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**Master of Medicine**

**Trend of asthma prevalence and risk factors  
in the 20s age band in South Korea**

국내 20대 연령대의 천식 유병률 추이 및 위험요인 분석

**The Graduate School of the University of Ulsan**

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**Trend of asthma prevalence and risk factors  
in the 20s age band in South Korea**

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For the Degree of**

**Master of Medicine**

**by**

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**February 2022**

# **Trend of asthma prevalence and risk factors in the 20s age band in South Korea**

**This certifies that the master's thesis of Da Som Jeon is approved**

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## Abstracts

**Background & Aims:** The prevalence of asthma has increased in many countries.

However, whether asthma prevalence may only be true in a specific age band is not well known. Thus, we analyzed the increase in asthma prevalence according to age band and analyzed the related factors.

**Methods:** We analyzed the trend of asthma prevalence according to 10-year age band intervals by using 2007 to 2018 data from the Korean National Health and Nutrition Survey. We determined the presence of subject-reported, physician-diagnosed asthma in 89 179 subjects. Multiple logistic regression analyses with a complex sample design were conducted to identify the risk factors for asthma.

**Results:** Among all age ranges, only the 20s age band showed an increase in the trend of asthma prevalence from 0.7% in 2007 to 5.1% in 2018 ( $p$ -value < 0.001 for joinpoint regression). Among the 7478 subjects in the 20s age band, 52.6% were male, 42.0% were ever-smokers, 21.2% had allergic rhinitis, 8.4% had atopic dermatitis, and 24.5% were obese. Multiple logistic regression analysis showed that asthma was related to allergic rhinitis (odds ratio [OR] 2.78; 95% confidence interval [CI], 2.03–3.81) and atopic dermatitis (OR, 4.13; 95% CI, 2.85–5.98), but not to male sex, ever-smoking, obesity, or other covariates.

**Conclusions:** From 2007 to 2018, the prevalence of asthma significantly increased in the 20s age band in South Korea. This may be related to the increase in the cases of allergic rhinitis and atopic dermatitis.

**Keywords:** Public data, allergic rhinitis, atopic dermatitis, physician-diagnosed asthma, Korean National Health and Nutrition Survey

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## Introduction

More than 339 million people worldwide had asthma in 2016, and the prevalence of asthma is increasing globally (1). To et al. (2) indicated that the global prevalence of physician-diagnosed asthma in adults was estimated to be 4.3% (95% confidence interval [CI] 4.2–4.4). According to the European Community Respiratory Health Survey, a multicenter survey of adults aged 20 to 44 years in 48 centers, the asthma prevalence ranged from 2% to 3.3% at centers in Europe and from 8% to 11.9% at centers in the United Kingdom, New Zealand, and Australia (3). In Asian countries, including South Korea, the prevalence of asthma ranged from 0.7% to 11.9% (4). One study reported that the prevalence of asthma in South Korea increased from 1.55% in 2002 to 2.21% in 2015 (5).

Several risk factors of asthma have been identified, including smoking (6), allergens (7), respiratory infection (8), and obesity (9). Adult asthma is more frequent in obese and overweight women (10, 11). Current and ex-smokers are known to be at increased risk of asthma and exacerbations. The total smoking amount (total pack-years) was also proportional to the asthma symptoms experienced, such as wheezing (12). Furthermore, a prospective study suggested that upper and lower respiratory tract infections were associated with the development of asthma in young adults (13).

Many studies have analyzed the prevalence and risk factors of asthma. However, the prevalence of asthma according to age is not well known. Thus, we analyzed the prevalence and the trend of prevalence of asthma according to age and analyzed the related risk factors.

# Methods

## *Study design*

This study was conducted using open public data from the Korean National Health and Nutrition Examination Survey (KNHANES), a national surveillance system that has been assessing the health and nutritional status of Koreans since 1998 (14). Stratified, multistage, clustered sampling based on national census data was used to ensure that the survey results represented the general Korean population (14). We analyzed the KNHANES data from 2007 to 2018 by merging the annual data from 2007–2009, 2010–2012, 2013–2015, and 2016–2018.

## *Subjects*

The number of subjects was 89 179, who were aged 1–80 years old. According to age bands, the subjects were classified with 10-year age band intervals to evaluate the increase in asthma prevalence. We also analyzed a subgroup of subjects with a specific age band in which asthma prevalence increased from 2007 to 2018.

