

Evaluation of the Impact of Environmental Changes on Asthma Control in Children, Access to Health Care, and Treatment Adherence in Early COVID-19 Lockdown

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What is already known on this topic?

- Studies in adults have shown that some chronic diseases increase the risk of mortality and morbidity of coronavirus disease 2019 (COVID-19). It is not known whether chronic diseases in children are a risk for severe COVID-19. Asthma is one of the most common chronic diseases in children. It is not known how asthmatic children are affected by the COVID-19 pandemic.

What this study adds on this topic?

- In this study, it was found that treatment adherence in children with asthma in the COVID-19 pandemic was good and asthma was under control.

ABSTRACT

Objective: During the coronavirus disease 2019 pandemic, lockdown measures and difficulties in accessing healthcare have impacted asthma management in children. This study aimed to determine the evaluation of the impact of environmental changes on asthma control in children, access to health care, and treatment adherence in early coronavirus disease 2019 lockdown.

Materials and Methods: The study included children with asthma aged 6-11 years. A survey form was administered to the patients who visited the pediatric allergy outpatient clinic between June 1 and 30, 2020. The survey acquired demographic information about the children and their families as well as information about their asthma symptoms, how they reached healthcare services, and adherence. The childhood asthma control test was administered. The *P* values <.05 were considered significant.

Results: The study included a total of 123 children (female/male : 48/75) with a mean age of 8.4 ± 1.9 years. According to the mothers' self-report, it was found that 78% of the patients were not able to follow-up routinely, 19.5% were non-adherence to treatment, and 16.2% were poorly controlled asthma. It was found that, based on childhood asthma control test scores, asthma control was better during the pandemic lockdown period (*P* = .001). Asthma symptoms were better in 41.5% of the patients compared to the previous months and in 53.7% compared to the same period last year.

Conclusion: Our study found that the children's asthma was controlled although most of them did not have their follow-up visits, and poorly controlled asthma was higher in older children in early coronavirus disease 2019 lockdown.

Keywords: Adherence, asthma, asthma control, children, COVID-19

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by the severe acute respiratory syndrome coronavirus 2 and was declared a pandemic in 2020.¹ Advanced age, male sex, and chronic diseases such as hypertension and diabetes were associated with an increased risk of severe COVID-19 in adults. In the early period of the pandemic, COVID-19 infection in children was usually asymptomatic or had mild symptoms, but it was unclear

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whether the accompanying chronic diseases increased the risk of severe COVID-19 infection.²⁻⁶ When the multisystemic inflammatory reaction detected in children in April 2020 was found to be associated with previous COVID-19 infection, this syndrome was named multisystem inflammatory syndrome in children (MIS-C) by the World Health Organization.⁷ Unlike acute COVID-19 infection in children, MIS-C was found to be more severe in children, even 68% of cases needed critical care support.⁸

The first case of COVID-19 in Turkey was recorded on March 11, 2020, three-and-a-half months after the first cases reported in Wuhan province in China on December 1, 2019. Soon after that, the schools were closed on March 16, 2020, government services were limited, and most of the private sector started working from home or part-time starting from March 22, 2020. During this period, clinical services for outpatients were suspended in hospitals, except for emergency cases. The lockdown measures were initially instated for people aged under 18 or over 65, then expanded to all age groups on the specified days after April 11, 2020.⁹ During the COVID-19 lockdown periods, most of the patients with chronic illness could not make their routine follow-up visits due to the curfews as well as the restrictions in outpatient clinics. In many hospitals, clinical services for outpatients were dispensed by alternative methods, such as online or phone consultation, instead of in-person visits to the physicians' offices.¹⁰ As the number of COVID-19 patients started to decrease after May 11, 2020, the restrictions were gradually relaxed, and the society transitioned to the "new normal" after the removal of all lockdown restrictions on June 1, 2020.⁹

Asthma is the most common chronic disease of childhood. Patients with asthma are recommended to have regular follow-up visits every 3–6 months and additional visits in case of asthma exacerbations.¹¹ The COVID-19 lockdown period (March–June 2020) coincided with the pollen season in Turkey. While the lockdown restrictions reduced the patients' exposure to viral infections, air pollution, pollens, or other outside allergens, their exposure to household allergens, indoor cigarette smoke, cleaners, or disinfectants has increased. Although there are studies showing that environmental changes during the pandemic period did not negatively affect the control of asthma, this issue is not clear yet.¹⁰

This study aimed to determine the effect of environmental changes associated with the restrictions imposed during the COVID-19 lockdown period on asthma control. In addition, it was aimed to determine how well children with asthma could access healthcare services and receive their medications during this period.

