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Urban–rural differences in the prevalence of allergen sensitization and self-reported rhinitis in the elderly population

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ABSTRACT

Background: Urbanization is frequently associated with allergic conditions during childhood; however, the literature lacks studies on the association between allergies and degree of urbanization in the elderly population.

Objective: To determine how the degree of urbanization affects the prevalence of allergic sensitization and self-reported rhinitis symptoms in elderly community populations.

Methods: The study population consisted of 1,311 elderly subjects identified from 2 community population cohort datasets who were divided into 3 groups according to the degree of urbanization (urban, semirural, and rural) where they resided. Current rhinitis symptoms were assessed using a questionnaire. Sensitization to inhalant allergen was measured using skin prick tests for 9 common allergens.

Results: Sensitization to inhalant allergen showed a positive correlation with degree of urbanization (urban 17.2%, semirural 9.8%, rural 6.0%; P for trend $<.001$), with a significant correlation observed between house dust mite allergens and degree of urbanization. Self-reported rhinitis symptoms were mostly nonallergic, but showed a positive correlation with degree of urbanization (urban 26.8%, semirural 18.2%, rural 11.5%; P for trend $<.001$). Self-reported rhinoconjunctivitis also correlated with urbanization. Correlations between self-reported allergic conditions and urbanization remained statistically significant in multivariate logistic regression tests.

Conclusion: The present analyses found significant correlations between degree of urbanization with self-reported rhinitis symptoms and sensitization to inhalant allergen in the elderly population. These findings warrant further investigation of the roles that urban factors play in the development of elderly rhinitis and allergen sensitization.

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Introduction

During the past century, there have been dramatic changes in the population and health profile. Global life expectancy at birth nearly doubled from 34.1 years in 1913 to 66.6 years in 2001.¹ Increases in life expectancy have been attributed to advances in hygiene and medicine, thus decreasing communicable diseases. However, this has been accompanied by a paradoxical increase in non-communicable diseases, including allergies.² Because increases in the prevalence of

allergies cannot be explained by genetic factors alone, other factors have been explored. The hygiene hypothesis proposes that hygiene and the environment in which individuals live are associated with an increased prevalence of allergies.³

Urbanization results from different environmental changes, including medical advances, improvements in hygiene, better socioeconomic conditions, Westernized lifestyles, loss of biodiversity, and increased air pollution. It has been frequently associated with increased risks of allergies in children and young adults^{4–13}; however, effects of urbanization on elderly populations have rarely been examined.

Although the elderly population is expected to double by 2030¹⁴ and the burden of allergic conditions in the elderly appears to be substantial,^{15–18} the pathophysiology of allergies in the elderly population remains unclear. In a previous study,¹⁹ the authors found a high prevalence of self-reported rhinitis (25.6%) and inhalant allergen sensitization (17.2%) in an urban elderly population; however, this was not clearly explained by host factors, including comorbidities. Because allergic conditions can be influenced by environmental factors, the authors hypothesized that allergies in the elderly could be associated with urban environments. To test this hypothesis, the authors used cohorts from urban and rural communities to assess the effects of urbanization degree on the prevalence of allergic conditions in the elderly.

Methods

Study Population

Data for analyses were collected using a cross-sectional survey drawn from 2 populations of community-dwelling elderly people. The sample of elderly people from the urban community was drawn from the Korean Longitudinal Study on Health and Aging.²⁰ This cohort originally consisted of 1,000 elderly adults living in one of the largest metropolitan cities, Seongnam, South Korea. Random samples were prepared from a roster of 61,730 elderly residents using computer-generated random sampling. They were invited to participate by letter and telephone. Of the original participants, 147 subjects did not undergo skin prick tests. Thus, the present analysis includes 853 subjects who completed the relevant questionnaire and skin prick tests.

The sample of elderly people from rural or semirural communities was drawn from the Changwon–Sancheong population cohort study,²¹ which originally recruited 1,116 adults (≥ 30 years old) living in Changwon or Sancheong, South Korea. These cities are predominantly agricultural; however, the region of Buk-meon in Changwon is defined as semirural, and Shinan-meon in Sancheong is considered rural. Random distribution of information sheets and contact were used to recruit participants; a total of 1,116 adult subjects were recruited from a target population of 17,474 residents (616 subjects from 5,526 Sancheong residents and 500 subjects from 11,968 Changwon residents). In the present analysis, all elderly adults ($n = 458$; ≥ 65 years old) from this cohort were included.

