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SOCIO-EPIDEMIOLOGICAL PROFILE AND EFFECTS OF LONG-COVID-19 ON POST-PANDEMIC PATIENTS FROM SOUTHERN BRAZIL

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ABSTRACT

COVID-19 has been the biggest public health problem worldwide. Several people were infected by the SARS-CoV-2 virus, developing or not the related symptoms. Among the COVID-19 symptoms, many subjects had fever, cough, muscle pain, headache, loss of taste, loss of smell, among others, while some individuals presented more complex symptoms, such as severe acute respiratory syndrome. Still today there is no specific treatment against COVID-19. Although many pharmacological protocols were tried, including for example antibiotics and anti-inflammatories. Most of the infected subjects recovered from the disease, however, several patients still have some persistent symptoms, characterizing the so-called long-COVID-19. The objective of this study was to identify socio-epidemiological profile and effects of long-COVID-19 on post-pandemic patients. For this, a questionnaire of self-report was applied for 74 patients who recovered from COVID-19. This instrument of data collection included questions regarding socioeconomic aspects, symptoms during the disease, previous health history, use of medication before, during and after COVID-19, vaccination, use of legal and illegal drugs, physical activities, and sequelae and persistent symptoms. It was found that most of the volunteers were female and were about 31-50 years old. Also, most of the patients did not use the hospitalization services. Several patients self-reported the presence of some comorbidities prior to the infection, such as metabolic diseases. The majority had mild symptoms, such as headache and dysgeusia. Interestingly, 69% of the participants reported presenting persistent symptoms after recovering from COVID-19, mainly memory loss, hair loss and fatigue. About 13% reported symptoms related to cognitive impairments. This study shows the importance of continuing the scientific investigations in

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the present, especially considering the long-COVID-19 for the public health agencies and governments to be able to plan potential actions for the affected patients.

Keywords: SARS-Cov-2. Comorbidities. Post-COVID-19.

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INTRODUCTION

The COVID-19 pandemic, caused by the *SARS-CoV-2* virus, began in December 2019 on the Asian continent. By April 2024, more than 775 million confirmed cases and around 6 million deaths had been recorded worldwide (WHO, 2024).

Clinical features such as transmission and common symptoms have been well defined over the years of the COVID-19 pandemic, however survivors of acute infection are still at risk of long-term sequelae causing damage to different organs and/or systems (Joshee; Vatti; Chang, 2022) Cases of disorders in cardiorespiratory function and the central nervous system have been reported in individuals following COVID-19 infection (Xu; Xie; Al-Aly, 2022). The main clinical signs and symptoms also include respiratory disorders such as cough, difficulty breathing, runny nose, nasal congestion, and sore throat, with the potential to trigger pneumonia. Additionally, gastrointestinal symptoms, loss of smell, and loss of taste may occur (Aslan et al., 2021). Other nonspecific symptoms, such as skin rashes, conjunctivitis, extremity swelling, and even severe myocardial dysfunction, can confuse and complicate the diagnosis (Baden et al., 2020).

The period of *SARS-CoV-2* infection typically lasts about 7-14 days, and a portion of those affected may progress to respiratory failure, potentially leading to conditions of hypoxia (Huang et al., 2020). Among the more severe cases, a small number of critically ill patients may develop acute respiratory distress syndrome (ARDS), metabolic acidosis, septic shock, coagulation dysfunction, and multiple organ failure (Mesquita et al*.,* 2021). Certain health conditions (comorbidities or pre-existing clinical conditions) that humans may have serve as risk factors for the development of more severe manifestations associated with *SARS-CoV-2* infection, such as hypertension, diabetes, cardiovascular, and cerebrovascular diseases (Wang et al., 2020).

