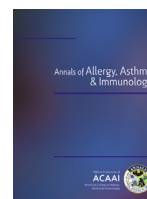




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Rhinitis in a community elderly population: relationships with age, atopy, and asthma

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ABSTRACT

Background: Rhinitis is one of the most frequent medical conditions. However, there is sparse epidemiologic evidence for rhinitis in the elderly population.

Objective: To investigate the prevalence of rhinitis in elderly adults and its relations to asthma and other comorbidities.

Methods: A cross-sectional analysis was performed using the baseline dataset of the Korean Longitudinal Study on Health and Aging, a community-based elderly population cohort in Korea (≥ 65 years old). Structured questionnaires were used to define rhinitis, asthma, and comorbidity, and allergen skin prick tests were used to define atopy. Health-related quality of life was assessed by short-form 36 questionnaires. **Results:** In total, 982 elderly adults (98.2%) were included in the present study. The prevalence of rhinitis was 25.6% and did not decrease until 90 years of age. The prevalence of atopy was 17.2% (18.8% in participants with rhinitis), and atopy did not show a significant association with rhinitis. In multivariate logistic regression analyses, relations between asthma and rhinitis were significant. Among comorbid conditions, none were significantly associated with rhinitis. In the short-form 36 questionnaire analyses, rhinitis was independently related to a decrease in the physical aspects of quality of life.

Conclusion: The present study found a high prevalence of nonallergic rhinitis in elderly participants, which was significantly related to asthma and quality of life.

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Introduction

Rhinitis is one of the most common medical conditions, but its significance has often been trivialized in the elderly population. However, the importance of rhinitis has recently been reappraised for its links with asthma,^{1–3} substantial socioeconomic costs,^{4–6} and impact on quality of life (QoL).⁷ Nevertheless, there is a paucity of evidence regarding the significance of rhinitis in the elderly population compared with younger populations.⁸

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The prevalence of rhinitis in elderly adults has been suggested to decrease with age.^{9–11} However, the decrease seems to be confined to the allergic form only because the prevalence of nonallergic or undetermined rhinitis is considerably higher in elderly compared with younger adults.^{12–14} Thus, rhinitis in elderly adults needs to be examined for its significance and uniqueness and for its potential relations with medical comorbidities.

The present study investigated the epidemiology of rhinitis in elderly adults using the baseline dataset of the Korean Longitudinal Study on Health and Aging (KLoSHA), a community-based elderly population cohort. In addition, relations with asthma and other comorbidities were examined.

Methods

Study Population

The present analysis was an integral part of the KLoSHA, which has been described in detail.¹⁵ Briefly, the baseline survey of KLoSHA was conducted from 2005 to 2006. In total, 1,000 elderly adults

(≥ 65 years old) were recruited from Seongnam City, one of the largest satellite cities of Seoul, Korea. The total population of the city was 977,166 in 2004, and the proportion of elderly adults was 6.2%. Possible subjects were recruited using a stratified random sampling method and were invited by postal mail and then by telephone to participate. Of the 1,118 responders who were randomly selected, 698 agreed to participate. Because information regarding the health status of the very old population was very limited, the oldest group (≥ 85 years old) was recruited as follows: all the 3,136 oldest residents were contacted by postal mail and telephone, and 302 agreed to participate in the study. All interviews were performed by trained nurses with certifications in epidemiologic studies and geriatric assessments. All assessments were performed at Seoul National University Bundang Hospital. All participants were fully informed of the protocol and were provided written statements of informed consent. The protocol was approved by the institutional review board of Seoul National University Bundang Hospital.

Definition of Rhinitis

Rhinitis was defined using structured questionnaires as previously used in Korean adult population surveys.¹⁶ It was deemed positive if the participants responded positively to the question: "Have you had sneezing or a runny or blocked nose without a cold in the past 12 months?"¹⁷ The presence of concomitant rhinoconjunctivitis symptoms was examined using the question: "Has this nose problem been accompanied by itchy or watery eyes?" In addition, specific rhinitis symptoms were checked using dichotomous questionnaires on the presence of sneezing, rhinorrhea, nasal obstruction, or nasal itch. Ever rhinitis was defined by the question: "Have you ever had sneezing or a runny or blocked nose when you did not have a cold or flu?"