Degree of urbanization (urban, semirural, and rural) was calculated from different indices in the 2005 Population and Housing Census database, including total population, density of population, total number of houses, density of housing, and proportion of apartment housing.²² In 2005, the total population in the city of Seongnam was 934,984 with a population density of 6,592 persons/km²; in Buk-meon, the total population was 11,334 with a density of 153.9 persons/km²; in Shinan-meon, the population was 5,219 with a density of 72.3 persons/km². Total housing and housing density per unit area showed similar trends, with Seongnam having 200,322 houses and a density of 1,412 houses/km² compared with 4,005 houses in Buk-meon (54 houses/km²) and 2,104 houses (29 houses/km²) in Shinan-meon. The proportion of apartment housing was 59.8% in Seongnam, 29.9% in Buk-meon,

and 22.8% in Shinan-meon. The extent of urbanization also was assessed by the degree of farming activity of the elderly participants in each area (0.23%, 48.7%, and 62.6%, respectively).

All these participants were fully informed of the study protocols and provided written statements of informed consent. The study protocols were approved by the institutional review board of Seoul National University Bundang Hospital (Seongnam, Korea) and the National Cancer Center (Goyang, Korea).

Questionnaires

Interviews were conducted by research nurses who had experience in conducting surveys with elderly persons. Allergic symptoms were defined using the structured questionnaire that was previously validated in Korean and used in adult population surveys.^{23,24} A positive response to the question, “Have you experienced sneezing or a runny or blocked nose without a cold in the past 12 months?,” indicated current self-reported rhinitis, whereas current self-reported rhinoconjunctivitis was indicated by a positive response to the follow-up question, “Has this nose problem been accompanied by itchy or watery eyes?” Current wheeze was defined by a positive response to the question, “Have you had a wheezing or whistling in the chest during the past 12 months?” The subjects who reported neither current rhinitis nor wheeze were defined as asymptomatic subjects. Current farming was defined as positive if the subjects answered that they were engaged in agricultural jobs at the time of the survey. Comorbidity was assessed using a structured questionnaire with items asking, “Have you been diagnosed with or treated for a specific disease by a physician in the past 12 months?”

Allergen Skin Tests

Inhalant allergen skin prick tests were performed to assess IgE sensitization resulting from different common inhalant allergens. The participants were instructed to discontinue medications for at least 7 days before skin testing under the guidance of their physicians, such as antihistamines, benzodiazepines, tricyclic antidepressants, or over-the-counter drugs for common colds, as described previously.²⁵ Sensitization to inhalant allergen was defined by a positive skin test response to at least 1 allergen, as previously described.²⁵ The following allergens were assessed: *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*, dog epithelia, *Blattella germanica*, 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). Positive (1 mg/mL of histamine) and negative (0.9% sodium chloride) controls also were tested. Positive skin reactivity was determined by an allergen-to-histamine wheal size ratio of at least 1. An atopy index was calculated by counting the total number of sensitized allergens.²⁶ Based on skin prick tests, rhinitis was classified as rhinitis with allergic sensitization or rhinitis without allergic sensitization.

Statistical Analyses

Continuous variables were presented as mean $\pm$ SD, and categorical variables were described as frequency (percentage). Continuous data were analyzed with *t* tests or 1-way analysis of variance, and nonparametric data were analyzed using Mann-Whitney *U* or Kruskal-Wallis tests. Categorical data were evaluated by χ^2 tests. Logistic regression analyses were performed to evaluate the associations between urbanization and allergic parameters. In multivariate logistic regression models, confounders included demographic factors (age, sex, smoking, body mass index, and current farming) and any variables with a *P* value less than .10

Table 1
Baseline characteristics of elderly subjects according to their living areas