## *Definition of asthma and covariates*

The self-reported questionnaire provided information on the subjects' asthma condition, household income, education, allergic rhinitis, atopic dermatitis, smoking status, environmental tobacco smoking, and body mass index (BMI).

These factors were simplified by newly classifying them into two groups because each group was too small to be further subdivided. Household income levels were divided into a lower half and a higher half, which were previously classified as quartiles. Education levels were classified as below high school and above two or three years of college.

Asthma was defined when the study subjects responded positively to the following question: "Have you been diagnosed with asthma by your doctors?" Allergic rhinitis and atopic dermatitis were determined when the study subjects responded positively to the following question: "Have you been diagnosed with the disease by your doctors?" Smokers were determined by those who replied with "more than 100 cigarettes" to the following question: "Have you ever smoked in your life?" Nonsmokers were determined by those who replied to the same question with "never" or "less than 100 cigarettes." Furthermore, we defined ever-smokers as those who had smoked in the past, were currently smoking daily, or were occasional smokers, and defined nonsmokers as those who did not smoke in other cases. Environmental tobacco smoking is defined as the exposure to secondhand smoking in the home. BMI was calculated as a subject's weight in kilograms divided by the square of

their height in meters. The BMIs were classified according to the criteria of the Korean Society for the Study of Obesity; thus, a BMI  $\geq 25.0$  kg/m<sup>2</sup> was defined as obesity (15).

### ***Statistics analysis***

Statistical analyses were conducted using SPSS version 24.0 (IBM Company). Survey sample weights were used in all analyses to produce estimates representing the noninstitutionalized civilian Korean population. To identify changes in prevalence rate trends, joinpoint regression was estimated for every age group. By using prevalence rates as inputs, this method identifies the year when a trend of asthma prevalence is produced, it calculates the annual percentage change (APC) in rates between trend-change points, and it also estimates the average annual percentage change (AAPC) in the whole study period. A *p*-value  $< 0.05$  was considered statistically significant. Multiple logistic regression analyses with a complex sample design were conducted to determine the risk factors for asthma. Each category was marked with different numbers because of missing values such as “non-responses” and “unknown;” thus, the missing values were treated as valid values and reflected in the statistical analysis by following the KNHANES guidelines.

### ***Study approval and informed consent***

The study protocol was approved by the Bioethics Committee of Asan Medical Center, Ulsan National University (S2020-10157-0001), which waived the requirement for informed consent because of the retrospective nature of the study.

## Results

### *Asthma prevalence according to age band from 2007 to 2018 in South Korea*

From 2007 to 2018, the prevalence of asthma was 4.5%. Furthermore, the prevalence of asthma according to age band decreased gradually, with the lowest level of 2.1% in the 40s age band. However, since then, the prevalence of asthma has gradually increased and reached 6.1% in individuals who are 70 years and older (Figure 1).

From 2007 to 2018, only the 20s age band showed a statistically significant increase in the prevalence of asthma (Figure 2). The asthma prevalence in the 20s age band was 0.7% in 2007 and 5.1% in 2018 ( $p$ -value < 0.001 for joinpoint regression).

### *Risk factors related to asthma in the 20s age band*

There were 7658 subjects in the 20s age band, with 237 and 7421 subjects having and not having asthma, respectively. Among the 7658 subjects in their 20s, the average age was similar to that of the asthma group (24.1 years) and that of the non-asthma group (24.7 years). The proportion of men was higher in the asthma group (54.9% in the asthma group and 43.9% in the non-asthma group,  $p$ -value = 0.018), and there were more ever-smokers in the asthma group than in the non-asthma group (43.9% in the asthma group and 37.5% in the non-asthma group,  $p$ -value = 0.009). The proportions of allergic rhinitis (44.6% in the

