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Level of asthma control in children and adolescents before and during the COVID-19 pandemic

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Abstract

Background: During the COVID-19 pandemic, national lockdowns were implemented worldwide. Asthma control was reported to have improved. However, some patients lost follow-up from the clinic because they intended to avoid crowds at the hospital.

Objective: To evaluate the level of asthma control during the COVID-19 pandemic and explore factors influencing asthma outcomes.

Methods: Subjects 8–18 years old from our previous study in 2019 were recruited. The data during the pandemic period were collected between June 2021 – May 2023. The level of asthma control was compared before and during the pandemic. We also evaluated inhaled corticosteroid (ICS) adherence and factors related to poor asthma control during the COVID-19 pandemic.

Results: One hundred and three subjects were enrolled. Asthma control levels remained relatively stable during the pandemic. However, an asthma exacerbation was significantly decreased from 36 (36.3%) in 2019 to 19 (19.2%) and 15 (15.1%) in 2021 and 2022 (p = 0.012, p < 0.001), respectively. Spirometry results demonstrated improved pre-bronchodilator FEV_1 (89.91 ± 11.02 vs. 101.91 ± 14.11, p < 0.001). The factors related to the poor asthma outcome were not wearing a face mask (aOR = 8.52, 95%CI 1.26–57.79) and previously poor-controlled by the ACT score (aOR = 2.55, 95%CI 1.41–4.63). The median adherence rate during the pandemic was 85%. The main reasons for poor adherence were hectic lifestyle and misunderstandings of disease.

Conclusion: Asthma exacerbation was significantly decreased during the lockdown. Not wearing a face mask and previously poorly controlled by the ACT score are related to poor asthma outcomes.

Key word: Asthma, COVID-19, Asia, Disease Progression, Adolescent

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Introduction

Since March 2020, The World Health Organization (WHO) has declared the SARs-CoV-2 virus outbreak a pandemic.[1] Surprisingly, the incidence of coronavirus disease 2019 (COVID-19) among children with asthma was not different from the general pediatric population.[2] Some studies have reported that asthmatic patients did not increase the risk of mortality in COVID-19.[3,4]

Nevertheless, the reported risk of asthmatic exacerbation following COVID-19 includes preschool age, male sex, and obesity.[5] The use of a controller significantly decreases this risk.[5]

Furthermore, The COVID-19 pandemic may affect attitudes and lifestyles toward self-care, especially among asthmatic children. It was reported that asthma control improved, including symptoms, spirometry, and emergency department visits during the COVID-19 pandemic.[6-8] The improvement in asthma outcomes during the pandemic is presumably explained by increased treatment adherence[7] and environmental control.[7,8] Shielding indoors can protect a child from air pollution and viral spread.[8]

Before the pandemic, we previously evaluated inhaled corticosteroid (ICS) adherence in school-age children and adolescents with asthma. We found that 42.5% of our patients had poor adherence (< 75%).[9] The most common reasons for poor adherence were intentional actions, hectic lifestyle, and forgetfulness. In addition, we identified that a lower total outcome expectation was significantly associated with suboptimal controller adherence.

In 2021, national lockdowns were implemented in Thailand. Children with asthma increased time spent at home, which could improve ICS adherence, especially in our patients who previously reported that the reason for poor adherence was a hectic lifestyle and forgetfulness. However, some patients lost follow-up from the clinic because they intended to avoid crowds at the hospital. As a result, these patients do not have medicine prescribed by the doctors. After the lockdown period in 2022, patients returned to the clinic, but they maintained other preventive strategies such as compulsory use of masks, social distancing, and regular handwashing.

Due to the differences in Asian lifestyles compared to the Western population, asthma control may either improve with better ICS adherence or worsen due to the lack of asthma medication resulting from missed doctor's appointments. This study aimed to assess the effect of lockdowns and non-lockdowns during the COVID-19 pandemic by comparing the level of asthma control in the same population. Our study specifically targets children and adolescents due to their unique psychological development, which strongly impacts ICS adherence. We assessed ICS adherence and reasons for poor compliance during the pandemic. The connection between asthma control and related factors during COVID-19 pandemic will provide valuable insights to inform targeted interventions and improve asthma management during public health emergencies such as the COVID-19 pandemic.

