

Original

Association between occupational clusters and allergic rhinitis in the Korean population: analysis of the Korean National Health and Nutrition Examination Survey data

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Abstract: Objectives: This study aimed to investigate the association between occupational clusters and allergic rhinitis (AR). **Methods:** The study was based on data from the Korean National Health and Nutrition Examination Survey (KNHANES: 2007-2015). This study included 46,965 individuals: 20,491 men and 26,474 women. AR was defined as having been diagnosed by a physician. Occupations were classified according to occupational characteristics and skill levels into white (chief executives, senior officials, legislators, managers, professionals, and technicians), pink (clerks, clerical support workers, services and sales workers), blue (craft and related trades workers, drivers, plant and machine operators, assemblers, elementary occupation workers), and green (skilled agricultural, forestry, and fishery workers) categories. We calculated the odds ratios (ORs) and 95% confidence intervals (CIs) of AR according to the occupational clusters by using the chi-squared test and logistic regression. **Results:** In the study population, 10.7% of the men and 13.5% of the women had AR. The prevalence of AR was highest among white-collar workers, followed by pink, blue, and green-collar workers. Compared to green-collar workers, among men the adjusted

ORs of the blue, pink, and white-collar workers were 2.00 (95% CI 1.58-2.53), 2.46 (95% CI 1.91-3.15), and 2.78 (95% CI 2.20-3.51), respectively; and among women were 2.45 (95% CI 1.99-3.02), 2.64 (95% CI 2.15-3.25), and 3.63 (95% CI 2.96-4.47), respectively.

Conclusions: This study suggests that AR prevalence is significantly associated with occupational clusters.

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Key words: Allergic rhinitis, Epidemiology, Health surveys, Occupations, Prevalence

Introduction

Allergic rhinitis (AR) is one of the greatest health concerns in the modern world, and its prevalence is on the rise¹. Approximately 500 million people suffer from AR¹, and its reported prevalence varies widely from 1% to 40%^{1,2}. However, the prevalence rates appear to be high in industrialized countries. AR frequently occurs in association with other inflammatory diseases that are related to the respiratory mucosa, including asthma, non-allergic

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rhinitis, and rhinosinusitis¹).

Patients with AR may have insomnia and find it difficult to maintain their social lives or a high level of performance at their workplace, leading to the loss of productivity^{1,3-5}. In addition to increasing medical expenses, AR also imposes a substantial socioeconomic burden in other ways. For example, AR contributes to increases in the social burden by causing absenteeism and presenteeism⁶.

With the development of the Korean economy, the industrial structure has undergone a rapid change. Correspondingly, the attention given to environmental issues and the prevalence of related health problems such as AR has also grown⁷. The prevalence of AR in Korea has been on the rise for several years, and its current prevalence has been reported to be 13.3%².

The prevalence of AR is closely related to age. The prevalence of AR peaks in adolescence and decreases with age in adults^{8,9}. The reported prevalence of symptom-based AR was 30.2% in children, 32.9% in adolescents, and 26.6% in adults; whereas test-based AR was 19.1%, 23.7%, and 14.9%, respectively⁸. It has also been reported that about 80% of people diagnosed with AR developed symptoms before age 20¹⁰.

Several previous studies have identified probable risk factors for AR including age⁹, sex^{9,11}, smoking status¹², alcohol consumption¹³, body mass index¹⁴, area of residence⁷, and socioeconomic factors^{7,15} including education and income. According to its various characteristics, an individual's occupation may also play a profound role as a risk or protective factor for AR^{9,16}. However, only a limited number of studies have focused on the relationship between occupation and incidences of AR. The few studies that have concentrated on this topic lacked proper stratification or occupational classification criteria^{9,16}. Therefore, we aimed to investigate the prevalence of AR according to occupational clusters using nationwide data from the Korean National Health and Nutrition Examination Survey (KNHANES), in order to identify risk groups and make suggestions for management plans.