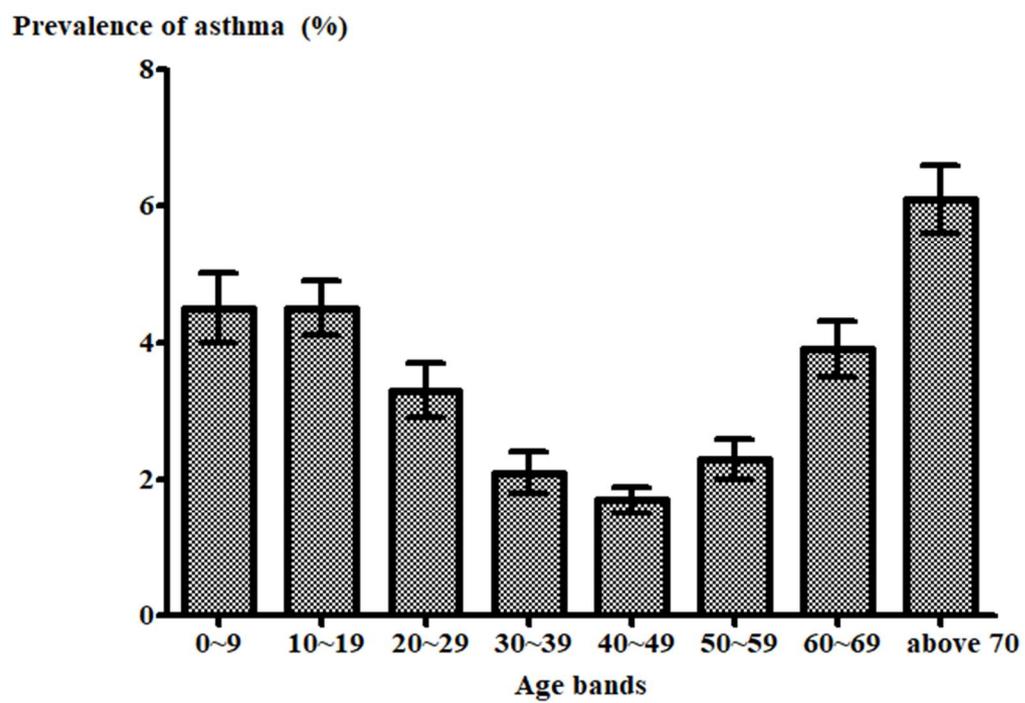
asthma group and 20.6% in the non-asthma group,  $p$ -value < 0.001) and atopic dermatitis (25.3% in the asthma group and 8.0% in the non-asthma group,  $p$ -value < 0.001) were higher in the asthma group than in the non-asthma group. The tendency of other variables such as household income, education status, environmental tobacco smoking, and obesity was similar to those of the 20s age band regardless of asthma (Table 1).

In a univariate logistic regression of the subjects in the 20s age band, asthma prevalence was related to male sex (odds ratio [OR], 1.51; 95% CI, 1.15–1.99), allergic rhinitis (OR, 3.14; 95% CI, 2.34–4.21), atopic dermatitis (OR, 4.44; 95% CI, 3.23–6.10), and ever-smoking (OR, 1.42; 95% CI, 1.09–1.86). Furthermore, in subjects in the 20s age band, multivariate logistic regression analysis revealed that asthma was related to allergic rhinitis (OR, 2.78; 95% CI, 2.03–3.81) and atopic dermatitis (OR, 4.13; 95% CI, 2.85–5.98). However, asthma was not related to male sex (OR, 1.43; 95% CI, 1.00–2.04), higher income (OR, 1.03; 95% CI, 0.75–1.40), higher education (OR, 0.98; 95% CI, 0.64–1.50), ever-smoking (OR, 1.32; 95% CI, 0.93–1.88), environmental tobacco smoking (OR, 1.23; 95% CI, 0.78–1.94), and obesity (OR, 0.99; 95% CI, 0.70–1.38) (Table 2).

