ORIGINAL ARTICLE

The effect of COVID-19 on asthma control: a cross-sectional study

B. Ibrahim[1], A. Essam[2], A. Tawfik[3], G. Obaid[4], R. Alshamrani[4], S. Bagdood[4], R. Alhadrami[4], K. Abdulrahman[4]

[1]Physiological Sciences Department, MBBS Program, Fakeeh College for Medical Sciences, Jeddah, 21461, Saudi Arabia, [2]Department of internal medicine, Doctor Soliman Fakeeh Hospital, Jeddah, Saudi Arabia, [3]Clinical Sciences Department, MBBS Program, Fakeeh College for Medical Sciences, Jeddah, 21461, Saudi Arabia, [4]MBBS Program, Fakeeh College for Medical Sciences, Jeddah, 21461, Saudi Arabia

ABSTRACT

Introduction: The COVID-19 pandemic has significantly affected healthcare systems worldwide and the way patients with chronic conditions, such as bronchial asthma, are managed.

Aim of study: This study sought to investigate the impact of the pandemic on the management of asthma by examining alterations in hospital admission rates, daily activities, the frequency of asthma symptoms, and the utilization of medication among patients.

Material-Method: The study employed a cross-sectional design to gather data from 200 participants, with a majority of them being females (86.4%). The data were collected through self-reported measures.

Results: The results of our study demonstrate a notable decrease in hospital admissions for asthma, declining from 11.6% prior to the pandemic to 6% afterwards. This suggests a potential change in patient conduct or healthcare accessibility during the pandemic. In addition, the study found a significant rise in disruptions to daily activities and a greater occurrence of asthma symptoms unrelated to breathing, even though medication usage remained consistent.

Conclusions: These findings emphasize the intricate difficulties experienced by individuals with asthma during the pandemic, such as heightened psychological distress and alterations in healthcare utilization patterns. Our research enhances the comprehension of the impact that pandemics can have on the management of chronic diseases and emphasizes the necessity for flexible healthcare strategies to assist patients during such periods. Subsequent investigations should prioritize conducting longitudinal studies to analyze the enduring impacts of the COVID-19 pandemic on the management and regulation of asthma.

Keywords: COVID-19, Asthma, Control, Inhalers, Nebulizer

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INTRODUCTION

The acute respiratory syndrome coronavirus 2 (SARS-CoV-2 virus) is the cause of the pandemic respiratory infectious disease known as coronavirus disease 2019 (COVID19). Risk factors for severe COVID-19

include old age, ethnicity, sex and associated co-morbidities [1]. While individuals with allergies and asthma are more likely to experience severe effects from viral infections, the relationship between asthma and COVID-19 is still under investigation [2].

The analyzed publications, reports, and expert opinions about asthma and COVID-19, that were released since the onset of the disease in Wuhan denote that the combination between COVID-19 and asthma represents a great challenge for doctors and authorities [3] and the high infection rate of COVID-19 in asthmatic patients has highlighted the priority of adequate asthma control during the pandemic [4].

Asthma has been identified as a possible risk factor for severe COVID-19, similar to many viral disorders that damage the lungs. This connection may be explained by an aberrant immunological reaction that develops in conjunction with an allergic reaction and an impaired respiratory function [5].

During the COVID-19 lockdown, the asthmatic patients suffered from accelerated attacks due to excessive use of asthma triggers in closed places, including detergents and sterilizers, in addition to psychological stress. The pandemic's abrupt and drastic changes to the environment, medical procedures, and drug use have changed the asthma management landscape and have an impact on asthma outcomes [6].

The current advice for treating asthma is to continue using biological treatments during the COVID-19 pandemic, either relying on biological treatment or stopping it in case of infection with the Coronavirus depends on the patient's health condition [7]

Several studies have reported that patients with moderate to severe asthma belong to a high-risk group that is susceptible to severe COVID-19, however, the potential risk of respiratory failure and mortality in COVID-19 patients with pre-existing asthma is still unclear [8].

Electronic health records were reviewed for sequential hospitalized patients 65 years or younger without chronic obstructive pulmonary disease with a confirmed positive severe acute respiratory COVID-19. The overall prevalence of asthma among all hospitalized patients with COVID-19 was 12.6%, yet a higher prevalence (23.6%) was observed in 55 patients younger than 21 years [9].

