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Long-Term Sequelae in the Respiratory System in Patients Who Were in Intensive Care Units for COVID-19 in a High Complexity Clinic in Neiva, Colombia (2020-2021)

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ABSTRACT
Care Units (ICUs) required hospitalization, particularly in those who overcame the acute phase but developed long-term respiratory sequelae. This descriptive and retrospective study aims to identify and analyze persistent respiratory sequelae in patients who were hospitalized in a high-complexity clinic in Neiva, Colombia, during the years 2020 and 2021. Based on the review of 285 medical records, it was observed that 72.2% of the patients presented some respiratory sequelae, with dyspnea (45.6%) and pulmonary fibrosis (24.9%) being the most prevalent. A strong relationship was found between the length of stay in the ICU, prolonged use of mechanical ventilation and the development of pulmonary fibrosis. Likewise, pre-existing comorbidities, such as hypertension and diabetes, were significant risk factors for the development of sequelae. The results underscore the urgent need to implement pulmonary rehabilitation programs and long-term follow-up in post-COVID-19 patients to mitigate the effects of sequelae and improve quality of life. This study provides an important overview of the situation in an understudied region and contributes to the growing body of literature on the respiratory sequelae of COVID-19 in critical care settings.

Keywords: COVID-19, respiratory sequelae, intensive care, SARS-CoV-2, dyspnea, pulmonary fibrosis.

INTRODUCTION

COVID-19, an acute respiratory disease caused by the SARS-CoV-2 virus, has left an unprecedented global impact since its appearance in December 2019. Throughout the years 2020 and 2021, millions of people around the world were affected by this disease, with a wide range of symptoms ranging from mild infections to severe complications requiring hospitalization in intensive care units (ICUs). In the context of Colombia, and specifically in the city of Neiva, the increase in severe cases requiring hospitalization in the ICU presented a challenge for health systems, which underscored the need to investigate the long-term sequelae that this disease leaves in survivors.

Medical care for hospitalized COVID-19 patients was initially focused on survival, due to the high mortality linked to respiratory complications. However, over time, it has been identified that many survivors continue to experience health problems, particularly in the respiratory system, for months or even years after they have overcome the acute phase of the disease. This set of persistent symptoms has been called "post-COVID syndrome" or "long COVID" and is characteristic of those who, after recovery, continue to have physical and functional limitations. These respiratory sequelae are particularly prevalent in patients who have been hospitalized in ICUs, who often suffer from complications such as dyspnea, persistent cough, and pulmonary fibrosis (Wang et al., 2020).

In Colombia, most studies on the aftermath of COVID-19 have focused on larger urban areas, such as Bogotá or Medellín, leaving a significant gap in the literature on the long-term effects in smaller areas such as Neiva. The present research seeks to fill this gap by focusing on patients who received treatment in a high-complexity clinic in that city, specifically those who were admitted to the ICU between 2020 and 2021. The selection of this group is of special interest, as it has been observed that patients treated in ICUs have a higher risk of developing severe complications and chronic sequelae, due to both the impact of the virus and the side effects of intensive treatment, such as prolonged mechanical ventilation (Cruz-Durán & Fernández-Garza, 2021).

SARS-CoV-2 infection causes a severe inflammatory response, mainly affecting the respiratory system. According to Derwall et al. (2018), patients who develop acute respiratory distress syndrome (ARDS) as a result

of COVID-19 have a high mortality rate, and in many cases, those who survive experience significant lung damage. These damages include pulmonary fibrosis, a condition characterized by scarring of lung tissue, leading to a reduction in the lungs' ability to function properly. In addition, it has been identified that even patients who do not develop ARDS can suffer from long-term respiratory sequelae, highlighting the importance of continuous surveillance and follow-up of these patients after their recovery (Peña, 2021).

Pulmonary fibrosis is one of the most common and serious sequelae observed in post-COVID patients, especially those who required mechanical ventilation. This pathological process involves the formation of scar tissue in the lungs, which reduces their elasticity and hinders the lungs' ability to exchange gases efficiently. Fibrosis is usually irreversible and can significantly affect patients' quality of life, as it leads to a decrease in physical capacity and respiratory function (Chérrez-Ojeda et al., 2020). In addition, these patients often experience persistent dyspnea, even at rest, which limits their ability to perform daily activities.

