The Prevalence of COVID-19 Infection in Patients Presented with Acute Exacerbation of Asthma, COPD and Idiopathic Pulmonary Fibrosis at the Emergency Department of Al-Shaab Teaching Hospital from July 2021 to November 2021

Abstract

Background: The ongoing global pandemic of COVID-19 has raised concerns about its impact on patients with pre-existing respiratory conditions. Understanding the association between COVID-19 and chronic lung diseases such as asthma, chronic obstructive pulmonary disease (COPD) and idiopathic pulmonary fibrosis (IPF) is crucial for early detection and appropriate management. Studying the prevalence rates of COVID-19 in this specific patient population will contribute to the existing knowledge and inform healthcare strategies for better patient care. The objective of this study is to assess the prevalence of COVID-19 infection in patients who presented with acute exacerbation of asthma, COPD and IPF.

Method: This cross-sectional descriptive hospital-based study was conducted at Al-Shaab Teaching Hospital in Sudan and included adult Sudanese patients with exacerbation of asthma, COPD, or IPF who presented in the ER from February 2021 to July 2021. A representative sample of 345 patients was selected using a convenience, non-randomized sampling technique. Data were collected using a structured questionnaire and analyzed using SPSS version 26. Ethical clearance and approval were obtained for the study.

Results: The study included 175 (50.7%) patients with asthma, 116 (33.6%) with IPF and 54 (15.7%) with COPD. The overall prevalence of COVID-19 among the patients was 58 (16.8%). Among the three groups, the highest prevalence of COVID-19 was observed in 22 (40.7%) patients with COPD, followed by 16 (13.8%) patients with IPF and 20 (11.4%) asthmatic patients (p value < 0.05). In the

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asthmatic patients, the most common age groups affected were 25-34 years and 35-44 years, while in COPD and IPF patients, the prevalence was higher among patients aged 55 years and above

(p value < 0.05). Additionally, the prevalence of COVID-19 in COPD and IPF patients was significantly higher among males than females (p value < 0.05).

Conclusion: The prevalence of COVID-19 among patients with pre-existing respiratory conditions, such as asthma, COPD and IPF, is considerable, with the highest prevalence observed in patients with COPD. Furthermore, this study found that age and gender are associated factors with the prevalence of COVID-19 in these patient populations. These findings contribute to our understanding of the association between COVID-19 and chronic lung diseases, providing valuable information for early detection and appropriate management. The results of this study can inform healthcare strategies and contribute to better patient care in this specific patient population.

Introduction

The COVID-19 pandemic is a worldwide outbreak of a viral disease called coronavirus. The virus, known as SARS-CoV-2, was first discovered in China in December 2019 and quickly spread to other countries [1]. The World Health Organization (WHO) declared it a global public health emergency on January 30, 2020 and categorized it as a pandemic on March 11, 2020 [2, 3]. Asthma is a chronic inflammatory disease that affects the airways of the lungs. It is characterized by recurring symptoms, reversible airflow obstruction and easily triggered bronchospasms. Symptoms include wheezing, coughing, chest tightness and shortness of breath. Asthma is believed to be caused by a combination of genetic and environmental factors [4]. An acute asthma exacerbation, also known as an asthma attack, is when the symptoms of asthma worsen suddenly. Common symptoms include shortness of breath, wheezing and chest tightness. During an asthma attack, accessory muscles of respiration may be used, a pulse may become weaker during inhalation and stronger during exhalation and the skin and nails may turn blue due to a lack of oxygen [5, 6].

COVID-19 primarily binds to angiotensin converting enzyme 2 (ACE2) receptors in host cells, which are abundant in the lungs, heart, blood vessels and intestine. Despite extensive research, there are currently no specific treatments or effective vaccines for the coronavirus [7]. COVID-19 can cause a range of respiratory symptoms, from mild to severe. Some patients develop a condition called acute respiratory distress syndrome (ARDS), which is associated with a cytokine storm and can be fatal. Recent studies have suggested that controlled allergic asthma does not increase the risk of severe disease during the COVID-19 pandemic [1,7]. Chronic obstructive pulmonary disease (COPD) is a progressive lung disease that is both preventable and treatable. It is characterized by long-term respiratory symptoms and airflow limitation. The main symptoms include shortness of breath and coughing. COPD worsens with everyday activities and can make simple tasks like walking or dressing difficult.

