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Prevalence of COVID-19 among healthcare workers before and after vaccination

Prevalência de COVID-19 entre trabalhadores da saúde antes e depois de vacinação

Prevalencia de COVID-19 entre trabajadores de salud antes y después de la vacunación

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ABSTRACT

Background and Objectives: healthcare workers are at high risk of acquiring infections during disease outbreaks. Therefore, this study aimed to determine the prevalence of COVID-19 among vaccinated and unvaccinated healthcare workers. **Methods:** a cross-sectional and observational study that assessed cases of flu syndrome that occurred between March 2020 and December 2021 in healthcare workers vaccinated and unvaccinated with CoronaVac or Astrazeneca in a hospital in the extreme south of Brazil. The study included cases of flu syndrome characterized and monitored by the institution's occupational health sector and who underwent diagnostic tests by RT-PCR for SARS-CoV-2. The Prevalence Ratio estimated by Poisson regression analysis with variance adjustment was used to verify the factors and strengths of the associations. **Results:** a total of 1,088 cases of flu syndrome that occurred in healthcare workers between 2020 and 2021 were assessed. When adjusted for sex, age, role, sector, type of vaccine or previous diagnosis of COVID-19, the prevalence of COVID-19 among cases of unvaccinated workers was 51.5% (95% CI: 46.5- 56.5) and 32.1% (95% CI: 25.3-38.8) among unvaccinated workers. Moreover, COVID-19 vaccination reduced the prevalence of new infections by 33% (PR: 0.67; 95% CI: 0.56-0.81). **Conclusion:** COVID-19 vaccination significantly reduced the prevalence of COVID-19 among healthcare workers, regardless of sex, age, sector, role, type of vaccine or previous diagnosis of COVID-19.

Keywords: *COVID-19. SARS-CoV-2. Health Personnel. Vaccines.*

RESUMO

Justificativa e Objetivos: os profissionais de saúde correm alto risco de adquirir infecções durante surtos de doenças. Assim, o objetivo deste estudo foi determinar a prevalência de COVID-19 entre profissionais de saúde vacinados e não vacinados. **Métodos:** estudo observacional e transversal, que avaliou casos de síndrome gripal ocorridos

entre março de 2020 e dezembro de 2021 em trabalhadores da saúde vacinados e não vacinados com CoronaVac ou Astrazeneca em um hospital do extremo sul do Brasil. O estudo incluiu casos de síndrome gripal caracterizados e acompanhados pelo setor de saúde ocupacional da intuição e que realizaram testes diagnósticos por RT-PCR para SARS-CoV-2. A medida da Razão de Prevalência estimada pela análise de regressão de Poisson com ajuste de variância foi utilizada para verificar os fatores e as forças das associações. **Resultados:** foram avaliados 1.088 casos de síndrome gripal ocorridos em profissionais de saúde entre 2020 e 2021. Quando ajustada por sexo, idade, função, setor, tipo de vacina ou diagnóstico prévio de COVID-19, a prevalência de COVID-19 entre os casos de profissionais não vacinados foi de 51,5% (IC 95%: 46,5-56,5) e de 32,1% (IC 95%: 25,3-38,8) entre profissionais não vacinados. Além disso, a vacinação para a COVID-19 reduziu a prevalência de novas infecções em 33% (RP: 0,67; IC 95%: 0,56-0,81). **Conclusão:** a vacinação para a COVID-19 reduziu significativamente a prevalência da COVID-19 entre os profissionais de saúde, independentemente do sexo, idade, setor, função, tipo de vacina ou diagnóstico prévio de COVID-19.