Methods

Study design and participants

This study is a single-center prospective study conducted with asthmatic patients during 2021–2022 who were undergoing follow-up at the Pediatric Allergy Clinic of the Division of Allergy and Immunology, Department of Pediatrics, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand. All participants were part of our previous study conducted from 2019–2020.[9] In brief, 134 children aged 8–18 years with a physician-diagnosed asthma were recruited. The evaluation encompassed asthma knowledge, ICS adherence, asthma control status, and psychological issues. Subsequently, a 3- to 6-month follow-up was implemented to reassess adherence to ICS and evaluate asthma control status. Participants with pre-existing chronic conditions, such as restrictive lung disease, or those inaccessible for clinic visits or phone consultations were excluded from the study.

The protocol was approved by the Siriraj Institutional Review Board (SIRB) (COA no. Si 317/2022). Written informed consent was obtained from both patients and parents. In the loss follow-up group, we obtained consent by phone.

Data collection

Data was collected in two periods: before the COVID-19 pandemic (April 2019 to January 2020) and during the COVID-19 pandemic (June 2021 to May 2023). In the pre-pandemic phase, we gathered demographic data, assessed the level of asthma control, obtained asthma control test (ACT) scores, conducted spirometry, and assessed ICS adherence, relying on our previous study.[9] During the pandemic, data collection occurred in the lockdown period (2021) to understand immediate effects and during the post-lockdown period (2022) to observe any sustained impacts. Information for 2021 (June 2021 to May 2022) was extracted from the medical record, whereas the data for 2022 (June 2022 to May 2023) was collected at the allergy clinic by face-to-face contact or telephone interviewed. We documented the level of asthma control, ICS adherence, history of COVID-19 infection, and attitudes toward COVID-19 infection. ACT scores and spirometry data were collected exclusively during the post-lockdown period. Reasons for nonadherence were investigated among patients with poor ICS adherence. Additionally, telephone interviews were attempted with patients who were lost to follow-up. The flow of participants throughout the study is shown in **Figure 1.**

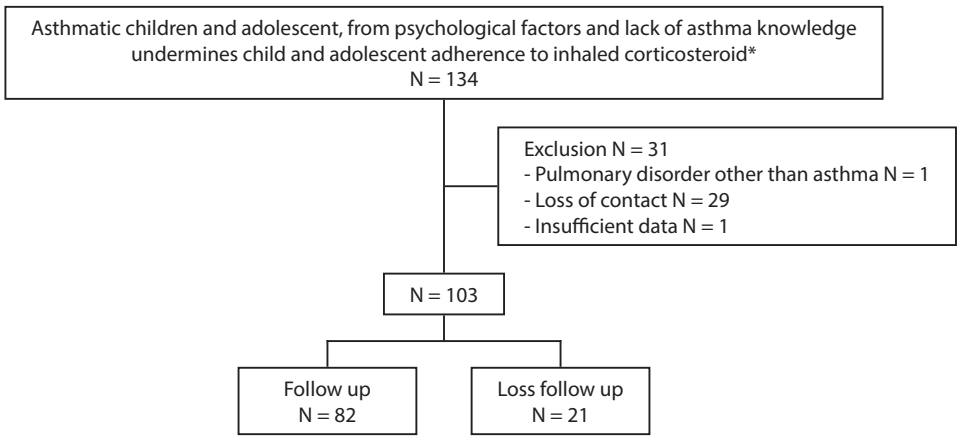

Figure 1. Flow diagram of the study population.

*Takkinsatian P, et al. Journal of Asthma. 2021:1-12.
ICS; inhaled corticosteroid

Schedule visit

During the lockdown period, patients visited doctors less frequently; some rescheduled, some followed at another hospital, and some lost follow-ups. Loss follow-up was defined as the patient who did not come to an appointment at an allergy clinic or another hospital during the post-lockdown 2022 period (June 2021 – May 2022).