The sociodemographic aspects of COVID-19 encompass a variety of population characteristics that influence the spread and impact of the disease. This includes factors such as age, sex, race/ethnicity, socioeconomic status, geographical location, and living conditions (Ortiz-Prado et al., 2021). These aspects play a crucial role in how the disease affects different groups of people. For example, studies have shown that older individuals and those with underlying medical conditions are at a higher risk of developing severe complications or even dying from COVID-19 (Wang et al., 2020). Additionally, there are ethnic and racial disparities in the incidence of the disease, with some minority communities facing higher rates of infection and mortality. Socioeconomic status also plays an important role regarding

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COVID-19, with low-income individuals often facing greater challenges in accessing adequate healthcare, following preventive measures, and maintaining social distancing due to working and housing conditions (Ma et al., 2020). Moreover, geographical location influences the spread and impact of the disease. Densely populated urban areas tend to have higher transmission rates, while rural areas may face specific challenges such as limited access to healthcare services and distance from treatment centers (Papageorge et al., 2021). In summary, sociodemographic data on COVID-19 are essential for guiding public health policies and targeted interventions, ensuring that resources and efforts are directed equitably to protect the most vulnerable groups and mitigate the impact of the pandemic.

It is also important to mention that pharmacological protocols play an essential role in the treatment of COVID-19, significantly contributing to symptom management and the reduction of associated complications. Since the emergence of the pandemic, a wide variety of medications have been the subject of studies and used to combat the *SARS-CoV-2* virus and improve patient clinical outcomes. Among the most widely studied and used medications against COVID-19 are antivirals, such as remdesivir and favipiravir. These medications were specifically developed to inhibit viral replication in the body, thereby reducing viral load and the severity of symptoms in infected patients (Frediansyah et al., 2021). Corticosteroids, such as dexamethasone, also were used in the treatment of COVID-19, especially in patients with more severe forms of the disease. These medications have the ability of reducing inflammation in the lungs and other organs affected by the infection, contributing to an improvement in clinical outcomes and a reduction in mortality rates. However, the side effects of these drugs can vary from person to person and depend on the dosage and treatment duration (Johns et al., 2022).

Regarding the vaccination, several vaccine types against *SARS-CoV-2* were developed globally mainly from the companies Pfizer-BioNTech, Moderna, AstraZeneca, and Johnson & Johnson. These vaccines have been authorized for emergency use in many countries (Baden et al., 2020), as well as they have undergone rigorous testing to ensure their safety and efficacy. However, despite all the prevention attitudes, the pharmacological treatments and the vaccination, there are several patients who report some persistent symptoms even after recovering from COVID-19. These cases are called "long COVID" or “post COVID” (Al Yazidi et al., 2021). Persistent symptoms include feeling short of breath, continuous cough, headache. Also, there are subjects who have been reporting cognitive

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symptoms after the infection, such as anxiety, depression, difficulty in paying attention and concentrating.

The objective of this study was to evaluate the socio-epidemiological profile and effects of long-COVID-19 on post-pandemic patients.

METHODS

STUDY DESIGN

This study was developed looking forward to identifying socio-epidemiological aspects of patients who had COVID-19 and recovered, mainly focusing on the long-COVID-19 symptoms. 74 adult subjects were included in this investigation. Inclusion criteria were: be older than 18 years old, have tested at least once positive for COVID-19, have received attendance in the Brazilian public health care system. Exclusion criteria were: be younger than 18 years old, not having received care via the Brazilian public health system.

A questionnaire of self-report was applied. This instrument was composed by several question regarding: i) socioeconomic aspects; ii) symptoms during COVID-19; iii) previous health history; iii) use of medication before, during and after COVID-19; iv) vaccination; v) use of legal and illegal drugs; vi) physical activities; and vii) sequelae and persistent symptoms.

ETHICS CONSIDERATION

This research project was submitted to the Ethics Committee on Research with Human Beings from the Franciscan University via the "Plataforma Brasil" system. The project included a consent form and term of confidentiality, both signed by the research coordinator. It is important to mention that the project was prepared following the Brazilian law for ethics on research with human beings. The project also included a questionnaire of self-report that was applied with each participant to obtain the information of interest. The study was approved receiving the approval number as 39845620.8.0000.5306).

