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ORIGINAL RESEARCH

Changes in Respiratory Sensitivity Status of Patients in a Hospital in Shanxi Province Before and After the COVID-19 Epidemic

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Background: The lifting of the regional blockade in early December 2022 in Shanxi Province, China, caused an epidemic of Coronavirus disease 2019 (COVID-19). And the high allergy season from July to September each year.

Purpose: To investigate the effect of the COVID-19 epidemic on the respiratory sensitivity status of the population, to provide a scientific and effective basis for the prevention, diagnosis, condition assessment, and treatment of allergic respiratory diseases.

Methods: We collected 500 outpatient cases from Shanxi Medical University Second Hospital during the period from July to September 2022 and 500 cases during the period from July to September 2023 and divided them into the pre-COVID-19 epidemic group (the 2022 group) and the post-COVID-19 epidemic group (the 2023 group). We conducted statistical analysis on these patients' general conditions, pulmonary function test results, laboratory parameters, and fractional exhaled nitric oxide.

Results: Compared with 2022, the number of smokers decreased in 2023 ($p = 0.007$), while the incidence of respiratory allergic diseases such as bronchial asthma and allergic rhinitis increased ($p < 0.05$). In 2023, the results of pulmonary function tests showed that the positive rate of bronchial provocation/dilatation tests increased ($p < 0.001$), and the decline in FEV1 during provocation tests became more significant ($p < 0.001$). At the same time, laboratory results indicated that the count of eosinophils and the level of immunoglobulin E (IgE) in peripheral blood rose ($p < 0.001$), suggesting that the respiratory sensitivity of the population after COVID-19 infection might have increased.

Conclusion: Research results from Shanxi Province, China, indicate that the COVID-19 epidemic leads to increased respiratory sensitization and the incidence of respiratory allergic diseases. This suggests that we should pay attention to the changes in immune status and respiratory sensitivity among the population after COVID-19 infection, to accurately and timely assess and intervene in patients' conditions.

Keywords: COVID-19, airway hyper responsiveness, lung function, IgE

Introduction

The novel coronaviruses are envelope-positive single-stranded RNA viruses with a genome length of approximately 30 K nucleotides. COVID-19 is defined as a disease caused by the Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[1] The COVID-19 epidemic began in Wuhan, China, and spread rapidly around the world, resulting in an exponential increase in the number of infected patients, a dramatic rise in mortality, and an enormous global economic burden.[2] According to the World Health Organization, as of 10 November 2024, there have been more than 776 million confirmed cases of COVID-19 and 7 million deaths worldwide.[3] COVID-19 not only caused different degrees of damage to several important physiological systems, such as the endocrine system, the urinary system, the cardiovascular system, and the nervous system, but especially attacked the respiratory system, causing a series of neo coronary sequelae, and demonstrating its wide-ranging and complex pathological effects.[4–7] There are retrospective studies that have found that after COVID-19 infection long-term side effects such as abnormal lung function, impairment of diffusing capacity of the

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lung for carbon monoxide(DLCO), pulmonary solidification and interstitial fibrosis can occur.[8,9] COVID-19 infection can cause prolonged coughing, shortness of breath, persistent fatigue, sleep disturbances, and mast cell activation syndrome, which affects the immune system of the patient's patients and triggers allergic reactions.[10] A Korean cohort study included 354527 COVID-19 patients and 6134940 controls. It showed that the risk of multiple autoimmune and autoinflammatory diseases was significantly elevated after COVID-19 infection, suggesting that we need to pay attention to the changes in immune status after COVID-19 infection.[11] Secondly, during the COVID-19 epidemic, the Government of China adopted a series of strict anti-epidemic measures, including the imposition of regional blockades on several occasions, which resulted in severe social restrictions and posed a great challenge to human physical and mental health.[12]