Outcome measurement

Asthma control was assessed using two methods: 1) the Global Initiative for Asthma (GINA) assessment of symptom control score, classifying patients as well-controlled or poorly controlled (including partial and uncontrolled).[10], and 2) Asthma Control Test (ACT) scores, where a score of above 19 indicates well-controlled asthma.[11] The translated version of ACT scores was used in subjects > 12 years old.[12] Asthma exacerbation is defined as an episode of increase in shortness of breath, cough, and wheezing, which need systemic corticosteroids.[10]

ICS adherence was evaluated only in those who regularly used ICS. It was expressed as a percentage of patient-reported ICS use (dose/day × days in a week, then divided by the actual prescribed doses). Poor ICS adherence is defined as less than 75%, which is the cutoff that was reported to be associated with poor asthma control.[13]

Statistical analysis

All statistical analyses were performed using SPSS version 22 software (SPSS, Inc., Chicago, IL, USA). Descriptive statistics for categorical data, such as age, BMI, duration of asthma, ACT score, spirometry results, and ICS adherence, were presented as either mean ± standard deviation (SD) or median and interquartile ranges (IQR), depending on the distribution of the data. The association between variables in well-controlled and poorly controlled groups was analyzed using the two-independent sample t-test, the Mann-Whitney U test for continuous variables, and the Chi-square test or Fisher's exact test for categorical variables. Variables from those analyses with p-values < 0.2 were included in univariable logistic regression. Variables from univariable logistic regression with p-value < 0.05 were included in multivariable analysis to identify independent factors. Paired sample t-test was used to compare ACT, ICS adherence, and spirometry during the period before the pandemic with the pandemic period. The level of asthma control and exacerbation were analyzed using the McNemar test. A p-value < 0.05 was considered statistically significant.

Results

Participants

Of the original 134 asthmatic subjects, 103 (76.9%) were enrolled. The median follow-up frequency was 2 times per year (IQR 1,3). The demographic data between subjects who were enrolled and loss of contact are shown in **Table S1**. The number of well-controlled asthma in loss of contact group was significantly lower than the enrollment group (p = 0.014). Eighty-eight participants (85.4%) had well-controlled asthma. The demographic data of the study population is shown in **Table 1** and **Table S2**. The average age was 15.12 ± 2.87 years old, and 67% were male. The mean duration of asthma was 11.90 ± 3.67 years. Sixty-five children (63.1%) used regular ICS. The median ICS adherence rate was 85.00% (IQR 42.83, 100.00), of which thirty-six (55.4%) were defined as good adherence. The overall mean ACT score was 24.05 ± 1.26, which ninety-four (96.9%) were defined as well-controlled asthma.

Table 1. Demographic data of asthmatic patients during the pandemic of covid-19. (N = 103)

Demographic data	Total (N = 103)	Well-controlled (N = 88)	Poor-controlled (N = 15)	*p*-value
Male, n (%)	69 (67%)	60 (68.2%)	9 (60%)	0.561
Age, years, mean ± SD	15.12 ± 2.87	15.36 ± 2.93	13.67 ± 1.99	**0.009**
BMI, mean ± SD	21.88 ± 6.57	22.14 ± 5.61	23.22 ± 6.89	0.505
Age onset of asthma, years, Median (IQR)	3 (1,4)	3 (1,4)	3 (2,6)	0.263
Duration of asthma, years, Mean ± SD	11.90 ± 3.67	12.31 ± 3.53	9.53 ± 3.68	**0.006**
Device				0.106
Dry powder inhaler, n (%)	67 (65.0%)	60 (68.2%)	7 (46.7%)	
Meter dose inhaler, n (%)	36 (35.0%)	28 (31.8%)	8 (53.3%)	
Inhaler regimen				**0.008**
As-needed, n (%)	38 (36.9%)	37 (42.0%)	1 (6.7%)	
Regular, n (%)	65 (63.1%)	51 (58.0%)	14 (93.3%)	
ICS adherence rate*				
Percent, median (IQR)	85.00 (42.83, 100.00)	85.71 (43.00, 100.00)	64.27 (0.00, 89.50)	0.120
Good adherence, n (%)	36 (55.4%)	31 (60.8%)	5 (35.7%)	0.095
Asthma controlled				
ACT score, mean ± SD	24.05 ± 1.26	24.28 ± 0.95	22.64 ± 1.95	**0.008**
ACT score > 19 (well-controlled), n%	94 (96.9%)	83 (100%)	11 (78.6%)	**0.002**
Asthma exacerbation, n (%)	15 (15.0%)	8 (9.3%)	7 (50.0%)	**0.001**
Schedule visit				
Loss follow up, n (%)	21 (20.4%)	14 (15.9%)	7 (46.7%)	**0.012**