Materials and Methods

Participants

We used data from the KNHANES IV (2007-2009), V (2010-2012) and VI (2013-2015). The KNHANES is a cross-sectional, nationwide survey conducted by the Korean Ministry of Health and Welfare. Families were randomly selected using multi-stage sampling by geographical location, and were voluntarily enrolled to the survey after obtaining written consent. Of the 73,353 participants who were surveyed, the 64,544 participants who answered a question regarding diagnosis of AR by a physician were enrolled. Of these enrollees, participants who had never had a job or were currently soldiers in the

armed forces were excluded. This left 46,965 individuals (20,491 men and 26,474 women) who were selected for the study. All study procedures were approved by the Institutional Review Board (IRB) of the Korea Centers for Disease Control and Prevention (KCDC) (IRB: 2007-02 CON-04-P, 2008-04 EXP-01-C, 2009-01 CON-03-2 C, 2010-02 CON-21-C, 2011-02 CON-06-C, 2012-01 EXP-01-2C, 2013-07CON-03-4C, 2013-12EXP-03-5C, 2015-01-02-6C).

Allergic rhinitis

Participants diagnosed with AR by a physician were placed in the AR group^{5,7,17}. Those who were diagnosed as not having AR were included in the non-AR group.

Occupation

In the case of participants who had had multiple jobs, the occupation in which the participant had been employed the longest was selected as the final occupation. The International Standard Classification of Occupation (ISCO) was initially used for classifying the occupations into the following 10 major groups¹⁸. Group 1: chief executives, senior officials, legislators, and managers; Group 2: professionals; Group 3: technicians and associate professionals; Group 4: clerks and clerical support workers; Group 5: services and sales workers; Group 6: skilled agricultural, forestry and fishery workers; Group 7: craft and related trades workers; Group 8: drivers, plant and machine operators and assemblers; Group 9: elementary occupation workers; and Group 10: those in the armed forces. Korea has made military service compulsory for all young men (predominantly those in the age group of 20-24 years). Therefore, Group 10 was excluded because the distribution of sex and age was distinctly different from that of the other groups. These occupational groups were then re-grouped into the following 4 occupational clusters according to their ISCO skill levels and Korea's sociocultural background^{19,20}: white-collar, encompassing major groups 1-3; pink-collar, encompassing major groups 4-5; blue-collar, encompassing major groups 7-9; and green-collar, encompassing major group 6.

White and blue-collar are relatively well-known designations compared to pink and green collar workers. The pink-collar designation first appeared after World War II to describe workers who mainly perform administrative, clerical, assistant, or secretarial work. Today pink-collar refers to wide range of occupations in the service industry²¹. The green-collar designation was used in an article²² to describe workers in the so-called green industries, occupations in which the main goals are to reduce energy consumption and waste production in manufacturing processes. Here, the term green-collar worker is also used to represent agricultural, fishery, and forestry workers, as was done in previous studies^{19,20}.

Covariates

Information on potential confounders such as sex⁹⁾, age^{9,11)}, obesity¹⁴⁾, alcohol consumption¹³⁾, and smoking status¹²⁾ were obtained. Obesity was defined using the Body Mass Index (BMI). Participants were classified as follows: low-weight (BMI < 18.5), normal-weight (BMIs 18.5 -25), and obese (BMI >25)¹⁹⁾. In terms of alcohol consumption, those who consumed less than one glass of alcohol per month in the past year were classified as 'non-drinkers', and those who consumed at least one glass of alcohol per month in the past year were classified as 'moderate drinkers'. 'Heavy drinkers' were defined as participants who consume 7 or more glasses of alcohol (men) or 5 or more glasses of alcohol (women) at least twice a week on average²³⁾. In this study, ex-smokers were considered as non-smokers²⁰⁾.

Statistical analysis

A chi-square test was used to identify differences in the prevalence of AR according to the participants' demographic variables. The ORs and 95% CI for AR according to occupational cluster were estimated using multiple logistic regression analysis, and were adjusted for age, obesity, smoking status, and alcohol consumption. All of the analyses were 2-tailed, and *p*-values less than 0.05 were considered statistically significant. All analyses were performed using SAS software, version 9.4 (SAS Institute, Cary, North Carolina, USA).