	KLoSHA cohort	Changwon/Sancheong cohort		<i>P</i> value ^a
	Seongnam city, urban area (n = 853)	Changwon city, semirural area (n = 193)	Sancheong-gun, rural area (n = 265)	
Age (y), mean ± SD	75.5 ± 8.6	70.4 ± 4.2	70.7 ± 4.3	<.001
Women, %	56.7	59.6	68.3	.004
BMI (kg/m ²), mean ± SD	24.1 ± 3.3	23.4 ± 3.1	23.1 ± 3.5	<.001
Current farming, %	0.23	48.7	62.6	<.001
Education (y), mean ± SD	7.3 ± 5.7	4.5 ± 4.2	3.5 ± 3.8	<.001
Income ≥\$12,000/y, %	44.6	20.5	30.4	<.001
Smoking status, %				
Never	62.1	61.1	64.6	.055
Former	26.0	25.8	18.3	
Current	11.9	13.2	17.1	
Alcohol intake, %				
Never	60.4	57.9	58.6	.002
Former	15.6	8.7	8.4	
Current	24.0	33.3	33.1	
Current wheeze, %	5.3	8.4	8.2	.103
Diabetes mellitus, %	14.2	10.9	10.6	.206

Abbreviations: BMI, body mass index; KLoSHA, Korean Longitudinal Study on Health and Aging.

^aP values were determined by 1-way analysis of variance or χ^2 tests.

in univariate analyses. Statistical analyses were performed using STATA 12.0 (STATA Corporation, College Station, Texas).

Results

Baseline Characteristics

The present analyses included a total of 1,311 elderly subjects recruited from 2 community population cohorts. Baseline characteristics of the participants are presented in Table 1. Several demographic differences were found according to degree of urbanization. A larger proportion of men lived in the urban area, and they were older, more obese, better educated, had higher monthly incomes, and a lower alcohol intake compared with their semirural and rural counterparts. However, prevalence of current wheeze did not significantly differ by area.

Urban Association of Sensitization to Inhalant Allergen

A total of 182 subjects (13.9%) had inhalant allergen sensitization. The sensitization rate significantly differed by area, particularly between urban and rural areas (17.2% vs 6.0%; $P < .001$; Fig 1). Urban dwellers, compared with their semirural or rural counterparts, were significantly more sensitized to indoor allergens such as *D farinae* and *D pteronyssinus* (Table 2). When comparing semirural

and rural areas, the overall sensitization rates did not differ; however, the sensitization rate was different for *D farinae* ($P = .034$). In univariate logistic regressions, overall sensitization to inhalant allergen positively correlated with male sex ($P < .001$), less farming ($P = .001$), lower monthly income ($P = .004$), higher education ($P < .001$), and urbanization ($P < .001$). Multivariate logistic regression analyses showed that living in an urban area was the single significant factor independently related to inhalant allergen sensitization (Table 3). The atopy index also showed significant associations with living in urban areas ($P < .001$; Table 2) and current farming status (non-farming vs farming 0.30 ± 0.82 vs 0.13 ± 0.52 ; $P < .001$).

As the major allergens in this study, sensitization to house dust mite (HDM; $n = 130$; *D farinae* or *D pteronyssinus*) was specifically examined for associated factors. The association patterns of HDM sensitization were largely similar to those of overall allergen sensitization; however, HDM sensitization had a stronger association with smoking history (7.9% in never smokers, 13.2% in former smokers, and 14.0% in current smokers; $P < .001$) compared with overall sensitization (12.3% in never smokers, 17.3% in former smokers, and 15.8% in current smokers; $P = .071$). Alcohol intake was not related to overall and HDM sensitization. In multivariate logistic regression, HDM sensitization showed significant relations with degree of urbanization (vs rural area as the reference; semirural area, odds ratio 3.73, 95% confidence interval 1.05–13.16, $P = .041$; urban area, odds ratio 11.8, 95% confidence interval 2.38–58.19, $P = .001$; table not shown).

Changing the cutoff in determining positive skin test responses to an allergen wheal size of at least 3 mm did not alter the conclusions on the urban association (data not shown). A total of 126 subjects (9.6%) had asymptomatic sensitization, comprising 69.2% of the sensitized population (total $n = 182$) and 13.5% of the asymptomatic population (total $n = 930$). This subgroup also had significant urban associations (Table 2).