SOCIO-EPIDEMIOLOGICAL DATA COLLECTION

To start applying the questionnaire, after ethics approval, a hospital located in the city of Santa Maria, Rio Grande do Sul state, Brazil, was selected to be part of the study. This hospital had authorized the study conduction. All patients who met the study criteria were contacted by telephone call. The subjects who accepted to be included in the study were

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visited in person by at least two members of our research teams. For each participant, the idea of the study was explained verbally, as well as any doubt was clarified before any procedure related to the data collection. After accepting the terms and signing the free and informed consent form, they received the term of confidentiality. Then, the questionnaire was applied by a trained professional. The instrument of data collection was composed by questions related to: i) socioeconomic aspects; ii) symptoms during COVID-19; iii) previous health history; iii) use of medication before, during and after COVID-19; iv) vaccination; v) use of legal and illegal drugs; vi) physical activities; and vii) sequelae and persistent symptoms.

DATA ANALYSIS

All the obtained data was quanti and qualitatively analyzed, organizing different tables and figures to express the results. These tables and figures were prepared following all the aspects included in the questionnaire (different sections).

RESULTS

As previously described, this study included 74 patients who recovered from COVID-19. Considering the total number of subjects, 56 of them (75.7%) were women and 18 (24.3%) men. In terms of participants' age, 24.3% were 18-30 years old, 52.7% were 31-50 years old, 21.6% were 51-70, and 1.3% were above 70 years old. Regarding education level, 2 (2.7%) volunteers did not complete primary education, 6 (8.1%) had completed primary education, 5 (6.7%) had incomplete secondary education, 19 (25.7%) completed high school, 7 (9.4%) had completed technical education, 15 (20.3%) had incomplete higher education, 12 (16.2%) had completed higher education and 8 (10.8%) had postgraduate studies. For the average family income, the subjects were asked about the average income considering residents of the same place. 1 (1.3%) reported having no income at the moment, while 42 (56.7%) reported having an average family salary between 1 and 3 minimum wages, 29 (39.2%) described having between 4 and 8 minimum wages, while 2 (2.7%) reported having more than 8 minimum wages (figure 1).

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Figure 1: socio-demographic information.

Legend: Data obtained from 74 patients who recovered from COVID-19. a) Data regarding subject's age; b) Information related to levels of education; c) Results obtained about average wage. Results are presented in absolute numbers and percentage.

Participants were asked about symptoms experienced during COVID-19. The symptoms described ranged from cough, headache, muscle pain, intestinal problems, among others, to cases with greater intensity, including those patients hospitalized due to pneumonia induced by the virus infection. Numerically, 5.4% of the participants reported not having presented any symptoms during the infection, which were classified as asymptomatic. 62.1% of the volunteers, the majority of those interviewed, described having presented mild symptoms, without serious complications related to the infection. 29.7% of participants