The studies comparing the clinical outcomes of asthmatic patients with those of non-asthmatic patients diagnosed with COVID-19 indicated a correlation between asthma and COVID-19.

It is necessary to elucidate the bidirectional connection between asthma and COVID-19. The supporting clinical evidence has raised major concerns about the relationship between the risk and protective factors for the severity of COVID-19 with asthma. The worldwide increase of asthma prevalence has potentially helped in the defense mechanism against COVID-19 by triggering T helper type 2 immune sensitivity reaction, was seen in asthmatic patients receiving their therapeutic regimen including corticosteroids and biological agents by reducing the inflammation. Conversely, long-term respiratory conditions including asthma are thought to be risk factors for COVID-19 infection [10].

There are disparities in the statistics on the prevalence of asthma among the hospitalized COVID-19 patients [11]. This disparity may be explained by the influence of the COVID-19 outbreak in that region as well as the incidence of asthma in the local community. For example, asthma was not found to be a risk factor for the severity and mortality of COVID-19 illness based on the epidemiological features of the COVID-19 outbreak in China [12]. In the Chinese community, asthma was either underreported or completely missing among COVID-19 patients (25). This sparked concern that a Th2 immune response in asthma patients could lessen their vulnerability to COVID-19. Additionally, there were no reports of increased asthma exacerbations in France or Italy due to COVID-19 [13].

A similar finding was reported in Russia, where 1.8% of patients in the intensive care unit (ICU) on mechanical ventilation for SARS-CoVID pneumonia had bronchial asthma, albeit mostly in females [14]. According to a quick analysis of the data conducted in Australia, those who have asthma had lower chance of acquiring COVID-19. Nonetheless, being admitted to the hospital increased their likelihood of mechanical ventilation and ICU admission. [15].

A cohort study in the UK biobank community showed that asthma was a common link of comorbidity between COVID-19 hospitalized patients. The study comprised individuals whose severe acute respiratory syndrome coronavirus 2 RNA-PCR tests were performed using linked medical claims data from the Health Insurance Review and Assessment Service. These tests validated the patients' COVID-19 status. Two percent of the COVID-19 patients had underlying asthma [16].

While other studies from Germany and the United States have reported increased asthma prevalence among patients post COVID-19 infection, based on the recent studies the CDC revealed that patients with moderate to severe asthma at increased risk from severe COVID-19 outcomes [17]. Generally, asthma diagnosis showed no contribution in worsening the COVID-19 outcomes, this was conducted by a study done in the United States on 1,526 hospitalized and non-hospitalized patients who were diagnosed with COVID-19 with asthma prevalence (14%). The incidence of hospitalization attributable to COVID-19 was not linked to the use of corticosteroids or underlying asthma. Even though a study in the United Kingdom showed that asthma (14.5%) was the fifth common major comorbidity, done on 20,133 hospitalized In-patients with COVID-19, showed that asthma had no association with the increasing mortality rate [18, 19]. Additionally, an Irish study found that of 193 patients hospitalized with COVID-19, 8.8% of them had asthma [20].

While a number of systemic reviews and meta-Analysis studies have assessed the prevalence and mortality risk of preexisting co-morbidities on patients with COVID-19 named asthma as one of the preexisting co-morbidities among those patients, yet asthma was not shown to be a significant contributor to the mortality risk in COVID-19 patients with respiratory disorders in this category of patients [21].

Due to the previously noted irregularities in the frequency of asthma in COVID-19 patients and the minimal coverage

on how the COVID-19 pandemic impacted the management of asthma, the current study has been designed to evaluate the prevalence of asthma among COVID-19 patients in KSA, assess the influence of COVID-19 on asthma control and to make recommendations about the approach of patients with asthma during the pandemic.

MATERIAL AND METHODS

Design of the study, estimating sample size, and sampling technique

Using the Epi-Info software calculator from the Centers for Disease Control (CDC), a cross-sectional study design was carried out on a sample of 200 Saudi adult participants as a convenient sample through an online survey. The sample size was determined at a 95% confidence level and an alpha error of 5%. Data were obtained from patients attending the pulmonary clinic of Doctor Soliman Fakeeh Hospital (DSFH) for follow up of their asthma symptoms after the COVID-19 pandemic through scoring the validated "Asthma Control Test ™". Additional data were obtained via distributing a digital Google self-administrated online questionnaire between June 2022 and September 2023 via Facebook and WhatsApp. Completing the questionnaire took an estimated time of 13 to 15 minutes. A brief explanation of the study's purpose, volunteer participation, a statement of confidentiality, data anonymity, and informed consent to participate in the study were all included in the first section. The participants were free to decline participation or to leave at any time, with no repercussions. Cross-verification of information was made possible by this multi-source method, which guaranteed comprehensive data collection.