Assessments

Current asthma was defined, as previously described,¹⁸ by positive responses to the following questions: (1) "Have you ever been diagnosed with asthma?" (ever asthma) and (2) "Have you had wheezing or whistling in the chest during the past 12 months?" (current wheeze). Another definition for asthma was included for recent asthma treatment, defined by positive answers to the following questions: (1) "Have you ever been diagnosed with asthma?" and (2) "Have you had treatment for asthma (including inhalers, aerosols, or tablets) during the past 12 months?"

Atopy was defined by a positive skin response to at least 1 of 12 common inhalant allergens, as previously described.¹⁹ The tested allergens were *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, cat epithelia, dog epithelia, *Blattella germanica*, *Aspergillus fumigatus*, *Alternaria tenuis*, tree pollen mixture 1 (alder, hazel, poplar, elm, and willow), tree pollen mixture 2 (birch, beech, oak, and plane tree), grass pollen mixture (velvet grass, orchard grass, rye grass, timothy grass, Kentucky blue grass, and meadow grass), mugwort, and ragweed (Allergopharma, Reinbeck, Germany). Skin response positivity was defined as an allergen-to-histamine wheal size ratio of at least 1, considering that skin reactivity may be decreased by aging in elderly adults.^{20,21} Height and weight were measured to the nearest 0.1 cm and 0.1 kg, respectively. Body mass index was defined as weight divided by height squared.

Comorbidity was checked by trained interviewers using a structured questionnaire containing questions of the following type: "Have you been diagnosed with or treated for (a specific disease) by a physician in the past 12 months?" The questionnaire items included disease categories by organ and detailed questions about the presence of more than 70 specific diseases that are common in the Korean elderly population. The total burden of chronic medical illness was rated using the modified Cumulative

Illness Rating Scale.²² Health-related QoL (HRQoL) was measured using the Korean version of the Short-Form 36 (SF-36) Health Survey.²³

Statistical Analysis

For descriptive statistics, continuous variables are presented as mean $\pm$ standard deviation, and categorical variables are presented as frequency. Parametric data were analyzed with the Student *t* test for intergroup comparison. Nonparametric data were analyzed using the Mann-Whitney *U* test. Categorical data were evaluated by χ^2 test. Logistic regression was performed to assess the associations between rhinitis and comorbidity. Controls were defined as participants without ever rhinitis. In multivariate logistic regression tests for associations between asthma and rhinitis (with asthma as a dependent variable), confounders included demographic factors (age, sex, body mass index, and smoking status) and atopy. To assess relations between rhinitis and SF-36 score, the Mann-Whitney *U* test was performed because each item score was not normally distributed (Shapiro-Wilk *W* test, $W < 0.001$). To determine the independent relation between rhinitis and SF-36 score, a general linear model was used with adjustments for Cumulative Illness Rating Scale score (comorbidity burden), atopy, and demographic factors with *P* values less than .1 in univariate tests (sex, marriage, and income). All statistical tests were performed using PASW 18.0 (SPSS, Inc, Chicago, Illinois). All statistical tests were 2-sided, and *P* values less than .05 were considered statistically significant.

Results

Prevalence of Rhinitis in Elderly Adults

The present analyses included 984 participants (98.4%) who underwent relevant assessments for rhinitis. Baseline characteristics are listed in Table 1. The prevalence of rhinitis was 25.6%, did not differ by sex (women, 23.8%; men, 27.9%; $P = .147$), and did not decrease until 90 years of age (Table 2). Rhinitis largely occurred in nonatopic form, with an atopy rate of 18.8% in participants with rhinitis. The sensitized allergens in participants with rhinitis were mostly indoor allergens.

