Analysis of various risk factors predisposing subjects to allergic rhinitis

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Summary

Background: In Korea, the prevalence of allergic rhinitis (AR) is increasing, as in other industrialized countries. However, no large population-based study defining risk factors for AR has yet been conducted.

Objective: The purpose of this study was to evaluate the prevalence and risk factors of AR in large population-based study.

Methods: A cross-sectional study was performed using data from the Korea National Health and Nutrition Examination Survey. We evaluated data from 31,217 subjects who were interviewed between 2008 and 2011.

Results: The prevalence of AR decreased with age (adjusted odds ratio [AOR] = 0.985; 95% CI = 0.984-0.987). Higher-level stress (AOR for severe stress = 1.470; 95% CI = 1.209-1.788); asthma (AOR = 1.868; 95% CI = 1.582-2.205); atopic dermatitis (AOR = 1.552; 95% CI = 1.309-1.841); pulmonary tuberculosis (AOR = 1.320;

95% CI = 1.119-1.555); depression (AOR = 1.250; 95% CI = 1.117-1.400); and thyroid disease (AOR = 1.328; 95% CI = 1.104-1.597) increased the risk of AR. Participants whose parents had a history of AR also had higher AORs (father, AOR = 1.566; 95% CI = 1.130-2.172; mother, AOR = 1.546; 95% CI = 1.190-2.008). Marriage (AOR = 0.846; 95% CI = 0.741-0.966) decreased the risk of AR. Farmers, fishers, laborers, and soldiers were at lower risk of AR. Although high BMI, a high educational level, living in a large household, specific types of daily living, and a history of diabetes mellitus have been reported as risk factors for AR; none of these factors attained statistical significance in the present study.

Conclusion: Our study revealed that age, stress level, marriage, occupation, asthma, atopic dermatitis, pulmonary tuberculosis, depression, thyroid disease, and parental AR history, all affected the prevalence of AR. We believe that defining the influence of various factors on AR will help to prevent development of the condition in the future. (*Asian Pac J Allergy Immunol 2015;33:143-51*)

Keywords: allergy, prevalence, risk factor; epidemiology, stress, asthma, atopic dermatitis, depression

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Introduction

The incidence of allergic rhinitis (AR) is increasing continuously in many industrialized countries.[1,2] In Korea, the prevalence of AR in middle- and high-school students has increased gradually from 24.5% in 2007 to 33.9% in 2012.[3] It is thus becoming increasingly important to define factors predisposing subjects to AR and risk factors for AR. However, the exact reason for the observed increase in AR prevalence remains unknown.

Improved hygiene, increased exposure to allergens, reduced levels of infection, and changes in lifestyle may increase the prevalence of AR.[4] Changes in dietary habits and the presence of fewer nuclear families may also affect AR development.[5-7]

Exposure to workplace allergens and high socioeconomic status may contribute to development of AR.[8,9] Recent studies found that diabetes, rheumatoid arthritis, and tuberculosis infection were associated with allergies.[10-12] Depressive disorders and short sleep duration have also been reported as risk factors for AR.[13,14] Genetic features are well-known predisposing factors for AR.[15] However, these data do not provide the full picture; previous studies on risk factors for AR have been fragmentary in nature.

The present study is the largest to date to analyze the prevalence of AR in the Korean population. The entire nation is covered, using formal statistical methods such as careful sample design and adjustment of weighted values. We classified AR risk factors in the general population into four types; these were personal, socioeconomic, disease, and parental factors. The influence of each factor on the prevalence of AR was evaluated. In terms of parental factors, the severity and duration of parental AR histories were compared with those of their children.

Methods

Study population and data collection

This study was approved by the institutional review board of the Thyroid/Head & Neck Cancer Center of the Dongnam Institute of Radiological & Medical Sciences (DIRAMS IRB no. D-1401-001-002).

Data from the fourth and fifth Korean National Health and Nutrition Examination Surveys (KNHANES), conducted in 2008, 2009, 2010, and 2011, were analyzed. The data were collected by the Centers for Disease Control and Prevention of Korea. Each year, 192 districts were selected by a panel and 20 households further selected in each district. The surveys evaluated data from the civilian, non-institutionalized South Korean population using stratified, multistage clustered sampling based on National Census Data. Sampling was weighted by statisticians, who performed post-stratification and considered the non-response rates and the extreme values.

