

National Trends in Allergic Rhinitis and Chronic Rhinosinusitis and COVID-19 Pandemic-Related Factors in South Korea, from 1998 to 2021

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Keywords

Allergic rhinitis · Chronic rhinosinusitis · COVID-19 · Prevalence · Trend

Abstract

Introduction: Existing studies provide insights into the prevalence and environmental factors associated with allergic rhinitis (AR) and chronic rhinosinusitis (CRS) globally. However, limitations still persist in these studies, particularly regarding cohort sizes and the duration of follow-up periods, indicating a need for more comprehensive and long-term research in these fields. Our study aimed to investigate the prevalence, long-term trends, and underlying factors of these conditions in the general population of adult participants

(≥19 years) in Korea. **Method:** We analyzed data from adult participants (≥19 years) from the Korea National Health and Nutrition Examination Survey (KNHANES) study to determine the prevalence of AR and CRS from 1998 to 2021. To analyze prevalence trends before and during the COVID-19 pandemic, we employed a weighted linear regression model and obtained β -coefficients with 95% confidence intervals (CI). **Results:** Between 1998 and 2021, over a span of 24 years, the comprehensive KNHANES study included 146,264 adult participants (mean age: 47.80 years, standard deviation: 16.49 years; 66,177, 49.3% men). The prevalence of AR and CRS

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increased from 1998 to 2021, with AR prevalence rising from 5.84% (95% CI, 5.57–6.10) in 1998–2005 to 8.99% (8.09–9.91) in 2021 and CRS from 1.84% (1.70–1.97) in 1998–2005 to 3.70% (3.18–4.23) in 2021. However, the increasing trend has slowed down during the COVID-19 pandemic era. **Conclusions:** The significance of continuous monitoring and focused interventions for AR and CRS is underscored by this study. The observed deceleration in the rising prevalence of AR and CRS during the pandemic indicates the possibility of beneficial impacts from lifestyle modifications triggered by the pandemic. These findings call for additional research to explore potential protective effects in greater depth.

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Introduction

Existing studies provide insights into the prevalence and environmental factors associated with allergic rhinitis (AR) and chronic rhinosinusitis (CRS) globally [1]. Recent findings highlight the growing public health concern of AR, emphasizing the role of environmental exposures and lifestyle changes, especially during the COVID-19 pandemic [2]. Similarly, research on CRS reveals significant variations in prevalence and treatment trends worldwide, with substantial socioeconomic impacts in regions like the USA and Europe [3, 4]. However, limitations still persist in these studies, particularly regarding cohort sizes and the duration of follow-up periods, indicating a need for more comprehensive and long-term research in these fields. Despite these advances, there is a noticeable gap in this research when it comes to specific populations, such as South Korea. Recognizing this, this study aimed to investigate the prevalence, long-term trends, and underlying factors of these conditions in the general population of Korea. We utilize nationally representative data from the Korea National Health and Nutrition Examination Survey (KNHANES), conducted annually by the Korea Disease Control and Prevention Agency (KDCA).

Methods

Data gathered from multiple national surveys carried out by the KNHANES were utilized to determine the prevalence of AR and CRS among Korean adults, defined as individuals aged 19 years and over [5, 6]. The KNHANES is an annual survey that commenced in 1998 and aims to collect information on the health and dietary habits of the Korean population. This study protocol was reviewed and approved by the KDCA and Institutional Review Board of Kyung Hee University, approval number (KHUH 2022-