Allergic or related diseases including asthma, allergic rhinitis, atopic dermatitis, urticaria, and food/drug allergies.[13] Respiratory allergic diseases mainly manifest by coughing, coughing up phlegm, wheezing, nasal congestion, sneezing, runny nose, runny eyes, chest tightness, sore throat, etc.[14,15] Studies have shown that COVID-19 infection can disrupt the immune system, causing an imbalance in T-cell homeostasis, which could be linked to respiratory tract allergic reactions.[16] IgE, eosinophils in blood or sputum, and fractional exhaled nitric oxide (FeNO) are biomarker markers for assessing allergic status[17] and provide an important reference for clinical diagnosis and treatment of allergic diseases. There has been evidence of increased rates of allergy to cats and dogs in adults during the COVID-19 pandemic.[18] Magdalena Chlabicz and her team found that serum High-sensitive C-reactive protein (hs-CRP) and FeNO levels increased in the population during the COVID-19 pandemic compared to the pre-pandemic period.[19] Additionally, a study discovered that individuals infected with COVID-19 may have enhanced airway reactivity.[20] A new coronavirus epidemic was brought on by the easing of the regional blockade in Shanxi Province, China, in early December 2022. Based on the information reviewed, we hypothesize that a COVID-19 epidemic may lead to increased respiratory sensitivity in the population.The study retrospectively included patients who attended the Department of Otorhinolaryngology or the Department of Respiratory and Critical Care Medicine of the Second Hospital of Shanxi Medical University between July and September of 2022 and 2023. The patients who attended in July and September of 2022 were classified as pre-COVID-19 epidemic, while those who attended in July and September of 2023 were classified as post-COVID-19 epidemic, referred to as the 2022 group and the 2023 group. The purpose of this study was to retrospectively analyze the general demographic characteristics, pulmonary function test results, FeNO, laboratory indicators (hematological analysis, IgE), and other respiratory sensitization indicators of the 2022 and 2023 populations using a cross-sectional study. The aim is to analyze and compare the changes in the respiratory sensitivity status of the population before and after the COVID-19 epidemic, to provide a more theoretical basis for the prevention, diagnosis, condition assessment, and treatment of allergic respiratory diseases.

Materials and Methods

Study Population

This study retrospectively collected patients who attended the outpatient clinics of the Department of Respiratory and Critical Care Medicine and the Department of Otorhinolaryngology of the Second Hospital of Shanxi Medical University from July-September 2022 and July-September 2023, and 500 patients were randomly selected from each to analyze their clinical data. The study was authorized by the Ethics Committee of Shanxi Medical University's Second Hospital under approval number 2023 YX 131, and all subjects gave their informed consent.

Research Methodology

Patients admitted from 1 July to 30 September 2022 were classified as the COVID-19 pre-epidemiology group, abbreviated as the 2022 group, and patients admission between 1 July and 30 September 2023 were assigned to the post-epidemic group (abbreviation as the 2023 group), with 500 patients randomly selected from each. 500 patients were randomly selected as the study sample from the entire population of each group, and to ensure that each patient was sampled with an equal probability, we used the random number generator of the SPSS version 27.0.1 software to help in random sampling. Demographic characteristics, pulmonary function results, FeNO, and laboratory indices at the time of patient visits were retrieved from the hospital outpatient system. All data were extracted by two independent researchers using a uniform data collection form. Clinical data including general information, smoking history, pulmonary function

test results (improvement rate of bronchial provocation/dilatation test, FEV1/FVC, MEF50, MEF25), FeNO, and laboratory indices (analysis of the peripheral blood cells, IgE) were collected from the two groups of patients.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) software, specifically version 27.0.1 (IBM Corp., Armonk, NY, USA). The normality of the distribution of the measurement data was assessed using the Kolmogorov–Smirnov test (KSMT). Descriptive statistics of quantitative variables were expressed as means or standard deviations. The values of normally distributed data are compared using the Independent Samples *t*-test. Continuous data that do not follow a normal distribution are first subjected to a homogeneity of variance test. If the homogeneity of variance assumption is not met, the Mann–Whitney *U*-Test is used for comparison. Categorical variables were expressed as frequency distributions and percentages, and data for categorical variables were compared using the chi-square test. $P<0.05$ was considered statistically significant.

Results

Demographic Characteristics and Smoking History of the Two Population Groups

The study showed little difference between the two groups analyzed in terms of gender (p=0.163), height (p=0.115), weight (p=0.902), and body mass index (p=0.171). In contrast, the mean age of people attending the clinic during the COVID-19 epidemic was reduced compared to before the COVID-19 epidemic (48.07±17.19 years vs 51.65±16.23 years, p=0.006). In addition, there was a decrease in the number of smokers in 2023 (40.6% vs 43.4%, p=0.007) (Detailed data can be found in Table 1).