Results

Demographics of the study participants by occupational clusters

Table 1 presents an overview of the demographics of the study population, grouped by occupational cluster. Of the men, 36.4% were white-collar workers, 35.3% were blue-collar workers, 16.4% were pink-collar workers, and 11.9% were green-collar workers. Among the women, 37.3% were white-collar workers, 26.6% were pink-collar workers, 23.4% were blue-collar workers, and 12.7% were green-collar workers. The prevalence of AR was 10.7% in men and 13.5% in women.

Prevalence of allergic rhinitis by demographics

Table 2 shows the prevalence of AR in different demographics. The prevalence rates of AR were significantly different between the men and women. In both sexes, these rates varied significantly by age, level of alcohol consumption, and occupational cluster. Among women, the prevalence of AR was significantly different between the obese and non-obese groups, but this was not the case among men. Among men, the AR prevalence was significantly different between smokers and non-smokers, but this was not the case among women.

Association between occupational clusters and allergic rhinitis

Table 3 shows the ORs of AR, according to the participants' occupational clusters. Green-collar workers were set as the reference group. The ORs for AR in male blue, pink, and white-collar workers were 2.85 (95% CI 2.26-3.60), 4.09 (95% CI 3.21-5.20), and 4.39 (95% CI 3.49-5.51), respectively; and in women were 3.19 (95% CI 2.60-3.92), 4.13 (95% CI 3.38-5.05), and 7.31 (95% CI 6.02-8.88), respectively. These results remained significant even after controlling for age, obesity, alcohol consumption, and smoking status in the multiple logistic regression analysis. The adjusted ORs of AR in men were 2.00 (95% CI 1.58-2.53) in blue-collar workers, 2.46 (95% CI 1.91-3.15) in pink-collar workers, and 2.78 (95% CI 2.20-3.51) in white-collar workers. For women, the adjusted ORs of AR were 2.45 (95% CI 1.99-3.02) in blue-collar workers, 2.64 (95% CI 2.15-3.25) in pink-collar workers, and 3.63 (95% CI 2.96-4.47) in white-collar workers (Fig. 1).

Discussion

In this study, the prevalence of AR was highest in white-collar workers, followed by in pink, blue, and green-collar workers in both sexes. Higher ORs for AR were observed in white, blue and pink-collar workers compared to green-collar workers after adjusting for age, obesity, smoking status, and alcohol consumption in both sexes. These results suggest a relationship between occupational clusters and the prevalence of AR. There are two types of AR; occupational and non-occupational. With our data from the nationwide survey, we solely focused on non-occupational rather than occupational AR and only examined the prevalence, not the incidence of AR in this study. Given that AR prevalence peaks in adolescents in Korea¹⁰⁾, our interpretation of our findings is that some work-related factors aggravate the latent non-occupational AR the subjects have had since their childhood.

There are very few studies that have focused on the association between occupation and the prevalence of AR, and the results are inconsistent. Our result is similar to a previous study which suggested a lower prevalence of AR in agricultural, fishery, military, and manual workers, who have long outdoor working hours¹⁶⁾. However, job classification was not specific in this study. Farmers, forestry workers, soldiers, and laborers were assigned to the reference group, while managers, professionals, and clerks were assigned to an occupational group. Min et al.²⁴⁾ found that AR was not associated with occupation, while Radon et al.¹⁵⁾ indicated that allergen exposure at the workplace contributed to the development of AR in adults. In 2012, Eriksson et al.⁹⁾ discovered that professionals had a higher risk of developing AR than manual

Table 1. Demographics of the study population, grouped by occupational cluster.