*Data available from 65 patients (well-controlled; n = 51, poor-controlled; n = 14)
Abbreviation: SD; standard deviation, BMI; body mass index, ICS; inhaled corticosteroid, ACT; asthma control test

During the pandemic in 2022, fifteen patients (15.1%) experienced asthma exacerbation. This occurred in 9.3% of well-controlled patients and 50% of those with poor control. Spirometry was performed in 44 patients, and the overall mean FEV_1/FVC, FEV_1 pre-bronchodilator, FEF_{25-75} were 87.69 ± 6.00, 101.69 ± 12.57, 91.31 ± 25.09, respectively (**Table S2**). The mean previous ICS adherence rate was 76.76 ± 27.31, which sixty-one (59.2%) were defined as good adherence. The overall previous asthma-controlled status shows ninety-one (88.3%) had well-controlled asthma, and thirty-six (35.3%) had previous asthma exacerbation (**Table S2**).

COVID-19 related outcome

The history of COVID-19 infection and vaccination are shown in **Table 2**. Sixty-two (62.6%) of subjects had a history of COVID-19 infection. Thirteen of them (21.0%) had recurrent COVID-19 infection. Most of them had upper respiratory tract symptoms. No patient needs intubation. **Table S3** shows the attitude toward COVID-19. About half of the patients fear to be infected. Eighty-two (84.5%) used face masks when going outside. Factors that related to well-controlled were wearing the face mask and avoiding crowds (p = 0.038 and p = 0.008, respectively)

Table 2. History of COVID-19 infection and vaccination. (N = 103)

Covid status	N (%)
Covid infection, n (%)	62 (62.6%)
1 time, n (%)	49 (79.0%)
> 2 times, n (%)	13 (21.0%)
Symptoms	
Asymptomatic, n (%)	2 (3.2%)
Upper respiratory tract symptoms, n(%)	59 (95.2%)
Pneumonia, n (%)	1 (1.6%)
Covid vaccination	
0-2 shots, n (%)	57 (55.3%)
> 3 shots, n (%)	46 (44.7%)
Type of vaccination	
mRNA vaccine, n (%)	81 (92.0%)
Inactivated vaccine, n (%)	3 (3.4%)
Combine regimen, n (%)	4 (4.5%)

Table 3. Comparing asthma-controlled status before and during the pandemic of covid-19.*

Asthma controlled	Before pandemic	Pandemic 2021	Pandemic 2022	*p*-value[a]	*p*-value[b]
ACT score (n = 43)					
Mean ± SD	23.60 ± 2.08	-	23.98 ± 1.21	-	0.293
Well-controlled (ACT > 19), n (%)	93 (96.9%)	-	93 (96.9%)		1.000
Well-controlled by physician†, n (%)	91 (88.3%)	81 (93.1%)	88 (85.4%)	0.549	0.629
Exacerbation, n (%) Spirometry (n = 33)	36 (36.3%)	19 (19.2%)	15 (15.1%)	**0.012**	**< 0.001**
FEV_1/FVC, Mean ± SD	88.42 ± 5.58	-	87.56 ± 6.39	-	0.379
FEV_1 pre, Mean ± SD	89.91 ± 11.02	-	101.91 ± 14.11	-	**< 0.001**
FVC, Mean ± SD	89.85 ± 10.16	-	103.76 ± 12.72	-	**< 0.001**
FEF_{25-75}, Mean ± SD	88.48 ± 23.27	-	92.36 ± 27.96	-	0.362
ICS adherence (N = 65)**					
Rate, mean ± SD	76.57 ± 26.91	69.21 ± 32.75	67.05 ± 37.48	0.151	0.084
Rate, median (IQR)	85.70 (57.14, 100.00)	75.29 (53.50, 100.00)	85.00 (42.83, 100.00)	0.216	0.205
Good adherence, n (%)	35 (54.7%)	31 (49.2%)	36 (56.3%)	0.557	1.000