Descritores: *COVID-19. SARS-CoV-2. Profissionais da Saúde. Vacinas.*

RESUMEN

Justificación y Objetivos: los trabajadores de la salud tienen un alto riesgo de contraer infecciones durante los brotes de enfermedades. Por tanto, el objetivo de este estudio fue determinar la prevalencia de COVID-19 entre profesionales sanitarios vacunados y no vacunados. **Métodos:** estudio observacional y transversal, que evaluó casos de síndrome gripal ocurridos entre marzo de 2020 y diciembre de 2021 en trabajadores de la salud vacunados y no vacunados con CoronaVac o Astrazeneca en un hospital del extremo sur de Brasil. El estudio incluyó casos de síndrome gripal caracterizados y monitoreados por intuición del sector de salud ocupacional y a los que se les realizaron pruebas diagnósticas por RT-PCR para SARS-CoV-2. Para verificar los factores y las fortalezas de las asociaciones, se utilizó la medida de la Razón de Prevalencia estimada mediante análisis de regresión de Poisson con ajuste de varianza. **Resultados:** se evaluaron 1.088 casos de síndrome gripal ocurridos en profesionales de la salud entre 2020 y 2021. Al ajustar por sexo, edad, función, sector, tipo de vacuna o diagnóstico previo de COVID-19, la prevalencia de COVID-19 entre los casos profesionales no vacunados fue de 51,5. % (IC 95%: 46,5-56,5) y 32,1% (IC 95%: 25,3-38,8) entre profesionales no vacunados. Además, la vacunación contra COVID-19 redujo la prevalencia de nuevas infecciones en un 33% (RP: 0,67; IC 95%: 0,56-0,81). **Conclusión:** la vacunación contra COVID-19 redujo significativamente la prevalencia de COVID-19 entre los trabajadores de la salud, independientemente de sexo, edad, sector, función, tipo de vacuna o diagnóstico previo de COVID-19.

Palabras Clave: *COVID-19. SARS-CoV-2. Personal de Salud. Vacunas.*

INTRODUCTION

Healthcare workers are at high risk of acquiring infections during outbreaks of contagious diseases, especially when there is little knowledge about the dynamics of infection.[1] In the period prior to COVID-19 vaccination, healthcare workers showed high rates of positivity for SARS-CoV-2, reaching a frightening 55.9% of symptomatic flu cases assessed.[2] Between March and April 2020, it was shown that healthcare workers were three times more likely to acquire SARS-CoV-2 when compared to the general population, even when these workers used adequate personal protective equipment, suggesting the urgent need for other infection control measures.[3]

Fortunately, throughout history, vaccines have been successfully developed for a number of potentially fatal diseases. Vaccines save lives by being able to stimulate the immune system, generating partial or total resistance against a particular pathogen. [4] In the COVID-19 scenario, vaccine development was carried out extremely quickly. The COVID-19 pandemic showed that, with the appropriate investments for input development, it is feasible to speed up many stages of vaccine development with a view to controlling diseases, preventing diseases and promoting health.[5]

However, although vaccines present a known strategy for disease control, population hesitancy to the COVID-19 vaccine is worrying reality. A global sample involving 23 countries including Brazil showed increasing hesitancy towards COVID-19 vaccination in at least eight countries. Belief in the vaccine's ability to prevent COVID-19, the vaccine's safety, and confidence in the vaccine development process remained strongly correlated with whether or not to accept the vaccine.[6]

Therefore, considering the high risk of SARS-CoV-2 transmission among healthcare workers, the development and initially emergency approval of vaccines to control COVID-19, and the constant population hesitancy regarding COVID-19 vaccination, it is of great importance to assess the impact of this vaccination on Brazilian healthcare workers. In this regard, this study aimed to determine the prevalence of COVID-19 among healthcare workers vaccinated and unvaccinated for COVID-19 and associated variables.

METHODS

This is a cross-sectional and observational study

that assessed cases of flu syndrome that occurred between March 2020 and December 2021 in healthcare workers from a highly complex hospital that has approximately 1,000 healthcare workers, with 231 beds exclusively for users of the public health system, in the municipality of Rio Grande, southern Brazil.

The institution initially offered the CoronaVac vaccine and later the Astrazeneca vaccine, and it was recommended that a second dose be of the same type as the first dose received. At the study site, the vaccines were administered from January 2021 according to the manufacturer's recommendations, with CoronaVac having an interval of 28 days between the first and second doses and Astrazeneca having an interval of 12 weeks (approximately three months). The hospital's occupational health sector (OHS) was responsible was responsible for administering the vaccines to professionals, monitoring the cases of flu syndrome developed by the institution's healthcare workers as well as scheduling and monitoring the results of tests for diagnosis of COVID-19 in these cases. Cases of flu syndrome were characterized by the OHS physician, considering the symptoms of fever, chills, sore throat, headache, cough, runny nose, smell or taste disturbances and gastrointestinal symptoms, following current recommendations of national health entities.