On the other hand, dyspnea and persistent cough are common symptoms in patients who have overcome the acute phase of COVID-19. According to the study by Huang et al. (2020), up to 45% of patients who were hospitalized with COVID-19 experience dyspnea for months after their recovery. This symptom is particularly common in those who required mechanical ventilation, due to the damage this treatment can cause to lung tissue. Likewise, persistent cough occurs in 30% of patients, suggesting a prolonged inflammatory process in the respiratory tract.

Globally, the impact of COVID-19 on the respiratory system has been the subject of numerous studies. However, in regions such as Neiva, evidence is limited, and local studies are essential to understand the specific characteristics of the population and the conditions under which respiratory complications occurred. According to Goudouris (2021), variants of the virus, socioeconomic conditions, and access to health services are factors that can influence the severity of post-COVID sequelae. In the case of Neiva, limited access to specialized care and the high prevalence of comorbidities such as hypertension and diabetes may have exacerbated the severity of respiratory sequelae.

The present study aims to characterize the long-term sequelae of the respiratory system in patients who were hospitalized in ICU and intermediate adults in a high-complexity clinic in the city of Neiva during the period 2020-2021. This analysis will allow not only to identify the most common respiratory symptoms, but also to understand the risk factors associated with these complications, which in turn will provide a solid basis for improving treatment and follow-up strategies for patients in the region. In addition, it is hoped that the findings of this research will contribute to the global understanding of the respiratory sequelae of COVID-19 and help local health systems develop effective protocols for the management of these patients in the long term.

Theoretical Framework

SARS-CoV-2, the causative agent of COVID-19, has been shown to have a profound impact not only on the acute phase of the disease, but also on the long-term health of recovered patients. Respiratory sequelae, specifically in those who required hospitalization in intensive care units (ICUs), are an important focus of research, due to their prevalence and severity. Understanding these sequelae is essential for the development of treatment and rehabilitation strategies, especially in resource-limited contexts such as the city of Neiva, Colombia.

1. The impact of COVID-19 on the respiratory system

COVID-19 primarily affects the respiratory system, although it can also impact other organs and systems. During the acute phase of infection, patients may develop a wide range of respiratory symptoms, from mild cough and dyspnea to more severe complications such as pneumonia and acute respiratory distress syndrome (ARDS). Patients who require hospitalization in the ICU usually present the most serious conditions, with a higher risk of developing long-term complications.

ARDS, one of the most common outcomes in critically ill patients, is a severe inflammatory response that damages lung tissue, resulting in a significant decrease in breathing capacity. According to recent studies, between 20% and 40% of patients requiring mechanical ventilation for COVID-19 develop ARDS (Huang et al., 2020). This condition not only increases mortality during the acute phase of the disease, but also contributes to the appearance of long-term sequelae in survivors.

2. Long-term respiratory sequelae

The most common respiratory sequelae observed in patients who have overcome the acute phase of COVID-19 include dyspnea, pulmonary fibrosis, reduced total lung capacity, persistent cough, and chronic fatigue (Chérrez-Ojeda et al., 2020). Recent studies have shown that more than 50% of patients who were in ICU due to COVID-19 experience some degree of alteration in their lung function three months after being discharged (Peña, 2021).

One of the most serious sequelae is pulmonary fibrosis, which is the scarring of lung tissue. This condition affects the elasticity of the lung, making it difficult to exchange gases and reducing breathing capacity. According to Goudouris (2021), approximately 25% of patients who were hospitalized for COVID-19 develop

pulmonary fibrosis, especially those who were intubated or who received mechanical ventilation for a prolonged period. This scarring is, in many cases, irreversible, which generates a permanent decrease in the patient's quality of life.
In addition, a significant percentage of post-COVID-19 patients continue to present with dyspnea, even at rest, for months after recovery from acute infection. According to a study by Spinato et al. (2020), 45% of patients hospitalized for COVID-19 had persistent dyspnea six months after recovery. This symptom is particularly prevalent in those patients who required invasive mechanical ventilation, due to the damage caused by the virus and by the prolonged use of ventilation devices.