The Reported Incidence of Respiratory Disease in Both Population Groups

Data analysis showed that involving respiratory diseases, the prevalence of bronchial asthma (25.2% vs 19.8%, p=0.041), allergic rhinitis (26.6% vs 21.2%, p=0.045), and chronic pharyngolaryngitis (2.8% vs 1.4%, p=0.123) was significantly higher in the 2023 population than in 2022. However, the prevalence of chronic obstructive pulmonary disease (COPD, 20.2% vs 22.8%) was lower than in 2022 (p=0.008) (Detailed data can be found in Figure 1).

Pulmonary Function Test results in Both Population Groups

We briefly analyzed the pulmonary function test results of the two population groups. There were no significant differences between 2023 and 2022 in 1-second rate (FEV1, p=0.437), and in instantaneous expiratory flow at forceful expiration of 50% of lung volume (MEF50, p=0.051). However, the instantaneous expiratory flow at forceful expiration of 75% of lung volume was slightly higher in 2023 than in 2022 (MEF25, 0.96±0.64 vs 0.82±0.48, p=0.001). The rate of positive bronchial provocation or dilatation tests was significantly higher in 2023 than in 2022 (25.2% vs 19.8%, p<0.001) (Detailed data can be found in Table 2 and Figure 2A).

Table 1 Demographic Characteristics Before and After the COVID-19 Epidemic

Variable	Population before the COVID-19 Epidemic N=500	Population after the COVID-19 Epidemic N=500	p
Age, years	51.65±16.23	48.07±17.19	0.006*
Male sex, n(%)	242 (48.4%)	220 (44%)	0.163
Height, cm	162.96±9.85	164.04±8.79	0.115
Weight, Kg	65.03±12.88	65.16±14.02	0.902
BMI, kg/m^2	24.61±5.94	24.09±4.12	0.171
Smoking, n(%)	217 (43.4%)	203 (40.6%)	0.007*

Notes: Quantitative variables are shown as mean ± SD and categorical variables are shown as n (%). *P<0.05.
Abbreviations: SD, standard deviation; cm, centimeter; kg, kilogram; BMI, body mass index; Kg/m^2, kilogram per square meter.

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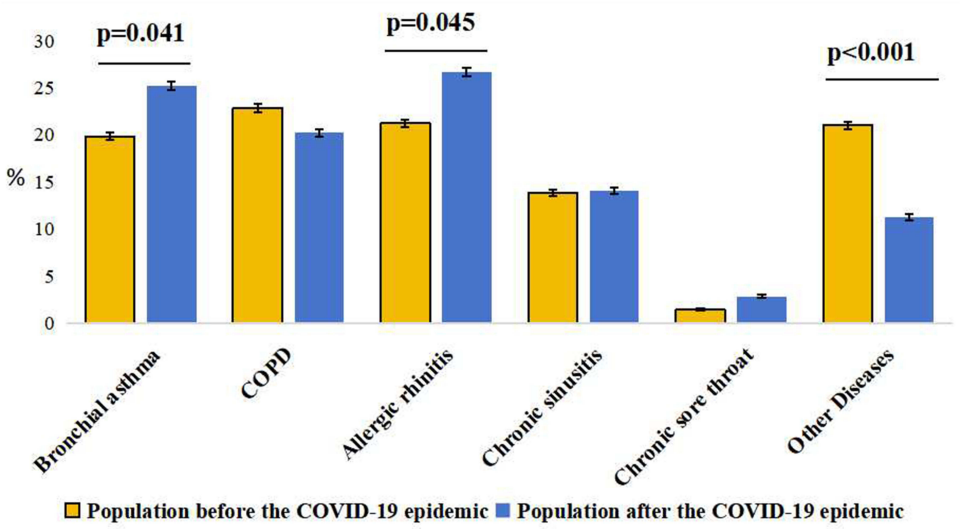

Figure 1 Incidence of respiratory diseases in the general population before and after the COVID-19 epidemic. The data are shown as n (%).
Abbreviation: COPD, Chronic obstructive pulmonary disease.

