ace3/download/ficha-srag-final-27.07.2020_final.pdf) (accessed August 27, 2021).
- [19] Havers FP, Pham H, Taylor CA, Whitaker M, Patel K, Anglin O, et al. COVID-19-Associated Hospitalizations Among Vaccinated and Unvaccinated Adults 18 Years or Older in 13 US States, January 2021 to April 2022. *JAMA Intern Med* 2022;182:1071. <https://doi.org/10.1001/jamainternmed.2022.4299>.
- [20] Xu S, Huang R, Sy LS, Glenn SC, Ryan DS, Morrisette K, et al. COVID-19 Vaccination and Non-COVID-19 Mortality Risk – Seven Integrated Health Care Organizations, United States, December 14, 2020–July 31, 2021. *MMWR Morb Mortal Wkly Rep* 2021;70:1520–4. <https://doi.org/10.15585/mmwr.mm7043e2>.
- [21] Luna-Muschi A, Borges IC, de Faria E, Barboza AS, Maia FL, Leme MD, et al. Clinical features of COVID-19 by SARS-CoV-2 Gamma variant: A prospective cohort study of vaccinated and unvaccinated healthcare workers. *J Infect* 2022;84:248–88. <https://doi.org/10.1016/j.jinf.2021.09.005>.
- [22] Calabrese C, Annunziata A, Mariniello DF, Coppola A, Mirizzi AI, Simioli F, et al. Evolution of the Clinical Profile and Outcomes of Unvaccinated Patients Affected by Critical COVID-19 Pneumonia from the Pre-Vaccination to the Post-Vaccination Waves in Italy. *Pathog* 2022, Vol 11, Page 793 2022;11:793. <https://doi.org/10.3390/PATHOGENS11070793>.
- [23] Fatima S, Zafar A, Afzal H, Ejaz T, Shamim S, Saleemi S, et al. COVID-19 infection among vaccinated and unvaccinated: Does it make any difference? *PLoS One* 2022;17:e0270485. <https://doi.org/10.1371/JOURNAL.PONE.0270485>.
- [24] Colaneri M, Asperges E, Calia M, Sacchi P, Rettani M, Cutti S, et al. Despite Vaccination: A Real-Life Experience of Severe and Life-Threatening COVID-19 in Vaccinated and Unvaccinated Patients. *Vaccines* 2022, Vol 10, Page 1540 2022;10:1540.

---

446 <https://doi.org/10.3390/VACCINES10091540>.

447 [25] Myers LC, Kipnis P, Greene J, Lawson B, Escobar GJ, Fireman BH, et al. Adults hospitalized with breakthrough COVID-19  
448 have lower mortality than matched unvaccinated adults. *J Intern Med* 2022;292:377–84. <https://doi.org/10.1111/JOIM.13504>.

449 [26] Vassallo M, Clement N, Lotte L, Manni S, Sindt A, Bertrand PM, et al. Prevalence and Main Clinical Characteristics of Fully  
450 Vaccinated Patients Admitted to Hospital for Delta Variant COVID-19. *Front Med* 2022;9:809154.  
451 <https://doi.org/10.3389/fmed.2022.809154>.

452 [27] Birol Ilter P, Prasad S, Berkkan M, Mutlu MA, Tekin AB, Celik E, et al. Clinical severity of SARS-CoV-2 infection among  
453 vaccinated and unvaccinated pregnancies during the Omicron wave. *Ultrasound Obstet Gynecol* 2022;59:560–2.  
454 <https://doi.org/10.1002/UOG.24893>.

455 [28] Ramos-Rincon JM, Cobos-Palacios L, López-Sampalo A, Ricci M, Rubio-Rivas M, Nuñez-Rodríguez MV, et al. Differences  
456 in clinical features and mortality in very old unvaccinated patients (≥ 80 years) hospitalized with COVID-19 during the first  
457 and successive waves from the multicenter SEMI-COVID-19 Registry (Spain). *BMC Geriatr* 2022;22:1–14.  
458 <https://doi.org/10.1186/S12877-022-03191-4/FIGURES/2>.