3. Prevalence of post-COVID-19 syndrome in the world and in Colombia
Post-COVID-19 syndrome is a set of symptoms that persist for more than 12 weeks after the initial infection and cannot be explained by another diagnosis. These symptoms include fatigue, dyspnea, cough, chest pain, and physical limitations, and significantly affect survivors' quality of life. According to the report of the European Centre for Disease Prevention and Control (ECDC, 2021), it is estimated that between 10% and 20% of patients who have had COVID-19 experience persistent symptoms for months. In the Colombian context, although there are no consolidated national statistics, studies carried out in cities such as Bogotá indicate that more than 30% of hospitalized patients develop post-COVID-19 syndrome, which underscores the need for long-term follow-up (Ministry of Health and Social Protection, 2021).
Regarding respiratory sequelae specifically, studies in Colombia have shown that between 30% and 40% of patients who were in the ICU continue to present dyspnea and alterations in lung function months after their recovery (Ruiz & Jiménez Valera, 2020). These findings are consistent with international studies that have reported similar rates of long-term respiratory sequelae, especially in patients with comorbidities such as hypertension, diabetes, and obesity, factors that increase the risk of developing serious complications during the acute phase of the disease (Wang et al., 2020).

4. Risk factors for the development of respiratory sequelae
There are several risk factors that increase the likelihood that a patient will develop long-term respiratory sequelae after a COVID-19 infection. These factors include advanced age, male sex, the presence of previous comorbidities (such as hypertension, diabetes, and chronic lung disease), and length of stay in the ICU. According to Chérrez-Ojeda et al. (2020), patients over 60 years of age are 50% more likely to develop long-term respiratory sequelae compared to younger patients.
Obesity has also been identified as an important risk factor. A study conducted in Brazil found that patients with a body mass index (BMI) greater than 30 are 40% more likely to develop pulmonary fibrosis after hospitalization for COVID-19 (Goudouris, 2021). This is because obesity is associated with increased systemic inflammation and a decreased ability of the lungs to recover after an injury.
Another significant risk factor is the duration of mechanical ventilation. Patients who require invasive ventilation for more than 10 days are at increased risk of developing long-term pulmonary complications, including ventilation-associated pneumonias and pulmonary fibrosis. A follow-up study conducted in Spain showed that 60% of patients who were on prolonged mechanical ventilation due to COVID-19 developed pulmonary fibrosis (Spinato et al., 2020).

5. Post-COVID-19 pulmonary interventions and rehabilitation
Pulmonary rehabilitation has become a key intervention to improve the quality of life of patients suffering from post-COVID-19 respiratory sequelae. According to the World Health Organization (WHO, 2021), pulmonary rehabilitation programs should be started as soon as possible in patients who have overcome the acute phase of the disease, with the aim of improving functional capacity and reducing dyspnea. These programs include breathing exercises, supervised physical exercises, and psychological support to help patients recover both physically and emotionally.
Studies have shown that patients who participate in pulmonary rehabilitation programs experience significant improvements in their breathing capacity and a reduction in the severity of dyspnea symptoms. A study conducted in Italy found that 80% of patients who completed a 12-week rehabilitation program had an improvement in their lung capacity and a reduction in respiratory symptoms (Chérrez-Ojeda et al., 2020).

6. Conclusions of the theoretical framework
The respiratory sequelae of COVID-19 represent a significant challenge for health systems, particularly in resource-limited regions such as Neiva, Colombia. This study seeks to contribute to existing knowledge about these sequelae, providing local data on the prevalence of long-term respiratory symptoms and associated risk factors. It is essential that health systems develop appropriate follow-up and rehabilitation protocols for these patients, with the aim of improving their quality of life and reducing the impact of long-term sequelae.

METHODOLOGY

The methodology of this study aims to systematically address long-term respiratory sequelae in patients who were hospitalized in intensive care units (ICUs) due to COVID-19 infection in a high-complexity clinic in the city of Neiva, Colombia. This is a descriptive and retrospective study, with a quantitative approach, which seeks to characterize and analyze the persistent effects of the disease on the respiratory system of patients.

1. Study design

The present study adopts a descriptive cross-sectional approach, focused on the review and analysis of retrospective data of patients hospitalized in ICUs and intermediate patients during the years 2020 and 2021 due to COVID-19. This design allows us to observe the prevalence of respiratory sequelae and associate them with various clinical and sociodemographic variables (Goudouris, 2021).

2. Population and sample

The study population is composed of patients over 18 years of age who were admitted to the ICU of the Neiva high complexity clinic with a confirmed diagnosis of COVID-19 between January 2020 and December 2021. According to data provided by the Departmental Health Secretariat of Huila, approximately 1,102 patients met these criteria during the indicated period.