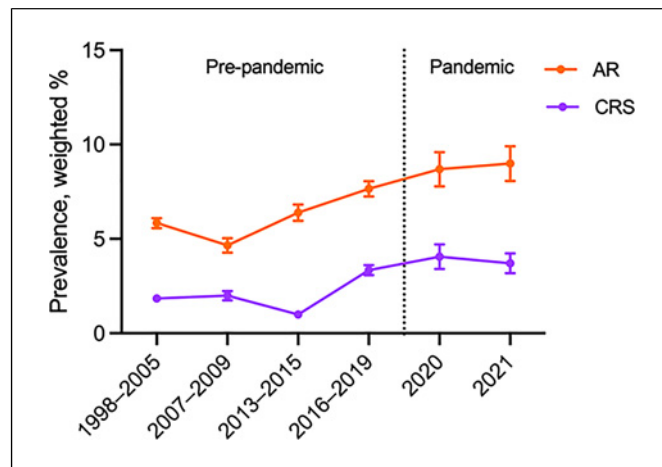


Fig. 1. Twenty-four-year trends in the weighted prevalence of AR and CRS in South Korea, 1998–2021. AR, allergic rhinitis; CRS, chronic rhinosinusitis.

06-042). This research adhered to the ethical guidelines established by relevant national and Institutional Review Boards for human research and followed the 1975 Helsinki Declaration, as amended in 2008. Written informed consent was obtained from participants prior to the study.

Our research aimed to uncover the risk factors associated with the two most frequent types of rhinitis, AR and CRS, over a span of 24 years from 1998 to 2021. We executed a survey involving a large population, posing two separate questions: “Have you been diagnosed by a doctor with AR?” and “Have you been diagnosed by a doctor with CRS? The respondents were given the options to answer either yes or no [7, 8]. Instances with missing data were excluded from the analysis. The specific detail of the factor smoking status was defined as “current smoking status of cigarettes.”

Weighted composite sampling analysis was carried out using linear and logistic regression models [5, 6]. To analyze prevalence trends before and during the COVID-19 pandemic, we employed a weighted linear regression model to obtain a β -coefficient with a 95% confidence interval (CI). Specifically, we defined the start of the pandemic period based on the notification to the WHO China Country Office of 44 cases of pneumonia of unknown cause in Wuhan, China, between December 31, 2019, and January 3, 2020 [9]. The β_{diff} was analyzed to indicate the distinction between the pre-pandemic (1998–2020) and pandemic periods (2020 and 2021) [5, 6]. Those with a two-sided p value <0.05 were included. Statistical analyses were conducted using SAS version 9.4 (SAS Institute; Cary, NC, USA) [10].

Results

General attributes are illustrated in online supplementary Table S1, which shows the baseline participants of this study (for all online suppl. material, see <https://doi.org/10.1159/000535648>). From the total participants

Table 1. National trend of the prevalence of AR and β -coefficients and ORs before and during the COVID-19 pandemic, weighted % (95% CI), in the KNHANES

