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Prevalence and severity of allergic asthma in children with COVID-19: a cross-sectional study

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Abstract

Objectives: The objective of this research was to evaluate the occurrence of allergic asthma symptoms in children between the ages of 3 and 15 years who tested positive for COVID-19 through PCR testing and were admitted to an educational hospital in Iran.

Methods: In 2021, we conducted a cross-sectional study that included 75 pediatric patients who tested positive for COVID-19 through PCR testing and were admitted to the Shahid Beheshti Hospital in Kashan, Iran. We used telephone interviews to complete the International Study of Asthma and Allergies in Childhood questionnaire to gather information on the frequency of allergic asthma symptoms and the demographic characteristics of the patients.

Results: The results showed that 12% of the children with COVID-19 had a history of wheezing, and 77.8% had mild wheezing in the past 12 months. Logistic regression analysis revealed that children with smoking fathers were 6.3 times more likely to wheeze than children with non-smoking fathers, and the likelihood of wheezing increased with age. The wheezing history of nine children revealed one allergy history in the family, one pet care in the home, seven home heaters, and two boilers. Nine children lived in personal houses and two lived in apartments, none of which were associated with wheezing.

Conclusion: The child's age and father's smoking behavior were found to have an impact on wheezing in asthmatic children with COVID-19. Further research is needed to better understand the impact of COVID-19 on pediatric populations, and the public health community should focus on studying this area more thoroughly.

Keywords: Asthma, COVID-19, Wheezing, PCR.

Introduction

Since December 2019, a novel strain of coronavirus called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has emerged within the human population. This disease, designated as Coronavirus Disease 2019 (COVID-19) by the World Health Organization (WHO), has affected over 50 million individuals globally and resulted in the unfortunate demise of more than 1.2 million people as of November 10, 2020.[1,2] Asthma, a chronic respiratory condition characterized by bronchospasm attacks and narrowing of the airways, can lead to breathing difficulties. Childhood asthma, in particular, has witnessed a rise in mortality rates in recent decades.[3] It is worth noting that asthma exacerbates the severity of viral respiratory tract infections,[4] and the level of asthma control directly influences the severity of viral infections.[5]

In numerous patients with asthma, type 1 hypersensitivity manifests in various ways, and allergic reactions play a significant role in the pathogenesis of the disease.[6] Both children (> 90%) and adults (> 50%) with asthma are associated with allergies. Asthma attacks occur when a patient's sensitivity to an allergen is triggered.[7] According to the United States (US) Centers for Disease Control and Prevention (CDC), out of 149,082 laboratory-confirmed pediatric COVID-19 cases with known age, 2572 cases (1.7%) were younger than 18 years of age.[8]

Asthmatic children, especially those with severe and uncontrolled asthma, should be classified as high-risk, according to both the CDC and the European Academy of

Allergy and Clinical Immunology (EAACI). However, it should be noted that this suggestion is based on common sense rather than scientific proof.[9] Only two out of 67 investigations and five reviews indicated asthma as a risk factor for COVID-19 in children, without taking severity or mortality into account.[10] In retrospective research undertaken by Ruano et al.,[11] no significant changes in asthma severity, control, lung function, or allergy comorbidity were found between likely COVID-19 individuals and non-COVID-19 cases. However, there was a higher use of relievers and controllers in probable COVID-19 cases, suggesting a potential link between COVID-19 and asthma exacerbations.

Various international agencies, including the CDC, have identified asthma as a risk factor for COVID-19-related outcomes such as illness and death.[12] The cause of this inconsistency in the findings is currently unknown and necessitates further investigation. However, it is believed to be attributed to decreased exposure to allergens in the outdoor environment, reduced levels of traffic and industrial pollution, and a decrease in viral agents.

Objectives

Considering the conflicting reports and the absence of such a study in Iran, this research aimed to assess the prevalence of allergic asthma symptoms in children aged 3–15 years who tested positive for COVID-19 through PCR and were admitted to an educational hospital in Iran.