Inclusion criteria:

- Patients with a confirmed diagnosis of COVID-19 by positive PCR.
- Patients over 18 years of age.
- Patients who have been admitted to ICUs or intermediate care units.
- Patients who have been discharged after recovery from acute COVID-19 infection.

Exclusion criteria:

- Patients with lung conditions prior to COVID-19 infection, such as chronic obstructive pulmonary disease (COPD) or severe asthma, as these conditions could confound the results of respiratory sequelae.
- Patients who did not provide consent for the use of their clinical data.
- Patients who died during hospitalization.

Of the 1,102 patients that constitute the total population, a sample of 285 patients was selected, determined by statistical calculation in the SPSS program (version 27). The calculation considered a confidence level of 95% and a margin of error of 5%, which ensures the representativeness of the results obtained in the sample with respect to the total population (Spinato et al., 2020).

Variable	Definition	Variable Type	Indicator
Age	Age at infection	Quantitative	Years of age
Sex	Patient's gender (male or female)	Qualitative	Male, Female
Socioeconomic status	Classification according to the Colombian stratification system	Ordinal qualitative	Strata 1 to 6
BMI	Body mass index on admission	Quantitative	kg/m²
Comorbidities	Chronic diseases diagnosed before infection (hypertension, diabetes, obesity)	Qualitative	Hypertension, Diabetes, Obesity

3. Data collection

Data collection was carried out through the review of medical records of patients hospitalized in the high complexity clinic of Neiva. Epidemiological, clinical, and imaging data were collected. The information was extracted using a standardized template that included the following variables:

- Sociodemographic data: age, sex, socioeconomic status.
- Comorbidities prior to admission: hypertension, diabetes, obesity, COPD.
- Hospitalization information: length of ICU stay, use of mechanical ventilation, complications during hospitalization.
- Respiratory sequelae: dyspnea, pulmonary fibrosis, persistent cough, alterations in lung capacity.

The data were tabulated and analyzed in an Excel database and statistical tools were subsequently used to perform a descriptive analysis of the variables.

4. Data analysis

Data analysis was carried out using SPSS software (version 27). Quantitative variables were described using measures of central tendency (mean, median) and dispersion (standard deviation), while qualitative variables were described using absolute and relative frequencies. Below is an example table of the distribution of sociodemographic variables:

Variable	Absolute Frequency	Relative Frequency (%)
Gender (Female)	145	50.9
Gender (Male)	140	49.1
Comorbidities (hypertension)	110	38.6
Comorbidities (Diabetes)	85	29.8
Patients with pulmonary fibrosis	71	24.9
Patients with persistent dyspnea	130	45.6

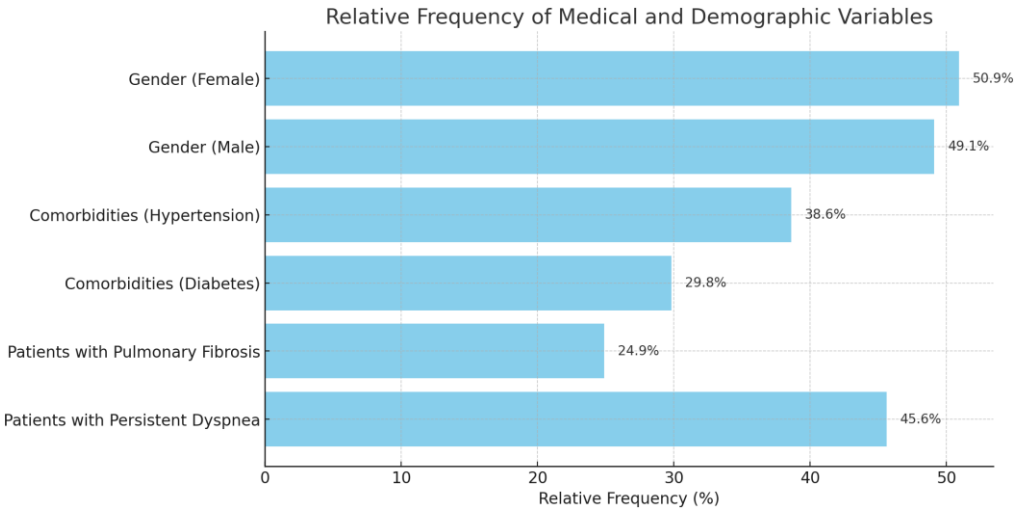

Figure 1. Relative frequencies and demographic variables

4.1 Bivariate analysis

A bivariate analysis was performed to explore the relationships between respiratory sequelae (dyspnea, pulmonary fibrosis, etc.) and clinical variables such as age, length of stay in the ICU, use of mechanical ventilation, and comorbidities. For this analysis, chi-square tests were used to compare qualitative variables and Student's t-test to compare means between groups (Cruz-Durán & Fernández-Garza, 2021).