Associations Between Atopy and Rhinitis in Elderly Adults

Participants with rhinitis did not have a significantly higher rate of atopy than those without rhinitis (18.8% vs 16.6%, $P = .458$). In addition, no significant differences were found in specific allergen sensitization between the 2 groups (Table 3). The association with atopy was further assessed for rhinitis-related symptoms. Nasal itch (odds ratio [OR] 1.84, 95% confidence interval [CI] 1.04–3.25, $P = .035$) and rhinorrhea (OR 1.53, 95% CI 1.02–2.29, $P = .039$) were positively associated with atopy, whereas other symptoms, such as rhinoconjunctivitis, sneeze, and nasal obstruction, were not (in multivariate logistic regression tests with adjustments for age and sex).

Associations Between Asthma and Rhinitis in Elderly Adults

Relations between rhinitis and asthma were evaluated with 2 different asthma definitions using questionnaires (current asthma and recent asthma treatment). Multivariate logistic regression tests were performed with adjustments for age, sex, smoking, body mass index, and atopy. The 2 asthma definitions showed similar positive associations (current asthma, OR 2.11, 95% CI 1.22–3.65, $P = .007$; recent asthma treatment, OR 2.56, 95% CI 1.33–4.91, $P = .005$) with rhinitis.

Table 1
Baseline characteristics of 984 study participants^a

Characteristics	Rhinitis (n = 252)	No rhinitis (n = 732)	P value
Age (y)	75.6 ± 8.5	76.8 ± 9.0	.068
Women	52.0	57.2	.147
BMI (kg/m ²)	24.1 ± 3.1	23.9 ± 3.3	.403
Smoking			
Never smoker	59.5	62.0	.770
Former smoker	28.2	26.8	
Current smoker	12.3	11.2	
Alcohol intake			
Never drinker	61.8	61.0	.787
Former drinker	14.1	16.1	
Current drinker	24.1	23.0	
Education (y)	7.1 ± 5.7	6.9 ± 5.7	.631
Marriage			
Married	59.2	55.5	.339
Never married/divorced/bereaved	40.8	44.5	
Income >US \$12,000/y	44.4	44.0	.905
CIRS, median (IQR)	4 (3–6)	3 (2–5)	<.001
Current comorbidity ^b			
Hypertension	43.7	45.1	.714
Coronary disease	13.9	13.9	1.000
Stroke	11.1	9.9	.595
Diabetes mellitus	17.5	12.2	.034
Gastritis	13.9	10.3	.131
Constipation	17.9	15.2	.313
Irritable bowel syndrome	6.3	3.6	.058
Atopy (n = 855) ^c	18.8	16.6	.458
Current asthma ^d	9.9	4.0	.017
Recent asthma treatment ^e	7.9	2.7	<.001
Ever rhinitis ^f	100.0	5.2	<.001
Rhinitis-related symptoms ^g			
Conjunctivitis	50.4	—	
Rhinorrhea	73.4	—	
Sneezing	71.0	—	
Nasal obstruction	29.0	—	
Nasal itch	26.6	—	

Abbreviations: BMI, body mass index; CIRS, total score for Cumulative Illness Rating Scale; IQR, interquartile range.

^aData are presented as percentage or mean ± standard deviation. *P* values were determined using Student *t* test, Mann-Whitney *U* test, or χ^2 test and deemed significant at lower than .05.

^bCurrent comorbidity was assessed using structured questionnaires: "Have you been diagnosed with or treated for (a specific disease) by a physician in the past 12 months?"

^cAtopy was defined as positive if the participant had a positive skin response (allergen-to-histamine wheal size ratio ≥ 1) to any of the tested 12 inhalant allergens.

^dCurrent asthma was defined by responses to the 2 following questions: "Have you ever been diagnosed with asthma?" and "Have you had wheezing or whistling in the chest during the past 12 months?"

^eRecent asthma treatment was defined by the response to the following question: "Have you had treatment for asthma during the past 12 months?"

