Research Article


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SUMMARY

Purpose: Longitudinal changes in the prevalence of self-reported physician-diagnosed allergic rhinitis (AR) in Korea and the association between the prevalence of AR and type of residence area among Korean males and females in 1998, 2001, 2005 and 2007–2009 were evaluated.

Methods: Age-standardized prevalence was calculated using the Korea National Health and Nutrition Examination Survey (KNHANES) I–IV. Stratified factors of sex, age, and socioeconomic status were adjusted to compare the prevalence of AR in relation to residential area by multiple logistic analysis.

Results: The prevalence of AR increased by tenfolds from 1.2 % in 1998 to 12.0 % in 2007–2009. The trends for prevalence of AR were also statistically significant (p < .05). The age-standardized prevalence of AR among urban females was higher (13.9%) than that in rural females (11.5%). After adjustment for survey years, age, socioeconomic levels and asthma, the odds of AR were higher in urban than rural residents, except for males in 1998.

Conclusion: The prevalence of AR in Korea has increased over the past decade, and living in an urban area may be a susceptible factor. For prevention and management of AR, further evaluations of contributing factors and mechanisms underlying differences in AR are needed.

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Introduction

Allergic rhinitis (AR) is one of the most common chronic diseases worldwide. The symptoms of AR can limit daily activities and result in sleep disorders. Thus, AR has a negative impact on quality of life and productivity (Reed, Lee, & McCrory, 2004). Due to its high prevalence and resulting impairment of personal and social activities, the overall expenditure for AR is recognized as a socioeconomic burden in Korea. A study based on National Health Insurance Service 2007 data showed that the direct and indirect burden of AR reached $272.92 million, which was almost 85% of the economic burden associated with cervical cancer in Korea in 2005 (Kim et al., 2010). Thus, appropriate means of preventing and managing AR are needed.

Some studies have indicated increases in the prevalence of AR over several decades and have suggested that environmental factors for AR were more likely to influence this increase than genetic factors (Braback, Hjern, & Rasmussen, 2004; Ghouri, Hippisley-Cox, Newton, & Sheikh, 2008; Sly, 1999). This is because the rapid increase in air pollution and climate change are reasonable explanations as risk factors for the marked increases in the occurrence and exacerbation of AR over the period of several decades than are genetic changes. Furthermore, several epidemiological studies showed that the prevalence of AR among urban residents was higher than that among rural residents (Braback et al., 2004; Zhang et al., 2009). Therefore, it seems that living in an urbanized area is a risk factor for the incidence and exacerbation of AR.

As Korea has been undergoing rapid industrialization and urbanization since the late 1970s, it has been expected that there may be increases in air pollutants and in the prevalence of AR in Korea. For nurses who work as public health providers as well as health policy makers, understanding which factors influence the prevalence of AR in Korean general population is important. However, there are few studies for evaluating trends of AR prevalence and the association between residence and the prevalence of AR among general population.

This study utilized the first through fourth (including 1998, 2001, 2005 and 2007–2009) Korea National Health and Nutrition Examination Survey (KNHANES) I–IV. Stratified factors of sex, age, and socioeconomic status were adjusted to compare the prevalence of AR in relation to residential area by multiple logistic analysis. The prevalence of AR increased by tenfolds from 1.2 % in 1998 to 12.0 % in 2007–2009. The trends for prevalence of AR were also statistically significant (p < .05). The age-standardized prevalence of AR among urban females was higher (13.9%) than that in rural females (11.5%). After adjustment for survey years, age, socioeconomic levels and asthma, the odds of AR were higher in urban than rural residents, except for males in 1998.

Conclusion: The prevalence of AR in Korea has increased over the past decade, and living in an urban area may be a susceptible factor. For prevention and management of AR, further evaluations of contributing factors and mechanisms underlying differences in AR are needed.

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Examination Survey (KNHANES) data to determine a time trend in the prevalence of self-reported physician-diagnosed AR in Korea and to evaluate the association between the prevalence of AR and type of residence area among Korean males and females over the past decade.