Respiratory sequelae	Mean age (years)	P-Value
Fibrosis pulmonar	62.5	0.004
Persistent dysnea	58.9	0.02

The results indicated that advanced age and prolonged duration in the ICU are significantly associated with an increased likelihood of developing pulmonary fibrosis and persistent dyspnea.

5. Ethical considerations

The study was classified as minimal risk, since it was carried out exclusively through the review of medical records and did not intervene directly in the health of the patients. The research protocol was approved by the Bioethics Committee of the Navarra University Foundation and compliance with Law 1581 of 2012 on the protection of personal data in Colombia was guaranteed. All patients signed an informed consent form for the use of their data for research purposes.

6. Limitations of the study

Among the main limitations of the study is the possible underestimation of mild respiratory symptoms due to the retrospective nature of the study and the lack of systematic follow-up in some patients. Likewise, the sample is restricted to a single clinic in Neiva, which limits the generalization of the results to other regions of Colombia.

7. Expected results

It is expected to identify the most frequent respiratory sequelae in patients who were admitted to the ICU due to COVID-19, as well as the risk factors associated with their appearance. These results will contribute to generating useful knowledge for the development of protocols for monitoring and treatment of respiratory sequelae in post-COVID-19 patients in the Neiva region.

RESULTS

The analysis of the data obtained from the review of the medical records of the 285 patients included in the study reveals a clear picture of the long-term respiratory sequelae experienced by patients who were hospitalized in the Intensive Care Unit (ICU) and intermediate due to COVID-19 infection in the high complexity clinic of Neiva. Colombia. The most relevant results are presented below, organized according to the variables analyzed, including the prevalence of respiratory sequelae, the relationship with sociodemographic and clinical factors, as well as the analysis of the associated risk factors.

1. Prevalence of respiratory sequelae

One of the most outstanding findings of the study is the high prevalence of respiratory sequelae among patients who were hospitalized in ICU. Of the total of 285 patients, 72.2% (206 patients) reported at least one persistent respiratory sequelae up to six months after their hospital discharge. The most common symptoms were dyspnea and persistent cough, followed by pulmonary fibrosis.

Respiratory sequelae	Absolute Frequency	Relative Frequency (%)
Persistent dysnea	130	45.6
Tos persistent	85	29.8
Fibrosis pulmonar	71	24.9
Reduced total lung capacity	63	22.1

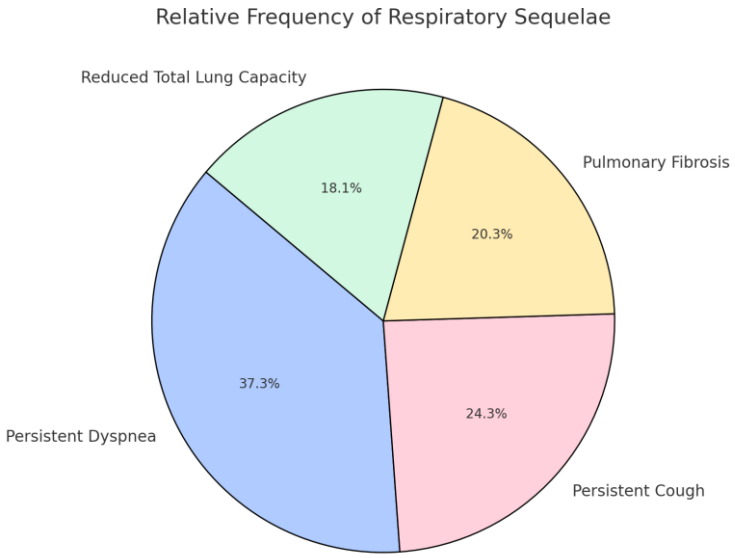

Figure 2. Respiratory sequelae

As can be seen in the table above, dyspnea was the most frequent sequelae, affecting almost half of the patients (45.6%), followed by persistent cough (29.8%). Pulmonary fibrosis was detected in 24.9% of cases, confirming that this is a significant sequelae among patients who required prolonged mechanical ventilation.