Urban Association of Current Self-reported Rhinitis and Rhinoconjunctivitis

Prevalence of current self-reported rhinitis was higher in the urban elderly population (26.8%) than in the semirural (18.2%) or rural (11.5%; P for trend $< .001$; Fig 1) populations. However, self-reported rhinitis was mostly nonallergic (83.6%). The 2 forms of self-reported rhinitis were more prevalent in the urban area than in the semirural or rural areas (rhinitis with allergic sensitization: 5.0%, 1.6%, and 0.8%, respectively; rhinitis without allergic sensitization: 21.8%, 16.6%, and 10.7%, respectively). The fraction of subjects with rhinitis with allergic sensitization per total rhinitis also was larger in the urban area than in the semirural or rural areas

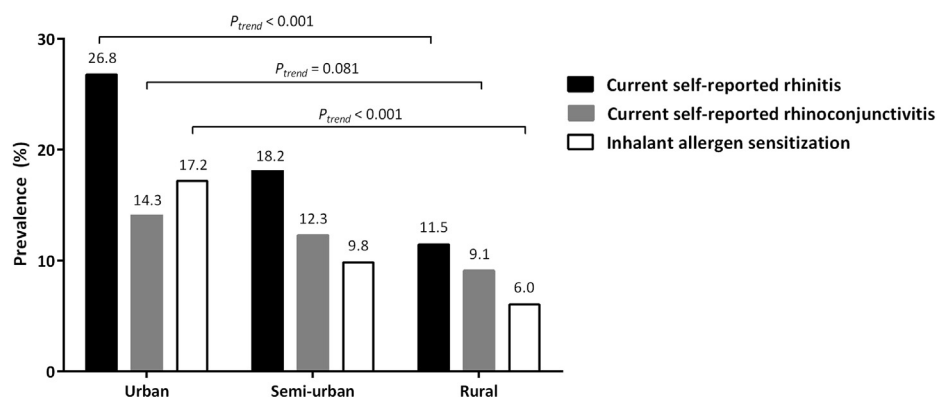


Figure 1. Comparison of prevalence of current self-reported rhinitis, rhinoconjunctivitis, and inhalant allergen sensitization according to living areas. P values were determined by likelihood ratio χ^2 tests.

Table 2

Comparison of inhalant allergen sensitization according to living area and allergic symptoms

	All subjects (n = 1,311)				Asymptomatic subjects (n = 930) ^a			
	Urban area (n = 853)	Semirural area (n = 193)	Rural area (n = 265)	P value	Urban area (n = 586)	Semirural area (n = 144)	Rural area (n = 200)	P value ^b
Individual allergen sensitization, % ^c								
<i>Dermatophagoides farinae</i>	11.8	5.7	1.1	<.001	11.6	6.3	0.0	<.001
<i>Dermatophagoides pteronyssinus</i>	10.5	4.7	1.1	<.001	10.4	4.9	0.5	<.001
Cockroach	2.9	2.6	3.0	.960	2.1	3.5	3.0	.531
Dog epithelia	0.9	0.0	0.8	.402	0.9	0.0	1.0	.513
Tree pollen 1	1.2	0.0	1.1	.322	1.4	0.0	0.5	.243
Tree pollen 2	1.4	0.0	1.1	.253	1.2	0.0	0.5	.313
Grass pollen	0.6	0.5	1.1	.612	0.5	0.7	0.5	.961
Ragweed	0.8	0.0	0.0	.152	0.7	0.0	0.0	.308
Mugwort	1.1	0.5	0.8	.745	1.2	0.7	1.0	.867
Overall sensitization, %	17.2	9.8	6.0	<.001	16.7	11.1	6.0	<.001
Atopy index ^d , mean $\pm$ SD	0.34 $\pm$ 0.87	0.15 $\pm$ 0.48	0.11 $\pm$ 0.55	<.001	0.33 $\pm$ 0.86	0.17 $\pm$ 0.51	0.08 $\pm$ 0.36	<.001

^aAsymptomatic subjects indicate elderly persons who reported no current rhinitis and wheeze.^bP values were determined by χ^2 or Kruskal-Wallis tests.^cAllergen sensitization was defined as positive if the allergen-to-histamine wheal size ratio was at least 1.^dAtopy index was calculated as the total number of sensitized allergens in each subject.