[a]*p*-value between before pandemic VS pandemic 2021
[b]*p*-value between before pandemic VS pandemic 2022
*Only patients who had data before pandemic and pandemic 2022
**The data in 2019 had normal distribution, and the data in 2022 had non-normal distribution
†Evaluated according to GINA guideline

Comparing asthma-controlled status before and during the pandemic of Covid-19

During the pandemic, asthma exacerbation was significantly lower [36 (36.3%) vs. 19 (19.2%) and 15 (15.1%) in 2019 vs. 2021 and 2022 (p = 0.012, p < 0.001), respectively. The comparison of spirometry and ACT scores were conducted exclusively among individuals who had data available for both before pandemic and pandemic 2022 (n = 33 and n = 43, respectively) The spirometry showed improvement of FEV_1 pre bronchodilator; 89.91 ± 11.02 vs 101.91 ± 14.11 (p < 0.001) and FVC; 89.85 ± 10.16 vs 103.76 ± 12.72 (p < 0.001). There was no significant difference in the mean ACT score and the percentage of well-controlled patients.

The ICS adherence rate was not significantly reduced compared to before the pandemic. The mean adherence rate was 76.57% ± 26.91% in 2019, 69.21% ± 32.75% in 2021 (p = 0.151), and 67.05% ± 37.48% in 2022 (p = 0.084). (**Table 3**).

***Factors related to poor asthma outcome during the pandemic.* (Table 4)**

According to univariable analysis, the factors related to poor asthma outcomes during the pandemic were previously poor controlled by the ACT score (OR = 13.23, 95%CI 1.12–156.47), the attitude of not wearing a face mask (OR = 3.6, 95%CI 1.02–12.70) and loss follow up (OR = 4.63, 95%CI 1.44–14.82).

Table 4. Factors related to poor asthma outcome during pandemic.

Risk factor related poor outcome	Univariable analysis			Multivariable analysis		
	OR	95%CI for OR	*p*-value	Adjusted OR	95%CI for adjusted OR	*p*-value
Age	0.77	0.60 - 0.99	**0.042**	0.96	0.63-1.46	0.837
Duration of asthma	0.78	0.65 - 0.94	**0.009**	0.77	0.57-1.04	0.083
Inhaler regimen						
As-needed/ Regular	0.10	0.01 - 0.78	**0.028**	0.17	0.02-1.94	0.154
Device, DPI/MDI	0.41	0.14 - 1.24	0.113			
ICS adherence						
poor adherence	2.79	0.82 - 9.54	0.102			

Table 4. (Continued)

Risk factor related poor outcome	Univariable analysis			Multivariable analysis		
	OR	95%CI for OR	*p*-value	Adjusted OR	95%CI for adjusted OR	*p*-value
Previous status						
Poor adherence	2.50	0.82 - 7.66	0.109			
Poor ACT score (score < 19)	13.23	1.12 - 156.47	**0.040**	2.55	1.41 – 4.63	**0.002**
Spirometry in 2022						
FEV_1/FVC	0.87	0.73 - 1.02	0.085			
FEF_{25-75}	0.96	0.92 - 1.01	0.136			
Follow up						
Loss follow up	4.63	1.44 - 14.82	**0.010**	4.80	0.84-27.33	0.077
Behavior during covid						
Not wear facemask	3.60	1.02 – 12.70	**0.046**	8.52	1.26-57.79	**0.028**
Not Avoid crowded	4.70	0.99 - 22.33	0.052			

After adjusting for age, duration of asthma, inhaler regimen, previous ACT score, loss follow-up, and not wearing face mask, the multivariable analysis showed that the identified factor that related to the poor outcome of asthma was not wearing face mask (aOR = 8.52, 95%CI 1.26–57.79) and previously poor-controlled by the ACT score (aOR = 2.55, 95%CI 1.41–4.63).