MATERIALS AND METHODS

Study Design, Date, and Settings

This study was a cross-sectional analytical survey. The study was conducted on children with asthma (age, 6–11 years) who applied to the pediatric allergy outpatient clinic between June 1 and 30, 2020, the initial period when the lockdown restrictions were lifted and the clinics started to return to their routine operation.

Ethical Aspects

The ethics committee for clinical research approved this study (Project no: 2020/6–9). Verbal and written consent was obtained from the families of the children with asthma before they participated in the study. All study procedures were conducted by following the Declaration of Helsinki and local laws and regulations.

Participants

The study was conducted in 2 pediatric allergy outpatients clinics. The diagnosis of asthma, disease severity score, and the prescribed treatments were defined according to the Global Initiative for Asthma guideline.¹¹ After the diagnosis, the patients were educated in terms of asthma medications and the use of inhaler devices. The patients were followed up with regular visits every 3–6 months and additional visits in case of an asthma exacerbation. The children between the ages of 6 and 11 who were followed up for at least a year with the diagnosis of asthma and agreed to participate in the study were included in the study. The patients who were not in the specified age group, who had chronic diseases or acute symptoms, or those who refused to participate in the study were excluded.

Data Collection

During the physical examination, the mothers of the participating children were asked about sociodemographic characteristics, asthma symptoms, medications, whether they attend their routine follow-ups during the COVID-19 lockdown period. The Childhood Asthma Control Test (C-ACT) was administered to all children. Their skin prick test (SPT) and pre-pandemic C-ACT scores were recorded from patient files.

The Allergic Rhinitis and its Impact of Asthma–The European Academy of Allergy and Clinical Immunology statement does not recommend routine spirometric evaluation because it increases the risk of transmission during the COVID-19 pandemic period; therefore, patients could not have spirometric evaluation.¹²

Sociodemographic Data and Asthma Symptom, Medications, and Follow-Up Data

A questionnaire of 35 questions was prepared to probe the changes in the lifestyle of families from April to May 2020, when the most severe lockdown restrictions had been imposed. A survey form was administered to the children with asthma and their mothers. The survey probed their demographic data (age, education, working status, etc.), medications used by children, the changes in their adherence to asthma treatment or clinical visits during the lockdown period (March–June 2020, based on the mother's self-report), whether there was a need for medical support, and how the support was provided in case of such needs (in-person visit to physician's office, e-mail, or phone consultation). The patients who used at least 80% of the planned medication were categorized as treatment adherents. Those who did not comply with the treatment plan (who discontinued the treatment or used less than 80% medication) were considered non-adherent.¹³ In addition, the patients were asked if they had a disease accompanied by respiratory tract infection symptoms such as runny nose, sneezing, fever, cough, and shortness of breath during this period; the findings were recorded in the patient data form. The patients' characteristics

with regard to their asthma and their SPT results were recorded from the patient file.