The study included cases of flu syndrome in professionals characterized by the OHS and who underwent diagnostic testing by RT-PCR for SARS-CoV-2 during the study period. The "vaccinated" group included cases of flu related to professionals who received at least one dose of the COVID-19 vaccine before the onset of symptoms of the reported flu episode. Cases with incomplete data were excluded from the analyses.

The variables assessed were sex, age, sector, role, previous diagnosis of COVID-19, vaccination (vaccinated or unvaccinated), type of vaccine (Astrazeneca or CoronaVac) as main exposure and result of the RT-PCR test for SARS-CoV-2 as an outcome.

Prevalence Ratio (PR) measure with 95% Confidence Interval, estimated by Poisson regression analysis with robust variance adjustment, was used to verify the factors and the strengths of the associations with the RT-PCR test result in the general sample. Analyses were performed using the Stata software 15, and a level of significance set at 5%.

This study was carried out in accordance with the required ethical standards (Resolutions 466/2012, 510/2016 and 580/2018 of the Ministry of Health), and approved by the *Universidade Federal do Rio Grande* Research Ethics Committee, under Opinion 4,980,106, on September 16, 2021, and Certificate of Presentation for Ethical Consideration 48156921.7.0000.5324.

RESULTS

A total 1,088 cases of flu syndrome were identified in healthcare workers, 581 flu cases in unvaccinated professionals and 507 in vaccinated professionals. Of the total sample, 83.2% were female, with a mean age of 41.3 years (standard deviation 9.0). More than half (70.6%) were from the nursing team, and most of them professionals in the Emergency/Inpatient/adult Intensive Care Unit (ICU) (38.7%) and surgical units (18.4%) (Table 1).

Table 1. Characteristics of healthcare workers with symptoms suggestive of COVID-19 (n:1,088).

Variables	%	95% CI*
Sex		
Male	16.8	14.7-19.2
Female	83.2	80.8-85.3
Age group		
1st tertile (21-36 years old)	35.7	32.9-38.6
2nd tertile (37-44 years old)	34.9	32.2-37.8
3rd tertile (45-66 years old)	29.4	26.8-32.2
Role		
Nurse/nursing technician and assistant	70.6	67.8-73.2
Physician	11.5	9.7-13.5
Physiotherapist	3.1	2.2-4.3
Others[a]	14.8	12.8-17.0
Sector		
Emergency/Inpatient/Adult ICU**	38.7	35.8-41.6
Surgical units	18.4	16.2-20.8
Pediatrics/neonatology	15.2	13.2-17.5
Others[b]	27.7	25.0-30.4
Vaccines		
CoronaVac	51.1	48.1-54.2
Astrazeneca	48.9	45.9-51.9
Previously confirmed COVID-19		
No	87.6	85.5-89.4
Yes	12.4	10.6-14.5

[a]Psychologist, pharmacist, pharmacy assistant or technician, radiology technician, laboratory/analysis technician, nutritionist and nutrition technician, speech therapist, optician, dentist, occupational therapist, physical educator, social worker, biologist, biomedical scientist, occupational safety technician.
[b]Outpatient clinics, rehabilitation service, nutrition, psychology, laboratories, pharmacy, imaging service, Central Sterile Supply Department, occupational health service, risk management, auditing, hotel management.
**Confidence Interval, **Intensive Care Unit.*

The prevalence of COVID-19 among the total cases monitored in the period was 25.3% (95% CI: 22.8-27.9), with a higher proportion among men (31.2%), older adults (26.6%) and medical workers (35.2%). We found a prevalence of 32.2% (95% CI: 28.5-36.1) of COVID-19 among flu cases of unvaccinated professionals and 17.4% (95% CI: 14.3-20.9) in cases of vaccinated professionals. Physician workers had a higher proportion of cases among vaccinated workers (29.6%) when compared to cases among unvaccinated physician workers or other vaccinated professional categories. Among unvaccinated flu cases, 38.4% of COVID-19 cases were identified among workers in surgical units, however in the vaccinated group only 15.9% of the cases were identified among workers in these units (Table 2).