(18.8%, 8.8%, and 6.9%, respectively). In univariate logistic regression tests, current self-reported rhinitis showed positive associations with urban living environments ($P < .001$), male sex ($P = .032$), less current farming ($P < .001$), diabetes mellitus ($P = .041$), and more years of education ($P < .001$) but did not correlate with a body mass index of at least 25 kg/m² ($P = .153$), sensitization to inhalant allergens ($P = .184$), atopy index ($P = .145$), sensitization to a single inhalant allergen, or other comorbidities. In multivariate tests, living in an urban area was the most significant factor related to current self-reported rhinitis (Table 4).

Current self-reported rhinoconjunctivitis showed positive trends toward an association with living in an urban area (P for trend = .081; Fig 1) but did not show any significant associations with demographic variables, including current farming ($P = .505$) or sensitization to inhalant allergen ($P = .128$). However, self-reported rhinoconjunctivitis showed positive relations with the atopy index (0.40 ± 1.00 vs 0.25 ± 0.74 ; $P = .016$) and with HDM

sensitization ($P = .040$ for *D. farinae*; $P = .038$ for *D. pteronyssinus*). In multivariate logistic regression, self-reported rhinoconjunctivitis showed significant associations with the atopy index and urban living (Table 4).

Discussion

The present analyses found that self-reported rhinitis symptoms and HDM sensitization in the elderly population were strongly associated with living in urban areas. These findings warrant further investigation of urban factors involved in the epidemiology of allergic conditions in the elderly.

Little research has been conducted in elderly community populations; therefore, the role of urban factors on allergen sensitization remains unknown. Most epidemiologic surveys conducted have focused on urban–rural differences in the prevalence of allergies in a younger population, because the topic traditionally has been related to the hygiene hypothesis.^{5,27} Two recent studies briefly mentioned urban–rural differences in the prevalence of rhinitis in the elderly (in Portugal, current rhinitis, urban vs rural 30.7% vs 27.6%, $P = .082$ ¹⁶; in Poland, perennial allergic rhinitis, urban vs rural 24.3% vs 10.0%, $P < .01$ ²⁸). Many studies of younger populations have reported positive associations between urban area and allergic rhinitis.^{4,6–13,29} In nationwide studies in Japan, metropolitan cities such as Tokyo showed a markedly higher prevalence of rhinitis than a rural area such as Hokkaido (49.1% vs 20.4%).³⁰ Collectively, urban association with rhinitis appears to be common across age groups.

Because rhinitis is a clinical presentation of a nasal neuronal reflex to environmental or inflammatory stimuli, environmental irritants and atopy could have synergistic interactions in developing nasal responses. In allergic rhinitis, allergic inflammation sensitizes sensory nerves, thus making them more susceptible to various external stimuli.³¹ However, the present elderly population was mostly nonallergic,¹⁹ suggesting that an urban association with elderly rhinitis might not be explained by allergic sensitization alone. Rather, it could be largely attributed to nonallergic (or idiopathic) rhinitis, which could respond to pollution or meteorologic factors.³² “Local allergic” rhinitis is another potential explanation in the elderly; older adults with a positive nasal allergen challenge might not have relevant serum specific IgE or skin prick responses.³³ However, the proportion with local allergic rhinitis might not be substantial, because the presence of nonallergic rhinitis at baseline did not predict de novo allergen sensitization after 8 years in the Copenhagen Allergy Study of adults 15 to 79

Table 3

Multivariate logistic regression analyses for inhalant allergen sensitization

	Adjusted OR ^a	95% CI	P value
Age (y)	0.98	0.96–1.01	.296
Sex			
Female	reference		
Male	0.92	0.49–1.74	.777
BMI (kg/m ²)			
<25	reference		
≥ 25	1.11	0.72–1.70	.637
Current farming			
No	reference		
Yes	1.51	0.58–3.94	.402
Education (y)	1.02	0.97–1.07	.446
Income			
$\geq \$12,000/y$	reference		
$< \$12,000/y$	0.80	0.51–1.25	.329
Smoking status			
Never	reference		
Former	1.56	0.87–2.77	.132
Current	1.51	0.78–2.94	.221
Living area			
Rural	reference		
Semirural	1.01	0.42–2.47	.977
Urban	4.51	1.79–11.4	.001

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.