Childhood Asthma Control Test

The C-ACT was administered to evaluate their asthma control in the last month. The C-ACT was developed by Liu et al¹⁴ in 2007 and adapted to Turkish by Sekerel et al¹⁵ in 2009. The C-ACT can be applied to children aged between 5 and 11 years and consists of 4 questions for the child and 3 questions for their parents. The scores range between 0 and 27 points, and a score below 19 indicates "poor disease control." Patients' asthma control levels were evaluated as "controlled" or "poorly controlled" based on their C-ACT scores. During the lockdown period, the C-ACT measurements between the 2 visits were averaged and recorded. The C-ACT scores before the lockdown period were recorded from patient files.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Sciences, version 17.0 software (SPSS Inc.; Chicago, IL, USA). The variables were investigated using visual (histograms, probability plots) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk's test). The results were expressed as frequency (percentage) for categorical data and mean \pm standard deviation for numerical data with normal distribution or median (minimum-maximum and interquartile range) for numerical data without normal distribution. The chi-square or Fisher's exact test (when chi-square test assumptions do not hold due to low expected cell counts), where appropriate, was used to compare these proportions in different groups. The Mann-Whitney *U* test was used to compare groups for numerical data as relevant. A paired-samples *t*-test was applied to analyze the change in the dependent variables. Independent variables were screened by univariate analysis at first and analyzed by multiple logistic regression (enter procedure). Variables with $P < .2$ were included in the multivariate analysis. Hosmer-Lemeshow goodness of fit statistics were used to assess model fit. The P values $< .05$ were considered statistically significant.

RESULTS

Demographic Data

During the study period, a total of 233 patients were admitted to 2 centers involved in the study. The patients with additional chronic diseases other than the atopic disease ($n = 15$) and those who were not in the specified age group ($n = 63$), those who had acute symptoms ($n = 22$) or refused to participate in the study ($n = 10$) were excluded (Figure 1). A total of 123 children (female/male (F/M) : 48/75) with a mean age of 8.4 ± 1.9 years were included in the study. Of the mothers, 53.7% were not working and 56.1% of the families had a low-medium income. Table 1 shows the demographic data of the patients.

Clinical and Laboratory Findings

The duration of asthma ranged between 1 and 8 years (median 3 years), and 47.2% had an additional atopic disease. At least 1 controller medication was used by 92.7% of the patients. In 86.2% of the cases, the SPT was positive for at least 1 allergen. Table 2 shows the asthma characteristics of the children.

Asthma Management and Asthma Control During the Lockdown Period

During the COVID-19 lockdown period, 23.6% of the patients had upper respiratory tract infections and 17.1% had asthma exacerbations. The C-ACT scores indicated that 16.3% of the participants had poorly controlled asthma. None of the patients had COVID-19 during the study period. Based on the participants' self-report, 41.5% had better symptoms compared to the previous period (before the lockdown) and 53.7% had better symptoms compared to the same period of the last year. According to the data obtained from the patient files, the rate of poorly controlled asthma in the pre-pandemic period was 43.9% (based on the C-ACT scores in that period). The C-ACT scores in the lockdown period were found to be higher compared to the pre-pandemic period (lockdown C-ACT = 22.6 ± 4.2 and pre-pandemic C-ACT = 20.2 ± 8.1 , $P = .001$). The rate of regular inhaled corticosteroids use was 86.2% before the lockdown period, while it was 80.5% during the lockdown period. Of the patients, 54.5% reported that they made their