Period	Pre-pandemic					Pandemic		Trend of the pre-pandemic era, β (95% CI)		Trend of the pandemic era, difference, β_{diff} (95% CI)	
	1998–2005	2007–2009	2013–2015	2016–2019	2020	2021					
AR, weighted % (95% CI)											
Overall	5.84 (5.57–6.10)	4.65 (4.27–5.03)	6.39 (5.96–6.82)	7.65 (7.24–8.06)	8.69 (7.78–9.60)	8.99 (8.07–9.91)		0.009 (0.007–0.011)	0.003 (–0.010 to 0.016)	–0.006 (–0.019 to 0.007)	
Age, weighted % (95% CI)											
19–59	6.60 (6.29–6.90)	5.06 (4.62–5.51)	7.09 (6.57–7.61)	8.55 (8.05–9.06)	10.11 (8.97–11.25)	10.08 (8.90–11.27)		0.036 (0.032–0.040)	–0.007 (–0.037 to 0.024)	–0.043 (–0.073 to –0.012)	
≥60	2.33 (2.02–2.63)	2.87 (2.29–3.45)	3.94 (3.37–4.50)	4.95 (4.41–5.48)	4.98 (3.93–6.02)	6.30 (5.12–7.48)		0.013 (0.010–0.016)	0.018 (–0.004 to 0.040)	0.005 (–0.017 to 0.027)	
Sex, weighted % (95% CI)											
Male	5.05 (4.70–5.39)	2.40 (1.97–2.82)	3.58 (3.05–4.11)	4.71 (4.24–5.18)	5.26 (4.29–6.22)	6.36 (5.22–7.50)		0.003 (0.000–0.005)	0.011 (–0.004 to 0.026)	0.008 (–0.007 to 0.023)	
Female	6.58 (6.22–6.93)	6.86 (6.21–7.51)	9.14 (8.49–9.80)	10.57 (9.91–11.22)	12.10 (10.65–13.55)	11.60 (10.27–12.93)		0.028 (0.024–0.032)	–0.010 (–0.038 to 0.019)	–0.038 (–0.066 to –0.010)	
Region of residence, weighted % (95% CI)											
Urban	6.33 (6.02–6.63)	4.90 (4.46–5.34)	6.84 (6.35–7.33)	7.74 (7.29–8.18)	9.04 (8.02–10.06)	9.46 (8.44–10.48)		0.027 (0.024–0.030)	0.004 (–0.020 to 0.029)	–0.022 (–0.047 to 0.002)	
Rural	3.74 (3.25–4.23)	3.60 (2.87–4.34)	4.29 (3.46–5.12)	7.18 (6.06–8.30)	6.77 (4.99–8.55)	6.52 (4.57–8.47)		0.022 (0.016–0.028)	–0.010 (–0.055 to 0.034)	–0.033 (–0.077 to 0.012)	
Education background, weighted % (95% CI)											
High school or lower	4.71 (4.44–4.97)	3.96 (3.54–4.38)	4.95 (4.51–5.39)	6.31 (5.85–6.77)	7.09 (6.10–8.08)	7.53 (6.46–8.60)		0.020 (0.017–0.023)	0.006 (–0.019 to 0.030)	–0.014 (–0.039 to 0.011)	
College or higher	8.20 (7.64–8.75)	6.26 (5.44–7.09)	9.33 (8.41–10.24)	9.65 (8.94–10.35)	11.13 (9.55–12.71)	11.05 (9.52–12.58)		0.037 (0.031–0.043)	–0.013 (–0.053 to 0.027)	–0.050 (–0.091 to –0.009)	
Household income, weighted % (95% CI)											
Low income (quartiles 1 and 2)	4.73 (4.40–5.05)	4.34 (3.78–4.90)	5.56 (4.95–6.18)	7.06 (6.43–7.69)	7.33 (6.10–8.55)	8.21 (6.82–9.59)		0.020 (0.016–0.023)	0.009 (–0.019 to 0.037)	–0.010 (–0.039 to 0.018)	
High income (quartiles 3 and 4)	6.78 (6.39–7.17)	4.87 (4.34–5.39)	6.95 (6.36–7.53)	8.05 (7.51–8.58)	9.50 (8.23–10.77)	9.44 (8.16–10.72)		0.031 (0.027–0.036)	–0.005 (–0.038 to 0.028)	–0.036 (–0.069 to –0.003)	

Table 1 (continued)

Period	Pre-pandemic					Pandemic		Trend of the pre-pandemic era, β (95% CI)		Trend of the pandemic era, β (95% CI)		Trend difference, β_{diff} (95% CI)	
	1998–2005	2007–2009	2013–2015	2016–2019	2020	2021							
Smoking status, weighted % (95% CI)													
Non- or ex-smoker	5.96 (5.68–6.24)	5.81 (5.31–6.30)	7.37 (6.85–7.89)	8.75 (8.27–9.24)	9.69 (8.64–10.74)	9.62 (8.59–10.65)		0.009 (0.005–0.013)	0.000 (–0.026 to 0.026)	–0.027 (–0.053 to –0.001)			
Smoker	4.57 (3.83–5.31)	1.51 (1.07–1.95)	2.81 (2.11–3.51)	3.54 (2.94–4.14)	4.51 (2.94–6.08)	6.16 (4.17–8.14)		0.025 (0.020–0.030)	0.031 (–0.042 to 0.103)	0.004 (–0.069 to 0.078)			
Asthma prevalence rates, weighted % (95% CI)													
Absence	5.75 (5.48–6.01)	4.44 (4.07–4.81)	6.03 (5.60–6.46)	7.25 (6.85–7.66)	8.30 (7.39–9.21)	8.45 (7.50–9.40)		0.025 (0.022–0.028)	–0.001 (–0.023 to 0.022)	–0.025 (–0.048 to –0.003)			
Presence	10.62 (8.38–12.85)	12.07 (8.55–15.59)	19.23 (14.93–23.52)	21.19 (17.83–24.56)	21.61 (14.34–28.87)	26.57 (17.94–35.20)		0.067 (0.043–0.091)	0.024 (–0.131 to 0.178)	–0.044 (–0.200 to 0.112)			