^fEver rhinitis was defined by the response to the following question: "Have you ever had sneezing or a runny or blocked nose when you did not have a cold?"

^gRhinitis was defined by the response to the following question: "Have you had sneezing or a runny or blocked nose without a cold in the past 12 months?"

Associations Between Comorbidities and Rhinitis in Elderly Adults

Exploratory analyses for comorbid disorders were performed for their relations with rhinitis. In univariate analyses, diabetes mellitus (OR 1.54, 95% CI 1.03–2.29, *P* = .033) and irritable bowel syndrome (IBS; OR 1.74, 95% CI 0.92–3.30, *P* = .086) were found to have *P* values lower than .1; thus, they were assessed further in multivariate tests. However, they showed only trends toward positive associations without reaching statistical significance (diabetes mellitus, OR 1.46, 95% CI 1.00–2.17, *P* = .050; IBS, OR 1.76, 95% CI 0.92–3.34, *P* = .086, when adjusted for age and sex). When applying the Bonferroni correction for multiple comparisons (corrected significance level, *P* < .0007; 70 comorbidities), their associations were not significant.

Table 2

Prevalence of rhinitis according to age group and atopy status in 855 participants who underwent allergen skin prick testing^a

	Age group (y)				<i>P</i> value ^b
	65–69 (n = 288)	70–79 (n = 307)	80–89 (n = 205)	≥ 90 (n = 55)	
Ever rhinitis	33.3 (96)	33.6 (103)	29.3 (60)	10.9 (6)	.009
Rhinitis (overall)	28.1 (81)	27.7 (85)	28.3 (58)	9.1 (5)	.087
Rhinitis without atopy	21.2 (61)	23.1 (71)	23.9 (49)	9.1 (5)	
Rhinitis with atopy	6.9 (20)	4.6 (14)	4.4 (9)	0 (0)	

^aData are presented as percentage (number). See Table 1 for definitions.

^b*P* values were determined by likelihood ratio χ^2 tests.

Impact of Rhinitis in Elderly Adults on HRQoL

Health-related QoL was assessed using SF-36 questionnaires (Table 4). In Mann-Whitney tests, participants with rhinitis had significantly lower general health (*P* = .003), bodily pain (*P* = .011), and physical component summary scores (*P* = .009). General linear models were used to determine their independence, with adjustments for Cumulative Illness Rating Scale score, atopy, and factors with *P* values lower than .1 (sex, marriage, and monthly income; in univariate tests with mental or physical component summary score). Rhinitis was found to be independently related to impaired HRQoL regarding physical domains (physical functioning, bodily pain, and physical component summary scores).

Discussion

The present study showed that rhinitis is a prevalent condition in the elderly population, mostly as a nonallergic form, and has a detrimental effect on physical aspects of HRQoL. Rhinitis showed significant relations with asthma irrespective of atopy.

The previous lack of research on rhinitis in elderly adults appears to be attributed to the underestimation of its prevalence and medical significance. However, population statistics have estimated that the proportion of elderly adults will double within a few decades,²⁴ and recent evidence has suggested that the prevalence of rhinitis is considerable in elderly populations.^{12–14} To the best of the authors' knowledge, the present study population had the largest samples of "very old" (≥ 85 years old) participants among epidemiologic studies on rhinitis. A comparably high prevalence of rhinitis until 90 years of age would indicate its substantial burden in the future "age of aging."