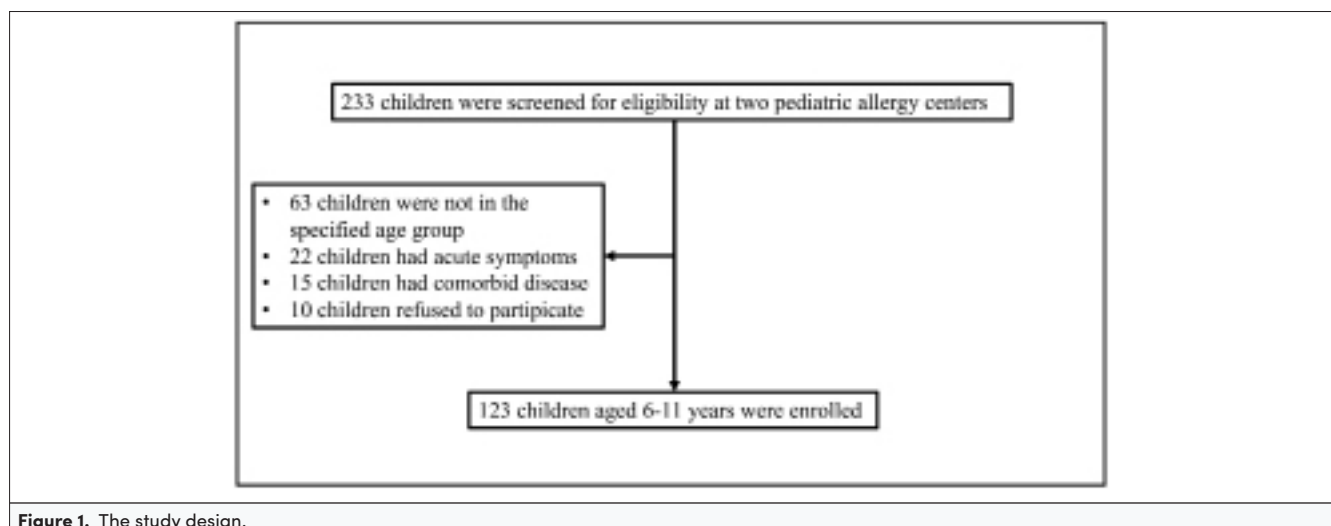


Figure 1. The study design.

Table 1. Demographic Characteristics of the Asthma Patients and Their Families, Expressed as n (%)

Age*	8.4 ± 1.9
Gender (female)	48 (39.0)
Mother's age*	38.5 ± 5.0
Mother's education status	
Primary school (8 years)	30 (24.4)
High school	40 (32.5)
University	53 (43.1)
Mother's employment status	
Housewife	66 (53.7)
Working mother	57 (46.3)
Household income	
Low-medium	69 (56.1)
High	54(43.9)
Number of people in the household	
3	54 (43.9)
4	58 (47.2)
>4	11 (8.9)
Having individuals aged >65 in the household	7 (5.7)
Secondhand smoke exposure at home	65 (52.9)

*Data expressed as mean ± SD.
SD, standard deviation.

Table 2. Children's Asthma Characteristics, Expressed as n (%)

Follow-up period (year)*	3.0 (2.0) [1.0-8.0]
Additional atopic disease	
None	65 (52.8)
Allergic rhinitis	45 (36.6)
Atopic dermatitis	7 (5.7)
Food allergies	5 (4.1)
Drug allergies	1 (0.8)
Medication	
None	9 (7.3)
Monotherapy (ICS)	40 (32.5)
Combined therapy (ICS+LABA and/or LTRA)	74 (60.2)
Skin prick test	
Negative	17 (13.8)
Indoor+outdoor allergen positivity	58 (47.2)
Indoor allergen positivity	38 (30.9)
Outdoor allergen positivity	10 (8.1)

*Median (IQR) [min-max]
IQR, interquartile range; ICS, inhaled corticosteroids; LABA, long-acting β₂ agonist; LTRA, leukotriene receptor antagonist.

own decision about how to continue their asthma medication (51.2% continued and 3.3% discontinued their medication), while 45.5% consulted their physician (37.4% through e-mail or phone and 8.1% through in-person visit) (Table 3). In this period, 27 (45.8%) of the 59 patients with asthma who had symptoms made their own decision about how to apply the treatment, 13 (22.0%) consulted their physician (by e-mail or phone), 16 (27.1%) visited their physician in-person, and 3 (5.1%) visited the emergency room. Table 3 shows the symptoms of patients with asthma and their families' attitudes during the lockdown period.

Table 3. Control and the Management of Asthma in Children During the COVID-19 Lockdown Period According to Maternal Self-Report, Expressed as n (%)