Among the pulmonary function tests performed, 368 patients underwent a bronchial provocation test (BPT) and 58 patients underwent a bronchial dilatation test (BDT) in 2022; 346 patients underwent a bronchial provocation test (BPT) and 102 patients underwent a bronchial dilatation test (BDT) in 2023. Next, the results of the provocation test and dilatation test were analyzed separately. In the BPT, there was no difference in FEV1 (p=0.517; p=0.512) and FEV1/FVC (p=0.116; p=0.736) between the pre- and post- provocation periods. The rate of decrease and value of decline in FEV1 were significantly higher in 2023 compared to 2022 (12.43±7.68 vs 9.91±7.08, p<0.001; 0.33±0.22 vs 0.27±0.19, p<0.0001). This corresponds to an increase in the positive rate of the BPT or BDT in 2023 compared with 2022 (Detailed data can be found in Table 3 and Figure 2B).

However, in the BDT, FEV1 was elevated pre- and post- dilatation in 2023 compared to 2022 (2.00±0.90 vs 1.55 ±0.48, p=0.004; 2.22±0.93 vs 1.82±0.58, p=0.019). FEV1/FVC pre- and post-dilatation was also elevated in 2023 compared to 2022 (63.99±15.46 vs 56.47±12.01, p<0.001; 66.11±15.47 vs 59.77±12.56, p=0.009). Most importantly, there was no significant change in FEV1 elevation values in 2023 compared to 2022 (p=0.122). Nevertheless, the rate of FEV1 elevation decreased compared to 2022 (12.61±9.59 vs 15.77±9.41, p=0.017), and the difference was statistically significant (Detailed data can be found in Table 4 and Figure 2C, D).

Table 2 Pulmonary Function Measurements Before and After the COVID-19 Epidemic

Variable	Population before the COVID-19 Epidemic N=500	Population after the COVID-19 Epidemic N=500	p
FEV1, L	2.61±0.82	2.63±0.87	0.437
Positive for provocation or dilatation, n(%)	99 (19.8%)	126 (25.2%)	<0.001*
MEF50, L/s	2.81±1.36	3.00±1.48	0.051
MEF25, L/s	0.82±0.48	0.96±0.64	0.001*

Notes: The data are shown as n (%), mean ± SD. *P<0.05.
Abbreviations: FEV1, forced expiratory volume in 1s; MEF50, maximal expiratory flow after 50% of the FVC has not been exhaled; MEF25, maximal expiratory flow after 25% of the FVC has not been exhaled; FVC, forced vital capacity; L, liter; s, second; L/s, liter per second.