Of a total of 31,217 participants (14,103 male, 17,114 female), young children (under 6 years of age) were considered to represent missing values, because they did not take part in the survey. Survey participants ranged in age from 6 to 97 years. After applying the weighted values recommended by KNHANES, data from a total of 45,201,279 subjects (22,623,966 males, 50.1%; 22,577,313 females, 49.9%) were analyzed.

Survey

Each participant was asked questions relevant to a history of rhinitis, including the prevalence of symptoms such as a runny nose, sneezing, and nasal blockage without fever or a sore throat, within the previous year; whether the symptoms were sustained for at least 4 days per week; whether the symptoms were sustained for at least 1 month; and whether study, work, or sleep was disturbed by the symptoms. A participant was considered to have had AR when a runny nose, sneezing, and nasal blockage, without fever or a sore throat, were reported.

All of height (cm), weight (kg), body mass index (BMI, kg/cm^2), smoking status, level of alcohol consumption, sleep time per night, and stress level in everyday life, were considered to be personal risk factors. Such factors were analyzed in those over 19 years of age. Smoking status was divided into three categories: never smoked; smoked less than five packs in a lifetime; and smoked five or more packs in a lifetime. Alcohol consumption was divided into seven categories: never; never in the past year; less than once a month; 2-4 times per month; 2-3 times per week; and 4 or more times per week. Sleep time was divided into two categories; 7 or fewer h per night and more than 7 h per night. The stress level usually experienced was investigated; stress was divided into four categories: no stress; a little stress; moderate stress; and severe stress.

To evaluate socioeconomic status, the number of persons in the household, the style of residence, marital status, educational level, monthly income, and occupation, were recorded. Such factors were analyzed in those over the age of 19 years. To explore the influence of educational level, participants who were uneducated or who had graduated from only elementary or middle schools were used to form a single group. Those who had graduated from high school, junior college, college, or graduate school, formed another group. Monthly income was divided into three categories: 200 million won or less (about $2,000 or less); 201 million to 400 million won (about $2,001-4,000); and more than 400 million won (about $4,000). Those in 10 types of Korean standard occupations were re-categorized into four groups according to the extent of outdoor activity; these were managers, experts, specialists, and clerks; service workers and

Table 1. Prevalence and characteristics of allergic rhinitis symptoms

Question	Answer	Number[*]	%
AR symptoms	Yes	12,201,131	27.0
	No	33,000,149	73.0
Duration of Symptoms	Seasonal	7,825,443	64.2
	Perennial	4,356,181	35.8
Persistence of	< 4 days	6,759,496	55.5
Symptoms a week	≥ 4 days	5,415,817	44.5
Persistence of	< 1 month	8,752,454	71.9
Symptoms	≥ 1 moth	3,421,202	28.1
Severity of Symptoms	Mild	3,800,185	31.2
(study, work or sleep)	Moderate-Severe	8,368,185	68.8

[*]Estimated number of population

Figure 1. Prevalence of allergic rhinitis in the Korean population.

salespersons; technicians, mechanics, production workers, and engineers; and farmers, fishers, laborers, and soldiers. Unemployed participants formed a sixth group.

Diagnoses of comorbidities, including hypertension, diabetes mellitus, hyperlipidemia, cerebral stroke, angina or myocardial infarction, osteoarthritis, rheumatoid arthritis, pulmonary tuberculosis, asthma, atopic dermatitis, depression, and thyroid disease, were documented in a manner similar to the recording of AR status.

Parents were asked the questions listed above to reveal the presence of AR symptoms in their children. Parental data were compared with those yielded when the children were asked the same questions. Of 31,217 participants, data from 1,740 fathers and 2,297 mothers were matched to those of their children.
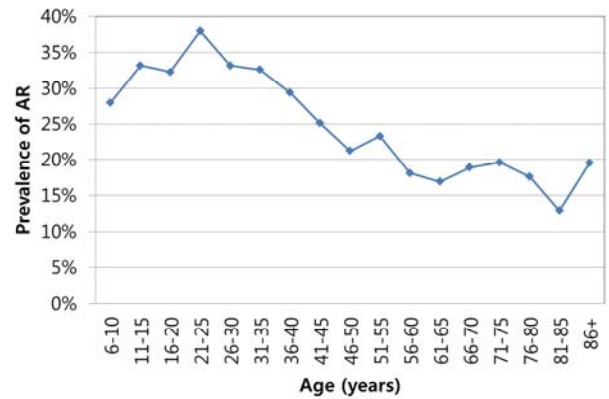
Statistical analysis