Upper respiratory tract infection during COVID-19 lockdown period (self-report)	29 (23.6)
Asthma exacerbations during COVID-19 lockdown period	21 (17.1)
Asthma symptoms during COVID-19 lockdown compared to previous periods	
Same	69 (56.1)
Better	51 (41.5)
Worse	3 (2.4)
Asthma symptoms during COVID-19 lockdown compared to the same period of last year	
Same	55 (44.7)
Better	66 (53.7)
Worse	2 (1.6)
ICS use before the COVID-19 lockdown period	
Yes, regular	106 (86.2)
Yes, irregular	9 (7.3)
No	8 (6.5)
ICS use during the COVID-19 lockdown period	
Yes, regular	99 (80.5)
Yes, irregular	8 (6.5)
No	16 (13.0)
Planning for controller medications during the pandemic (n = 123)	
Self-decision to take drugs (mother)	63 (51.2)
E-mail or phone consultation with a physician	46 (37.4)
Face-to-face visit with a physician	10 (8.1)
Self-decision to stop taking the drugs (mother)	4 (3.3)
Planning for reliever medications during the pandemic (n = 59)	
Self-decision (mother)	27 (45.8)
Face-to-face visit with a physician	16 (27.1)
E-mail or phone consultation with a physician	13 (22.0)
Emergency visit	3 (5.1)
Effect of COVID-19 lockdown period on ICS use	
None	90 (73.2)
Yes, used more regularly	24 (19.5)
Yes, stopped medications	9 (7.3)
C-ACT scores during the COVID-19 lockdown period*	22.6 ± 4.2
C-ACT scores before the COVID-19 lockdown period*	20.2 ± 8.1
Poorly controlled asthma during COVID-19 lockdown period (C-ACT < 20)	20 (16.3)
Poorly controlled asthma before the COVID-19 lockdown period (C-ACT < 20)	54 (43.9)

*Data expressed as mean ± SD
ICS, inhaled corticosteroids; C-ACT, childhood asthma control; COVID-19, coronavirus disease 2019; SD, standard deviation.

In the comparison between the patients with controlled or poorly controlled asthma, the latter group had significantly higher age ($P = .016$) (Figure 2). Sex, household income, the presence of additional atopic disease, having a smoker at home, and having allergic reactions to indoor allergens were

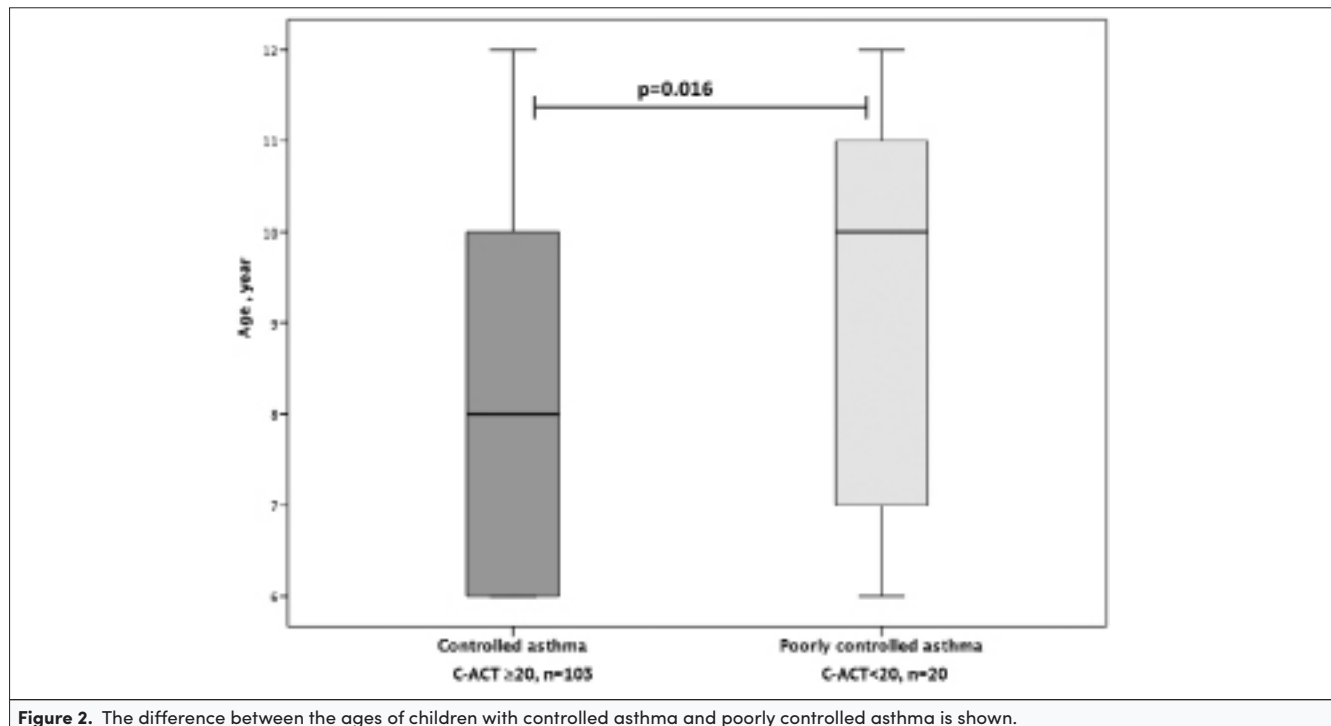


Figure 2. The difference between the ages of children with controlled asthma and poorly controlled asthma is shown.

not different between the groups with controlled or poorly controlled asthma (Table 4).