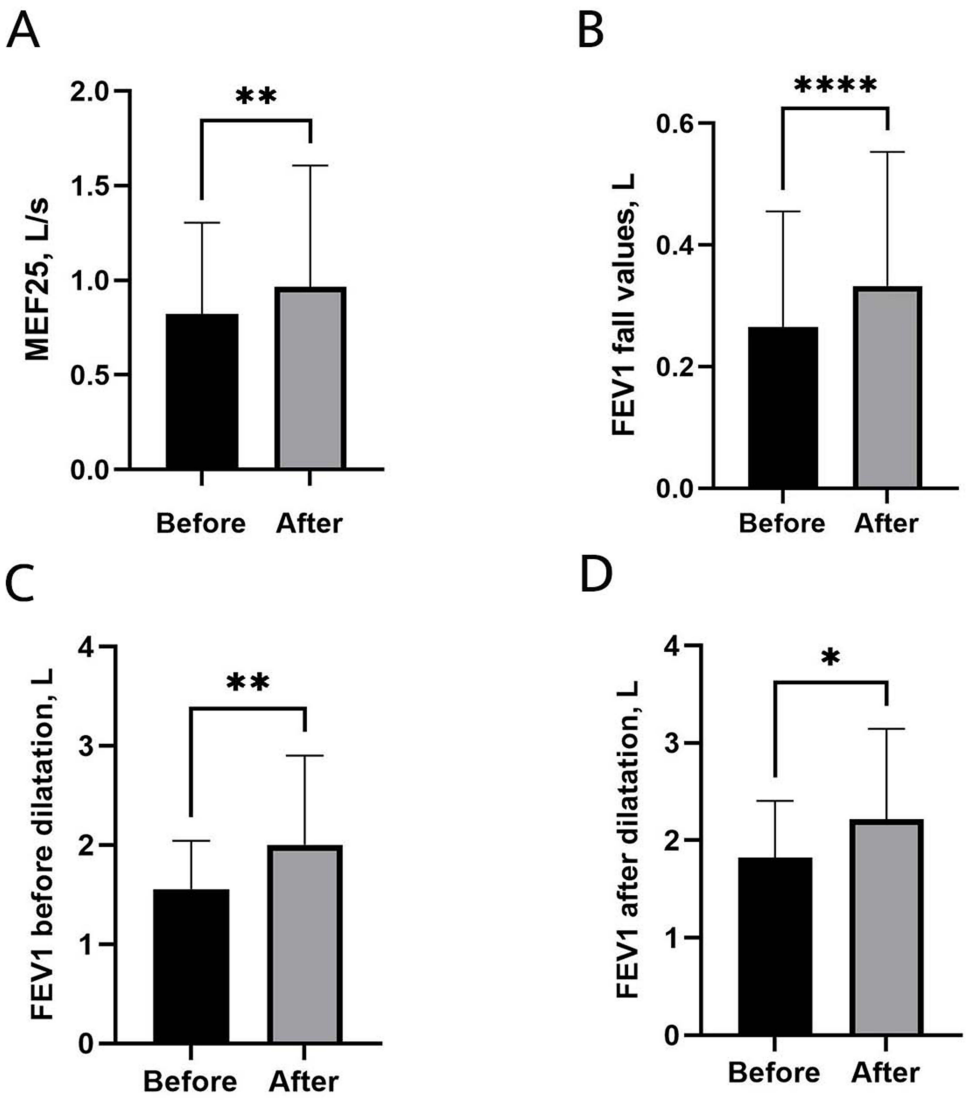

Figure 2 In the figure, the Before group refers to the Population before the COVID-19 epidemic group, and the After group refers to the Population after the COVID-19 epidemic group. (**A**) MEF25 values of pre-COVID-19 group and post-COVID-19 group. (**B**) Decline in FEV1 in patients undergoing bronchial provocation testing before and after the COVID-19 epidemic. (**C**) Values of the predilation FEV1 during bronchodilator testing were obtained before and after the COVID-19 epidemic. (**D**) Values of postdilation FEV1 during bronchodilator testing were obtained before and after the COVID-19 epidemic. *indicates $P < 0.05$, **indicates $P < 0.01$, **** indicates $P < 0.0001$. **Abbreviations**: MEF25, maximal expiratory flow after 25% of the FVC has not been exhaled; FEV1, forced expiratory volume in 1s.

Laboratory Indicators in Both Population Groups

The results showed that allergic indicators such as the absolute value of eosinophils and IgE were significantly higher in peripheral blood in 2023 compared with 2022 (0.32±0.30 vs 0.22±0.23, $p<0.001$; 190.42±149.97 vs 142.50±104.65, $p<0.001$). In addition, peripheral blood leukocyte count (7.33±2.36 vs 6.89±2.65, $p<0.001$), absolute lymphocyte count (2.34±1.02 vs 2.07±0.75, $p<0.001$), absolute monocyte count (0.43±0.22 vs 0.41±0.20, $p=0.004$) and platelet (PLT) count (273.28±71.56 vs 263.24±76.93, $p=0.014$) were higher than in 2022 and the difference was statistically significant. In the line nitric oxide breath test, FeNO concentration was higher after COVID-19 epidemic (39.91±41.05 vs 36.88±35.42, $p=0.558$), but the difference was not statistically significant (Detailed data can be found in Table 5).