^aAdjusted ORs were calculated by multivariate logistic regression tests with adjustment for age, sex, BMI, current farming, education year, income, smoking status, and living area.

Table 4

Multivariate logistic regression analyses for current self-reported rhinitis and rhinoconjunctivitis

	Self-reported rhinitis			Self-reported rhinoconjunctivitis		
	Adjusted OR ^a	95% CI	P value	Adjusted OR ^b	95% CI	P value
Age (y)	1.00	0.98–1.02	1.000	0.99	0.97–1.02	.539
Sex						
Female	reference			reference		
Male	0.92	0.57–1.41	.633	0.71	0.45–1.14	.137
BMI (kg/m ²)						
<25	reference			reference		
≥25	1.07	0.77–1.48	.685	1.21	0.85–1.73	.300
Current farming						
No	reference			reference		
Yes	1.34	0.68–2.62	.400	1.57	0.82–3.01	.174
Education (y)	1.04	1.00–1.08	.033	—		
Income						
≥\$12,000/y	reference			—		
<\$12,000/y	1.13	0.80–1.60	.470	—		
Smoking status						
Never	reference			reference		
Former	1.19	0.77–1.85	.437	1.42	0.80–2.79	.205
Current	1.08	0.63–1.83	.786	0.91	0.49–1.70	.771
Diabetes mellitus						
No	reference			—		
Yes	1.39	0.91–2.13	.124	—		
Inhalant allergen sensitization						
No	reference			—		
Yes	1.24	0.83–1.86	.286	—		
Atopy index	—			1.21	1.01–1.45	.037
Living area						
Rural	reference			reference		
Semirural	1.60	0.86–2.98	.136	1.50	0.80–2.79	.205
Urban	2.75	1.43–5.30	.003	2.26	1.16–4.43	.017

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.

^aAdjusted ORs were calculated by multivariate logistic regression tests with adjustment for age, sex, BMI, current farming, education year, income, smoking status, diabetes mellitus, inhalant sensitization, and living area.^bAdjusted ORs were calculated by multivariate logistic regression tests with adjustment for age, sex, BMI, current farming, smoking status, atopy index, and living area.

years old.³⁴ Compared with rhinitis, rhinoconjunctivitis had stronger associations with allergen sensitization. This could conversely infer that concomitant conjunctivitis symptoms indicate a higher probability of atopy in subjects with rhinitis.

Interestingly, HDM sensitization showed a strong urban association. These positive associations between atopy and urbanization have frequently been reported in young populations^{6,7,35–37}; the findings have been frequently explained by the hygiene hypothesis or the biodiversity perspective,^{38,39} which could correspond to early-life health and diseases. However, these early-life factors might not be directly applicable to the elderly. Further studies are necessary to elucidate the mechanisms of urban association in the elderly. In a study conducted in Korea, air pollutant or dust concentrations were significantly higher in urban and indoor settings than in rural and outdoor areas⁴⁰; increased exposure to dust and pollution increases the chance of tolerance breakdown to allergen by co-exposed microbial antigens.^{41–43} In addition, modern housing such as apartments are predominant in urbanized areas²² and have less natural ventilation compared with traditional Korean houses.⁴⁴ Poor ventilation can influence indoor allergen burden⁴⁵; however, because HDM exposure was not measured in the present study, further investigation is required.

Unlike HDM, cockroach sensitization rate was similar between urban and rural areas. In previous studies of Korean homes, apartments had lower cockroach trapping rates than detached houses⁴⁶; as mentioned earlier, apartment housing was more common in the urban area than in the semirural or rural areas (59.8%, 29.9%, and 22.8%, respectively). Exposure to cockroaches might have been further decreased in urban areas, because the garbage disposal system and insecticide usage have recently been improved in these areas.⁴⁷