Reasons for poor adherence **(Figure 2)**

Forty-two of 103 (40.8%) subjects reported poor adherence before the pandemic. The common reasons for poor adherence included deliberate actions due to the burden of treatment outweighing benefits, along with a hectic lifestyle and forgetfulness. During the pandemic, the proportion of subjects with poor adherence slightly increased to 39 of 88 (44.3%) and 28 of 64 (43.8%) subjects. The main reason for poor adherence was a hectic lifestyle and a misunderstanding of the disease; they supposed their asthma was completely resolved. Interestingly, deliberate actions and forgetfulness were less frequently reported during the pandemic.

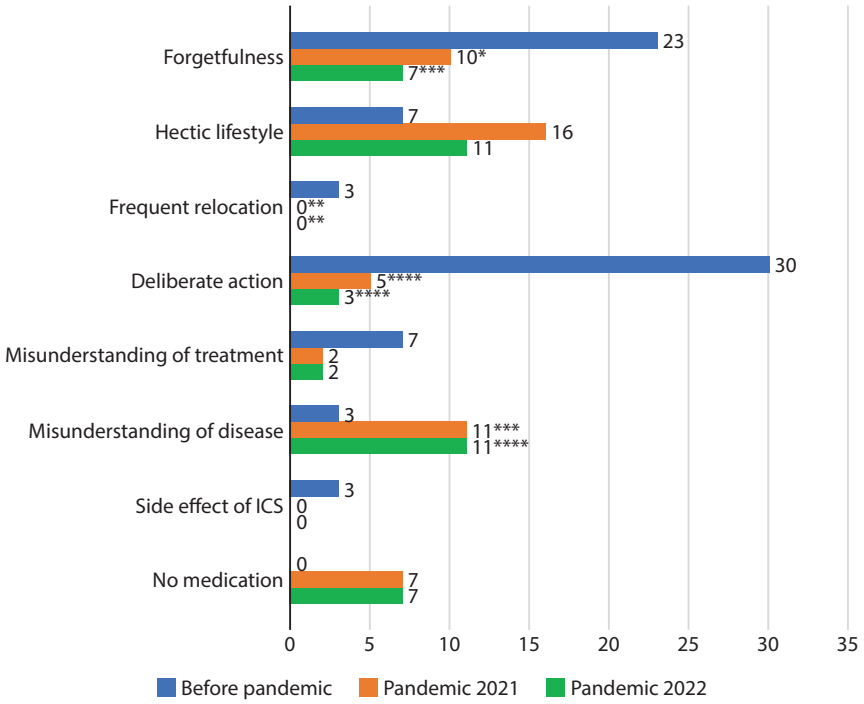

Figure 2. Reason related to poor adherence.

*p-value = 0.01, **p-value = 0.04, ***p-value = 0.001, ****p-value < 0.001

Discussion

In this study, we followed up on our school-age children and adolescents with asthma, comparing their asthma control status before the COVID-19 pandemic with during the pandemic, encompassing both the lockdown period and the time after. We found a significant decrease in asthma exacerbations, from 36.3% during the pandemic to 19.2% and 15.1% during the pandemic periods of 2021 and 2022, respectively. Furthermore, the risk factor for having poorly controlled asthma is not wearing a mask and previously poor-controlled by the ACT score.