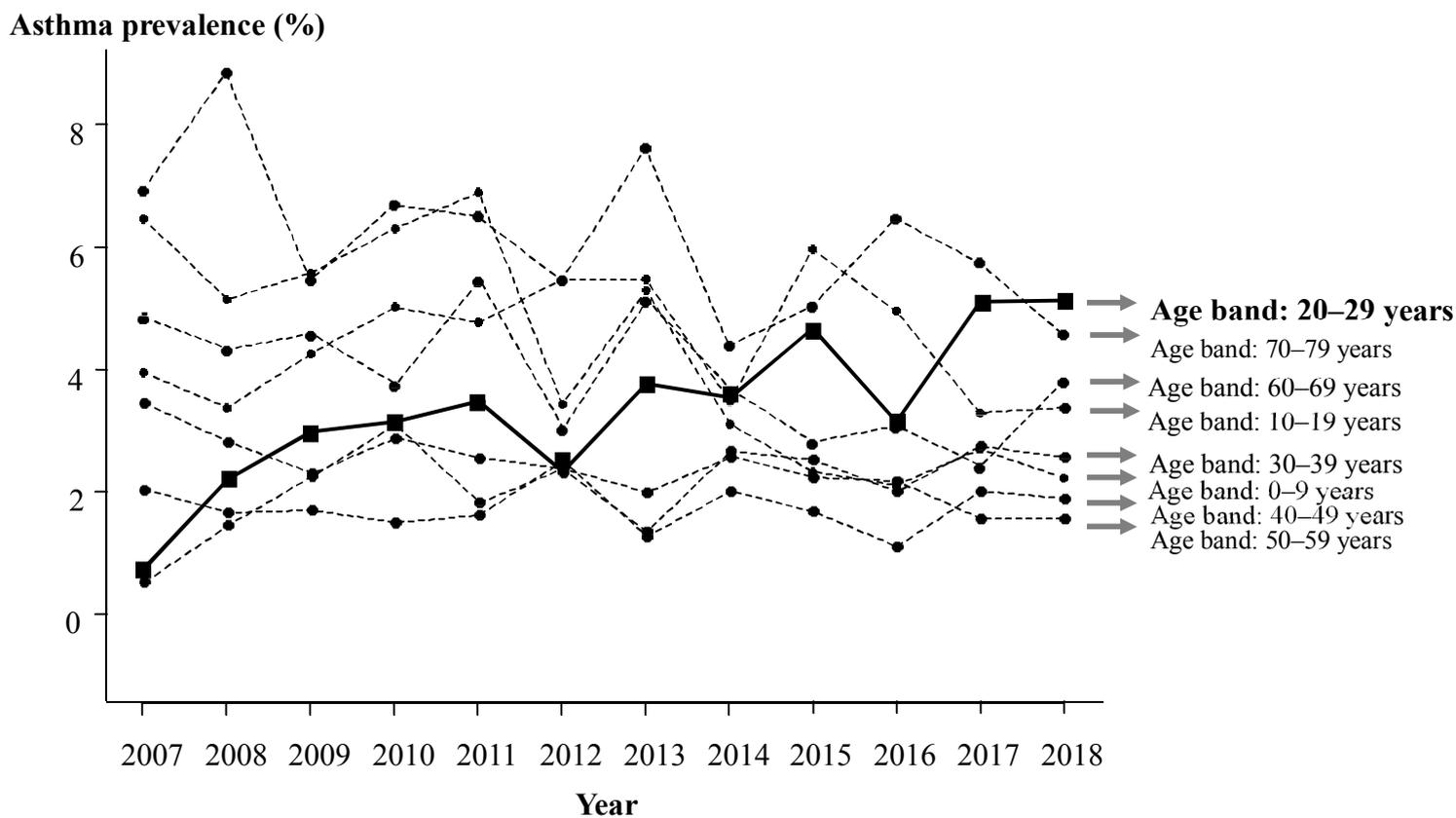
The prevalence rates of allergic rhinitis and atopic dermatitis in the 20s age band increased from 2007 to 2018. The prevalence of allergic rhinitis was 17.2% in 2007 and 23.5% in 2018 ( $p$ -value < 0.001 via the chi-square test; Figure 3), and the prevalence of atopic dermatitis was 5.9% in 2007 and 11.7% in 2018 ( $p$ -value = 0.001 via the chi-square test; Figure 4).

These results tend to be similar to the increase in the prevalence of asthma in the 20s age band.

Figure 1. Asthma prevalence according to age band



**Figure 2. Prevalence of asthma according to 10-year age band intervals**



**Table 1. Characteristics of subjects in the 20s age band.**

<b>Characteristics</b>	<b>Asthma</b>	<b>Non-asthma</b>	<b><i>p</i>-value</b>
<b>Number of subjects</b>	237	7421	
<b>Mean age, years</b>	24.1	24.7	
<b>Sex (Male)</b>	130/237 <sup>a</sup> (54.9)	3193/7421 <sup>b</sup> (43.0)	0.003
<b>Lower-household income</b>	79/236 (33.5)	2516/7343 (34.3)	0.915
<b>Education (Junior college or higher)</b>	194/237 (81.9)	6138/7414 (82.8)	0.905
<b>Ever-smokers</b>	104/237 (43.9)	2779/7414 (37.5)	0.009
<b>Environmental tobacco smoking</b>	197/237 (83.1)	6281/7410 (84.8)	0.254
<b>Allergic rhinitis</b>	82/184 (44.6)	1150/5584 (20.6)	<0.001
<b>Atopic dermatitis</b>	60/237 (25.3)	590/7421 (8.0)	<0.001
<b>Obesity</b>	67/230 (29.1)	1657/7343 (22.6)	0.051