AR, allergic rhinitis; CI, confidence interval; OR, odds ratio; KNHANES, Korea National Health and Nutrition Examination Survey. Values in bold indicate a significant difference ($p < 0.05$).

(mean age: 47.80 years, standard deviation: 16.49 years), 66,177 (49.3%) were male and 80,087 (50.7%) were female. Figure 1 and Table 1 show that AR prevalence was significantly increased in the pre-pandemic period (5.84% [95% CI, 5.57–6.10] in 1998–2005; 7.65% [7.24–8.06] in 2016–2019), which slightly decreased during the pandemic (8.69% [7.78–9.60] in 2020; 8.99% [8.07–9.91] in 2021). Figure 1 and Table 2 show that the prevalence of CRS increased at years 1998–2020, 1.84% (95% CI, 1.70–1.97) in 1998–2005 and 3.34% (95% CI, 3.08–3.60) in 2016–2019, with a slight decrease during the pandemic 4.06% (95% CI, 3.40–4.71) in 2020 and 3.70% (95% CI, 3.18–4.23) in 2021. Through this large-scale, longitudinal, and representative study, from 1998 to 2021, this study observed the prevalence of AR and CRS across 24 years from 1998 to 2022, analyzing both the differences before and during the COVID-19 pandemic by the KNHANES data (Tables 1; 2). This is necessary to understand the long-term effects of the previous pandemic period on these health conditions. Tables 1 and 2 present the trends in prevalence of various factors relevant to our study, both before and during the pandemic. These factors include age, sex, region of residence, educational background, household income, smoking status, and asthma prevalence rates. Moreover, the tables highlight the differences observed in these factors between the pre-pandemic and pandemic periods. Online supplementary Table S2 shows that the overall ratio of odds ratio for AR or CRS was not associated with any socioeconomic factors during the pandemic, suggesting there is no COVID-19-related vulnerable association between any socioeconomic factors and AR or CRS in South Korea.

Discussion

Our study, conducted over 24 years from 1998 to 2021, investigated the effects of the COVID-19 pandemic on AR and CRS, particularly regarding the prevalence and risk factors associated with these conditions. The longitudinal nature of this research, coupled with the large sample size and representative data of the Korean population, has allowed us to perform a comprehensive investigation of age-stratified trends in AR and CRS. As the first study to specifically investigate the relationship between COVID-19 pandemic and AR and CRS, our research makes a pioneering contribution to the existing body of the literature.

Despite these strengths, our study has several limitations. The presence of AR and CRS in elderly individuals could lead to recall bias, and changes in diagnostic tools

Table 2. National trend of the prevalence of CRS and β -coefficients and ORs before and during the COVID-19 pandemic, weighted % (95% CI), in the KNHANES