Asthma controlled status by GINA guideline assessment before and during the pandemic period was not significantly different in our study (88.3% vs. 85.4%). This lack of significant change might be attributed to the loss of contact group, which was not enrolled in our study and had a lower percentage of well-controlled asthma status. The better asthma control status observed in the enrolled participants of our study may have masked any significant changes that could have been expected during the pandemic period. In addition, the mean and the percentage of well-controlled by ACT scores are also not significantly different. This result contrasts with a multi-national cohort study showing that the ACT score significantly increased during the COVID-19 pandemic.[7] It might be explained that the patients in our study had a higher pre-pandemic ACT score compared to those in the multi-national cohort (23.6 vs. 20). As a result, lack of significant change in ACT score control during the pandemic could be observed.

Asthma exacerbation was significantly decreased during the pandemic period. This result is similar to previous studies.[7,14] Unfortunately, we did not have the data on respiratory tract infections before the pandemic. So, we cannot conclude whether it is the cause of decreasing exacerbation. In Asia, especially Thailand, we had strict protocols during the COVID-19 pandemic. A survey in 2020 found that 97.6% of Thai adults wore face masks outside their homes.[15] We found that 84.4% of our subjects wore face masks when they went outside. While we lacked data on respiratory tract infections before the pandemic to demonstrate a decrease in infections during that period, a systematic review provided valuable insights. According to the review, wearing masks can reduce respiratory virus infections in healthcare workers by 80% and in non-healthcare workers by 47%.[16] Additionally, they revealed that the protective effect of wearing masks in Asia was significantly higher than in Western countries, with an odds ratio of 0.3 compared to 0.45. For this reason, we encourage asthmatic patients to wear face masks during a viral pandemic to reduce asthma exacerbation rate.

Adherence to the ICS use is a major cause of asthma exacerbation in adolescents.[17,18] In our study, the overall adherence rate during the pandemic was not significantly different from before the pandemic. However, the reasons for poor adherence were different. Before the pandemic, most reasons for poor adherence were deliberate action and forgetfulness. In contrast, the main reason during the pandemic was a misunderstanding of the disease that their asthma was completely resolved. Therefore, improvement of asthma education is a crucial factor.

The strength of our study is we followed up the same patients and compared the results before and during the pandemic, including both lockdown and non-lockdown periods. In addition, we had the details of the reason for poor adherence to the medication. Also, the attitude toward COVID-19 might be related to disease control.

The limitations of our study include: first, we cannot contact 29 (22%) of our patients from the previous study. The number of well-controlled asthma cases in this group was lower than in the enrollment group, which potentially introduces selection bias (**Table S1**). Consequently, the impact of the COVID-19 pandemic on individuals with previously poorly controlled asthma cannot be conclusively determined from our study. Second, 21 out of 103 subjects were lost to follow-up from the clinic, leading to an inability to evaluate lung function in these individuals. Nevertheless, our analysis focused solely on those subjects for whom pre-pandemic data were available, ensuring comparison of lung function within the same individuals and mitigating potential bias. Third, there is a lack of data on the frequency of respiratory tract infections before the pandemic. Consequently, we are unable to conclude whether the observed decrease in exacerbation during the pandemic is directly related to the decline in respiratory tract infections.

Conclusion

In summary, asthma exacerbation significantly decreased during the pandemic. Spirometry of FEV_1 of pre-bronchodilator and FVC were improved. Not wearing a face mask and previously poorly controlled by the ACT score are related to poor asthma outcomes.

Acknowledgments

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Author's Contribution

- PP and WP conceptualized this study.
- WP and KB contributed to subject recruitment and collected data.
- WP contributed to data analysis.
- WP and PP participated in writing the original draft.
- All authors have read and approved the manuscript.

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Supplementary table

Table S1. Demographic data comparing patients who follow up at the clinic VS loss of contact.