Multiple logistic regression analysis featuring complex sampling was used. Two-tailed analyses were conducted and P-values lower than 0.02 were considered to indicate significance. AORs with 95% confidence intervals (CIs) for AR were calculated. All results are presented as weighted values. All analyses were conducted using the SPSS software (version 20.0; SPSS Inc., Armonk, NY, USA).

Results

Prevalence and characteristics of allergic rhinitis symptoms

Of the estimated 45,201,279 subjects, 12,201,131 (estimated rate 27.0%) had AR. Seasonal AR (64.2%) was more frequent than was perennial AR (35.8%). AR symptoms lasting less than 4 days per week (55.5%) were more frequent than symptoms of longer duration (44.5%). Most subjects with AR had symptoms lasting for less than 1 month (71.9%). Most such subjects (68.8%) reported that study, work, or sleep had been disturbed (Table 1).

The mean subject age was 39.4 years. The mean age of subjects who had experienced AR (35.4 years) was lower than that of those who did not report AR (40.8 years). AR prevalence was highest in those aged 21-25 years. Thereafter, AR prevalence decreased with age. The prevalence of AR was less than 20% in those aged over 50 years (Figure 1). Age was negatively associated with AR (AOR = 0.985, 95% CI = 0.984-0.987, $P < 0.001$). AR prevalence was slightly higher in males (27.9%) than females (26.0%). However, after adjustment for age, gender was not significantly associated with AR (AOR = 1.067, 95% CI = 0.999-1.139, $P = 0.055$).

Personal factors

None of height, weight, BMI, smoking status, alcohol consumption, or mean sleep time was associated with AR prevalence.

After adjusted with age, sex, height, weight, BMI, smoking status, alcohol consumption, and mean sleep time, exposure to higher-level stress, and stress per se, increased the risk of AR (a little stress: AOR = 1.137, 95% CI = 1.012-1.279; moderate stress: AOR = 1.455, 95% CI = 1.278-1.657; severe stress: AOR = 1.470, 95% CI = 1.209-1.788, $P < 0.001$) (Table 2).

Socioeconomic factors

None of the number of persons in the household, residential style, educational level, or monthly income affected AR prevalence significantly. The

Table 2. Analysis for personal factors ($\geq$ 20 years old)

	Number[*]	%	AOR	95% CI	P-value
Height (cm)			1.002	0.973-1.032	0.883
Weight (kg)			1.003	0.967-1.040	0.869
BMI (kg/cm^2)			0.977	0.886-1.078	0.640
Smoking for entire life					
Never	19,437,201	53.5	1		0.186
< 5 Pack	1,004,300	2.8	1.194	0.944-1.510	
$\geq$ 5 Pack	15,917,599	43.8	0.961	0.861-1.073	
Alcohol consumption for one year					
Never for entire life	4,073,789	11.2	1		0.565
Never for one year	4,425,692	12.2	1.098	0.941-1.280	
< 1 times a month	6,431,164	17.7	1.171	1.011-1.356	
1 times a month	3,875,434	10.7	1.089	0.923-1.285	
2-4 times a month	9,036,369	24.9	1.095	0.936-1.282	
2-3 times a week	5,769,911	15.9	1.079	0.910-1.280	
$\geq$ 4 times a week	2,746,732	7.6	1.124	0.917-1.377	
Sleep time per night					
$\leq$ 7 Hour	25,166,216	69.2	1		0.049
> 7 Hour	11,192,884	30.8	.0915	0.838-1.000	
Stress level in everyday life					
Little	4,913,211	13.5	1		<0.001[†]
A little	20,881,387	57.5	1.137	1.012-1.279	
Moderate	8,747,229	24.1	1.455	1.278-1.657	
Severe	1,817,273	5.0	1.470	1.209-1.788	

[*]Estimated number of population

[†]P- value < 0.02, Multiple logistic regression analysis featuring complex sampling

mean number of persons per household was 3.4. After adjusted with age, sex, the number of persons in the household, residential style, educational level, monthly income, and types of job, marriage was negatively associated with AR (AOR = 0.846, 95% CI = 0.741-0.966, P = 0.014).