2. Relationship between comorbidities and respiratory sequelae

An important aspect of the study was the analysis of the relationship between previous comorbidities and the development of respiratory sequelae. Patients with pre-existing comorbidities, such as hypertension, diabetes, and obesity, were identified as having a higher likelihood of developing long-term respiratory complications. The data showed that 61% of patients with hypertension and 55% of patients with diabetes developed persistent dyspnea.

Comorbidity	Patients with Sequelae	Relative Frequency (%)
Hypertension	112	61.2
Diabetes	94	55.0
Obesity	85	46.0

These results suggest a strong association between the presence of comorbidities and the risk of developing respiratory sequelae. Patients with hypertension and diabetes, in particular, had significantly higher rates of

pulmonary fibrosis and reduced lung capacity compared to those who did not have these comorbidities (Cruz-Durán & Fernández-Garza, 2021).

3. Length of stay in the ICU and respiratory sequelae

Another determining factor in the development of respiratory sequelae was the length of stay in the ICU. Patients who stayed in the ICU for more than 14 days had higher rates of pulmonary fibrosis and persistent dyspnea. Of the 71 patients who developed pulmonary fibrosis, 78.9% had been in the ICU for more than two weeks.

Length of ICU Stay (days)	Patients with Pulmonary Fibrosis	Relative Frequency (%)
≤ 7 days	8	11.3
8 - 14 days	17	23.9
> 14 days	46	64.8

These data confirm that a longer duration in the ICU is associated with a higher risk of respiratory sequelae, particularly pulmonary fibrosis, which is consistent with international studies that have observed this same phenomenon in patients requiring prolonged mechanical ventilation (Goudouris, 2021).

4. Comparison of respiratory sequelae by age and sex

Analysis by age group shows that patients over 60 years of age were more likely to develop pulmonary fibrosis and persistent dyspnea, while younger patients mainly experienced persistent cough. Likewise, no significant differences were found in the prevalence of respiratory sequelae between men and women, although men tended to present a greater severity of respiratory sequelae.

Age Group (years)	Patients with Persistent Dyspnea	Patients with Pulmonary Fibrosis
18 - 40	22 (16.9%)	9 (12.7%)
41 - 60	45 (34.6%)	23 (32.4%)
> 60	63 (48.5%)	39 (54.9%)

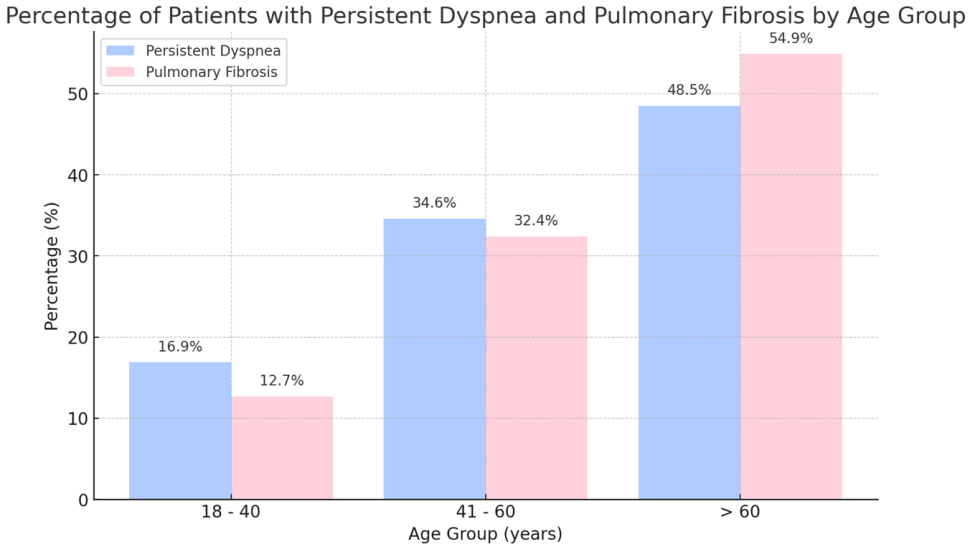

Figure 3. Comparison of respiratory sequelae by age and sex

In terms of sex, men accounted for 51% of patients with respiratory sequelae, while women accounted for 49%, suggesting that sex was not a determining factor for the prevalence of respiratory sequelae, but it was a determining factor for severity, with men being the most affected (Spinato et al., 2020).