Discussion

This study primarily provides data on the incidence of respiratory diseases in the population of Shanxi, China, for the years 2023 and 2022, as well as information on lung function tests and laboratory indicators. The results of the study

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Table 3 Bronchial Provocation Tests Before and After the COVID-19 Epidemic

	Population before the COVID-19 Epidemic N=368	Population after the COVID-19 Epidemic N=346	p
Before FEV1 provocation, L	2.81±0.75	2.83±0.77	0.517
After FEV1 provocation, L	2.54±0.74	2.50±0.78	0.512
FEV1 decline rate, %	9.91±7.08	12.43±7.68	<0.001*
FEV1 fall values, L	0.27±0.19	0.33±0.22	<0.0001*
FEV1/FVC before provocation, %	77.41±6.82	78.45±7.19	0.116
FEV1/FVC after provocation, %	74.49±8.38	75.10±8.28	0.736

Notes: The data are shown as n (%), mean ± SD. *P<0.05.
Abbreviations: FEV1, forced expiratory volume in 1s; FVC, forced vital capacity; FEV1 decline rate, percentage decrease in the value of FEV1 relative to its baseline or initial measurement value; FEV1 fall values, The amount of decrease in FEV1 relative to normal expected value or previously measured value; FEV1/FVC(One-second rate), 1st second exertion lung volume as a percentage of exertion lung volume; L, liter; s, second; L/s, liter per second.

Table 4 Bronchial Dilation Tests Before and After the COVID-19 Epidemic

	Population before the COVID-19 Epidemic N=58	Population after the COVID-19 Epidemic N=102	p
FEV1 before dilatation, L	1.55±0.48	2.00±0.90	0.004*
FEV1 after dilatation, L	1.82±0.58	2.22±0.93	0.019*
FEV1 elevation rate, %	15.77±9.41	12.61±9.59	0.017*
FEV1 elevated values, L	0.27±0.21	0.21±0.15	0.122
FEV1/FVC before dilatation, %	56.47±12.01	63.99±15.46	<0.001*
FEV1/FVC after dilatation, %	59.77±12.56	66.11±15.47	0.009*

Notes: The data are shown as n (%), mean ± SD. *P<0.05.
Abbreviations: FEV1, forced expiratory volume in 1s; FVC, forced vital capacity; FEV1 elevation rate, Percentage increase in FEV1 values relative to their baseline or initial measurements; FEV1 elevated values, The amount of increase in FEV1 relative to the normal expected value or previously measured value; FEV1/FVC(One-second rate), 1st second exertion lung volume as a percentage of exertion lung volume; L, liter; s, second; L/s, liter per second.

Table 5 Laboratory Parameters Before and After the COVID-19 Epidemic

	Normal Range	Population before the COVID-19 Epidemic N=500	Population after the COVID-19 Epidemic N=500	p
WBC ($\times10^9$/L)	3.50–9.50	6.89±2.65	7.33±2.36	<0.001*
Hgb (g/L)	130.00–175.00	139.60±18.90	139.50±17.13	0.825
PLT ($\times10^9$/L)	125.00–350.00	263.24±76.93	273.28±71.56	0.014*
Eosinophil ($\times10^9$/L)	0.02–0.52	0.22±0.23	0.32±0.30	<0.001*
Neutrophils ($\times10^9$/L)	1.80–6.30	4.16±2.40	4.21±1.96	0.145
Basophil ($\times10^9$/L)	0.00–0.06	0.028±0.20	0.028±0.20	0.997
Lymphocytes ($\times10^9$/L)	1.10–3.20	2.07±0.75	2.34±1.02	<0.001*
Monocytes ($\times10^9$/L)	0.10–0.60	0.41±0.20	0.43±0.22	0.004*
Erythrocyte ($\times10^{12}$/L)	4.30–5.80	4.71±0.50	4.79±0.48	0.039
IgE (IU/mL)	0–100	142.50±104.65	190.42±149.97	<0.001*
FeNO (ppb)	5–25	36.88±35.42	39.91±41.05	0.558

Notes: The data are shown as mean ± SD. *P<0.05.
Abbreviations: WBC, white blood cell; Hgb, hemoglobin; PLT, platelet count; IgE, immunoglobulin E; FeNO, fractional exhaled nitric oxide; ppb, parts per billion; L, liter; g/L, gram per liter; IU/mL, international units per milliliter.

showed that: (1) the prevalence of respiratory diseases such as bronchial asthma, allergic rhinitis, and chronic pharyngolaryngitis increased in 2023 compared with 2022, the number of smokers decreased, and the reported prevalence of COPD decreased compared with that of the previous year; (2) the positive rate of bronchial provocation or dilation tests in 2023 was significantly higher than that in 2022; moreover, during the bronchial provocation tests, the rate and value of decline in FEV1 in 2023 had significantly increased compared to 2022; (3) among the laboratory indicators, the absolute value of eosinophils and IgE in the peripheral blood of the population were higher in 2023 compared with 2022. In summary, the current study found that the COVID-19 epidemic may lead to increased respiratory susceptibility in the population and will have an immeasurable long-term impact on human health.