After adjusted with age, sex, the number of persons in the household, residential style, educational level, monthly income, and marriage, compared to farmers, fishers, laborers, and soldiers, who were assumed to have the highest levels of outdoor activity, those in other occupations exhibited higher levels of AR (unemployed: AOR = 1.278, 95% CI = 1.112-1.469; manager, expert, specialist, or clerk: AOR = 1.183, 95% CI = 1.093-1.521; service worker or salesperson: AOR = 1.183, 95% CI = 1.010-1.385; technician, mechanic, production worker, or engineer: AOR = 1.320, 95% CI = 1.106-1.577, P = 0.008) (Table 3).

Disease factors

After adjusted with age, sex, and each disease factors, histories of pulmonary tuberculosis, asthma, atopic dermatitis, depression and thyroid diseases, were positively associated with AR (pulmonary tuberculosis: AOR = 1.320, 95% CI = 1.119-1.555, P = 0.001; asthma: AOR = 1.868, 95% CI = 1.582-2.205, P < 0.001; atopic dermatitis: AOR = 1.552, 95% CI = 1.309-1.841, P < 0.001; depression: AOR = 1.250, 95% CI = 1.117-1.400, P < 0.001; and thyroid disease: AOR = 1.328, 95% CI = 1.104-1.597, P = 0.003).

Histories of hypertension, diabetes mellitus, hyperlipidemia, cerebral stroke, angina or myocardial infarction, osteoarthritis, and rheumatoid arthritis were not risk factors for AR (Table 4).

Parental factors

Parental factors were adjusted with age and sex. If a father or mother had AR, their children were at higher risk of AR (father: AOR = 1.566, 95% CI = 1.130-2.172, P =0.007; mother: AOR = 1.546, 95% CI = 1.190-2.008, P = 0.001). If the mother experienced symptoms for more than 1 month, the children also had symptoms for more than 1 month (AOR = 2.872, 95% CI = 1.188-6.945, P = 0.020). However, even if the father or mother had AR symptoms that persisted for 4 or more days per week, the children did not have such symptoms (Table 5).

Table 3 Analysis for socioeconomic factors ($\geq$ 20 years old)

	Number[*]	%	AOR	95% CI	P-value
The number of person in the household			1.029	0.995-1.064	0.092
Style of Residence					
Detached house	14,083,996	40.3	1		0.387
Condominium	12,821,204	36.7	1.040	0.918-1.178	
Row house	3,301,609	9.5	1.138	0.955-1.357	
Multiplex house	2,681,431	7.7	1.067	0.894-1.273	
Commercial Building	1,305,211	3.7	0.943	0.712-1.248	
Etc	726,956	2.1	1.315	0.966-1.790	
Marital status					
Married	28,018,769	80.2	0.846	0.741-0.966	0.014[†]
Unmarried	6,901,639	19.8	1		
Education Level					
Uneducated, elementary school, middle school	8,519,672	24.4	1		0.122
High school	7,792,052	22.3	1.047	0.925-1.185	
Junior college	7,599,305	21.8	1.046	0.907-1.205	
College	6,787,996	19.4	1.197	1.023-1.402	
Graduate school	4,221,383	12.1	1.036	0.866-1.238	
Monthly Income					
≤200 million won ($2000)	12,767,329	36.6	1		0.300
200-400 million won ($2001-4000)	12,237,881	35.0	0.959	0.862-1.066	
>400 million won ($4000)	9,915,199	28.4	0.908	0.804-1.026	
Occupation					
Unemployed	12,664,769	36.3	1.278	1.112-1.469	0.008[†]
Manager, Expert, Specialist, Clerks	7,731,008	22.1	1.289	1.093-1.521	
Service worker, Seller	4,929,825	14.1	1.183	1.010-1.385	
Technician, Mechanics, Production worker, Engineer	4,140,738	11.9	1.320	1.106-1.577	

Discussion

Prevalence and characteristics of allergic rhinitis symptoms

The prevalence of AR in Korea was as high as that in other industrialized countries; our results were similar to those of another recent epidemiological study performed in Korea.[3] Seasonal AR was more frequent than perennial AR and AR of shorter duration (less than 4 days per week) more common than AR of longer duration (4 or more days per week). Although most patients (71.9%) reported symptoms that did not persist for long, most (68.8%) also complained that their lives were disturbed by the condition. We evaluated AR prevalence using a questionnaire, even though data on physician-diagnosed AR were available to us. We considered that physician diagnoses would underestimate the actual prevalence of AR in an epidemiological context, and that questionnaire data would be more accurate.[2] We found, however, that the AR prevalence as revealed by the questionnaire correlated with the level of physician-diagnosed AR. Compared to physician-diagnosed AR, the accuracy of AR diagnosis by questionnaire was 80.0%.