The 11 variables that provided significance in the univariate analyses were chosen as independent variables included in the multivariate logistic regression analysis, as a result, a total of 2 risk factors entered the logistic regression equation. The 2 predictive variables were age and using the regular controller medications during the lockdown. When the factors that may affect asthma control were analyzed, only age was found to be related to asthma control (odds ratio (95% CI): 1.33 (1.01-1.76), $P = .043$). There was no relationship between asthma control and using the regular controller medications during the lockdown ($P > .05$) (Table 5).

DISCUSSION

In our study, it was shown that the lockdown measures and related changes in environmental and healthcare settings during the COVID-19 pandemic did not affect the patients' asthma control adversely. It was also found that although approximately half of the patients could not access healthcare services during this period, there was no significant decrease in treatment adherence.

The lockdown measures during the COVID-19 pandemic have been shown to disrupt routine follow-up schedules in allergy outpatient clinics as well as in the long-term care of other chronic diseases.¹⁶ Our study found that most of the patients could not have their routine controls; 37.4% could get consultation via e-mail or phone and only 8.1% could visit their physicians in-person. It was found that 54.5% of the families made their own decision about how to continue their medications to keep asthma under control during this period and 45.8% made their own decision about which medication to take when they had symptoms. In addition, treatment adherence was found to

be relatively high, although face-to-face visit rates were low in our study. A recent online survey study by the Pediatric Asthma in Real Life and the World Allergy Group investigated the status of allergy outpatient clinics during the COVID-19 pandemic.¹⁰ They found that the number of patients was reduced in most clinics, control intervals were extended, and only severe asthma cases were accepted in some clinics. More than 90% of the centers participating in the study provided services to their patients through online or phone consultations. A previous study in Turkey also showed that the patients were consulted via phone for various allergic diseases, and this method was most commonly used for asthma.¹⁶

There have been several social and environmental changes during the COVID-19 pandemic. Strict social isolation measures were implemented in many countries, with curfews, school closures, mandates to wear masks outside, and recommendations for frequent hand wash and the use of hand sanitizers. It was advantageous for asthma control that the children with asthma were exposed to viral infections, outdoor allergens, and air pollution to a lesser extent in this period; however, reduced physical activity and increased exposure to household allergens and disinfectants constituted a disadvantage.¹⁷⁻²⁰ Although more than three-quarters of the patients had sensitivity to indoor allergens and almost half of them were exposed to cigarette smoke indoors, no significant deterioration was observed in the symptoms. Asthma controls in the pre-pandemic and pandemic lockdown periods were compared. According to the mothers' perception, almost half of the patients had better symptoms during the lockdown period; according to the C-ACT results, the rate of poorly controlled asthma decreased by about half during the lockdown period. In our study, the symptoms were reported to be better in almost half but worse in less than 3% of the children with asthma compared with the previous periods. Although the rate of poorly controlled asthma was 16.3% and the rate of asthma exacerbations was 17.1% in the lockdown

Table 4. Comparison of the Characteristics of Patients With and Without Asthma Control, Expressed as n (%)