The inclusion criteria comprised mentally competent Saudi Arabian citizens more than 12 years old, literate (able to read and write in Arabic or English), and willing to participate in the study.
The inclusion criteria included individuals less than 12 years old and respondents whose language barrier prevented them from communicating with Arabic or English speakers.

The validated questionnaire included the socio-demographic data of the studied population including age and sex, the presence of chronic illness (hypertension, diabetes or both), the effect of COVID-19 on hospital admission, the drugs used for asthma control, the frequency of using rescue inhaler or nebulizer medication, the effect of COVID-19 on daily life activities *(at works, school or home),* the frequency of shortness of breath, wheezing, coughing, chest tightness, chest pain, etc.) and the efficiency of asthma control before and after COVID-19.

Data management

Microsoft Excel was used to code, insert, and edit the data. The Statistical Package for the Social Sciences (SPSS) software (version 20) (IBM Corp., Armonk, NY) was used to analyze the data. Descriptive statistics were used to describe the data in frequencies and percentages (%).

Ethical consideration

Prior to commencing with the questionnaire responses, every participant was required to provide informed consent, signifying their authorization to take part in the research. The participants were informed in an introduction portion of the questionnaire about the aim of the study, the voluntary nature of their involvement, and the confidentiality of the data obtained, which would only be used in this study. In addition, the data were coded, and all responses were gathered in an anonymous manner. Ethical approval was obtained from the institutional review board of Doctor Soliman Fakeeh Hospital (33\IRB\2022).

A total of 200 participants were studied, with a mean age ±SD of 28±13 years; 86.4% of them were females; and most of them reported that they have no chronic illness (88.4%) **(Table 1).** Admission was statistically significant at a lower rate due to bronchial asthma after the COVID-19 pandemic (P-value <0.05) **(Table 2).** Interruption of daily life activity all, most, and some of the time after the COVID-19 pandemic was more statistically significant (P-value is <0.05) **(Table 3).** The frequency of other asthma symptoms rather than shortness of breath, as three and four a week, was more statistically significant (P-value is <0.05) after the COVID-19 pandemic **(Table 4).**

RESULTS

Table 1. General characteristics of the studied participants (n=200)

General characteristics			
Age (years)	Mean ±SD	28±13	
		Frequency	**Percent**
Gender	Male	28	13.6
	Female	172	86.4
Chronic illness	None	177	88.4
	Hypertension	12	6
	Diabetes mellitus	6	3
	Hypertension and Diabetes mellitus	3	1.5
	Others	2	1

Table 2. Effect of COVID-19 on bronchial asthma admission and use of medications among the studied participants (n=200)

		COVID-19		*P-value*
		Before	**After**	
Admission	Yes	24(11.6)	12(6)	*0.038**
	No	176(88.4)	188(94)	
The drugs used for asthma	None	137(68.8)	140(70.4)	*0.894*
	Inhaler	26(13.1)	28(14.1)	
	Ventolin	26(13.1)	21(10.6)	
	Multiple	11(5)	11(5)	
Frequency of using rescue inhaler or nebulizer medication	not at all	116(58.3)	103(51.8)	*0.435*
	once a week or less	26(12.6)	23(11.1)	
	2-3 a week	20(10.1)	21(10.6)	
	1-2 per day	22(11.1)	34(17.1)	
	3 or more per day	16(8)	19(9.5)	

*Frequency (%), *P-value is statistically significant*

Table 3. Effect of COVID-19 on daily life activity and control among the studied participants (n=200)

		COVID-19		*P-value*
		Before	**After**	
Daily life activity ***(at work, school, home)***	None of the time	128(64.3)	106(53.3)	*0.048**
	A little of the time	32(16.1)	29(14.6)	
	Some of the time	22(11.1)	30(15.1)	
	Most of the time	15(7)	26(12.6)	
	All the time	3(1.5)	9(4.5)	
Control of asthma condition	Completely controlled	83(41.2)	71(35.2)	*0.2*
	Well controlled	48(24.1)	39(19.6)	
	somewhat controlled	35(17.6)	46(23.1)	
	Poorly controlled	11(5.5)	20(10.1)	
	Not controlled	23(11.6)	24(12.1)	