There are two common conditions of COPD: emphysema and chronic bronchitis [8]. Emphysema causes the airspaces in the lungs to enlarge and the lung tissue to sustain permanent damage. An acute exacerbation of COPD is a sudden worsening of symptoms, including increased breathlessness, excessive mucus and increased cough and wheezing. Patients with chronic respiratory diseases, especially COPD, have a higher risk of COVID-19 infection due to their compromised lung function and increased expression of ACE2 receptors. However, more comprehensive analyses are needed to determine the specific risks and disease severity in COVID-19 patients with COPD [9].

Idiopathic pulmonary fibrosis (IPF) is a rare and progressive respiratory illness characterized by the thickening and stiffening of lung tissue, leading to the formation of scar tissue. It is a chronic scarring lung disease that results in a progressive and irreversible decline in lung function. Symptoms include gradual onset of shortness of breath and a dry cough [10]. Acute exacerbations of IPF (AE-IPF) are defined as unexplained worsening or development of shortness of breath within 30 days, accompanied by new radiological abnormalities. The interaction mechanism between COVID-19 and pulmonary fibrosis involves the virus's spike protein (S protein) binding to the host cell's ACE2 receptor during the infection process [11].

Many studies have been conducted to investigate various aspects of this disease exacerbation and its relationship

to COVID-19. De Boer conducted a study to investigate the prevalence of asthma exacerbation and fear of COVID-19 in patients with moderate-severe asthma and controls in the Netherlands. The study was based on data from a recently completed controlled trial. They found that the mean frequency of exacerbations per patient in the second quarter of 2020 was significantly lower than in previous years ($\chi^2(3)$=9.91, p=0.019). They also found that patients with asthma were more likely to engage in avoidance behavior (38.8% vs. controls, 0.0%, p<0.001) [12]. According to Prieto-Alhambra, COVID-19 had affected more than 6 million people in the Netherlands as of June 2020, including 121,263 confirmed cases (both hospitalized and outpatients) [13]. The most common comorbidities among COVID-19 patients were hypertension (24.3%) and obesity (19.9%). Asthma and COPD were present in 6.8% and 3.2% of the patients, respectively. Inhaler treatment was used by 10.7% of all patients [13]. Moreover, a study by Regina from Switzerland reported an asthma prevalence rate of 4.0% among 200 hospitalized COVID-19 patients [14].

Among those requiring mechanical ventilation, the asthma prevalence rate was 2.7% [14]. Two studies from the United States described the characteristics and outcomes of ICU-admitted COVID-19 patients. [15] Reported a mortality rate of 50% among 24 patients, with common comorbidities including diabetes (58%), current or former tobacco smoking (22%), chronic kidney disease (21%) and asthma (14%). Three cases of mild asthma had been treated with systemic corticosteroids in the week preceding ICU admission for a presumed asthma exacerbation [15]. Arentz described 21 patients with a mean age of 70 years (range 43-92 years), with common comorbidities including chronic kidney disease (47.6%), congestive heart failure (42.9%), diabetes (33.3%) and COPD (33.3%). Two patients (9.5%) had asthma [16].

Another study from the USA, by [17] involving 345 children (<18 years) with COVID-19 found that 23% of them had at least one comorbidity. The most common comorbid condition was chronic respiratory diseases, such as asthma, but the exact prevalence was not reported. Comorbidities were more prevalent in children who needed hospitalization than in those who did not (77 vs. 12%), but asthma was not identified as a significant risk factor [17]. An analysis of COVID-19 patients hospitalized in 14 states of the USA done by Garg in March 2020 [18] (n = 1,482) showed that hospitalization was more common in older adults (74.5% aged ≥50 years). Among the patients with available data on underlying conditions (n = 120), 89% had one or more comorbidities. The most frequent were hypertension and other cardiovascular diseases (77.5%), followed by obesity (48.3%) and diabetes mellitus (28.3%). Asthma was present in 17% of the patients and COPD in 10.7%. According to the CDC report, obesity was the most frequent underlying condition in hospitalized patients aged 18–49 years (59.0%), followed by asthma (27.3%) [18].