When adjusted for sex, age, sector, role and previous diagnosis of COVID-19, the prevalence of COVID-19

Table 2. Prevalence of COVID-19 between the cases of flu syndrome in healthcare workers.

Variables	Overall (n: 1,088)		Unvaccinated (n: 581)		Vaccinated (n: 507)	
	%	95% CI*	%	95% CI*	%	95% CI*
Sex						
Male	31.2	24.8-38.3	40.6	31.1-50.9	20.7	13.3-30.7
Female	24.1	21.4-27.0	30.5	26.6-34.8	16.7	13.4-20.6
Age group						
1st tertile (21-36 years old)	25.3	21.2-29.8	32.4	26.4-39.1	16.9	12.0-23.2
2nd tertile (37-44 years old)	24.2	20.1-28.8	33.2	26.8-40.2	15.3	10.8-21.2
3rd tertile (45-66 years old)	26.6	22.0-31.7	30.9	24.6-38.1	20.9	14.8-28.5
Role						
Nurse/nursing technician and assistant	23.8	20.9-27.0	31.0	26.7-35.6	15.6	12.2-19.8
Physician	35.2	27.2-44.1	39.4	28.6-51.5	29.6	18.7-43.5
Physiotherapist	32.4	18.3-50.5	42.9	18.3-71.6	25.0	10.0-50.3
Others[a]	23.0	17.1-30.2	30.2	21.3-40.9	14.7	8.2-24.9
Sector						
Emergency/Inpatient/Adult ICU**	25.9	21.9-30.3	31.4	25.3-38.1	20.7	15.8-26.7
Pediatrics/neonatology	22.9	17.1-30.0	28.2	20.2-37.8	14.3	7.4-25.6
Surgical units	28.5	22.6-35.2	38.4	29.7-47.8	15.9	9.5-25.3
Others[b]	23.6	19.1-28.7	31.5	24.7-39.1	14.4	9.4-21.4
Vaccines						
CoronaVac	-	-	-	-	26.6	23.1-30.5
Astrazeneca	-	-	-	-	23.9	20.4-27.7

*[a]Psychologist, pharmacist, pharmacy assistant or technician, radiology technician, laboratory/analysis technician, nutritionist and nutrition technician, speech therapist, optician, dentist, occupational therapist, physical educator, social worker, biologist, biomedical scientist, occupational safety technician. [b]Outpatient clinics, rehabilitation service, nutrition, psychology, laboratories, pharmacy, imaging service, Central Sterile Supply Department, occupational health service, risk management, auditing, hotel management. *Confidence Interval, **Intensive Care Unit.*

Table 3. COVID-19 Prevalence Ratio adjusted for to sex, age, sector, role, type of vaccine and previous diagnosis of COVID-19.

Variables	PR*	95% CI**	*p*
Sex			>0.05
Male	0.45	0.29-0.71	
Female	0.70	0.57-0.86	
Age group			> 0.05
1st tertile (21-36 years old)	0.60	0.44-0,82	
2nd tertile (37-44 years old)	0.66	0.48-0.90	
3rd tertile (45-66 years old)	0.80	0.58-1.11	
Role			> 0.05
Nurse/nursing technician and assistant	0.75	0.58-0.96	
Physician	0.43	0.25-0.75	
Physiotherapist	0.85	0.53-1.35	
Others[a]	0.69	0.37-1.31	
Sector			> 0.05
Emergency/Inpatient/Adult ICU***	0.82	0.64-1.04	
Pediatrics/neonatology	0.68	0.41-1.72	
Surgical units	0.58	0.35-0.95	
Others[b]	0.59	0.40-0.86	
Vaccines			> 0.05
CoronaVac	0.70	0.55-0.90	
Astrazeneca	0.67	0.51-0.87	
Previously confirmed COVID-19			> 0.05
No	0.68	0.56-0.82	
Yes	0.53	0.31-0.89	