*Frequency (%), *P-value is statistically significant*

Table 4. Effect of COVID-19 on shortness of breathing and other asthma symptoms among the participants studied (n=200)

		COVID-19		*P-value*
		Before	**After**	
Frequency of shortness of breathing	Not at all	117(58.3)	97(48.2)	*0.71*
	Once or twice a week	37(18.6)	32(16.1)	
	3 to 6 times a week	15(7.5)	17(8.5)	
	Once a day	12(6)	21(10.6)	
	More than once a day	19(9.5)	33(16.6)	
Frequency of other symptoms	Not at all	113(56.3)	98(48.7)	*0.017**
	once a week	17(8.5)	17(8.5)	
	Twice a week	36(18.1)	24(12.1)	
	Three a week	19(9.5)	40(20.1)	
	Four a week	15(7.5)	21(10.6)	

*Frequency (%), *P-value is statistically significant*

DISCUSSION

This study aimed to elucidate the impact of the COVID-19 pandemic on the management of bronchial asthma by examining changes in hospital admission rates, daily activities, frequency of asthma symptoms, and utilization of medication among patients. The results demonstrate the complex impact of the pandemic on asthma treatment, highlighting the ability of patients and healthcare systems to adapt and overcome significant global health obstacles.

An important finding from the study is the substantial reduction in hospital admissions for asthma following the COVID-19 pandemic, declining from 11.6% to 6% (P-value < 0.05). This finding aligns with a prior study carried out in the United States, which discovered that compared to the corresponding months in 2019, asthma hospitalizations decreased by 62% by August 2020 and continued to stay below the rates of the previous year until the middle of 2021 [22]. On the contrary, a separate study conducted in the United States that investigated the impact of COVID-19 pandemic isolation measures on hospital admissions specifically related to pediatric asthma discovered a noteworthy reduction in the monthly number of asthma admissions during the most stringent isolation measures enforced between March 2020 and June 2020. The decline in asthma admissions, in comparison to the initial data, remained

consistent for around 12 months until the reduction of isolation measures. Subsequently, admissions reverted back to their original levels in spring 2021 [23]. These findings suggest that there can be significant variations in hospital admissions for asthma after COVID-19 among different populations and clinical situations. Several factors may contribute to this decline, such as decreased viral infections due to reduced social contact and changes in patient behavior, the effects of social distancing, and measures taken to avoid exposure, all of which may have resulted in fewer asthma exacerbations. It may also be multifactorial, encompassing factors such as enhanced asthma care and the administration of biologic treatments.

The COVID-19 pandemic has caused a significant change in the daily routines of people with asthma. The proportion of participants who experienced no disruption in their daily activities decreased significantly from 64.3% before the pandemic to 53.3% after the pandemic (P-value = 0.048*). This finding aligns with a prior study conducted in Egypt during the COVID-19 pandemic, which revealed that individuals suffering from asthma experienced constraints in their daily activities as a result of asthma symptoms, which had a negative impact on their overall quality of life. The study highlighted that the health-related quality of life (HRQOL) of asthma patients was primarily affected by limitations in physical activities [24]. Moreover, a study conducted in Canada revealed that individuals suffering from asthma encountered increased levels of anxiety during the pandemic. This was primarily due to apprehensions about the availability of healthcare and the possibility of misinterpreting symptoms, both of which could significantly affect their daily activities [25]. This discovery implies that the pandemic, along with its related social and economic pressures, has made the lives of asthma patients more complicated, possibly worsening stress-induced triggers and affecting overall asthma management. These disruptions emphasize the significance of comprehensive asthma management strategies that take into account not only the physical but also the psychosocial aspects of living with asthma.

Curiously, although the occurrence of shortness of breath did not undergo a significant alteration, other symptoms of asthma became more frequent during the pandemic. These symptoms encompass feelings of anxiety, depression, apprehension, and the deliberate avoidance of medical facilities out of concern for contracting the COVID-19 illness. For example, a study conducted in England discovered that individuals with asthma exhibited elevated levels of anxiety and depression and displayed heightened fear of contracting the COVID-19 disease in comparison to the control group amidst the COVID-19 pandemic [26]. In a similar vein, a study conducted in the United States found that individuals with asthma exhibited elevated levels of anxiety, perceived stress, and burnout symptoms in comparison to the control group [27].