Jiyeon Oh et al conducted a large-scale cohort study across 3 countries, Korea, Japan, and the United Kingdom, with an initial enrollment of 22 million participants, and found that the risk of developing allergic diseases in people who had been infected with COVID-19 was 1.2 times higher than that of those who had not been infected with the COVID-19. Among them, the risk of developing allergic asthma was 2.25 times higher than that of uninfected people, and the risk of developing allergic rhinitis was 1.23 times higher.[16] Our study examined the prevalence of asthma and allergic rhinitis among Chinese patients in the context of the COVID-19 epidemic. The results showed a significant increase in the prevalence of both diseases, which coincided with our expectations. More importantly, this finding further corroborates that the COVID-19 pandemic has indeed led to a generalized increase in respiratory sensitization in Chinese patients. This is consistent with the findings of Jiyeon Oh et al. Interestingly, the prevalence of asthma and allergic rhinitis decreased among Korean adolescents during the COVID-19 pandemic,[21] which may be related to the more restricted population and region of the study.

Globally, smoking remains a major determinant of preventable morbidity and mortality.[22] We found a decrease in smoking during and after the COVID-19 epidemic compared to the previous period, consistent with the findings of Sarich et al.[23] The study, a meta-analysis of smoking behavior before and during the COVID-19 pandemic, involved 24 countries and included nearly 270,000 subjects, with smoking prevalence during the pandemic being lower than before and 21% of smokers reducing their tobacco use. The growing public health awareness and the gradual realization of the serious respiratory harm caused by smoking have prompted more and more people to turn away from tobacco and choose a healthy lifestyle. Therefore, we can observe that the number of smokers is gradually decreasing, showing the enhancement of social health awareness and the improvement of public health behaviors.

Pulmonary function tests are particularly important because novel coronaviruses primarily affect the respiratory system; FEV1% is defined as the percentage of expiratory lung volume in the first second as a proportion of expiratory lung volume. FEV1% is the most commonly used parameter and sensitivity index for determining ventilation dysfunction and its extent, and its decrease indicates the presence of obstructive ventilation dysfunction.[24] Allergic airway inflammation is a key pathogenesis of bronchial asthma,[25] which is mainly characterized by airway hyper responsiveness-(AHR), reversible airflow limitation, airway inflammation, and airway remodeling.[26] BPT/BDT is an important laboratory test for the diagnosis of bronchial asthma. The changes in FEV1 measured before and after excitation/dilatation reflect AHR and are used to assess airway sensitivity.[27] In our study, we found that the rate of FEV1 decline and the value of decline in the BPT were significantly higher after the COVID-19 epidemic compared with the pre-epidemic period, laterally reflecting the increased airway responsiveness of the population after the COVID-19 epidemic. In the BDT, the pre-dilatation FEV1 was elevated in 2023 compared with 2022, which may indicate that the patient's lung function has recovered and airway obstruction has been relieved, while the post-dilatation FEV1, which was also elevated in 2023, indicates that airway obstruction is reversible, which contributes to the diagnosis of bronchial asthma, and indirectly indicates that airway responsiveness is increased. It has been demonstrated that AHR already occurs during early recovery from COVID-19.[20] Maniscalco et al found that the use of bronchodilators in patients following COVID-19 infection induced improved lung function and helped to promote respiratory health.[28] However, there was a Swedish study based on lung function before and after COVID-19 in young people, which did not find evidence of the long-term effects of mild to moderate COVID-19 on lung function.[29] This may be related to the small sample size included in its study and the more restricted area.