*[a]Psychologist, pharmacist, pharmacy assistant or technician, radiology technician, laboratory/analysis technician, nutritionist and nutrition technician, speech therapist, optician, dentist, occupational therapist, physical educator, social worker, biologist, biomedical scientist, occupational safety technician. [b]Outpatient clinics, rehabilitation service, nutrition, psychology, laboratories, pharmacy, imaging service, Central Sterile Supply Department, occupational health service, risk management, auditing, hotel management. *Prevalence Ratio, **Confidence Interval, ***Intensive Care Unit.*

among the unvaccinated was 51.5% (95% CI: 46.5-56.5) and among the vaccinated it was significantly lower ($p < 0.05$) at 32.1% (95% CI: 25.3-38.8). Among cases of flu syndrome occurring in workers vaccinated with CoronaVac, there was a prevalence of 26.6% of COVID-19, and among cases who received Astrazeneca, the prevalence of COVID -19 was 23.9% (Table 2).

When adjusted for these variables, it was found that, among cases of flu syndrome in professionals already vaccinated for COVID-19, there is a 33% (PR: 0.67) lower probability of having COVID-19. The CoronaVac vaccine reduces the prevalence of COVID in 30% (PR: 0.70) and Astrazeneca reduces by 33% (PR: 0.67) when compared to cases occurred in workers not yet vaccinated. A higher probability of vaccine protection against COVID-19 was observed among male professionals (PR: 0.45), among those aged between 21 and 36 years (PR: 0.60), in medical workers (PR: 0.43) and in workers of surgical units (PR: 0.58). Moreover, a previous diagnosis of COVID-19 reduced prevalence by 47% (PR: 0.53) (Table 3).

DISCUSSION

The prevalence of COVID-19 found in our study among unvaccinated professionals was higher than that reported in a previous study also conducted in southern Brazil, which presented a rate of 14.7% with data from April to June 2020.[7] In eastern Brazil, a prevalence of 42.4% of COVID-19 was identified among healthcare workers.[2] Such discrepancies may be related to the specific characteristics of the study site and the time of data collection, considering the territorial extension of Brazil,

many regions and locations presented different periods of greater and lesser spread of the disease.

There was considerable variation in the prevalence of COVID-19 among healthcare workers around the world. A similar study in Belgium identified a prevalence of COVID-19 of 49.9% (185 cases among 373 healthcare workers).[8] A study in Spain showed a prevalence of 20.1%, and another,[9] in Oman (Arabian Peninsula), a prevalence of 21.2% of COVID-19.[10] However, in Italy, a prevalence of 7.2% and 12.2% was found among symptomatic healthcare professionals or exposed to a confirmed case in the 1st wave (February 2020 to July 2020) and 2nd wave (August 2020 to January 2021), respectively.[11] When considering studies that included asymptomatic professionals, the prevalence dropped dramatically, as is the case in a study in Denmark, where the prevalence of COVID-19 in samples from asymptomatic healthcare workers with no contact with positive cases was 4.04%,[12] and in the United Kingdom and the United States of America, which was 2.7%.[3] Such differences in prevalence may be related to the working conditions of each institution and/or country, demand for care, frequency of contact with positive cases, in addition to other specific characteristics of the sample and study design that may interfere with the findings. Therefore, considering the reality of each location and identifying the specific variables related to the highest risk of contagion becomes essential to establish effective control measures.

Our finding regarding the prevalence of COVID-19 among vaccinated professionals (17.3%) was much lower than the 35.4% identified in a similar study conducted at another university hospital in southern Brazil.[13] However, a study conducted in Israel points to the same scenario of a significant reduction in COVID-19 cases after vaccination of healthcare professionals.[14] Just as the prevalence rates of COVID-19 before vaccination varied throughout the pandemic and in different countries and regions of the world, this variation was also observed even after vaccination. However, the importance of the findings lies in the significant reduction in cases regardless of the study location. In addition to this, maintaining infection control practices such use of personal protective equipment, even with adequate vaccination coverage, can also interfere with these results.

About the finding related to the higher prevalence of COVID-19 among medical workers compared to nursing team, we also found this in other studies.[10,13] Although nursing professionals present a greater risk of contamination because they have the longest contact time with patients,[15] it is known that nursing professionals demonstrate greater adherence to contamination prevention measures such as hand hygiene practice, when compared to medical workers,[16] which can positively interfere with the lower prevalence of COVID-19 in nursing professionals.