	Occupational cluster					<i>p</i> *
	White-collar	Pink-collar	Blue-collar	Green-collar	Total	
Men, n (%)	7464 (36.4)	3354 (16.4)	7230 (35.3)	2443 (11.9)	20491 (100)	
Age, years (%)						<.001
<20	21 (0.3)	108 (0.5)	86 (1.2)	0	215 (1.1)	
20-29	789 (10.6)	666 (19.9)	757 (10.5)	14 (0.5)	2226 (10.9)	
30-39	1918 (25.7)	575 (17.1)	1104 (15.3)	42 (1.8)	3639 (17.8)	
40-49	1762 (23.6)	638 (19.0)	1331 (18.4)	179 (8.0)	3910 (19.1)	
50-59	1242 (16.6)	540 (16.1)	1589 (22.0)	443 (17.5)	3814 (18.6)	
≥60	1732 (23.2)	827 (24.7)	2363 (32.7)	1765 (72.3)	6687 (32.6)	
Obesity (%)						<.001
Low	167 (2.2)	82 (2.4)	248 (3.4)	141 (5.8)	638 (3.1)	
Normal	4408 (59.1)	2008 (59.9)	4492 (62.1)	1628 (66.6)	12536 (61.2)	
Obese	2889 (38.7)	1264 (37.7)	2490 (34.4)	674 (27.6)	7317 (35.7)	
Alcohol consumption (%)						<.001
Non-drinkers	1891 (25.3)	785 (23.4)	1983 (27.4)	941 (38.5)	5600 (27.3)	
Moderate drinkers	4121 (55.2)	1778 (53.0)	3758 (52.0)	1159 (47.4)	10816 (52.8)	
Heavy drinkers	1452 (19.5)	791 (23.6)	1489 (20.6)	343 (14.0)	4075 (19.9)	
Smoking (%)						<.001
Never and past	4644 (62.2)	1872 (55.8)	4029 (55.7)	1607 (65.8)	12152 (59.3)	
Current smoker	2820 (37.8)	1482 (44.2)	3201 (44.3)	836 (34.2)	8339 (40.7)	
Allergic rhinitis (%)						<.001
No	6456 (86.5)	2928 (87.3)	6563 (90.8)	2359 (96.6)	18306 (89.3)	
Yes	1008 (13.5)	426 (12.7)	667 (9.2)	84 (3.4)	2185 (10.7)	
Women, n (%)	9871 (37.3)	7038 (26.6)	6199 (23.4)	3366 (12.7)	26474 (100)	
Age, years (%)						<.001
<20	51 (0.5)	157 (2.2)	47 (0.8)	0	255 (1.0)	
20-29	1860 (18.8)	813 (11.6)	282 (4.6)	13 (0.4)	2968 (11.2)	
30-39	3666 (37.1)	951 (13.5)	480 (7.7)	32 (1.0)	5129 (19.4)	
40-49	2475 (25.1)	1374 (19.5)	1086 (17.5)	159 (4.7)	5094 (19.2)	
50-59	1128 (11.4)	1686 (24.0)	1607 (25.9)	580 (17.2)	5001 (18.9)	
≥60	691 (7.0)	2057 (29.2)	2697 (43.5)	2582 (76.7)	8027 (30.3)	
Obesity (%)						<.001
Low	838 (8.5)	344 (4.9)	165 (2.7)	135 (4.0)	1482 (5.6)	
Normal	7189 (72.8)	4411 (62.7)	3728 (60.1)	2003 (59.5)	17331 (65.5)	
Obese	1844 (18.7)	2283 (32.4)	2306 (37.2)	1228 (36.5)	7661 (28.9)	
Alcohol consumption (%)						<.001
Non-drinkers	5478 (55.5)	3899 (55.4)	4137 (66.7)	2687 (79.8)	16201 (61.2)	
Moderate drinkers	3980 (40.3)	2652 (37.7)	1855 (29.9)	651 (19.3)	9138 (34.5)	
Heavy drinkers	413 (4.2)	487 (6.9)	207 (3.3)	28 (0.8)	1135 (4.3)	
Smoking (%)						<.001
Never and past	9491 (96.2)	6409 (91.1)	5888 (95.0)	3261 (96.9)	25049 (94.6)	
Current smoker	380 (3.9)	629 (8.9)	311 (5.0)	105 (3.1)	1425 (5.4)	
Allergic rhinitis (%)						<.001
No	7887 (79.9)	6162 (87.6)	5586 (90.1)	3254 (96.7)	22889 (86.5)	
Yes	1984 (20.1)	876 (12.5)	613 (9.9)	112 (3.3)	3585 (13.5)	

**p*-value from chi-square tests between baseline variables and occupational classification.

Table 2. Prevalence of allergic rhinitis.