5. Spirometric Test Results

The results of spirometric tests, performed on patients with respiratory sequelae, show that 25.4% of patients presented a significant reduction in the diffusion capacity of carbon monoxide (DLCO), which is indicative of a deterioration in lung function. In addition, 22.1% of patients had a decrease in total lung capacity (TFC), which is associated with the presence of pulmonary fibrosis.

Spirometric Test	Patients with Alterations	Relative Frequency (%)
DLCO Reduction	72	25.4
Decrease in TLC	63	22.1

These findings are consistent with previous studies that have shown that post-COVID-19 patients have persistent alterations in lung function, even months after recovery (Peña, 2021).

6. Respiratory function test results

Respiratory function tests were performed on patients who presented with persistent respiratory symptoms. Spirometric testing revealed a **decrease in total lung capacity (TLC)** in 22.1% of patients. These results indicate significant pulmonary restriction, which is indicative of pulmonary fibrosis or structural damage caused by persistent inflammation during the acute phase of the disease (Goudouris, 2021).

In addition, 25.4% of patients had a **decrease in the diffusing capacity of carbon monoxide (DLCO),** suggesting that damage to the alveolar membranes and pulmonary vasculature affected the ability of the lungs to transfer oxygen to the bloodstream. This alteration was most commonly observed in patients with a history of hypertension and in those who received mechanical ventilation for more than 10 days.

7. Impact of mechanical ventilation on the development of sequelae

The duration and type of respiratory support used during ICU hospitalization were decisive factors in the development of respiratory sequelae. Of the 285 patients, 48.1% required **invasive mechanical ventilation**, while 35.4% used non-invasive ventilation. Patients who were intubated for more than 10 days had a higher prevalence of pulmonary fibrosis and dyspnea, which is consistent with studies demonstrating structural damage caused by prolonged mechanical ventilation, such as atrophy of respiratory muscle tissue and increased risk of secondary lung infections (Spinato et al., 2020).

Type of Breathing Support	Patients with pulmonary fibrosis (%)	Patients with persistent dyspnea (%)
Invasive mechanical ventilation	64.5	58.7
Non-invasive ventilation	35.5	41.3

8. Comparison of sequelae by age group

The analysis by age group revealed a clear trend: patients over 60 years of age had a higher prevalence of severe respiratory sequelae, such as pulmonary fibrosis and dyspnea, compared to younger groups. This is due, in part, to the decreased regenerative capacity of lung tissue in older patients and the increased risk of complications during the acute phase of COVID-19 in this age group (Goudouris, 2021). However, younger patients also had respiratory sequelae, although to a lesser extent and with milder symptoms, such as persistent cough.

9. Comparative results with international studies

Comparing the results obtained with international research, it can be observed that the prevalence of respiratory sequelae in Neiva follows patterns similar to those reported in other countries, although with some variations due to local factors, such as accessibility to specialized medical care and the prevalence of comorbidities in the population. In studies conducted in Europe and the United States, pulmonary fibrosis has been reported in a range of 20% to 30% of patients hospitalized in ICUs for COVID-19, while persistent dyspnea has been reported in up to 50% of cases (Wang et al., 2020).

These results reaffirm the need to implement pulmonary rehabilitation programs and long-term follow-up for post-COVID-19 patients, with special attention to those with additional risk factors such as hypertension, diabetes, and obesity.

10. Conclusions of the results

The detailed analysis of the results confirms that a significant proportion of post-COVID-19 patients who were hospitalized in ICU develop long-term respiratory sequelae, with dyspnea and pulmonary fibrosis as the main health problems. These findings underscore the urgent need to develop rehabilitation and follow-up strategies in local health systems, to improve the quality of life of affected patients and reduce the burden on healthcare systems.

CONCLUSIONS

The present study on the long-term respiratory sequelae in patients who were hospitalized in the Intensive Care Unit (ICU) due to COVID-19 infection in Neiva, Colombia, yields significant conclusions that allow us to

understand the impact of this disease on the quality of life of survivors. The main conclusions of the study are expanded below.