However, Gómez-Ochoa *et al*.[17] pointed to nursing as the category of healthcare workers most frequently affected by SARS-CoV-2, accounting for 48% of infected healthcare workers. It is important to highlight that nursing workers are the largest professional category in health, accounting for about 59% of healthcare workers in the world, 56% in the Americas region and approximately 70% in Brazil, so it is expected that, in absolute numbers, the contamination of nursing workers will be higher.[18, 19]

In our study, professionals in sectors that, in accordance with local institutional protocols, normally did not provide care to COVID-19 patients (such as surgical units), showed a high prevalence of COVID-19 before vaccination. Such results differ from other authors who pointed to the high prevalence of COVID-19 in sectors of care for COVID-19 patients due to a higher risk of contagion related to greater exposure.[13,20] However, institutional protocols regarding surgical procedures in symptomatic patients and non-testing in asymptomatic patients and even the possible misuse of protective equipment related to the perception of safety by professionals working in sectors that do not treat symptomatic patients may have been responsible for this outcome.

Moreover, after vaccination, we identified a significant reduction in cases of COVID-19 among professionals in sectors at greater risk of contact with contaminated patients, such as emergencies and ICUs. However, the prevalence of cases remained high among professionals in these sectors, which reinforces the importance to maintain preventive measures.

Our study did not show any significant difference in the protection provided by the use of vaccines in relation to the variables of sex, age, role, sector of activity or previous diagnosis of COVID-19, which may suggest that the protection provided by the vaccine outweighs the risk that any of these variables may confer. However, more robust studies with specific designs are needed to adequately analyze this topic.

The present study did not identify a significant difference in the protection provided by CoronaVac and Astrazeneca, unlike Toniasso *et al*.,[12] who assessed the effectiveness of both vaccines in the short term (less than three months after application). Therefore, our study, which included case data up to approximately six months after administration of the second dose of the vaccine, may suggest that, in the medium term, the effectiveness of different vaccines may become similar.

Limitations of this study include the study design that tracked and tested only symptomatic healthcare professionals. Furthermore, the study was not designed to identify the severity of infection or include data on the presence of comorbidities relevant to the SARS-CoV-2 infection process among workers. This approach limited the possibility of a better understanding of more factors related to the prevalence of COVID-19 among healthcare workers. However, the present study preserves its relevance, considering the importance of data on the medium-term impact of COVID-19 vaccination among healthcare professionals in high-complexity hospitals and findings that reinforce the impact of vaccination on communicable disease prevention.

In conclusion, our study showed a reduction in the prevalence of COVID-19 among cases of flu syndrome of

vaccinated healthcare workers when compared to cases of professionals unvaccinated for COVID-19, revealing that COVID-19 vaccination significantly reduced the chances of COVID-19 cases among healthcare workers, regardless of sex, age, sector, role, type of vaccine or previous diagnosis of COVID-19. Despite the reduction in COVID-19 cases among flu cases among professionals in sectors with a higher risk of contact with infected patients, the prevalence of cases remained high among professionals in these sectors, which reinforces the importance of maintaining complementary preventive measures, such as personal protective equipment (masks, glasses, gloves), in case of contact with patients suspected of having COVID-19. It is also worth noting that in the medium term (up to six months after the first dose), there may be no significant difference in the protection offered by CoronaVac and AstraZeneca. Thus, it reinforced the importance of COVID-19 vaccination as a practice to prevent the disease regardless of the type of vaccine available.

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AUTHORS' CONTRIBUTIONS

Karina Pinheiro Teixeira dos Reis contributed to the literature search, writing of the abstract, introduction, methodology, discussion, interpretation and description of results, preparation of tables, conclusions, review and statistics. **Mirelle de Oliveira Saes** contributed to the interpretation and description of results, explanations, review and statistics. **Ivy Bastos Ramis** contributed to the literature search, writing of the abstract, introduction, methodology, discussion, interpretation and description of results, preparation of tables, conclusions, review and statistics.

All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its version and integrity.