Period	Pre-Pandemic				Pandemic		Trend of the pre-pandemic era, β (95% CI)	Trend of the pandemic era, β (95% CI)	Trend difference, β_{diff} (95% CI)
	1998–2005	2007–2009	2013–2015	2016–2019	2020	2021			
CRS, weighted % (95% CI)									
Overall	1.84 (1.70–1.97)	1.99 (1.74–2.23)	0.99 (0.78–1.21)	3.34 (3.08–3.60)	4.06 (3.40–4.71)	3.70 (3.18–4.23)	0.006 (0.005–0.008)	–0.004 (–0.012 to 0.005)	–0.010 (–0.019 to –0.001)
Age, weighted % (95% CI)									
19–59	1.88 (1.72–2.03)	1.88 (1.59–2.16)	0.92 (0.70–1.15)	3.39 (3.07–3.72)	4.49 (3.63–5.36)	3.65 (2.97–4.33)	0.017 (0.014–0.020)	–0.019 (–0.041 to 0.003)	–0.036 (–0.058 to –0.014)
≥60	1.64 (1.37–1.91)	2.47 (1.95–2.99)	1.24 (0.86–1.62)	3.20 (2.78–3.61)	2.92 (2.19–3.66)	3.83 (2.97–4.69)	0.007 (0.005–0.009)	0.012 (–0.003 to 0.028)	0.005 (–0.011 to 0.021)
Sex, weighted % (95% CI)									
Male	1.98 (1.77–2.19)	1.35 (1.05–1.65)	0.61 (0.39–0.83)	2.31 (1.97–2.65)	3.20 (2.43–3.98)	3.04 (2.15–3.92)	0.014 (0.010–0.017)	–0.007 (–0.035 to 0.020)	–0.021 (–0.049 to 0.007)
Female	1.70 (1.53–1.87)	2.61 (2.24–2.99)	1.37 (1.05–1.69)	4.37 (3.97–4.78)	4.91 (3.99–5.83)	4.36 (3.57–5.16)	0.014 (0.011–0.017)	–0.009 (–0.026 to 0.009)	–0.023 (–0.041 to –0.005)
Region of residence, weighted % (95% CI)									
Urban	1.92 (1.76–2.08)	1.91 (1.65–2.18)	1.04 (0.80–1.28)	3.38 (3.09–3.66)	4.09 (3.37–4.81)	3.81 (3.20–4.41)	0.014 (0.012–0.017)	–0.007 (–0.024 to 0.011)	–0.021 (–0.038 to –0.003)
Rural	1.48 (1.23–1.73)	2.29 (1.71–2.87)	0.79 (0.37–1.21)	3.17 (2.52–3.83)	3.87 (2.35–5.40)	3.17 (2.20–4.14)	0.012 (0.007–0.017)	–0.015 (–0.046 to 0.017)	–0.027 (–0.058 to 0.005)
Education background, weighted % (95% CI)									
High school or lower	1.66 (1.50–1.81)	1.99 (1.72–2.27)	0.75 (0.54–0.95)	2.80 (2.49–3.11)	3.51 (2.73–4.29)	2.80 (2.23–3.38)	0.010 (0.008–0.013)	–0.013 (–0.029 to 0.004)	–0.023 (–0.040 to –0.006)
College or more	2.21 (1.94–2.48)	1.97 (1.54–2.41)	1.50 (1.09–1.90)	4.16 (3.68–4.63)	4.89 (3.78–6.00)	4.98 (3.99–5.97)	0.020 (0.016–0.024)	–0.003 (–0.032 to 0.026)	–0.023 (–0.052 to 0.006)
Household income, weighted % (95% CI)									
Low income (quartiles 1 and 2)	2.01 (1.79–2.22)	2.25 (1.86–2.65)	1.05 (0.71–1.40)	3.33 (2.94–3.73)	3.84 (2.95–4.73)	3.40 (2.60–4.20)	0.01 (0.008–0.013)	–0.009 (–0.027 to 0.010)	–0.019 (–0.038 to –0.001)
High income (quartiles 3 and 4)	1.69 (1.51–1.87)	1.80 (1.47–2.12)	0.95 (0.70–1.20)	3.35 (3.01–3.69)	4.19 (3.30–5.08)	3.88 (3.17–4.59)	0.017 (0.013–0.020)	–0.008 (–0.030 to 0.014)	–0.024 (–0.046 to –0.002)
Smoke, weighted % (95% CI)									
Non- or ex-smoker	1.78 (1.64–1.92)	2.35 (2.04–2.66)	1.17 (0.91–1.42)	3.88 (3.56–4.20)	4.43 (3.68–5.18)	4.07 (3.48–4.67)	0.006 (0.003–0.009)	0.002 (–0.016 to 0.020)	–0.011 (–0.029 to 0.007)
Smoker	2.43 (1.92–2.94)	1.00 (0.64–1.36)	0.37 (0.10–0.64)	1.36 (0.97–1.74)	2.51 (1.38–3.65)	2.04 (0.97–3.11)	0.016 (0.012–0.020)	–0.024 (–0.071 to 0.024)	–0.037 (–0.084 to 0.011)