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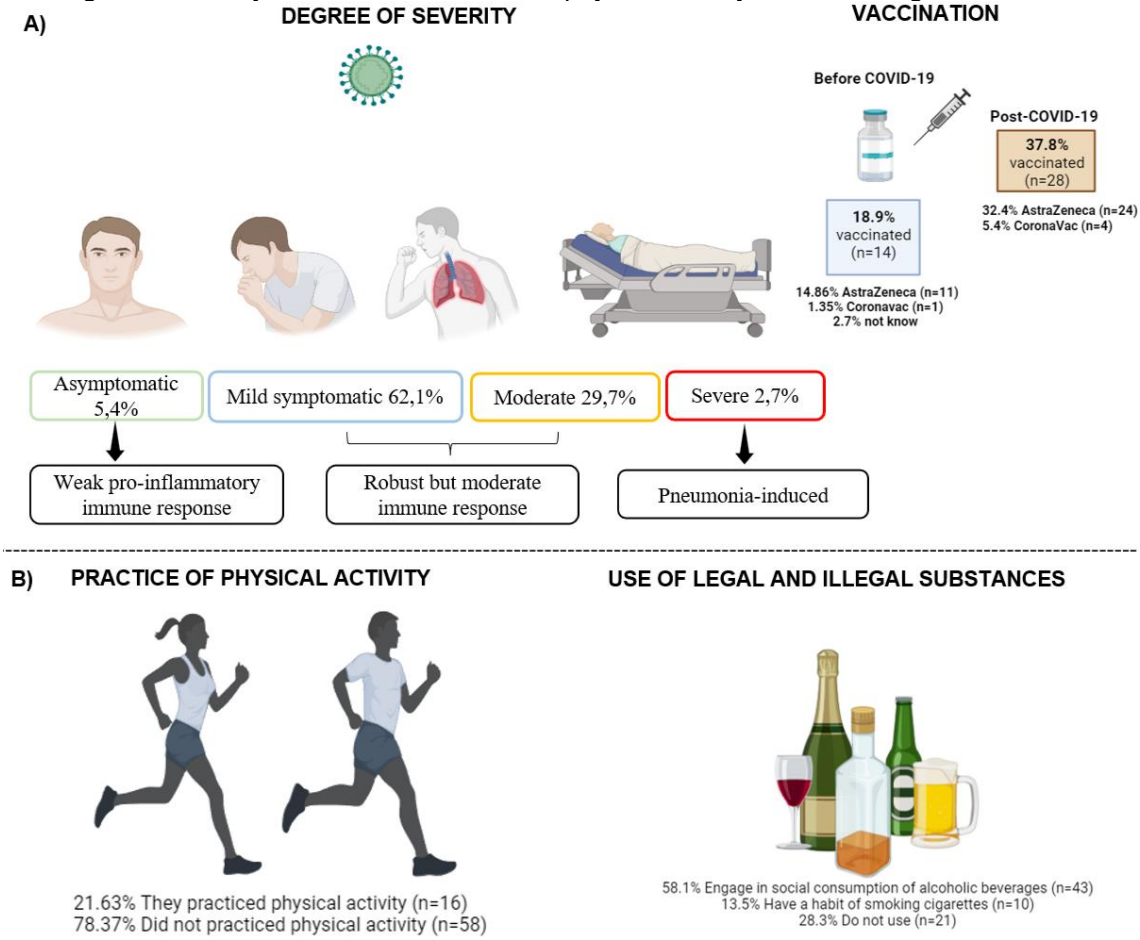
described having experienced moderate symptoms during COVID-19, which required more intense therapeutic interventions compared to those who had mild symptoms. Finally, 2.7% of patients described having severe symptoms, being those who were admitted to intensive care units (ICU) (figure 2A). Regarding vaccination, 60 (81.1%) patients had not received the vaccine before having the disease. While only 14 (18.9%) patients had been vaccinated. Among those vaccinated, 11 patients were vaccinated with AstraZeneca (78.6%), 1 CoronaVac (7.1%) and 2 did not know (figure 2A).

Related to physical activity, only 16 (21.6%) volunteers self-reported to perform physical activity regularly, while 58 (78.4%) did not mention having this habit. Regarding the use of legal and/or illicit drugs, none of the participants reported the use of illicit drugs. On the other hand, 43 (58.1%) volunteers reported the social consumption of alcoholic beverages, and 10 (13.5%) participants reported the habit of smoking cigarettes. 21 (28.3%) volunteers self-reported not using any type of drugs (figure 2B).

Figure 2: Degree of severity of infection, vaccination, physical activity and use of legal and illicit substances.



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To better detail the symptoms that the subjects presented during COVID-19, table 1 is showing the ten symptoms more frequent in patients' self-report. Most of the patients self-reported to present headache, 41 of them (55.4%). 40 (54%) subjects had dysgeusia, 30 (40.5%) had anosmia, as well as myalgia. 28 (37.8%) described presenting fever and fatigue. Additionally, 25 (33.7%) individuals had coughs, 18 (24.3%) presented shortness of breath, 12 (16.2%) had diarrhea, and 10 (13.5%) had runny nose.

Table 1: Symptoms presented during *SARS-CoV-2* infection.