In this context, this study is crucial for several reasons. Firstly, it aims to understand the impact of the ongoing pandemic on individuals with pre-existing respiratory conditions, which have been identified as risk factors for severe COVID-19 outcomes. When examining the prevalence of COVID-19 infection in this specific patient population, the research can help in determining the need for tailored preventive strategies and interventions. Additionally, understanding the prevalence of COVID-19 in patients presenting with acute exacerbation of asthma, COPD and idiopathic pulmonary fibrosis can aid in identifying potential patterns or trends in disease severity and outcomes, ultimately improving patient management and informing healthcare providers about the risks associated with these respiratory conditions during the pandemic. Overall, this research is essential for improving the care and outcomes of individuals with these respiratory conditions amidst the ongoing COVID-19 crisis. This study aimed to measure the prevalence of covid-19 infection in patients presenting with acute exacerbation of asthma, COPD and idiopathic pulmonary fibrosis at the emergency department of Al-Shaab Teaching Hospital from July 2021 to November 2021.

Methods

This cross-sectional descriptive hospital-based study was conducted at Al-Shaab Teaching Hospital, the cardio-respiratory center in Khartoum State, Sudan. The hospital receives all referred respiratory cases from other Sudan states and has a busy emergency department (ER) with around 200 patients per day. It also has four respiratory general wards, a respiratory intensive care unit and daily respiratory referral clinics. The study included all adult

Sudanese patients who presented with exacerbation of asthma, chronic obstructive pulmonary disease (COPD), or idiopathic pulmonary fibrosis (IPF) in the ER of Al-Shaab Teaching Hospital from February 2021 to July 2021. The study excluded patients who refused to participate, were younger than 18 years, or were severely ill. Written informed consent was obtained from all participants and the research purpose and objectives were explained to them. The participants' privacy, confidentiality and right to withdraw at any time without any deprivation or harm were insured.

A convenience, non-randomized sampling technique was used to select a representative sample of 345 patients, including 175 asthmatics, 116 IPF and 54 COPD patients. The sample size was calculated using the relevant sample size formula assuming that the population of ER patients at Al-Shaab Teaching Hospital is 12,110 within a period of three months. Data were collected using a structured self-administered questionnaire after taking written consent and polymerase chain reaction (PCR) tests for COVID-19 with protective measures. The questionnaire included variables such as age, gender, clinical presentation and PCR test results. Data were entered into the Statistical Package of Social Sciences (SPSS) version 26.0 and frequency and chi-square tests were performed when appropriate. A p-value of less than 0.05 was considered as significant. Ethical clearance was obtained from the committee of the Sudan Medical Specialization Board (SMSB) and approval was obtained from the University of Khartoum, the Khartoum State Ministry of Health, the Research Department and the hospital administration. The remaining samples were not used for any other study and the questionnaire was filled without interrupting the work. The PCR results were received immediately.

Results

Out of 345 participants, the study sample comprised of 115 patients (33.3%) aged 65 years and above, followed by 78 patients (22.6%) aged 55-64 years. The majority of patients were male (58.3%), while 41.7% were female. The educational level varied, with 127 patients (36.8%) being illiterate, 87 (25.2%) having a secondary school education, 80 (23.2%) having a primary school education and 51 (14.8%) having a university education. Freelancers accounted for the majority of patients (76.2%), followed by unemployed individuals (10.7%). Regarding smoking habits, smokers represented 24.9% of the population, with 61.6% consuming one pack per year. Cigarettes were the most common form of tobacco used (89.5%), followed by shisha (9.3%) and marijuana (1.2%). The average number of exacerbations per year was three (50.1%), followed by more than three (36.7%) and two (13.2%).