Methods

This study was conducted in Kashan, Iran, in 2021 as a cross-sectional study. The inclusion criteria for participants were children aged 3–15 who tested positive for COVID-19 through a polymerase chain reaction (PCR) test and were admitted to Shahid Beheshti Hospital between January 1, 2021, and September 30, 2021. Shahid Beheshti Hospital, with 704 beds, is one of the largest educational hospitals in Kashan. The selection of participants was based on the medical records of the pediatric patients admitted to Shahid Beheshti Hospital. To ensure accuracy, the COVID-19 records of the hospital were thoroughly reviewed to identify all children who met the age and positive COVID-19 test criteria. The medical records of these eligible participants were obtained from the Vice Chancellor of Health office at Kashan University of Medical Sciences. The sample size of 75 was calculated using data from prior research by Fadaeizadeh et al.[13] This study found that 73.2% of children with a history of wheezing in the past 12 months had mild severity. By considering this prevalence, a confidence level of 95%, and a margin of error of 10%, the minimum required sample size was calculated to be 75 patients. Out of the 91 pediatric patients admitted during the study period who tested positive for COVID-19, 75 met the eligibility criteria and were included in the study. All 75 patients completed the questionnaire without any missing data.

The study utilized the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire. This self-administered questionnaire by the ISAAC is widely used due to its convenience and affordability in determining the prevalence and severity of asthma symptoms and allergic diseases. Various countries have employed this questionnaire to investigate the standard epidemiology of asthma and allergies. Several studies in our nation have used this questionnaire and proved its validity and reliability, including those done by Gharagozlou et al.,[14] Shakurnia et al.,[15] and Ansari et al.[16] The questionnaire consisted of various items, such as age, sex, wheezing history and frequency in the past 12 months, sleep disturbance and speech limitations caused by wheezing, dry cough without a cold, wheezing after exercise, allergy history in children and family members, smoking history, presence of pets at home, and the type of fuel used for cooking. Additionally, Fadaizadeh et al.[13] introduced a new variable called "severity of wheezing" based on the conventional scoring of three variables' results: A) rate of wheezing attacks in the past 12 months; B) frequency of sleep disturbance; and C) speech limitations due to wheezing in the past 12 months. Negative answers were assigned a score of 1, while other answers received higher scores. For instance, wheezing attack rates were scored from 1 to 4, sleep disturbance frequency from 1 to 3, and speech limitations due to wheezing received a score of 1 or 2. Consequently, the new variable for wheezing severity ranged from 3 to 9, with 3 indicating the absence of symptoms. Traditionally, intensities of 4-5, 6-7, and 8-9 are classified as mild, moderate, and severe, respectively.

Telephone interviews were conducted to gather information on the frequency of allergic asthma symptoms and the demographic characteristics of the patients.

All participants were invited to take part in the study and were informed of the study's objectives in accordance with the Declaration of Helsinki. Participants were assured that their information would remain confidential and would not be published in the article. The local ethics committee approved the study (No. IR.KAUMS.NUHEPM.REC.1400.049).

The data collected were analyzed using the Statistical Package for the Social Sciences (SPSS) 22 (IBM SPSS

Statistics, IBM Corporation, Armonk, NY, USA). The T-test-testchi-square test were used for data analysis, while logistic regression was utilized to establish the correlation between the prevalence of wheezing and demographic variables. The continuous variables were expressed as the mean ± SD, and the categorical variables were presented as a percentage and frequency. A "P-value" less than 0.05 was considered significant.

Results

In the study, a total of 75 patients between the ages of 3 and 15 were included. Out of these patients, 35 (46.7%) were girls and 4 (53.3%) were boys. The average age of the patients was 8.5±3.7 years. It was found that 20% of the children did not breastfeed in the first six months of their lives. The allergy history of the children's families was 12% (n=9). Additionally, 25.3% (n=9) of the children's fathers used tobacco (hookah or cigarette). Families with four members had the highest frequency at 58.8% (n=44). Five of the children had pets. Approximately 67% of the participants used a heater to warm their homes, and 72% lived in villas [Table 1].

According to Table 2, it was observed that nine children (12%, n=9) had wheezing in the past 12 months, and all of them experienced wheezing attacks one to three times within that period. Two children (22.2%, n=2) with a history of wheezing also had sleep disturbances in the past 12 months. Except for one child, all children with a history of wheezing experienced worsened wheezing during cold or cold seasons. Two children (22.2%, n=2) were diagnosed with asthma by a physician. Three children (33.3%, n=3) experienced wheezing during the past 12 months, either during or after exercise. Lastly, two children (2.7%, n=2) had a history of dry cough at night in the past 12 months, and both of them had a history of wheezing. Furthermore, 77.8% of the children with a history of wheezing had mild wheezing severity.