Although there were noticeable alterations in hospital admissions and the frequency of symptoms, the utilization of asthma medications remained relatively constant after the COVID-19 pandemic. This discovery is consistent with an earlier study carried out in China, which found that the COVID-19 pandemic led to increased adherence to asthma medication as a result of

heightened awareness of asthma management [28]. In contrast, a study conducted in Japan revealed that the COVID-19 pandemic led to an increase in canceled appointments and a decrease in compliance with asthma treatment among patients [29].

Limitations

The study acknowledges various inherent limitations in its design and execution. The overwhelming majority of females in the sample (86.4%) may not accurately reflect the wider population of individuals with asthma, which could impact the relevance of the findings to all asthma sufferers. Due to its cross-sectional nature, the study is unable to establish causal relationships between the COVID-19 pandemic and the observed changes in asthma management and patient behaviors. Recall bias is a valid concern as it relies on participants' memories to report their behaviors and symptoms before the pandemic, which may result in inaccuracies. The study's exclusive geographical focus may not fully encompass the diverse experiences of asthma patients in different regions or under varying healthcare systems. Furthermore, certain results of the study did not reach statistical significance, possibly because the sample size was too small to detect smaller effects or because the effects themselves were subtle. Furthermore, the study fails to consider the dynamic stages of the pandemic, each of which may have distinct consequences for the management of asthma.

CONCLUSION

The study on the impact of the COVID-19 pandemic on the management of bronchial asthma has produced insightful results. Significantly, the pandemic has caused a substantial decrease in hospitalizations for asthma and has heightened disruptions to daily activities. Simultaneously, the occurrence of asthma symptoms unrelated to breathing has increased, even though there has been consistent use of medication. These results demonstrate the extensive impact of the pandemic's consequences, extending beyond the immediate health issues caused by the virus to encompass broader aspects of overall well-being.

Recommendations

Based on the results of this study, several suggestions can be put forward. It is imperative to strengthen the existing support systems for asthma patients in order to effectively address the physical and psychological challenges they face during the pandemic. For the continuous care and management of asthma during times of disrupted healthcare access, it is advised to expand telehealth services. Education programs focused on improving medication adherence and asthma control are essential, particularly given the observed decrease in hospital visits for asthma. Subsequent investigations should prioritize longitudinal studies to accurately assess the lasting consequences of the pandemic on asthma treatment. Additionally, it is crucial to take into account regional disparities in the influence of COVID-19 on healthcare systems and patient encounters.

REFERENCES

1. Zhang JJ, Dong X, Liu GH, et al. Risk and protective factors for COVID-19 morbidity, severity, and mortality. Clin Rev Allergy Immunol. 2023, 64:90-107.
2. Halpin DM, Faner R, Sibila O, et al. Do chronic respiratory diseases or their treatment affect the risk of SARS-CoV-2 infection?. Lancet Respir Med. 2020, 8:436-8.
3. Guan WJ, Liang WH, He JX, et al. Cardiovascular comorbidity and its impact on patients with COVID-19. Eur Respir J. 2020, 55.
4. Carli G, Cecchi L, Stebbing J, et al. Is asthma protective against COVID-19?. Allergy. 2021, 76:866-68.
5. Shaker MS, Oppenheimer J, Grayson M, et al. COVID-19: pandemic contingency planning for the allergy and immunology clinic. J Allergy Clin Immunol Pract. 2020, 8:1477-88.
6. Jia Y, Bao J, Yi M, et al. Impact of the COVID-19 pandemic on asthma control among children: a qualitative study from caregivers' perspectives and experiences. BMJ open. 2021, 11:e046525.
7. Sheha DS, Abdel-Rehim AS, Abdel-Latif OM, et al. Level of asthma control and mental health of asthma patients during lockdown for COVID-19: a cross-sectional survey. EJB. 2021, 15:1-0.
8. Van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. N Engl J Med. 2020, 382:1564-7.
9. Calver JF, Fabbri L, May J, et al. COVID-19 in patients with chronic lung disease. Clinics in Chest Medicine. 2023, 44:385-93.
10. Mohanty SK, Satapathy A, Naidu MM, et al. Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) and coronavirus disease 19 (COVID-19) - anatomic pathology perspective on current knowledge. Diagn Pathol. 2020, 15: 103.
11. Caminati M, Lombardi C, Micheletto C, et al. Asthmatic patients in COVID-19 outbreak: Few cases despite many cases. J Allergy Clin Immunol. 2020, 146: 541–542.
12. Li X, Xu S, Yu M, et al. Risk factors for severity and mortality in adult COVID-19 inpatients in Wuhan. J Allergy Clin Immunol. 2020, 146: 110–118.
13. Pignatti P, Visca D, Cherubino F, et al. Impact of COVID-19 on patients with asthma. Int J Tuberc Lung Dis. 2020, 24: 1217-1219.
14. Avdeev S, Moiseev S, Brovko M, et al. Low prevalence of bronchial asthma and chronic obstructive lung disease among intensive care unit patients with COVID-19. Allergy. 2020, 75:2703.