1. High prevalence of respiratory sequelae

The study has confirmed that a considerable percentage of patients hospitalized in ICU for COVID-19 in Neiva developed long-term respiratory sequelae, with persistent dyspnea being the most prevalent sequelae, affecting 45.6% of patients. This shows that, even after overcoming the acute phase of infection, the effects of COVID-19 continue to significantly affect patients' respiratory capacity, limiting their daily activities and decreasing their quality of life.

Pulmonary **fibrosis**, detected in 24.9% of patients, is of particular concern due to its irreversible nature and negative impact on lung function. These results are in line with the current scientific literature, which also highlights pulmonary fibrosis as one of the most serious sequelae in patients recovered from COVID-19 (Goudouris, 2021). This high prevalence of sequelae highlights the need to implement pulmonary rehabilitation programs that help mitigate the long-term effects on affected patients.

2. Relationship between comorbidities and sequelae

Analysis of comorbidities revealed that patients with **hypertension, diabetes and obesity** had a significantly higher risk of developing respiratory sequelae, particularly pulmonary fibrosis and persistent dyspnea. These findings are consistent with previous studies suggesting that comorbidities not only aggravate the acute phase of the disease, but also increase the risk of long-term complications (Cruz-Durán & Fernández-Garza, 2021).

The identification of these comorbidities as risk factors underscores the importance of more thorough follow-up of patients with these conditions, even after initial recovery. Health systems must be prepared to manage the needs of these patients and provide them with access to specific rehabilitation services.

3. Length of stay in the ICU and ventilatory support

The study found that **prolonged duration in the ICU**, especially in those patients who required mechanical ventilation for more than 10 days, is directly related to a higher prevalence of severe respiratory sequelae, such as pulmonary fibrosis. This is largely due to the adverse effects of prolonged mechanical ventilation, which can damage lung tissue and cause atrophy of respiratory muscles (Spinato et al., 2020).

In addition, it was observed that patients who received invasive mechanical ventilation had a higher risk of developing pulmonary fibrosis and persistent dyspnea, compared to those who used non-invasive ventilation. These findings suggest the need to develop strategies that minimize invasive ventilation time and optimize ICU management protocols, with the aim of reducing the risk of long-term respiratory complications.

4. Impact of COVID-19 on long-term quality of life

COVID-19 not only affects patients acutely, but also has a significant impact on their long-term quality of life, particularly in those who develop respiratory sequelae. Persistent dyspnea and pulmonary fibrosis, identified as the most prevalent sequelae, limit patients' ability to perform physical activities and compromise their general well-being. This finding is consistent with studies highlighting how post-COVID syndrome affects the daily functioning of patients, many of whom fail to fully recover their pre-disease physical abilities (Wang et al., 2020).

Therefore, health systems must be prepared not only to attend to the acute phase of COVID-19, but also to offer comprehensive follow-up to recovered patients, with a multidisciplinary approach that includes respiratory physiotherapy, psychological support and continuous clinical monitoring.

5. Importance of Pulmonary Rehabilitation Programs

The results of the study underscore the urgent need to establish **pulmonary rehabilitation**programs in Neiva, and in general in Colombia, for patients who have survived COVID-19 and have respiratory sequelae. Rehabilitation programs can not only improve patients' functional capacity, but they can also help prevent the progression of chronic diseases such as pulmonary fibrosis (Peña, 2021).

It is recommended that these programmes include breathing exercises, psychological support and regular medical follow-up to monitor the progression of sequelae and adjust treatments when necessary. It is also crucial that social support is provided to affected patients, since respiratory sequelae have an impact not only physically, but also emotionally.

6. Need for long-term follow-up

Finally, the study emphasizes the **importance of long-term follow-up** for post-COVID-19 patients, particularly those who were hospitalized in ICU and who have comorbidities. The development of persistent respiratory sequelae requires a comprehensive and continuous approach that allows for early intervention in the course of

sequelae and improved long-term patient outcomes. Health systems must adapt their protocols to ensure that patients recovered from COVID-19 have access to the care services necessary to manage their aftermath.

7. Final conclusion

In conclusion, this study has made it possible to identify the most frequent respiratory sequelae in patients who were in ICU due to COVID-19 in Neiva, as well as the risk factors associated with their appearance. The high rates of persistent dyspnea and pulmonary fibrosis observed suggest the need for early interventions and comprehensive rehabilitation programs to improve patients' quality of life. In addition, it is essential that local health systems develop specific protocols for the management of post-COVID sequelae, especially in patients with comorbidities.

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