**Methods**

**Data source and study subjects**

All data were derived from the publicly available the first (1998) through fourth (2007–2009) KNHANES conducted by the Korean Center for Disease Control and Prevention in 1998, 2001, 2005, and 2007–2009, respectively. The subjects were selected from among noninstitutionalized civilians in a stratified multistage clustered probability design (Korea Center for Disease Control and Prevention, 2011). The sampling frame for the subjects was derived from recent population and housing census (e.g., 2005 population and housing census for the fourth KNHANES and 2000 for the third KNHANES). The KNHANES randomly selected sampling units for health interview and health examination from primary sampling units. In addition, 20 sampling units for health interview and health examination from KNHANES randomly selected population and housing census for the fourth KNHANES and 2000 derived from recent population and housing census (e.g., 2005 population and housing census for the fourth KNHANES). Subjects aged 19 or less were excluded to restrict participants to adults.

**Socioeconomic status indicators and residence**

Education and household total income were included in this study as indicators of socioeconomic status. Education was classified into four categories (elementary school or less; middle school; high school; college/university or higher). Household income was calculated by equivalized gross household income per month (equivalized income = household income/no. of family members) and divided into four levels according to quartile distributions of equivalized household income per month. Residence was classified into two levels according to address: urban (Dong) and rural (Eup/Myeon).

**Definition of allergic rhinitis and other disease**

Subjects with AR were defined as those who had been told by a physician that they had AR. Subjects with asthma were defined as those who had been told by a physician that they had asthma. All of these responses were self-reported during KNHANES I through IV.

**Statistical analysis**

The prevalence of AR were standardized and shown in the figures and tables for their changes. The age-standardized prevalence of AR in each survey was measured by the standardization methods for the population derived from the 2005 Korean Census as the standard population. After taking account of sample weights, stratification and primary sampling units from the KNHANES, logistic regression (SAS syntax: PROC SURVEYLOGISTIC) was used to estimate linear time trends of the age-standardized prevalence. After stratification according to sex, multiple logistic regression analysis was performed to estimate the odds of the prevalence of AR with adjustment for survey year, age, socioeconomic status, and asthma. Probabilities less than .05 were considered as statistically significant. All statistical analyses were performed using SAS 9.2 (SAS institute Inc., Cary, NC, USA) after taking into account primary sampling units, stratification, and sample weights in each survey.

**Ethics statement**

This study design was approved by the Institutional Review Board.

**Results**

Changes in the prevalence of AR from the first (in 1998) through the fourth (2007–2009) KNHANES among Koreans aged 19 and over were shown in Figure 1. In 1998, age-standardized prevalence rates of AR were 1.0% in males and 1.5% in females. This figure also reveals that the prevalence rates of AR increased to 10.6% and 13.5% in 2007–2009 for males and females, respectively. Statistically significant linear time trends for AR were shown in both males and females (p < .05).

Tables 1 and 2 show the percentages and SE for age-standardized prevalence of AR with age, residence, household income, and education level among Korean males and females, respectively, from 1998 to 2007–2009. The prevalence of AR among both males and females aged 30–39 was higher than that in all other age groups throughout the decade except in 1998. Both males and females with higher education levels had a higher prevalence of AR. In males, the prevalence of AR was higher in subjects with higher household income. However, in females, no such association was observed in either 1998 or 2005. There were significant linear time trends for AR in all variables (p < .05).

Figure 2 shows the association between the prevalence of AR and type of residence area after adjusting for age, education level, and household income among males and females in 1998 through 2007–2009. Living in an urban area was associated with the prevalence of AR among both males and females. For males living in an urban area compared to those living in a rural area, the odds of AR were 1.27 (95% confidence interval [CI]: 0.86–1.87) in 2001, 1.30 (95% CI: 1.02–1.67) in 2005 (p < .05), and 1.10 (95% CI: 0.85–1.41) in 2007–2009. For females living in an urban area, the odds of AR compared to those living in a rural area were 1.14 (95% CI: 0.75–1.73) in 1998, 1.70 (95% CI: 1.16–2.50) in 2001 (p < .05), 1.24 (95% CI: 1.04–1.49) in 2005 (p < .05), and 1.18 (95% CI: 0.97–1.43) in 2007–2009.