15. Fernando M, Agusti A, Dharmage S, et al. Are women with asthma at increased risk for severe COVID-19?. Lancet Respir Med. 2021, 9:125-6.

16. Atkins JL, Masoli JA, Delgado J, et al. Preexisting comorbidities predicting COVID-19 and mortality in the UK biobank community cohort. J Gerontol A. 2020, 75:2224-30.

17. Garg S. Hospitalization rates and characteristics of patients hospitalized with laboratory-confirmed coronavirus disease 2019—COVID-NET, 14 States. MMWR. 2020, 69:1–30.

18. Chhiba KD, Patel GB, Vu TH, et al. Prevalence and characterization of asthma in hospitalized and nonhospitalized patients with COVID-19. J Allergy Clin Immunol. 2020, 146:307-14.

19. Docherty AB, Harrison EM, Green CA, et al. Features of 20 133 UK patients in hospital with covid-19 using the ISARIC WHO Clinical Characterisation Protocol: prospective observational cohort study. BMJ. 2020, 369.

20. Butler MW, O'Reilly A, Dunican EM, et al. Prevalence of comorbid asthma in COVID-19 patients. J Allergy Clin Immunol. 2020, 146: 334-335.

21. Khan MMA, Khan MN, Mustagir MG, et al. Effects of underlying morbidities on the occurrence of deaths in COVID-19 patients: a systematic review and meta-analysis. J Glob Health. 2020, 10: 020503.

22. Moore WC, Ledford DK, Carstens DD, et al. Impact of the COVID-19 pandemic on incidence of asthma exacerbations and hospitalizations in US subspecialist-treated patients with severe asthma: results from the CHRONICLE study. J Asthma Allergy. 2022, 31:1195-203.

23. Hamadneh M, Alquran A, Manna R. Impact of the COVID-19 on asthma control among children: A systematic review. J Public Health Res. 2023, 12:22799036231197186.

24. Youssef N, Evans J, Elrifai AW, et al. A multicentre survey of asthma-related quality-of-life and treatment in Egypt during the COVID-19 pandemic. East Mediterr Health J. 2023, 29:285-294.

25. Linton S, Xu K, Hossenbaccus L, et al. Anxiety in adults with asthma during the coronavirus disease 2019 pandemic: a Canadian perspective. Allergy Asthma Clin Immunol. 2023, 19:73.

26. de Boer GM, Houweling L, Hendriks RW, et al. Asthma patients experience increased symptoms of anxiety, depression and fear during the COVID-19 pandemic. Chron Respir Dis. 2021,18:14799731211029658.

27. Salsman ML, Nordberg HO, Howell J, et al. Psychological distress and symptom-related burnout in asthma during the COVID-19 pandemic J Behav Med. 2023, 46:960-72.

28. Grandinetti R, Palazzolo E, Rizzo L, et al. Impact of SARS-CoV-2 infection in children with asthma and impact of COVID-19 vaccination: current evidence and review of the literature. Microorganisms. 2023, 11:1745.

29. Kitazawa H, Hizawa N, Nishimura Y, et al. The impact of the COVID-19 pandemic on asthma treatment in Japan: Perspectives based on doctors' views. Respir Investig. 2021, 59:670 - 674.

Corresponding author: **Basma Ibrahim,** E-mail: beibrahim@fcms.edu.sa