Among the patients, 57.1% did not have any other chronic diseases. The reported comorbidities included diabetes (19.4%), hypertension (16.8%), ischemic heart disease (5.8%) and hypothyroidism (0.9%).

Inhalers were the most commonly used treatment modality (65.5%), followed by injections (9.3%) and tablets (4.3%). Notably, 20.9% of patients were not on steroids. The majority of patients (74.5%) did not follow any protective measures, while 23.2% wore masks, 1.4% washed their hands and 0.9% practiced social distancing. Common clinical presentations included cough and shortness of breath (47.2%), cough, shortness of breath, chest pain (40.9%), shortness of breath alone (5.5%) and others. Oxygen saturation levels were 92-85% in 38.6% of patients, more than 92% in 33% and less than 85% in 28.4%. Most patients (95.9%) had no history of contact with COVID-19 patients. Among the patients, 88.7% had no organ failure other than lung, while other organ failures included the heart (7.2%), kidney (7.2%), liver (0.6%), heart and kidney (0.6%), heart and liver (0.3%) and liver and kidney (0.3%).

The patients' diagnoses included asthma (50.7%), lung fibrosis (33.6%) and COPD (15.7%). The disease duration was 0-5 years for 38.3% of patients, more than 10 years for 33.3% and 6-10 years for 28.4%. The majority of patients had a body mass index of 18.5-24.9 (65.8%). Regular follow-up was reported by 58.9% of patients. Lymphocyte count ranged from 20-30 in 58.3% of patients, less than 20 in 35.9%, 30-50 in 4.6% and more than 50 in 1.2%. The BFFM test was negative in 71.3% of patients and positive in 28.7%. Education regarding inhaler use was received by 75.1% of patients. Previous ICU admission was reported by 23.8% of patients. Peripheral shadow was observed in 96.8% of patients' chest x-rays, indicating pleural effusion in 3.2%. Most patients (92.4%) did not experience a loss of smell or taste, while 7.5% reported diarrhea. Only 9.3%

of patients were willing to take the COVID-19 vaccine if available. A history of low oxygen saturation was reported by 84.9% of patients.

The prevalence of COVID-19 among the patients was 16.8%. Among the three groups, the highest prevalence was found in patients with COPD (40.7%), followed by IPF (13.8%) and asthma (11.4%). The prevalence of COVID-19 was higher in males and smokers among COPD and IPF patients. COVID-19 prevalence was also positively correlated with the number of exacerbations per year. No significant association was found between COVID-19 prevalence and comorbidities, disease duration, or other organ failures.

Discussion

The objective of this study was to evaluate the prevalence of COVID-19 infection in patients presenting with acute exacerbation of asthma, COPD and IPF. A total of 175 patients with asthma, 116 with IPF and 54 with COPD were included in the study, resulting in an overall prevalence of COVID-19 of 16.8% among the patients. The highest prevalence was observed in patients with COPD (40.7%), followed by IPF (13.8%) and asthma (11.4%). Additionally, the prevalence of COVID-19 was significantly higher among males than females in the COPD and IPF patient groups. In comparison, existing literature provides additional insights into the prevalence of COVID-19 among patients with respiratory conditions. De Boer conducted a study in the Netherlands, which assessed the prevalence of asthma exacerbation and fear of COVID-19 in patients with moderate-severe asthma [12]. They found a significantly lower frequency of asthma exacerbations per patient in the second quarter of 2020 compared to previous years. However, this study did not directly report the prevalence of COVID-19 among asthma patients.

Another study from Switzerland reported an asthma prevalence rate of 4.0% among 200 hospitalized COVID-19 patients, with a lower prevalence rate of 2.7% among those requiring mechanical ventilation (14). These prevalence rates contrast with the findings of our study, where the prevalence of COVID-19 among asthma patients was 11.4%. It is important to note that these studies focused on different populations and settings, which may explain the discrepancy in results [15,16] conducted studies in the United States that described the characteristics and outcomes of ICU-admitted COVID-19 patients. Bhatraju reported a mortality rate of 50% among ICU patients, with asthma present in 14% of cases [15]. Arentz described 21 COVID-19 patients with comorbidities, including asthma in 9.5% of cases [16]. These findings align with our study, which found a higher prevalence of COVID-19 in patients with pre-existing respiratory conditions.