Symptoms	Number of patients	Percentage
Headache	41	55.4%
Dysgeusia	40	54%
Anosmia	30	40.5%
Myalgia	30	40.5%
Fever	28	37.8%
Fatigue	28	37.8%
Cough	25	33.7%
Shortness of breathe	18	24.3%
Diarrhea	12	16.2%
Runny nose	10	13.5%

Another aspect considered in the questionnaires applied was the previous health history, that is, the presence of previous diseases (comorbidities) presented by the volunteers before the *SARS-CoV-2* infection. Around 15.7% of participants described not having any illness prior to the virus infection. Of the remaining participants, the most frequently cited comorbidities were: i) respiratory diseases (39.2%); ii) obesity (28.4%); iii) hypertension (25.7%); and iv) overweight (24.3%). The following table schematically shows all the diseases described by the participants; these diseases being presented before COVID-19.

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Table 2: Comorbidities cited by patients.

Comorbidities	Number of Patients	Percentage (%)
Respiratory diseases	29	39.2%
Obesity	21	28.4%
Hypertension	19	25.7%
Overweight	18	24.3%
Denies comorbidities	12	16.2%
Anxiety	7	9.4%
Hypothyroidism	6	8.1%
Heart diseases	6	8.1%
Diabetes I and II	6	8.1%
Dyslipidemia	5	6.7%
Depression	4	5.4%
Cancer	3	4%
Fibromyalgia	1	1.3%

Just as many of the participants reported having illnesses prior to the infection, many of them also described the use of medications. The following table (table 3) lists the main classes of medicines used by the volunteers. 31 (41.9%) of them reporting the use of medicines against metabolic diseases, 11 (14.8%) using medicines against psychiatric diseases, 11 (14.8%) use medication for respiratory diseases, 11 (14.8%) using contraceptives and 7 (9.4%) described using drugs to treat heart disease.

Table 3: Classes of medications used by the patients prior COVID-19.

Classes of medications used prior the disease	Number of individuals and Percentage (%)
Medications for Metabolic Diseases	31 (41.9%)
Medications for Neuropsychiatric Diseases	11 (14.8%)
Medications for Respiratory Diseases	11 (14.8%)
Contraceptives	11 (14.8%)
Medicines for Heart Disease	7 (9.4%)

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Regarding post-COVID-19 symptoms (sequelae), 23 of the participants reported not having had any sequelae after recovering from COVID-19. However, the remaining participants reported experiencing one or more post-COVID-19 sequelae, the most described were: i) memory loss (27%); 2) hair loss (27%); 3) fatigue (25.6%); and 4) anxiety (9.4%). Another interesting aspect is that 13.5% of participants also reported having developed depression or other psychiatric illnesses for the first time after recovering from COVID-19. The following table (table 4) shows all the sequelae described by the participants.

Table 4: Sequels presented post-COVID-19.

Sequels	Number of patients	Percentage (%)
No sequelae	23	31%
Memory loss	20	27%
Hair Loss	20	27%
Fatigue	19	25.6%
Anxiety	7	9.4%
Mental confusion	7	9.4%
Dyspnea	5	6.7%
Dysgeusia	4	5.4%
Depression	3	4%
Headache	2	2.7%
Irritability	2	2.7%

DISCUSSION

The pandemic caused by the *SARS-CoV-2* virus, responsible for the respiratory tract infection called coronavirus disease 2019 or COVID-19, has had major impacts on people's lives. According to the World Health Organization (WHO), by April 2024 there were around 775 million confirmed cases and 6 million deaths recorded worldwide. In this study we evaluated socio-epidemiological profile and the effects of long-COVID-19 on post-pandemic patients via self-report methods.

The COVID-19 clinical consequences include a wide spectrum of symptoms that may vary among those infected, with minimal or no symptoms, while others may develop ARDS, induced by a well-called “cytokine-storm” and, therefore, an intense pulmonary inflammatory response (Zhang et al., 2020; Yang et al., 2020). Cytokines act as cellular mediators and are

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essential for the correct functioning of the immune system, being involved in a series of pathophysiological processes such as inflammation, tissue repair, coagulation, among others. However, when produced in excess, because of a dysfunction of the immune system, they become harmful to the body, leading to an overexpression of inflammatory factors (Hu; Huang; Yin, 2021).