Table 1. Patients' demographic information

Items	Variables	N (%)
Sex	Girl	35(46.7)
	Boy	40(53.3)
Age		8.5±3.7
Consumption of milk other than breast milk in the first six months of life		15(20)
Allergy history in the family		9(12)
Father's smoking	Cigarettes	19(25.3)
	Hookah	3(4)
Family Smoking except for father		0
Family members	Two	1(1.3)
	Three	13(17.3)
	Four	44(58.8)
	Five and more	17(22.6)
Having a pet	Myna/Cockatiel bird	1(1.3)
	Rabbit	2(2.6)
	Sheep and chicken	1(1.3)
	Chicken	1(1.3)
House heating device	Heater	50(66.7)
	Radiator	24(32)
	Spilt	1(1.3)
Housing type	Villa	54(71.9)
	Apartment	21(28.1)

Table 2. Asthma prevalence among 3–15-year-old children using the ISAAC questionnaire

	Item		N (%)
Wheezing history	**Lifetime wheeze**		9(12)
	Wheeze in the past 12 months		9(100)
	Number of wheezing attacks in the past 12 months	1-3	7(77.8)
		4-12	2(22.2)
	Sleep disturbances due to wheeze in the past 12 months	None	7(77.8)
		>1/wk[a]	2(22.2)
	Wheezing exacerbation during colds or cold seasons		8(88.9)
	Speech-limiting wheeze in the past 12 months		0
	Physician-diagnosed asthma		2(33.3)
	Exercise-induced wheeze in the past 12 months		2(2.7)
Wheezing severity	**Score 4: Mild**		5(55.6)
	Score 5: Mild		2(22.2)
	Score 6: Moderate		2(22.2)

a, One or more night in a week

Table 3. Comparison of variables between children with and without a wheezing history

Items	Variables	Wheezing history		P value	OR (95%CI)
		Yes(n=9)	No(n=66)		
Sex	Girl	5(55.6)	30(45.5)	0.569	
	Boy	4(44.4)	36(54.5)		
Age		6±2.9	8.9±3.7	0.028	(0.997-0.612) 0.781
Consumption of milk other than breast milk in the first six months of life		2(22.2)	13(19.7)	0.859	
Allergy history in the family		1(11.1)	8(12.1)	0.930	
Father's smoking (Cigarettes/Hookah)		6(11.1)	16(24.2)	0.009	(30.261-1.337) 6.361
Family members	Two/ Three	1(66.7)	13(19.7)	0.656	
	Four	5(55.6)	39(59.1)		
	Above four	3(33.3)	14(21.2)		
Having a pet		1(11.1)	4(6.1)	0.569	
House heating device	Heater	7(77.8)	43(65.2)	0.451	
	Radiator/Spilt	2(22.2)	23(34.8)		
Housing type	Villa	7(77.8)	47(71.2)	0.681	
	Apartment	2(22.2)	19(28.8)		

Table 3 revealed a significant relationship between a child's age and their father's smoking. For every unit increase in age, a child's wheezing history decreased by 28% (0.781). Additionally, a child with a wheezing history whose father smoked had a 6.3-fold increased risk of wheezing compared to a child whose father did not smoke.

Discussion

Children with asthma experience bronchospasm attacks and narrowed airways, leading to breathing difficulties that can affect their daily lives. Diagnosing asthma in children can be challenging as there is no unique diagnostic test available. However, paying attention to wheezing can aid in its diagnosis.[17] On the other hand, COVID-19 has been declared a pandemic with the highest alert level by the WHO.[18] Fortunately, studies suggest that children tend to have milder illnesses and a better prognosis after infection.[19] In the early stages of COVID-19, simple chest radiography may not reveal any abnormal findings in children. Therefore, it is not recommended for patients with no symptoms or risk factors, and PCR-RT is used to detect the RNA of the virus.[20]

In this research, it was discovered that nine children who contracted COVID-19 (12%) had previously experienced wheezing, with 77.8% of them having mild wheezing within the last 12 months. By conducting a logistic regression analysis, it was determined that children with fathers who smoked were 6.3 times more likely to wheeze compared to children with non-smoking fathers. Additionally, the likelihood of wheezing increased as the children grew older. The wheezing history of these nine children revealed that one of them had a family history of allergies, one had a pet at home, seven had home heaters, and two had boilers. Furthermore, nine of the children lived in personal houses, while two lived in apartments, but none of these factors were associated with wheezing. Another study conducted over the course of one year found that males exhibited a higher prevalence of wheezing, with the maximum occurrence observed between the ages of one and two.[21] On the other hand, a separate study discovered that boys had a three-fold greater prevalence of bronchiolitis, with the highest age of occurrence being 3–4 months.[22] However, in our study, it was found that wheezing history was more common among females (55.6%).