Demographic data	Total (N = 132)	Enrollment N = 103 (78.0%)	Loss of contact N = 29 (22.0%)	*p*-value
Age (years), mean ± SD	15.31 ± 2.84	15.12 ± 2.87	16.00 ± 2.67	0.139
Sex, male, n (%)	94 (71.2%)	69 (67.0%)	25 (86.2%)	**0.043**
Inhaler regimen in 2019				
Prn, n (%)	2 (1.6%)	1 (1%)	1 (3.7%)	0.392
Regular, n (%)	121 (98.4%)	95 (92.2%)	26 (96.3%)	0.392
Device				
DPI, n (%)	48 (36.4%)	37 (35.9%)	11 (37.9%)	0.843
MDI, n (%)	84 (63.6%)	66 (64.1%)	18 (62.1%)	0.843
ICS adherence rate				
Percent in 2019, mean ± SD	76.07 ± 27.43	76.76 ± 27.31	73.63 ± 28.17	0.588
Good adherence in 2019, n (%)	76 (57.6%)	61 (59.2%)	15 (51.7%)	0.470
Asthma controlled in 2019				
Level of control, well, n (%)	110 (83.3%)	91 (88.3%)	19 (65.5%)	**0.014**
ACT, mean ± SD	23.64 ± 1.98	23.60 ± 2.08	23.73 ± 1.71	0.831
Asthma exacerbation, n (%)	49 (38.0%)	36 (35.3%)	13 (48.1%)	0.439

Table S2. Demographic data of asthmatic patients during the pandemic of covid-19. (N = 103)

Follow up	Total (N = 103)	Well-controlled (N = 88)	Poor-controlled (N = 15)	*p*-value
Influenza vaccine, n (%)	74 (74%)	63 (73.3%)	11 (78.6%)	1.000
Comorbid				
Allergic rhinitis, n (%)	89 (86.4%)	75 (85.2%)	14 (93.3%)	0.687
Atopic dermatitis, n (%)	88 (88.9%)	11 (12.5%)	15 (100%)	0.207
Positive skin prick test to any aeroallergen, n (%)	89 (87.3%)	75 (86.2%)	14 (93.3%)	0.686
Frequency of Exercise				0.751
Never, n (%)	41 (43.2%)	36 (43.9%)	5 (38.5%)	
1-4/wk, n (%)	39 (42.0%)	34 (41.5%)	5 (38.5%)	
5-7/wk, n (%)	15 (15.8%)	12 (14.7%)	3 (23.1%)	
Passive smoking, n (%)	41 (42.3%)	35 (41.7%)	6 (46.2%)	0.458
Pets at home, n (%)	43 (44.3%)	36 (42.9%)	7 (53.8%)	0.551
Spirometry (N = 44)				
FEV_1/FVC, mean ± SD	87.69 ± 6.00	88.18 ± 5.87	82.96 ± 5.89	0.068
FEV_1 pre, mean ± SD	101.69 ± 12.57	101.59 ± 12.00	101.00 ± 18.84	0.230
FEF_{25-75}, mean ± SD	91.31 ± 25.09	92.74 ± 24.397	75 ± 27.45	0.138
Previous ICS adherence rate				
Percent, mean ± SD	76.76 ± 27.31	77.58 ± 27.61	71.99 ± 25.89	0.466
Good adherence, n (%)	61 (59.2%)	55 (62.5%)	6 (40.0%)	0.101
Previous controlled status				
Well-controlled†, n (%)	91 (88.3%)	81 (92%)	10 (66.7%)	**0.056**
ACT scores, mean ± SD	23.6 ± 2.08	23.87 ± 1.49	21.00 ± 4.77	0.315
Asthma attack, n (%)	36 (35.3%)	26 (29.9%)	10 (66.7%)	**0.006**

†Evaluated according to GINA guideline

Table S3. Attitude toward COVID-19.

Attitude toward covid	Total (N = 97)	Well-controlled (N = 82)	Poor-controlled (N = 15)	*p*-value
Fear, n (%)	51 (53.7%)	45 (55.6%)	6 (40.0%)	0.272
Self-awareness				
Wear facemask, n (%)	82 (84.5%)	72 (87.8%)	10 (66.7%)	**0.038**
Hand hygiene, n (%)	64 (66.7%)	54 (66.7%)	10 (66.7%)	1.000
Avoid crowds, n (%)	38 (39.2%)	36 (43.9%)	2 (13.3%)	**0.008**