Variables	Male		Female		Total	
	N (%)	<i>p</i> *	N (%)	<i>p</i> *	N (%)	<i>p</i> *
Sex						<.001
Men	2185 (10.7)				2185 (10.7)	
Women			3585 (13.5)		3585 (13.5)	
Age, years		<.001		<.001		<.001
<20	46 (21.4)		58 (22.8)		104 (22.1)	
20-29	418 (18.8)		680 (22.9)		1098 (21.1)	
30-39	581 (16.0)		1111 (21.7)		1692 (19.3)	
40-49	436 (11.1)		801 (15.7)		1237 (13.7)	
50-59	326 (8.6)		526 (10.5)		852 (9.7)	
≥60	378 (5.7)		409 (5.1)		787 (5.4)	
Obesity		0.282		<.001		<.001
Low	56 (8.8)		273 (18.4)		329 (15.5)	
Normal	1350 (10.8)		2513 (14.5)		3863 (12.9)	
Obese	779 (10.7)		799 (10.4)		1578 (10.5)	
Alcohol consumption		<.001		<.001		<.001
Non-drinkers	527 (9.4)		1929 (11.9)		2456 (11.3)	
Moderate drinkers	1229 (11.4)		1478 (16.2)		2707 (13.6)	
Heavy drinkers	429 (10.5)		178 (15.7)		607 (11.7)	
Smoking		<.001		0.937		<.001
Never and past	1380 (11.4)		3391 (13.5)		4771 (12.8)	
Current smoker	805 (9.7)		194 (13.6)		999 (10.2)	
Occupational cluster		<.001		<.001		<.001
White-collar	1008 (13.5)		1984 (20.1)		2992 (17.3)	
Pink-collar	426 (12.7)		876 (12.5)		1302 (12.5)	
Blue-collar	667 (9.2)		613 (9.9)		1280 (9.5)	
Green-collar	84 (3.4)		112 (3.3)		196 (3.4)	

**p*-value from chi-square tests between baseline variables and occupational classification.

Table 3. The association between occupational clusters and AR.

	Crude		Model I*	
	OR	95% CI	OR	95% CI
Men				
Green-collar	1.00		1.00	
Blue-collar	2.85	2.26-3.60	2.00	1.58-2.53
Pink-collar	4.09	3.21-5.20	2.46	1.91-3.15
White-collar	4.39	3.49-5.51	2.78	2.20-3.51
Women				
Green-collar	1.00		1.00	
Blue-collar	3.19	2.60-3.92	2.45	1.99-3.02
Pink-collar	4.13	3.38-5.05	2.64	2.15-3.25
White-collar	7.31	6.02-8.88	3.63	2.96-4.47

OR = odds ratio, 95% CI = 95% confidence interval

*Adjusted for age, obesity, alcohol consumption, and smoking status

workers. In a 2005 study conducted by Braback et al.²⁵⁾, the OR of AR in white-collar workers was found to be higher than in blue-collar workers. The authors of these two studies interpreted their results as suggesting that the prevalence of AR was higher in affluent populations, or in individuals belonging to a higher social class.

The results of our study can be explained on the basis of several hypotheses pertaining to the environment and lifestyle. Modern construction techniques have led to increases in the temperature and humidity of buildings; in addition, the structures of these buildings do not allow for easy ventilation. The advanced technologies behind the air-conditioning systems in modern buildings²⁶⁾ might contribute to the promotion or the growth of indoor allergens, such as mites and molds²⁷⁾. White and pink-collar workers spend most of their time indoors and are likely to be exposed and sensitized to indoor allergens. Therefore, modern building technologies could lead to a higher prevalence of AR in white and pink-collar workers, who predominantly work in controlled environments.