<sup>a</sup> Number of subjects with percent in parentheses

<sup>b</sup> Target subjects over the total number of subjects

**Table 2. Risk factors for asthma in the 20s age band**

Potential risk factors	Univariate analysis			Multivariate analysis		
	Adjusted OR	95% CI	<i>p</i> -value	Adjusted OR	95% CI	<i>p</i> -value
Sex (male)	<b>1.51</b>	<b>1.15-1.99</b>	<b>0.003</b>	1.43	1.00-2.04	0.05
Higher income	1.02	0.76-1.36	0.92	1.03	0.75-1.40	0.87
Higher education	1.04	0.72-1.48	0.85	0.98	0.64-1.50	0.94
Allergic rhinitis	<b>3.14</b>	<b>2.34-4.21</b>	<b>&lt;0.001</b>	<b>2.78</b>	<b>2.03-3.81</b>	<b>&lt;0.001</b>
Atopic dermatitis	<b>4.44</b>	<b>3.23-6.10</b>	<b>&lt;0.001</b>	<b>4.13</b>	<b>2.85-5.98</b>	<b>&lt;0.001</b>
Ever-smokers	<b>1.42</b>	<b>1.09-1.86</b>	<b>0.01</b>	1.32	0.93-1.88	0.12
Environmental tobacco smoking	0.83	0.58-1.19	0.32	1.23	0.78-1.94	0.37
Obesity	1.34	1.00-1.79	0.05	0.99	0.70-1.38	0.93

Higher income: top two quartiles of income divided by quartiles; higher education: above two or three years of college; ever-smokers: smoked more than 100 cigarettes in the past or now smoking daily or occasionally; obesity: BMI  $\geq 25.0$  kg/m<sup>2</sup> (BMI = weight in kilograms / square of height in meters)

This table covers 5641 subjects with information on allergic diseases (allergic rhinitis and atopic dermatitis)