Another study involving 345 children with COVID-19 in the USA identified chronic respiratory diseases, such as asthma, as common comorbid conditions [17]. Furthermore, an analysis of COVID-19 patients hospitalized in 14 states of the USA showed that asthma was present in 17% of the patients [18]. These findings support the prevalence rate of 11.4% among our asthmatic patients. Overall, both the literature and our study support the association between COVID-19 and chronic lung diseases, including asthma, COPD and IPF. However, discrepancies in the reported prevalence rates may be attributed to differences in study populations, settings and methodologies. The comparison of our study's findings with the corresponding literature highlights the importance of considering various factors, such as geography, population characteristics and study design when interpreting and generalizing the results.

These discrepancies underscore the need for further research to better comprehend the prevalence and impact of COVID-19 among patients with pre-existing respiratory conditions. The findings from both our study and the existing literature contribute to the growing knowledge about the association between COVID-19 and chronic lung diseases, which can inform healthcare strategies and enhance patient care in this specific population.

In conclusion, this study aimed to assess the prevalence of COVID-19 infection in patients presenting with acute exacerbation of asthma, COPD and IPF. The results revealed an overall prevalence of COVID-19 among the patients, with the highest prevalence observed in patients with COPD followed by IPF and asthma. The findings highlight the importance of understanding the association between COVID-19 and chronic lung diseases, as it provides valuable insights into the impact of the ongoing global pandemic on patients with pre-existing respiratory conditions. Early detection and appropriate management

of COVID-19 in these patient populations are crucial for optimizing patient care and health outcomes. The study also identified certain demographic patterns about the prevalence of COVID-19. The age groups most affected varied among the different respiratory conditions, with younger age groups being more affected in asthmatic patients, while older age groups showed higher prevalence in COPD and IPF patients.

Moreover, the prevalence of COVID-19 was found to be significantly higher among males than females in COPD and IPF patients. Based on these findings, several recommendations can be made. First, there is a need for increased awareness and education among patients with chronic lung diseases about the potential risks and preventive measures related to COVID-19. Healthcare professionals should provide specific guidance on infection prevention strategies, such as hand hygiene, wearing masks and social distancing. Second, healthcare systems should prioritize COVID-19 testing and vaccination for patients with pre-existing respiratory conditions, especially those with COPD and IPF and in older age groups. Targeted efforts should be made to ensure equitable access to testing and vaccination services.

Furthermore, future research should delve deeper into the underlying mechanisms that contribute to the increased susceptibility of patients with COPD and IPF to COVID-19 infection. Understanding these mechanisms can aid in the development of tailored treatment approaches and preventive strategies for this vulnerable patient population.

Limitations

One limitation of this study is the use of a convenience, non-randomized sampling technique to select the study sample. This may introduce selection bias, as patients with more severe exacerbations or greater healthcare-seeking behavior may be more likely to present at the ER and be included in the study, potentially over representing the prevalence of COVID-19 in this specific patient population. Furthermore, the study was conducted at a single hospital in Sudan, which may limit the generalizability of the findings to other settings or populations with different healthcare resources or demographics. Therefore, caution should be exercised when interpreting the results and further research using more rigorous sampling methods and diverse study populations is needed to validate these findings.

Author Contributions

The principal author was responsible for all aspects related to sample collection. The second author provided supervision and reviewed the proposal. The third author, a specialist in diseased tissues at the Stack laboratory, facilitated the examination of all samples in the research by liaising with the Ministry of Health and providing general supervision and advice. All other research activities were carried out by the principal author. The fourth author assisted the principal author in sample collection. The Stack laboratory team, especially the fifth author, cooperated in investigating the samples, making the process easier.

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Informed Consent Statement

Informed consent was obtained from all participants involved in the study, from all relevant curative, academic and form relevant authorities.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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