The prevalence of asthma among adult patients with COVID-19 varies across different countries. In China, Italy, Sweden, Russia, and Brazil, the prevalence is relatively low, ranging from 0.9% to 1.96%. However, in Spain, Ireland, the United Kingdom, and the US, the prevalence is higher, ranging from 5.2% to 17.9%.[23–31] The occurrence of asthma in pediatric COVID-19 patients is not very common. Only one patient with asthma and four patients positive for SARS-CoV-2 had a 25% prevalence of asthma attributable to COVID-19, according to retrospective research done by Ibrahim et al., on 433 pediatric patients hospitalized at an Australian children's hospital.[32] Another recent study on 182 pediatric patients hospitalized for COVID-19 found that 22.8% of them had allergic diseases, with allergic rhinitis being the most common, but there was no significant difference in clinical, immunological, or disease severity findings

between those with allergies and those without.[33] Since all previous epidemiological studies were retrospective and asthma diagnoses were mainly based on patient declarations, it is likely that the actual prevalence of asthma is lower. Self-protection awareness, regular intake of asthma medications during the pandemic, reduced expression of angiotensin-converting enzyme 2 (ACE2) in atopic individuals, and inhaled corticosteroid treatment are all possible explanations for the relatively low COVID-19 prevalence among asthma patients.[34]

The findings revealed that passive smoking exposure and patient age had a substantial influence on children's health, but owning a pet had no effect. In recent times, it has become evident that smoking, age, and comorbid conditions such as hypertension, diabetes, obesity, and coronary artery disease are linked to a higher severity of COVID-19,[35–37] although the relationship with asthma remains controversial. There is no evidence to prove that asthma in childhood is a risk factor for SARS-CoV-2 infection or COVID-19 hospitalization. According to Beken et al.,[38] the prevalence of allergic rhinitis, asthma, atopic dermatitis, and episodic wheeze was 10.3%, 6.5%, 4.7%, and 3.7%, respectively, in the overall study population. COVID-19 hospitalization was not associated with asthma, allergic rhinitis, atopic dermatitis, or exposure to secondhand smoke. However, living with a pet was found to reduce this risk. Currently, there is no evidence to suggest that domestic pets can transmit new coronaviruses to humans. The CDC has reported various health benefits of owning pets, including lowering blood pressure and cholesterol levels, increasing opportunities for physical activity, and reducing loneliness.[39] Considering these factors, owning a pet may potentially reduce the severity of COVID-19.

According to a recent review of studies, only three studies have investigated asthma as a potential risk factor for COVID-19 infection but not its severity or mortality. However, the studies that have been conducted on COVID-19 cases have only provided information on case numbers by age group, leaving it unclear whether childhood asthma or other respiratory diseases in children increase the risk or severity of COVID-19. Therefore, it is crucial for the public health community to conduct more in-depth studies on pediatric populations. It is important to determine whether asthma increases the risk of COVID-19 infection in children, as well as its effectiveness in controlling asthma and reducing its severity. Joint international efforts are necessary to address this issue, as the number of pediatric admissions per center is limited. Coordination between major professional associations worldwide may be necessary to achieve this goal, not only for childhood asthma but for all childhood illnesses.

The findings of this study, conducted in a single hospital, may not be applicable to the wider pediatric population affected by COVID-19. The study only included patients admitted to Shahid Beheshti Hospital, which may not accurately reflect the full range of disease severity in children with COVID-19. Moreover, the sample size of 75 patients from a single geographic area is relatively small. To establish the prevalence of allergic asthma symptoms in children with COVID-19 across larger populations, it is necessary to conduct extensive multi-center studies encompassing diverse geographic regions. Additionally, expanding the demographic characteristics of the participants would further enhance the generalizability of the findings.

Conclusions

According to this study, the age of the child and the father's smoking behaviors can impact the occurrence of wheezing in children with COVID-19 who have asthma. Previous studies have only provided information on the number of cases in different age groups, leaving it uncertain whether asthma or other respiratory illnesses in children affect the severity or risk of COVID-19. This highlights the need for the public health sector to conduct more extensive research on pediatric populations.

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Competing interests

The authors declare that they have no competing interests.

Abbreviations

Coronavirus Disease 2019: COVID-19; Positive Polymerase Chain Reaction: PCR; International Study of Asthma and Allergies in Childhood: ISAAC; Severe Acute Respiratory Syndrome Coronavirus 2: SARS-CoV-2; World Health Organization: WHO; Disease Control and Prevention: CDC; European Academy of Allergy and Clinical Immunology: EAACI; Statistical Package for the Social Sciences: SPSS.

Authors' contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Role of the funding source

None.

Availability of data and materials

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

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. The local ethics committee approved the study (IR.KAUMS.NUHEPM.REC.1400.049).

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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