	Poorly Controlled Asthma C-ACT < 20, n = 20	Controlled Asthma C-ACT ≥ 20, n = 103	P
Age ¹	10.0 (4.0) [6.0-12.0]	8.0 (4.0) [6.0-12.0]	.016
Sex (female)	7 (35.0)	41(39.8)	.687
Secondhand smoking at home	9 (45.0)	56 (54.4)	.473
Household income			
Low-medium	11 (55.0)	58 (56.3)	.915
High	9 (45.0)	45 (43.7)	
Comorbid allergic diseases			
Only asthma	9 (45.0)	56 (51.4)	.442
Asthma with other allergic diseases	11 (55.0)	47 (45.6)	
Skin prick test ¹			
Negative	3 (15.0)	14 (13.6)	.915
Indoor+outdoor allergen	8 (40.0)	50 (48.6)	
Indoor allergen	7 (35.0)	31 (30.0)	
Outdoor allergen	2 (10.0)	8 (7.8)	
Skin prick test (Indoor allergen positivity with/without outdoor allergen positivity)			
No	5 (25)	22 (21.4)	.769
Yes	15 (75)	81 (78.6)	
Routine outpatient visit during lockdown period			
No	14 (70)	82 (79.6)	.379
Yes	6 (30)	21 (20.4)	
Using the controller medications during the lockdown period			
Irregular	7 (35.0)	17 (16.5)	.068
Regular	13 (65.0)	86 (83.5)	
Planning for controller medications during the lockdown period			
Physician	9 (45.0)	47 (45.7)	.959
Self-decision	11(55.0)	56 (54.3)	
Planning for reliever medications during the lockdown period			
Physician	6 (42.9)	26 (67.8)	.328
Self-decision	8 (57.1)	19 (42.2)	

C-ACT, childhood asthma control test, chi-square test, for categorical data; IQR, interquartile range.
¹Median (IQR) [min-max], (Mann-Whitney U test); ¹Fisher's exact test.

Table 5. Multiple Logistic Analysis of Risk Factors Related to Poorly Controlled Asthma*

Risk Factors	Poorly Controlled Asthma	
	OR (95% CI)	P
Age	1.33 (1.01-1.76)	.043
Using the regular controller medications during the lockdown	0.48 (0.16-1.44)	.188

*Multivariate logistic regression analysis.
 OR, odds ratio.

period, less than 3% of the families reported that their children's conditions were worse than the pre-pandemic period. This inconsistency could be related to mothers' inability to recognize or disregard asthma symptoms. Other studies had found significant decreases in asthma exacerbations and respiratory tract infections during the periods when strict lockdown measures were applied.²⁰⁻²³ A survey by Papadopoulos et al⁸ subjectively evaluated their patients' asthma control status based on their patients' self-report. While 85% of the participants reported that their symptoms were as expected and followed previous symptom patterns, 20% reported that their control exceeded their expectations, and asthma control had deteriorated in only 10%.

In our study, it was found that the only influencing factor in asthma control during the COVID-19 lockdown period was the age of the patient. Previous studies also showed that age is an important factor in asthma control and there might be lower treatment adherence, especially in adolescents.²⁴ Although our study did not include the adolescents similar to other studies, the children with poorly controlled asthma were found to be older.

Our study found that social isolation measures during the COVID-19 pandemic did not adversely affect asthma control in our patients. On the contrary, disease control was better compared to previous periods. However, it would be better not to underestimate the impact of COVID-19 on children with asthma since there are still many unknowns about COVID-19.

The evaluation of treatment compliance and medication use through self-reports is a limitation of our study. In addition, the fact that our study covered a limited period (April-June 2020) during the pandemic can be considered a limitation. However, this period was critical because it was when strict social isolation measures were in place and covered the pollen season in Turkey. In addition, our study is significant for showing the impact of the changes in environmental and

healthcare settings during the COVID-19 pandemic on children with asthma. Another limitation of our study is that we could not compare pulmonary function tests before and during the pandemic period because routine pulmonary function tests could not be performed during the pandemic period.

CONCLUSION

In our study, it was found that in the early period of the pandemic, environmental changes had no negative effect on asthma control and treatment adherence and even asthma symptoms were better than in the previous year. In addition, in early COVID-19 lockdown, poorly controlled asthma was higher in older children.

Although children were exposed to higher indoor allergens in the first period of the pandemic, we think that social isolation and hygiene measures are effective in controlling asthma by reducing the frequency of viral infections. More studies are needed to investigate the relationship between COVID-19 and asthma.

Ethics Committee Approval: The study was approved by the Institutional Review Board of İzmir University of Health Sciences İzmir Tepecik Training and Research Hospital (Approval No: 2020/6-9).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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