Table 3

Allergen sensitization profiles compared by presence of rhinitis^a

	Rhinitis (n = 229)	No rhinitis (n = 626)	<i>P</i> value
<i>Dermatophagoides farinae</i>	12.7	11.5	.641
<i>Dermatophagoides pteronyssinus</i>	10.9	10.4	.822
Cat epithelia	1.3	0.3	.093
Dog epithelia	0.9	1.0	.909
<i>Aspergillus fumigatus</i>	1.7	1.8	.992
<i>Alternaria tenuis</i>	0.9	1.9	.287
Cockroach (<i>Blattella germanica</i>)	4.4	2.2	.095
Tree pollen mixture 1 ^b	0.9	1.3	.626
Tree pollen mixture 2 ^c	2.2	1.1	.241
Grass pollen mixture ^d	0.9	0.5	.503
Ragweed	1.3	0.6	.335
Mugwort	0.9	1.1	.756

^aAllergen sensitization was defined as positive if the participant had a positive skin response (allergen-to-histamine wheal size ratio ≥ 1) to any of the tested 12 inhalant allergens. *P* values were determined by χ^2 test.

^bAlder, hazel, poplar, elm, and willow.

^cBirch, beech, oak, and plane tree.

^dVelvet grass, orchard grass, rye grass, timothy grass, Kentucky blue grass, and meadow grass.

Table 4

Comparisons of short-form 36 health-related quality-of-life questionnaire scores by presence of rhinitis^a

	Rhinitis (n = 252)	Controls (n = 694)	P value
Section score			
General health	40.1 ± 22.7	44.4 ± 21.6	.082
Physical functioning	51.8 ± 26.8	56.1 ± 29.1	.009
Role limitation due to physical problem	62.4 ± 32.0	71.0 ± 29.6	.048
Role limitation due to emotional problem	81.9 ± 23.7	79.4 ± 28.8	.698
Social functioning	76.2 ± 24.2	79.6 ± 25.4	.055
Bodily pain	57.3 ± 29.5	63.3 ± 30.4	.022
Vitality	50.8 ± 22.6	51.7 ± 20.7	.235
Mental health	67.5 ± 20.8	68.3 ± 19.9	.334
Summary scale score			
MCS	51.0 ± 9.1	50.9 ± 9.3	.756
PCS	36.8 ± 11.0	39.2 ± 11.1	.004

Abbreviations: MCS, mental component summary; PCS, physical component summary.

^aSee Table 1 for the definition of rhinitis. P values were determined by general linear model analyses with adjustments for sex, marriage, income, atopy, and Cumulative Illness Rating Scale score.

The high prevalence of rhinitis until 90 years of age needs to be discussed. As noted by Edelstein,²⁵ aging-related changes in nasal anatomy and vasculature may lead to an increased likelihood of rhinitis symptoms in elderly adults. However, the reasons for the decrease after 90 years of age are unclear. One possible reason could be the decreased perception of symptoms in very old adults. However, this may not be a sufficient explanation because the positive response to other items (eg, asthma) did not decrease in the oldest group. Another plausible explanation could be a cohort effect. The prevalence of never rhinitis (defined by the absence of ever rhinitis) was significantly higher in the oldest group than in the other groups (Table 2). The issue of remission rate could be clarified in longitudinal studies of the KLoSHA cohort, for which follow-up is scheduled every 5 years.

No significant association was found between atopy and rhinitis symptoms, such as rhinoconjunctivitis, sneeze, or nasal obstruction. These findings might suggest the presence of local allergic rhinitis.²⁶ The disparity between skin prick and nasal challenge responses is more frequent in elderly than in younger adults.²⁷ However, the present study did not investigate these observations.

Rhinitis in elderly participants was independently related to significant impairment in QoL, particularly in physical aspects. Relations with HRQoL have been clearly reported for allergic rhinitis in younger adult populations.²⁸ In this regard, the present findings are an extension of previous knowledge concerning the elderly population. The authors observed that the impact on HRQoL did not differ for rhinitis with vs without atopy, a finding that was similarly observed in a recent study in younger adult patients with rhinitis (mean age 32 years).²⁹ This lack of difference might be attributed to the similarity in disease perception in patients with allergic vs nonallergic rhinitis.³⁰ Taken together, these results show that QoL needs to be considered an important outcome in forthcoming studies assessing rhinitis in elderly patients.