Figure 3. The trend of atopic dermatitis prevalence

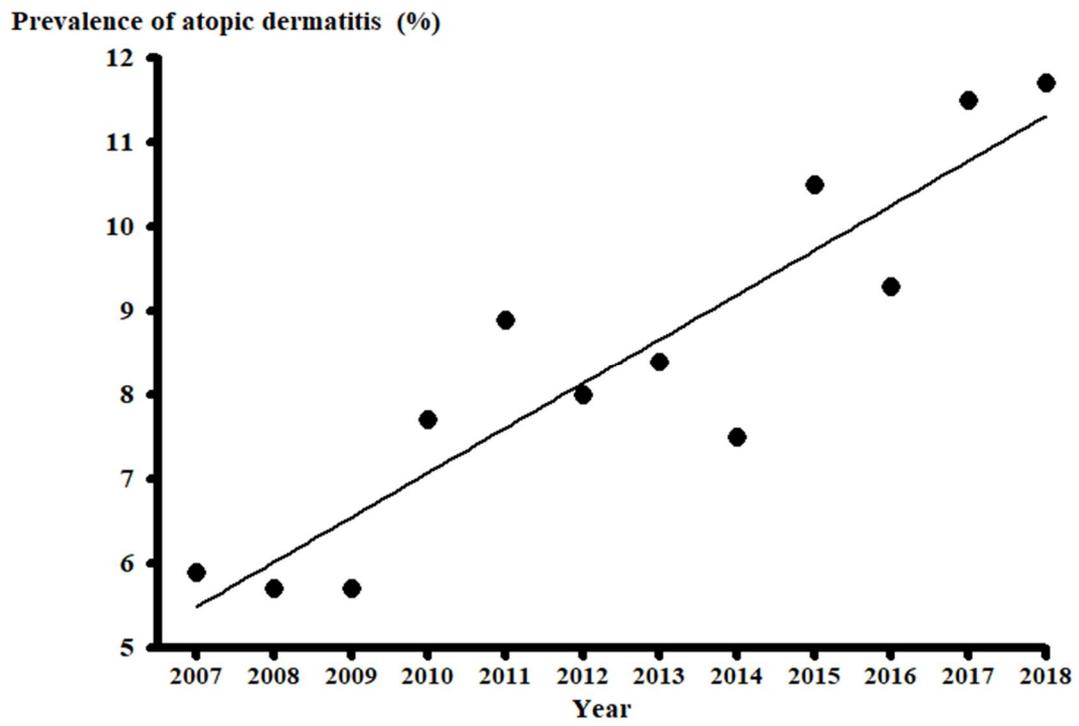
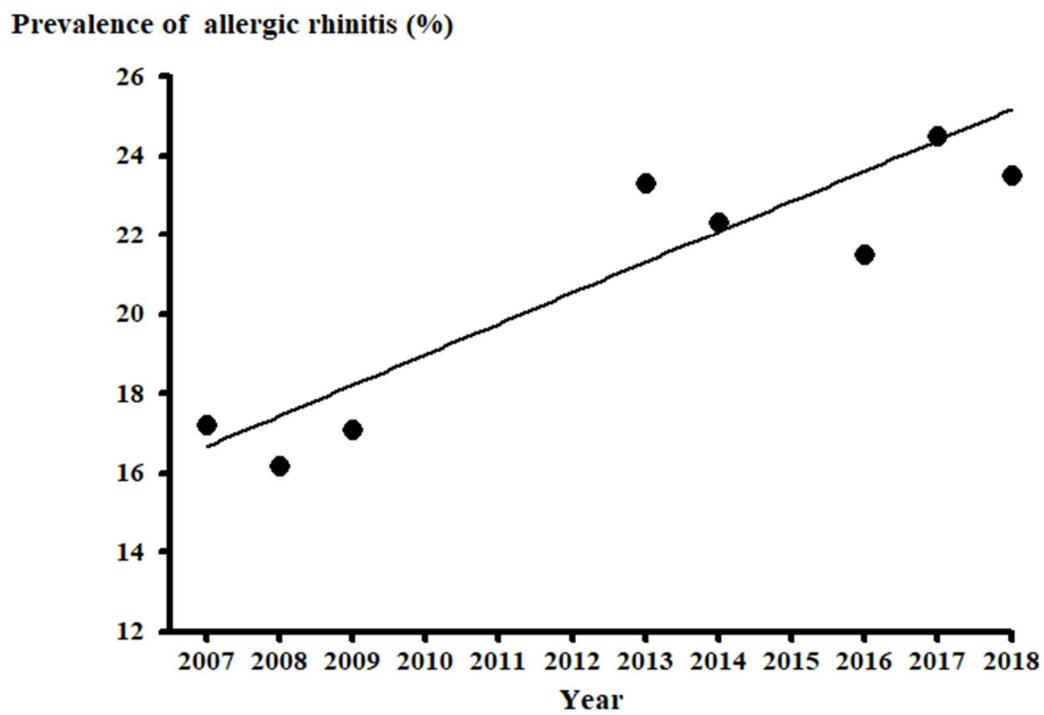


Figure 4. The trend of allergic rhinitis prevalence



Information on allergic rhinitis was not obtained during 2010–2012.

## Discussion

This study identified that the prevalence of asthma in the 20s age band significantly increased in South Korea from 2007 to 2018. Furthermore, this finding was related to allergic rhinitis and atopic dermatitis.

This is the first study that analyzed the trend of asthma prevalence in South Korea by age group. Asthma is a chronic disease that accounts for 1 in every 250 deaths worldwide, with 12 million people experiencing acute exacerbation every year in the United States (16). Considering the need for long-term care, the increase in the prevalence of asthma in the 20s age band in Korea is an important discovery.

Studies conducted on the basis of the National Health Insurance Sharing Service reported an increase in the prevalence of asthma in South Korea (1.55% in 2002 and 2.21% in 2015), and the prevalence of asthma in the 20s age band seemed to be steadily increasing (5). This is consistent with the results of the current study.