459 [29] Taylor CA, Patel K, Pham H, Whitaker M, Anglin O, Kambhampati AK, et al. Severity of Disease Among Adults  
460 Hospitalized with Laboratory-Confirmed COVID-19 Before and During the Period of SARS-CoV-2 B.1.617.2 (Delta)  
461 Predominance — COVID-NET, 14 States, January–August 2021. *MMWR Morb Mortal Wkly Rep* 2021;70:1513–9.  
462 <https://doi.org/10.15585/mmwr.mm7043e1>.

463 [30] Arbel R, Hammerman A, Sergienko R, Friger M, Peretz A, Netzer D, et al. BNT162b2 Vaccine Booster and Mortality Due to  
464 Covid-19. *N Engl J Med* 2021;385:2413–20. <https://doi.org/10.1056/NEJMoa2115624>.

465 [31] G1 Pará RL. Governo do PA anuncia que todas as doses do primeiro lote da Janssen serão destinadas ao interior.  
466 G1GloboCom 2021.  
467 [https://g1.globo.com/pa/para/noticia/2021/06/26/governo-do-pa-anuncia-que-todas-as-doses-do-primeiro-lote-da-janssen-se-](https://g1.globo.com/pa/para/noticia/2021/06/26/governo-do-pa-anuncia-que-todas-as-doses-do-primeiro-lote-da-janssen-se-rao-destinadas-ao-interior.ghtml)  
468 [rao-destinadas-ao-interior.ghtml](https://g1.globo.com/pa/para/noticia/2021/06/26/governo-do-pa-anuncia-que-todas-as-doses-do-primeiro-lote-da-janssen-se-rao-destinadas-ao-interior.ghtml) (accessed February 16, 2023).

469 [32] Madhi SA, Kwatra G, Myers JE, Jassat W, Dhar N, Mukendi CK, et al. Population Immunity and Covid-19 Severity with  
470 Omicron Variant in South Africa. *N Engl J Med* 2022;386:1314–26. <https://doi.org/10.1056/NEJMoa2119658>.

471 [33] Irengé LM, Bulakali HM, Akonkwa AI, Ambroise J, Gala J-L. Seroprevalence of COVID-19 infection in a densely populated  
472 district in the eastern Democratic Republic of Congo. *Epidemiol Infect* 2023;151:e24.  
473 <https://doi.org/10.1017/S0950268823000158>.

474 [34] Tenforde MW, Self WH, Adams K, Gaglani M, Ginde AA, McNeal T, et al. Association Between mRNA Vaccination and  
475 COVID-19 Hospitalization and Disease Severity. *JAMA* 2021;326:2043. <https://doi.org/10.1001/jama.2021.19499>.

476 [35] Rosenberg ES, Dorabawila V, Easton D, Bauer UE, Kumar J, Hoen R, et al. Covid-19 Vaccine Effectiveness in New York  
477 State. *N Engl J Med* 2022;386:116–27. <https://doi.org/10.1056/NEJMoa2116063>.

478 [36] Moline HL, Whitaker M, Deng L, Rhodes JC, Milucky J, Pham H, et al. Effectiveness of COVID-19 Vaccines in Preventing  
479 Hospitalization Among Adults Aged ≥65 Years — COVID-NET, 13 States, February–April 2021. *MMWR Morb Mortal*  
480 *Wkly Rep* 2021;70:1088–93. <https://doi.org/10.15585/mmwr.mm7032e3>.

481 [37] Rzymiski P, Borkowski L, Drag M, Flisiak R, Jemielity J, Krajewski J, et al. The Strategies to Support the COVID-19  
482 Vaccination with Evidence-Based Communication and Tackling Misinformation. *Vaccines* 2021;9:109.  
483 <https://doi.org/10.3390/vaccines9020109>.

484 [38] Damijan JP, Damijan S, Kostevc Č. Vaccination Is Reasonably Effective in Limiting the Spread of COVID-19 Infections,  
485 Hospitalizations and Deaths with COVID-19. *Vaccines* 2022;10:678. <https://doi.org/10.3390/vaccines10050678>.

486 [39] Caycho-Rodríguez T, Ventura-León J, Valencia PD, Vilca LW, Carbajal-León C, Reyes-Bossio M, et al. What Is the Support  
487 for Conspiracy Beliefs About COVID-19 Vaccines in Latin America? A Prospective Exploratory Study in 13 Countries.  
488 *Front Psychol* 2022;13:855713. <https://doi.org/10.3389/fpsyg.2022.855713>.

UNDER PEER REVIEW