This study involved 74 individuals who had COVID-19 and recovered. After agreeing to take part in this scientific investigation, the individuals received a copy of the consent form, and answered a self-report questionnaire. About the number of participants, 56 (75.7%) were women and 18 (24.3%) were men. Regarding the age of the participants, 24.3% were between 18 and 30 years old, 52.7% of the participants were between 31 and 50 years old, 21.6% were between 51 and 70 years, while 1.3% of the participants were over 70 years old. Otufowora et al. (2021) developed a study related to the acceptance of individuals in epidemiological investigation as the present one. The authors described that usually most participants are female. It is observed that men and women have different perceptions with clinical research, and trust in researchers is considered an essential component for participation in this type of study. This information corroborates with our findings.

Most participants were between 31 and 50 years old and had at least completed high school level of education. Rocha et al., (2021) and Aspachs et al (2021) performed some social and economic analysis in different populations with COVID-19. Both authors described that the education level plays an important influence in terms of the disease outcome. The higher the level of education of volunteers, the lower the fatality rate, and this effect may be the result of differences in income that generate disparities in access to basic health services.

The main symptoms reported by the participants during COVID-19 infection were: headache (55.4%), dysgeusia (54%), anosmia (40.5%), myalgia (40.5%), fever and fatigue (37.8%). These parameters are similar to those found by Bouwensch et al. (2022), in which these symptoms were the most frequent in an analysis of 160 non-hospitalized COVID-19 positive patients. Vaccination for COVID-19 was also questioned in this study and 81.1% of patients had not been vaccinated before having the disease, while only 18.9% of patients had been vaccinated. According to Tregoning et al. (2021) the vaccination has been extremely effective in preventing COVID-19, and especially in the development of the most serious form of the disease. It is important to mention that the current vaccination rate in Brazil is much higher due to the intensification of the vaccination actions. The vaccination data described were obtained previously when the vaccination process against COVID-19 was starting.

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The practice of physical activity was reported by only 16 volunteers (21.6%), while 58 participants (78.4%) did not practice any physical exercise. It is already known that physical exercise performed at moderate intensity has positive effects on the immune system's responses against viral respiratory infections. Moderate-intensity physical activities have the impact to increase immune cells counting in the blood (including neutrophils and natural killer (NK) cells). It is interesting that even in the saliva it is possible to find increased concentrations of immunoglobulin A (IgA) (Miao et al., 2009). In this regard, moderate physical activities could increase stress hormones, reducing excessive inflammation and leading to increased immunity against viral infections, for example (Nogueira et al., 2021).

Regarding the use of legal and illegal drugs, none of the participants reported using illegal drugs. On the other hand, regarding the consumption of alcoholic beverages, 43 volunteers (58.1%) reported the habit of using alcoholic beverages and 10 volunteers (13.5%) reported the habit of smoking cigarettes, while 21 volunteers (28.3%) did not use any type of drug. Dai et al (2022) showed that the consumption of alcohol (mainly above guidelines levels) can induce a higher risk of COVID-19 compared to those who do not have this habit. Additionally, the COVID-19 risk seems to be associated with the alcoholic beverages consumption frequency and beer is an example of beverage which increases the disease risk. Related to the smoking habits, Neira et al (2021) already showed the relationship between smoking cigarettes and the COVID-19 progression. The authors described that comparing former smokers and non-smoker, the ones with this habit had a higher odd of hospitalization. This information demonstrates how important is the knowledge of patients' habits on the understating of COVID-19 progression expectancy.

Another relevant aspect when considering COVID-19 and long-COVID-19 is the subject's comorbidities. It is very well described in the literature that comorbidities are associated with development of severe COVID-19 and subsequent complications. The most relevant comorbidities include diabetes mellitus, obesity, respiratory and cardiovascular diseases, such as hypertension and coronary disease (Li et al., 2020; Wang et al., 2020). According to the results found in this research, it was possible to observe that about 83% of patients had at least some type of pre-existing disease, being the most prevalent ones: respiratory diseases (39.2%), obesity (28.4%), hypertension (25.7%) and overweight (24.3%). Sanyaolu et al (2020) reported that patients with comorbidities underlying COVID-19 have a faster progression and are more likely to develop the severe disease and progress to death. Of the 74 volunteers in this study, 3 of them developed ARDS, making intubation