In European countries, the weighted prevalence of diagnosed asthma was 6.2% in 2018 (17). The trend of global prevalence varies significantly from country to country owing to the absence of large-scale standardized data; however, there were no signs of declining prevalence, and prevalence is still increasing in many parts of the world (18).

Data on asthma prevalence trends by age group are limited; however, the prevalence of asthma in Sweden has been on the rise for 30 years and has been increasing in all age groups,

except in men aged 65–74 years old (19). US data during the last 20 years show an increase in asthma prevalence in older people aged 65 years or older (20). In the current study, asthma prevalence increased in people in their 20s but not in other age groups.

We performed a birth cohort analysis to confirm whether an increase in asthma prevalence in the 20s age band was the result of bias among those born at a particular time. Thus, the prevalence of asthma was analyzed annually among those in the 20s age band at the beginning of the study (i.e., in 2007), but there was no significant increase in the trend of asthma prevalence (Figure 5).

Univariate and multivariate analyses were conducted to determine the factors affecting the increase in asthma prevalence in people in their 20s. Univariate analysis showed that asthma prevalence has a significant relationship with male sex, allergic rhinitis, atopic dermatitis, and ever-smoking. Furthermore, multivariate analysis showed that asthma prevalence has a significant relationship with allergic rhinitis and atopic dermatitis.

According to previous studies, asthma-related hospital visits and hospitalization were higher in boys under 14 years old (16). However, after puberty, asthma is more common in women and is more severe (17). This is attributed to the differences in anatomical structures between men and women: the ratio of forced flow rate to forced vital capacity is higher in women than in men (18). Furthermore, female hormones in relation to menstruation can also have an effect on asthma prevalence (10). However, in the current study, men had a higher

prevalence of asthma than women in the 20s age band. Considering that the smoking rate among men in their 20s was higher, we believe that the association between smoking status and asthma may be affected.

Studies showed that the risk of developing asthma was significantly higher in smokers and that the risk of asthma increased even when exposed to environmental tobacco smoking (21).

In adults, smokers have a higher risk of asthma than never-smokers, and this effect is more pronounced in women than in men (22). Smoking increased bronchial hypersensitivity, eosinophilia, and helper T-cell cytokine response after exposure to allergens (23).

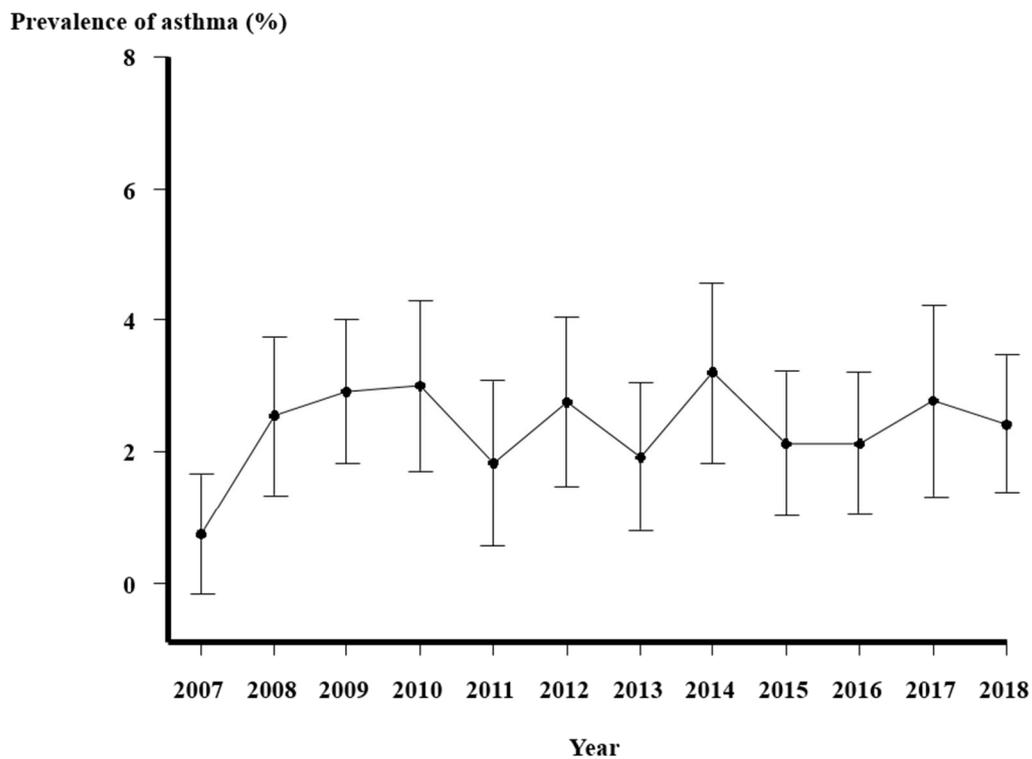
Additionally, continuous exposure to smoking can promote airway remodeling and produce asthma by activating epithelial cells (24).