In agreement with the results of previous studies, the prevalence of AR decreased with age.[2,16] Similarly, the prevalence in males and females did not differ.[2]

Personal factors

An earlier epidemiological study found that stress was risk factors for AR in children.[14] We found similar results in adults. Higher stress levels increased the risk of AR in the present study. The stress-related hypothalamic-pituitary-adrenal axis reacts to psychological stressors and triggers a cortisol response; this may explain our data.[17]

Table 4. Analysis for disease factors ($\geq$ 20 years old)

	Number*	%	AOR	95% CI	P-value
Hypertension					
Yes	6,337,771	17.5	0.987	0.880-1.107	0.822
No	29,846,990	82.5	1		
Diabetes mellitus					
Yes	2,381,330	6.6	1.066	0.907-1.253	0.439
No	33,803,431	93.4	1		
Hyperlipidemia					
Yes	2,935,854	8.1	1.056	0.922-1.210	0.428
No	33,248,907	91.9	1		
Cerebral stroke					
Yes	522,673	1.4	0.906	0.678-1.210	0.503
No	35,662,088	98.6	1		
Angina or myocardial infarction					
Yes	689,895	1.9	1.293	1.009-1.657	0.042
No	35,494,866	98.1	1		
Osteoarthritis					
Yes	4,144,534	11.5	1.148	1.019-1.292	0.023
No	32,040,227	88.5	1		
Rheumatoid arthritis					
Yes	747,028	2.1	1.195	0.938-1.523	0.148
No	35,437,733	97.9	1		
Pulmonary tuberculosis					
Yes	1,931,553	5.3	1.320	1.119-1.555	0.001[†]
No	34,253,208	94.7	1		
Asthma					
Yes	1,473,772	4.1	1.868	1.582-2.205	<0.001[†]
No	34,710,989	95.9	1		
Atopic dermatitis					
Yes	1,796,483	5.0	1.552	1.309-1.841	<0.001[†]
No	34,388,278	95.0	1		
Depression					
Yes	4,796,951	13.3	1.250	1.117-1.400	<0.001[†]
No	31,387,810	86.7	1		
Thyroid disease					
Yes	1,179,762	3.3	1.328	1.104-1.597	0.003[†]
No	35,004,998	96.7	1		

*Estimated number of population

[†]P- value < 0.02, Multiple logistic regression analysis featuring complex sampling

Smoking was a risk factor in some studies[9] but not others.[18] BMI was found to be an AR risk factor in some studies[19,20] but not others.[18] We found no association between smoking status, BMI and AR in the present study.

Socioeconomic factors

Living in a big family has been considered to protect against AR, because of a higher probability of infection by older siblings.[6] Immune downregulation mediated by the TH2 response may support this hypothesis.[21] However, the number of persons in the household did not affect AR prevalence in the present study.

The educational levels of the mother and father were associated with child AR prevalence in other studies.[5,9,14] Personal educational levels were also associated with AR prevalence in adults.[8] However, we found no such associations in the present study.

Table 5. Analysis for parental factors (<20 years old)

Question	Father			Mother		
	AOR	95% CI	P-value	AOR	95% CI	P-value
AR symptoms						
Yes	1.566	1.130-2.172	0.007*	1.546	1.190-2.008	0.001*
No	1			1		
Duration of Symptoms						
Seasonal	1		0.033	1		0.282
Perennial	2.282	1.072-4.856		0.689	0.347-1.367	
Persistence of Symptoms in 1 week						
< 4 days	1		0.064	1		0.086
≥ 4 days	2.214	0.952-5.148		1.934	0.909-4.116	
Persistence of Symptoms						
< 1 month	1		0.353	1		0.020*
≥ 1 moth	1.529	0.616-3.795		2.872	1.188-6.945	
Severity of Symptoms (study, work, sleep)						
Mild	1		0.174	1		0.038
Moderate-Severe	1.880	0.750-4.716		2.183	1.044-4.565	