The association between asthma and rhinitis also should be discussed. Rhinitis has been repeatedly associated with asthma in large-scale epidemiologic studies in general adult populations,^{2,31,32} supporting the “united airway” hypothesis. However, data on this topic for the elderly population are scarce. Because rhinitis in elderly adults in the present study was largely nonatopic, the positive associations with asthma might suggest smaller roles for atopy regarding their related mechanisms. However, the authors could not determine the detailed diagnosis for nonallergic rhinitis; thus, further studies should be conducted to elucidate the mechanisms.

Exploratory analyses were performed for the relations between rhinitis in elderly participants and comorbidities. Considering the large proportion of nonallergic rhinitis, it may be necessary to consider the associations with systemic comorbidity, particularly with rhinitis, in elderly patients.³³ However, there is a paucity of epidemiologic data regarding their relations. Thus far, few studies have suggested associations between rhinitis and nonrespiratory disorders, such as hypertension,^{34,35} atherosclerosis,³⁶ coronary heart disease,³⁷ stroke,³⁸ or IBS.³⁹ However, in the present analysis using structured questionnaires on recent medical history, diabetes mellitus and IBS were the only comorbid factors that showed marginal relations with rhinitis. This finding warrants careful interpretation because of the possibility of type I error. From a pathophysiologic perspective, these findings on IBS and nonallergic rhinitis might suggest cholinergic hyper-reactivity^{40,41} as the common factor in the 2 disorders and as the driving mechanism for the association. In fact, vasomotor rhinitis is the most common form of nonallergic rhinitis, particularly in elderly adults.⁴²

The present study has several limitations. First, a cross-sectional design was used; thus, causal or temporal relations could not be addressed. Another major limitation was the definition of rhinitis. Although a standard questionnaire was used for the rhinitis survey,⁴³ it was originally developed for allergic rhinitis.¹⁷ In fact, there is still no validated questionnaire for nonallergic rhinitis.³³ The lack of questions on seasonal relevance is another limitation; however, the sensitized allergens in these elderly participants with rhinitis were mostly indoor allergens. Moreover, more than 80% of elderly participants with rhinitis did not have atopy, and the clinical relevance of atopy might be less than its observed prevalence. Therefore, the authors suggest that the lack of seasonal relevance information would not have changed the main conclusions regarding asthma associations. The lack of a detailed diagnosis for nonallergic rhinitis is another limitation because the nonallergic form is a heterogeneous entity.³³ The lack of objective tests for asthma, such as methacholine challenge, was another limitation. To address this issue, 2 different questionnaire-based definitions were combined for consistency testing.

In addition, the study was conducted in a local urban area; thus, the results cannot be generalized to the general population. Moreover, the 2-step selection of the cohort sample could have caused selection bias: to collect the information on health and disease status of the oldest adults (>85 years old), a group composed of the oldest participants (n = 302) also was recruited from among the 3,136 oldest residents by postal mail or telephone contact.

The KLoSHA cohort study was initiated by multidisciplinary collaboration to examine the epidemiology of common geriatric disorders and to establish a comprehensive database of general health and functional status in the Korean elderly.¹⁵ In this context, the sample size was not calculated for a specific condition. Although it was not predetermined for rhinitis, the minimum sample size (N) could be calculated with the following formula⁴⁴: $N = Z^2 P(1 - P)/d^2$, where Z is the normal standard deviation (set as 1.96, corresponding to the 95% CI), P is the estimated prevalence of rhinitis in Korean adults (set as 0.2),^{8,16} and d is the precision (set as 0.03). Then, the minimum sample size for the rhinitis prevalence survey in Korea was calculated at 683.

The present analysis possesses several strengths. It is a comprehensive analysis of a well-defined elderly population using structured questionnaires and allergen skin prick tests. Another strength is that more than 25% of participants were older than 85 years, a population that has rarely been included in studies. Collectively, the present findings are helpful for understanding the nature of rhinitis in elderly adults.

In conclusion, there is a high prevalence of nonallergic rhinitis in elderly adults, and it is significantly related to asthma and QoL.

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