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and mechanical ventilation necessary. Of these, 2 participants were female and obese and 1 male patient was overweight and diabetic. It is believed that the comorbidities that these volunteers presented may have directly influenced the outcome and progression of COVID-19. Additionally, the results obtained corroborate the findings of Crespo et al. (2022) in which the severity of the *SARS-CoV-2* infection in obese patients was described. As body fat increases, there is a predominance of inflammatory factors that are related to insulin resistance. Research participants also reported the use of medications for such comorbidities, where 41.9% of them were already using medications for metabolic diseases, 14.8% for respiratory diseases, 14.8% for neuropsychiatric illnesses, 14.8% contraceptives and 9.4% were taking medications for coronary heart problems.

After recovering from the infection, several individuals continued to present signs, symptoms, or abnormal clinical parameters of a physical, psychological or cognitive nature. These signs and symptoms are considered long-term effects of the disease (Lopez-Leon et al., 2021). These long-term sequelae of COVID-19 are being described as a major public health issue currently (Ballering et al., 2022). Although these changes are reported more frequently in survivors who progressed to severe disease, lasting effects also occur in individuals with mild infection who did not require hospitalization (Townsend et al., 2021). Similar results were found in this study, in which only 31% of participants reported not having had any sequelae after recovering from COVID-19. While the other participants presented one or more sequelae, being the most prevalent ones: memory loss, hair loss, fatigue, and anxiety. Post-infection symptoms, such as headache, fatigue, dizziness, memory loss, confusion, and difficulty concentrating, are associated with post-COVID-19 infection (Nordvig et al., 2020). Garrigues et al. (2020) provide data that more than 30% of post-COVID-19 individuals report memory loss, for example.

Another important fact found in this study is that around 13% of participants reported having developed some type of psychiatric illness such as anxiety and/or depression for the first time after recovering from the infection. It has become clear that COVID-19 has a pathophysiology that affects multiple organs, including the brain and nervous system. The data found in this study are in line with several other studies that demonstrate a high incidence of acute psychiatric symptoms in patients with COVID-19 (Hu et al., 2020; Kong et al., 2020). According to Kong et al. (2020) about 35% of post-COVID patients experience symptoms of anxiety and depression. Rogers et al. (2020) found that in both situations, during and after the infection, an increase in the incidence of cognitive impairments as well as

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depression and anxiety. According to Divani et al. (2020) neuroinflammation is present in a large proportion of patients with the *SARS-CoV-2* infection. Authors report that increased levels of cytokines, both peripheral and central, can lead not only to inflammation and lung dysfunction, but also to the development of psychiatric diseases (Muccioli et al., 2020; Tang et al., 2021).

The pandemic has affected almost all individuals directly or indirectly, whether due to infection or psychological fear of it, or the effects of long-term measures and their economic and social impacts (Manchia et al., 2022). Currently, vaccination has led to a large decrease in positive cases of COVID-19, but the effectiveness of the vaccine may end up being undermined by the emergence of new variants of *SARS-CoV-2* (Hassine et al., 2022). Perhaps we still will suffer the most severe consequences of long-COVID-19 in the future and this is the reason why understanding about these conditions are scientifically important.

CONCLUSION

The obtained data reflect the social conditions and epidemiological aspects in the outcome of COVID-19. It is notorious that comorbidities play an essential role in the progression of the *SARS-Cov-2* infection. Additionally, most of the patients who had COVID-19 and recovered self-reported having persistent symptoms. Cognitive impairments were highlighted among the long-COVID consequences, mainly depression and anxiety. The severity and duration of these sequels are still difficult to assess. In general, there is a tendency for symptoms to improve over time. This study shows the importance of continuing the scientific investigations in the present, especially considering the long-COVID-19 for the public health agencies to be able to plan potential actions for those patients.

CONFLICT OF INTEREST

The authors declare that there are no competing interests regarding the publication of this paper.

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