*P- value < 0.02, Multiple logistic regression analysis featuring complex sampling

Min reported that AR prevalence was not associated with job type, but rather with educational level.[18] However, in other reports, exposure to workplace allergens may have contributed to development of AR in adults;[8] living on farms and in rural areas afforded protection from AR.[22] Moreover, modern building techniques increase indoor temperatures and humidity levels[23] facilitating the growth of mites and molds (indoor allergens).[4] Such considerations explain our results: farmers, fishers, laborers, and soldiers, who generally engage in outdoor activities, had a lower AOR for AR than did those in other occupations.

It is well-known that AR occurs frequently in subjects of higher socioeconomic status.[2,9,14] However, neither higher education nor high income were risk factors for AR in the present study. We hypothesize that those who obtain higher education and who enjoy a high income usually work, today, in jobs featuring more indoor than outdoor activity. Although no adjustment was performed for other occupational factors, other studies have described a higher prevalence of AR in those with higher-level education and who enjoy higher incomes.

We could not find any prior description of an association between AR prevalence and marriage. One substantial study has connected marriage to positive physical and mental health outcomes.[24]

Indeed, marriage exerted a protective effect on AR in the present study.

Disease factors

Children with type I diabetes mellitus are known to exhibit a lower prevalence of atopy.[25] Also, high fasting glucose levels induce chronic inflammation, which lowers the risk of AR.[10] However, diabetes mellitus was not associated with AR in the present study.

Rheumatoid arthritis is characterized by (predominantly) Th1 activity,[26] whereas allergic disease is associated with (predominantly) Th2 activity. Thus, in another study, allergic disease-like atopy was less prevalent in rheumatoid arthritis patients than the normal population.[27] The prevalence of allergic diseases, such as asthma, hay fever, and eczema, was lower in rheumatoid arthritis than osteoarthritis patients.[11] However, some studies have found that Th1- and Th2-dominant diseases may co-exist, and the prevalence of asthma was higher in young rheumatoid arthritis patients than in healthy subjects.[28] Rheumatoid arthritis was not associated with AR in the present study.

The higher prevalence of AR in patients with asthma or atopic dermatitis, noted in the present study, is in agreement with previous reports.[29,30]

In the present study, as in earlier reports, AR prevalence was higher in those with depression.[13,31]

Some authors have reported a genetic association between AR and depression.[32]

Pulmonary tuberculosis was a risk factor for AR in the present study. Others have described a higher prevalence of AR in pulmonary tuberculosis patients.[12] Also, the prevalence of AR was reduced after treatment of pulmonary tuberculosis.[33] Increased IL-4 levels in AR patients enhance endocytosis by macrophages. Ingestion of tubercular bacilli by macrophages increases the risk of tuberculosis infection.[34]

We asked all participants if they had suffered from thyroid disease; the association between such disease and AR was statistically significant. However, the question was ambiguous; a broad range of thyroid disease was effectively surveyed. A higher prevalence of AR has been reported in patients with various thyroid diseases, including autoimmune thyroiditis, hypothyroidism, and hyperthyroidism.[35,36] The observed statistical association suggests the possibility that AR is associated with thyroid disease.

Parental factors

A family history of AR was strongly associated with AR development in many studies.[37-40] In agreement with previous reports, we found that a parental history of AR strongly influenced AR prevalence. A genetic predisposition to AR, or an environmental factor, may explain the high association between AR in parents and their children. Maternal AR symptom duration of over 1 month increased the prevalence of AR in children. We currently cannot explain these observations.

Conclusions

In summary, age, stress level, marriage, occupation, asthma, atopic dermatitis, pulmonary tuberculosis, depression, thyroid disease, and parental AR history, all affected the prevalence of AR. However, BMI, educational level, the number of subjects in the household, type of residence, a history of diabetes mellitus (which have been reported to be AR risk factors in other studies), did not. Our present large population-based study affords reliable information on AR risk factors and improves our understanding of AR. We believe that our work will help to lower the prevalence of AR. Further confirmatory studies are required.

Acknowledgments

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