Table 2 (continued)

Period	Pre-Pandemic				Pandemic		Trend of the pre-pandemic era, β (95% CI)	Trend of the pandemic era, β (95% CI)	Trend difference, β_{diff} (95% CI)
	1998–2005	2007–2009	2013–2015	2016–2019	2020	2021			
Asthma prevalence rates, weighted % (95% CI)									
Absence	1.76 (1.63–1.89)	1.94 (1.70–2.18)	0.93 (0.73–1.14)	3.22 (2.95–3.49)	3.79 (3.15–4.44)	3.52 (3.00–4.04)	0.013 (0.011–0.015)	–0.006 (–0.022 to 0.009)	–0.019 (–0.035 to –0.004)
Presence	5.90 (4.27–7.52)	3.71 (1.97–5.46)	3.19 (1.41–4.97)	7.61 (5.40–9.82)	12.80 (6.47–19.14)	9.68 (5.20–14.17)	0.038 (0.018–0.059)	–0.072 (–0.187 to 0.043)	–0.111 (–0.227 to 0.006)
CI, confidence interval; CRS, chronic rhinosinusitis; OR, odds ratio; KNHANES, Korea National Health and Nutrition Examination Survey. Values in bold indicate a significant difference ($p < 0.05$).									

and criteria over time may have resulted in under-diagnosed or overdiagnosed allergic diseases. Moreover, many Koreans are unfamiliar with accurate medical terms for specific diseases and often mistakenly refer to common illnesses such as the common cold as AR. By acknowledging these limitations, we were able to refine our methodology and increase the rigor of our analysis, ultimately drawing more reliable conclusions and providing valuable insights into the effects of COVID-19 on AR and CRS. Furthermore, these limitations set the stage for future research to build upon and further explore the intricate relationship between these conditions and the COVID-19 pandemic.

Statement of Ethics

This study protocol was reviewed and approved by the Korea Disease Control and Prevention Agency (KDCA) and Institutional Review Board of Kyung Hee University, approval number (KHUH 2022-06-042). This research adhered to the ethical guidelines established by relevant national and Institutional Review Boards for human research and followed the 1975 Helsinki Declaration, as amended in 2008. Written informed consent was obtained from participants prior to the study.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Dr. Dong Keon Yon had full access to all the data used in the study and took responsibility for the integrity of the data and accuracy of the data analysis. All the authors approved the final version of the manuscript before submission. Study concept and design; acquisition, analysis, or interpretation of data; drafting of the manuscript; and statistical analysis: Hojae Lee and Dong Keon Yon. Critical revision of the manuscript for important intellectual content: Hojae Lee, Jaeyu Park, Myeongcheol Lee, Hyeon Jin Kim, Minji Kim, Rosie Kwon, Seung Won Lee, Ai Koyanagi, Lee Smith, Min Seo Kim, Sang Youl Rhee, Joong Ki Cho, Sunyoung Kim, Masoud Rahmati, and Dong Keon Yon. Study supervision:

Sunyoung Kim, Masoud Rahmati, and Dong Keon Yon. Dong Keon Yon supervised the study and is the guarantor for this study. Dong Keon Yon is a senior author. Jaeyu Park, Sunyoung Kim, Masoud Rahmati, and Dong Keon Yon contributed equally to this work as corresponding authors. The corresponding author attests that all listed authors meet the authorship criteria and that authors meeting the criteria have not been omitted.

Data Availability Statement

Data are publicly available on legal and ethical grounds from the Korea Disease Control and Prevention Agency as open data (<https://knhanes.kdca.go.kr/knhanes/eng/index.do>). Further inquiries including study protocol and statistical code can be directed to the corresponding author D.K.Y. (email: yonkkang@gmail.com).

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