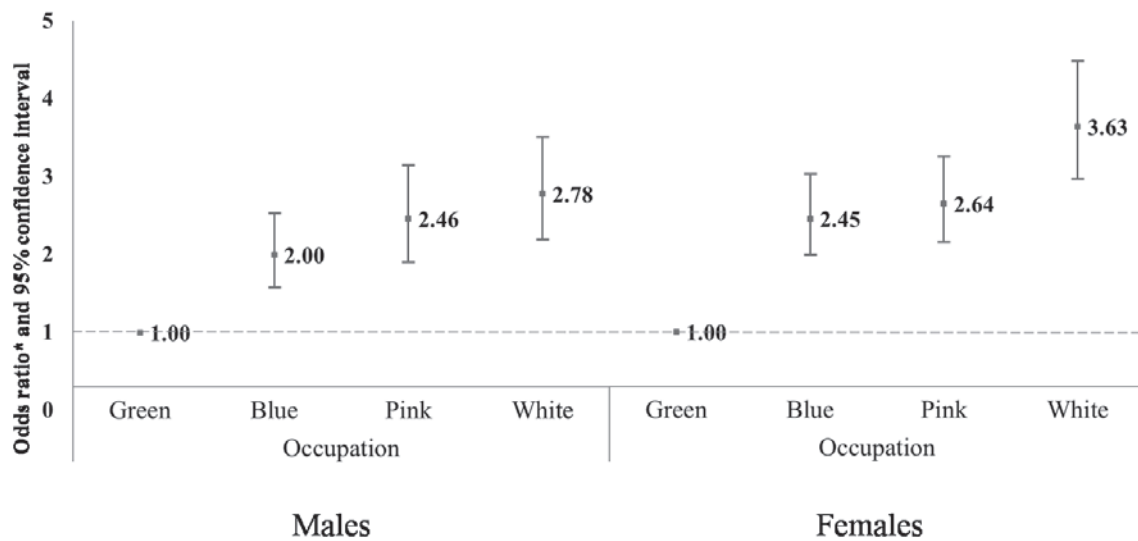


Fig. 1. Odds ratios for the association between allergic rhinitis and occupational cluster.

*Adjusted for age, obesity, alcohol consumption, and smoking status

Living on a farm or in a rural area has been associated with a low prevalence of AR and atopy in both children and adults²⁸. This could be attributed to the fact that agricultural environments, especially farms that raise cattle and poultry, offer a protective effect against the development of AR²⁸. Farming environments and those in which livestock are raised are rich in diverse microbial populations, organic dust, and endotoxins^{28,29}. Therefore, it can be assumed that AR prevalence rates are low in farmers working in such environments.

High socioeconomic status is associated with high prevalence of AR^{7,9,16,25}. Although Braback et al.²⁵ found that the association between social class and AR is becoming weaker over time, Eriksson et al.⁹ reported high AR prevalence in the high socioeconomic groups. Though the reason for the relationship between high social class and high AR prevalence is not clear, previous studies have suggested several hypotheses. People with high levels of income and education tend to work indoors rather than outdoors, which can raise the prevalence of AR¹⁶. In addition, the improved hygiene hypothesis might explain the higher AR prevalence in high socioeconomic classes³⁰. With respect to utilization of medical services, people with high socioeconomic status are likely to have more knowledge of AR symptoms, and can see a doctor more easily, making it easier to report AR³¹. Moreover, people with high socioeconomic status appear to be diagnosed with AR more often, because they are less likely to tolerate uncomfortable diseases that are not life-threatening such as AR³². Taken together, the high prevalence of AR among white-collar workers in our study could be explained by the higher levels of income, education, and medical accessibility present in these occupations.

On the other hand, green-collar workers in Korea tend to live in rural areas. According to Lee et al., the proportion of green-collar workers living in rural areas was 85.6%, which was much higher than that of white (10.9%), pink (16.4%), blue-collar workers (20.4%)¹⁹. Differences in the prevalence of AR due to differences in urbanization have been proposed in previous studies^{7,28,33}. Urban areas might have a higher prevalence of AR due to differences in medical access, the degree of air pollution, hygiene, socioeconomic conditions, lifestyle, biodiversity, and the ventilation status of modern buildings³⁴. Moreover, as urbanization proceeds, populations who live in the cities may benefit from better medical accessibility, better nutrition, and higher socioeconomic status such as income and education level³⁵. Therefore, the low prevalence of AR in green-collar workers might be explained by the fact that most of these workers live in rural areas, which have a lower AR prevalence than urban areas for several reasons including medical accessibility.