Immunoglobulin E plays a crucial role in allergic reactions, and in sensitized individuals, it triggers a strong inflammatory response as soon as it comes into contact with the antigen.[30] IgE-dependent allergy is driven by a type

2 inflammatory response (Th2) involving the participation of multiple immune cells and cytokines.[31] For example, type 2 helper T cells, mast cells, eosinophils, basophils, type 2 innate lymphocytes, and cytokines such as interleukin-4, interleukin-5, interleukin-9, and interleukin-13.[32] Gevaert et al observed significantly elevated IgE levels in allergic airway diseases such as allergic rhinitis, allergic fungal sinusitis, bronchial asthma, and allergic bronchopulmonary aspergillosis.[33] It has been established that IgE induces AHR after respiratory viral infections,[34] and our study found that IgE and eosinophils were significantly elevated in COVID-19-infected patients, which may further contribute to increased respiratory susceptibility in COVID-19-infected patients, and thus anti-IgE could be a potential treatment for COVID-19 in future Research.

Some studies have shown that FeNO levels are significantly elevated in patients with novel coronavirus infections[19,35] and that FeNO level scores also predict COVID-19 disease severity.[36] We found elevated FeNO values in the population after COVID-19 infection compared to pre-infection, but the difference was not statistically significant. Maniscalco et al analyzed 68 patients with COVID-19 infection and 29 healthy volunteers and found that the mean difference in FeNO values was not statistically significant (18.55 vs 17.46, p=0.053),[37] which is similar to our findings. We should conduct multi-center and multi-geographic studies to make the results more accurate.

It has been established that asthma and some allergic diseases are exacerbated by seasonal changes.[38] Our study was a single center cross-sectional study with small sample size, and the study sample was concentrated in July-September of each year. The results may be affected by confounding factors such as climate change and selection bias. Moreover, environmental factors may also affect the respiratory health of the population, such as air pollution, tobacco exposure, Particulate Matter 2.5 (PM2.5), sulfur dioxide, and airborne allergens, which can irritate the respiratory tract, leading to respiratory inflammation and allergic reactions.[39] We should conduct more in-depth and detailed studies to control confounding factors and obtain more accurate results.

Limitations

The study was a single-center cross-sectional study with retrospective sampling that increases the risk of selection bias. The sample size of this study was relatively small due to time and resource constraints. In addition, seasonal allergies may have interfered with the study results. It is worth noting that the study area was mainly concentrated in Shanxi Province, China, so the results may be affected by the constitution of specific populations in the region. Future studies may consider conducting the study in more diverse regions to enhance the generalizability and replicability of the results of this study.

Conclusion

The results of the study in Shanxi Province, China, suggest that the COVID-19 epidemic leads to increased respiratory sensitivity in the population and an increase in the incidence of respiratory-associated allergic diseases. Multicenter studies are needed to investigate the long-term effects of the COVID-19 epidemic on the immune status and respiratory health of the population and to further explore the pathogenesis of the increased respiratory sensitivity in the population due to new coronavirus infections. We should pay attention to the changes in the immune status and respiratory sensitivity of the population after COVID-19 infection, and long-term follow-up studies are recommended to accurately and promptly assess and intervene in patients.

Abbreviations

COVID-19, coronavirus disease 2019; IgE, immunoglobulin E; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; DLCO, diffusing capacity of the lung for carbon monoxide; FeNO, fractional exhaled nitric oxide; hs-CRP, high-sensitive C-reactive protein; FEV1, forced expiratory volume in 1 s; FEV1/FVC, 1st second exertion lung volume as a percentage of exertion lung volume; MEF50, maximal expiratory flow after 50% of the FVC has not been exhaled; MEF25, maximal expiratory flow after 25% of the FVC has not been exhaled; SPSS, statistical package for the social sciences; COPD, chronic obstructive pulmonary disease; BPT, bronchial provocation test; BDT, bronchial dilatation test; PLT, platelet count; AHR, airway hyper responsiveness; Th2, type 2 inflammatory response; PM2.5, particulate matter 2.5.

Statement of Informed Consent

All procedures conducted in the study involving human subjects were by the ethical standards of the Ethics Committee of the Second Hospital of Shanxi Medical University (approval number 2023 YX 131) and the 1964 Declaration of Helsinki and its subsequent amendments or similar ethical standards. Written informed consent was obtained from all volunteers and the anonymity of each participant was strictly preserved.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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