Many studies have revealed the similarities of the pathophysiology of asthma and the relation between asthma and allergic disease (25, 26). We found a relationship between the increased prevalence of asthma in the 20s age band and allergic diseases such as allergic rhinitis and atopic dermatitis. Allergic asthma occurs more often in people under 30 years old, and non-allergic asthma is more common in late adulthood (27). In the current study, allergic rhinitis had the highest prevalence in the 20s age band, and atopic dermatitis had the highest prevalence in adolescents and individuals under the age of 30. Considering that the prevalence of allergic disease also increased during the survey period, we posit that the increase in allergic disease affected the increase in asthma prevalence in the 20s age band.

There are several limitations to this study. First, this study was conducted on samples representing South Korea; therefore, the results may be difficult to generalize in other racial groups or countries. Second, this study was a cross-sectional design; therefore, it was difficult to ascertain a causal relationship for asthma development. Third, asthma was defined as self-reported, physician-diagnosed asthma in this study; therefore, no laboratory measurements were evaluated.

This study was based on representative data in Koreans and was conducted on young subjects in the 20s age band. Therefore, it is meaningful that the research was conducted only on asthma by minimizing the possibility of mistaking asthma for chronic obstructive pulmonary disease (COPD) or asthma–COPD combination.

**Figure 5. Birth cohort analysis conducted in subjects in their 20s in 2007.**



We performed the birth cohort analysis of asthma prevalence annually for the 20s age band in 2007.

## **Conclusion**

From 2007 to 2018, the prevalence of asthma significantly increased in the 20s age band in South Korea. This finding may be related to the increase in allergic rhinitis and atopic dermatitis. Further research is needed to discover the causes of increased asthma prevalence in subjects in their 20s.

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## 국문요약

**연구배경 및 목적:** 천식의 유병률은 전 세계적으로 증가하는 추세이다. 그러나 특정 연령대에서의 천식 유병률 추이는 현재까지 알려져 있는 바가 제한적이다. 따라서, 연령대에 따른 천식 유병률의 변화와 관련 요인에 대하여 분석하고자 하였다.

**방법:** 2007 년부터 2018 년까지 국민건강영양조사의 자료를 활용하여 10 세 간격으로 나누어 따른 천식 유병률의 추이를 분석하였다. 총 89,179 의 응답자를 대상으로 자가 보고한 의사 진단 천식의 유병률을 확인하였고, 천식의 위험 요인을 확인하기 위하여 복잡 표본 설계를 사용한 다중 로지스틱 회귀 분석을 수행하였다.

**결과:** 모든 연령대 중 20 대에서만 천식의 유병률이 2007 년 0.7%에서 2018 년 5.1%로 유의하게 증가하였다. 20 대 응답자 7,478 명 중 남성 52.6%, 비흡연자 58.0%, 알레르기 비염 21.2%, 아토피성 피부염 8.4%, 비만 24.5%의 분율로 나타났다. 다중 로지스틱 회귀 분석에 따르면 천식은 알레르기 비염 (교차비

2.78; 95% 신뢰 구간 2.03-3.81) 과 아토피 피부염 (교차비 4.13; 95% 신뢰 구간 2.85-5.98)과 관련이 있지만, 성별, 흡연 여부, 비만 및 기타 공변량과는 유의한 관련성이 확인되지 않았다.

**결론:** 2007 년부터 2018 년까지 한국의 20 대 연령대에서 천식의 유병률이 유의하게 증가하였다. 이는 알레르기 비염과 아토피 피부염 발생의 증가와 연관이 있을 것으로 생각된다.

**중심단어:** 알러지 비염, 아토피 피부염, 의사진단 천식, 국민건강영양조사, 공공 데이터