Dog sensitization rate was lower than 1.0% in the present elderly populations and did not appear to be a major allergen in older adults in Korea.⁴⁸ In younger community population surveys in Korea, the sensitization rate was 2.8% at 6 to 7 years and 5.2% at 12 to 13 years of age and more prevalent in the metropolitan area than in rural areas (3.8% vs 2.1% at 6–7 years; 6.7% vs 3.4% at 12–13 years).⁴⁹ Dog sensitization is influenced by direct exposure, and thus dog ownership and pet habits could be determinant factors.⁵⁰ In rural areas of Korea, dogs have been frequently bred outside the house, presumably because of traditional habits and house structures, which might explain the regional difference. These ownership and breeding habits also could explain the difference in pet sensitization rate between Korea and European countries, because dog is a major allergen in the European general adult population.⁵¹ Pet ownership data are very scarce in Korea, but a recent survey conducted in Seoul reported that the dog ownership rate was 16.6% (total pet ownership rate 17.2%) in 2004.⁵² The pet ownership rate might differ by populations but was 42% in the Finnish population.⁵³

Cat allergen was not included in the present skin test panel of the Changwon–Sancheong cohort study. Unlike dog, cat allergen sensitization can occur by indirect contact⁵⁰; however, the cat ownership rate was much lower than the dog ownership rate (0.8% vs 16.6%) in an urban area of Korea,⁵² and sensitization was 0.6% in the urban elderly.²⁵ Thus, the authors believe that the exclusion of cat allergen from the skin prick test panel did not alter the conclusions.

The authors found that 13.5% of “asymptomatic” elderly subjects were sensitized to inhalant allergen. In the Copenhagen Allergy Study, 21% of adults were classified as to have asymptomatic sensitization³⁴; interestingly, these subjects had a significantly

higher incidence of allergic rhinitis during 8 years of follow-up compared with asymptomatic and non-sensitized subjects. Because the present participants were elderly, the clinical outcome of asymptomatic sensitization warrants evaluation.

The present study had several limitations. First, it was an explorative analysis that compared participants from 2 previously established cohorts, and thus inter-regional comparison was not the primary intention. Detailed investigations of mechanisms were not conducted, and sample size was not sufficient for semirural or rural areas. Urbanization is a broad term that embraces several possible effector mechanisms, which warrants further studies focused on the elderly. Second, this was a cross-sectional analysis that could not determine causal or temporal relations. The relations between urbanization and sensitization could have been confounded by previous living environments, previous occupation, and place of birth, the data of which were not collected in this study. Thus, the authors could not preclude a “healthy worker effect” in the urban associations of rhinitis symptoms and sensitization.

Third, the current epidemiologic definition of self-reported rhinitis does not identify phenotypes of nonallergic rhinitis, which is considered a heterogeneous disorder.⁵⁴ Moreover, the questionnaire did not include further details for characterizing the relation of allergen exposure to rhinitis,⁵⁵ and thus the authors could not relate the relevance of sensitized allergen to rhinitis symptoms. Fourth, although the 2 study cohorts were random samples from their respective communities, different recruitment could have influenced the findings. However, the 2 studies were conducted by the same research group using the same questionnaire and skin prick test protocol. The choice of inhalant allergen skin test panels could not have biased the regional difference in sensitization rates, because major inhalant allergens did not significantly differ between regions within the country except for Jeju Island.⁵⁶ The panel selection of inhalant allergens for skin prick testing was based on previous surveys of adult patients with respiratory allergy⁵⁶ and is considered to cover at least 90% of current inhalant allergen sensitization in Korean adults, including the elderly.⁴⁸

Older age is usually related to a lower prevalence of rhinitis and atopy within populations.^{19,57} In this study, the urban dwellers were older than their rural counterparts but had a higher prevalence of self-reported rhinitis and sensitization, suggesting the strong effects of urbanization. The authors' classification of urbanization was supported by the population and census data and by the farming proportion. In addition, 2 cohort studies were conducted during a similar period (2005–2007), which precluded a cohort effect and enabled the inter-regional comparison of prevalence. Urban–rural comparison of allergen skin prick test results in the elderly is a strength of this study. Collectively, these findings might generate a hypothesis that urban factors are involved in the epidemiology of rhinitis and allergen sensitization in the elderly.

In conclusion, these explorative analyses found significant urban associations between self-reported rhinitis symptoms and sensitization to inhalant allergen in elderly populations. These findings warrant further studies to clarify the mechanistic roles of urban environmental factors on elderly allergic conditions.

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