In our study the prevalence of AR and the differences in the ORs between the occupational clusters were greatest in women. This finding was consistent with other studies^{7,9,20}. An experimental study on animals suggested that estradiol promotes allergic sensitization by leading to increased production of immunoglobulin E (IgE)³⁶. However, it is also important to note that estrogen is known to have pro-inflammatory effects that testosterone lacks³⁷.

In this study, we observed a negative relationship between age and AR prevalence consistent with other studies^{9,16,38}. This decrease in prevalence seems to be due to the fact that IgE levels decrease with age³⁹. Since the prevalence of allergic diseases such as AR has increased gradually over time, these observations might reflect an increased propensity for allergic diseases in more recent

generations⁴⁰.

Smoking status (OR 0.83 [95% CI 0.76-0.91]) was only found to be negatively associated with the prevalence of AR in men. This could be due to “healthy smoker” bias (the tendency of those with allergic disease not to smoke), with several studies reporting lower rates of sensitization to common environmental allergens and less hay fever in smokers⁴⁰. Obesity (OR 0.69 [95% CI 0.63-0.75]) was only found to be negatively associated with the prevalence of AR in women. However, this result is inconsistent with previous studies^{14,41}. Obesity is presumed to be a risk factor for AR but its relevance in epidemiological studies is controversial¹⁴. It has been strongly proposed that alcohol consumption increases serum total IgE levels, thereby leading to sensitization to allergens⁴². In this study, moderate alcohol consumption was positively associated with the prevalence of AR in men (OR 1.23 [95% CI 1.11-1.37]), while both moderate (OR 1.43 [95% CI 1.33-1.54]) and heavy (OR 1.38 [95% CI 1.17-1.63]) alcohol consumption were positively associated with AR prevalence in women.

Our study has some limitations. First, it was based on cross-sectional data, and therefore the causal relationship between AR prevalence and occupational clusters cannot be demonstrated. Second, three consecutive KHNANES datasets (IV, V, and VI) were used for analysis. In order to reduce bias due to differences between datasets, the dataset was added as covariate for adjustment in addition to age, obesity, alcohol consumption, and smoking status. After adjusting for such variables, the ORs of AR in males were 1.97 (95% CI 1.55-2.49) in blue-collar workers, 2.40 (95% CI 1.87-3.08) in pink-collar workers, and 2.72 (95% CI 2.15-3.44) in white-collar workers, respectively. In female workers the OR was 2.36 (95% CI 1.91-2.90) in blue-collar workers, 2.51 (95% CI 2.04-3.09) in pink-collar workers, and 3.43 (95% CI 2.79-4.22) in white-collar workers. Additionally, the ORs after adjusting the dataset were quite similar to the ORs of the unadjusted dataset, indicating that bias from differences between datasets was negligible. Third, the occupational clusters were assessed based on a self-reported questionnaire. However, the questionnaire contained examples of each occupational group, and since we re-classified the occupations into 4 clusters, the misclassification bias was minimized. Fourth, the presence of AR was also defined based on a self-reported questionnaire. This method can lead to a recall bias and thus lead to results that do not reflect the actual prevalence of AR. Additionally, this self-reported questionnaire might have increased the reported prevalence of AR in white-collar workers who were likely to have more knowledge of AR symptoms. Although bias of this type is possible, this method has been used to define AR in many epidemiological studies^{5,7,17,43,44}. Finally, this study lacked data on possible confounders such as the presence of common comorbid conditions such as asthma

or atopic dermatitis.

Our study’s strength lies in the fact that the results were drawn from large-scale, nationwide representative data, in which more than 40,000 participants were examined. Moreover, as mentioned above, since gender is an important factor in the prevalence of AR, our study provides sex-stratified results. Finally, to the best of our knowledge this is the first study to demonstrate the relationship between the occupation and the prevalence of AR using occupational clusters classified by the ISCO-08. AR is one of the major health concerns of the modern world, and therefore it is important that possible risk factors to be thoroughly investigated, and efforts taken to reduce the risk of AR. Workers belonging to high-risk groups, as defined by our study, should receive special attention when considering the risk for AR. Further studies should focus on improvements in indoor working environments and their effect on AR prevalence.

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