**Discussion**

The prevalence of self-reported physician-diagnosed AR in Korea increased by tenfold from 1.2% in 1998 to 12.0% in 2007–
2009. With regard to the factors influencing the increase in AR, previous studies have highlighted the effects of climate change, such as the increase in the length of the pollen season, earlier start of the pollen season, and increased pollen production (Asher et al., 2008). This provides a plausible explanation for the observed increase in AR over time. Our results were consistent with those of previous reports. The prevalence of AR has been increasing continuously since 1998, corresponding to an increase in medical claim for AR from 2.7 million cases in 2001 to 5.3 million cases in 2009 according to the Korean Health Insurance Review Agency (National Health Insurance Corporation, 2010).

Increases in the prevalence of AR have also been seen overseas. In Sweden, a birth cohort study (n = 1,309,652) showed that the incidences of AR and allergy-related diseases increased threefold to fourfold over the past three decades (Braback et al., 2004). A study performed in the United Kingdom indicated an increase in registration of cases requiring treatment for AR from 220,000 in 1981 to 700,000 in 1992 (Ross & Fleming, 1994), and the age-standardized incidence of AR increased by 33% between 2001 and 2005 (Ghouri et al., 2008).

Both males and females living in urban areas showed higher AR prevalence rates than those in rural areas after adjusting for age.
income, and education level. Climate change per se is not sufficient to explain why the prevalence of AR is higher among urban than among rural residents. In general, there are much higher levels of traffic and air pollution in urban areas. Several studies of the prevalence of airway disease have demonstrated associations between airway diseases and both traffic and air pollution (Hajat et al., 2001; Hwang, Jaakkola, Lee, Lin, & Guo, 2006; Polosa & Salvi, 1999). These studies indicated that the impact of residence area on the incidence and worsening of AR was mostly due to increased exposure to air pollutants. The results of a study investigating the association between the prevalence of AR and air pollutants among Taiwanese school children (n = 32,143) in 2001 indicated that the odds ratio (OR) for prevalence of AR increased by 1.43 (95% CI: 1.25–1.64) and 1.11 (95% CI: 1.08–1.15) with increases of 10 ppb in levels of SO2 and NOx, respectively. When CO level increased by 100 ppb, the OR for prevalence of AR increased by 1.05 (95% CI: 1.04–1.07) (Hwang et al.). To assess the relationship between traffic-related air pollution and prevalence of AR, a study was performed in Sweden among 9,316 people living within 100 m of roads carrying traffic. In that study, a traffic intensity of more than 10 cars per minute (annual 24 hour mean levels) was related to the incidence of AR (OR: 1.30, 95% CI: 1.05–1.61) (Lindgren et al., 2009). Thus, there may be a relationship between the density of air pollutants and the incidence of AR. The geometric mean density of air pollutants in an urban area in Korea (Seoul) in 2009 was 0.035 ppm (max: 0.203 ppm), 0.005 ppm (max: 0.027 ppm), and 54 ppm (max: 359 ppm) ppm for SO2, NO2, and PM10 (particulate matter 10), respectively. Those in a rural areas (Jeju) in Korea were 0.012 ppm (max: 0.093 ppm), 0.002 ppm (max: 0.010 ppm), and 42 ppm (max: 315 ppm), respectively (Environmental Data and Information Office of Ministry of Environment, 2010). This study demonstrated that the odds for the prevalence of AR in urban areas were significantly higher than those in rural areas in 2001–2009, consistent with previous studies suggesting that the degree of exposure to air pollutants was associated with AR prevalence. However, the gap of prevalence of AR between urban and rural area have decreased, so further study is needed to evaluate why this gap change has happened.

In addition to the relationship between type of residence area and AR prevalence, this study found a higher prevalence rate of AR among those with higher socioeconomic status. In the first Austrian allergy report, the AR prevalence rate was shown to be high in those with higher education level (compulsory education alone: 3.2% in men, 3.9% in women; college and university graduates: 7.1% in men, 8.1% in women; Dorner, Lawrence, Rieder, & Kunze, 2007). A British cohort study demonstrated a similar conclusion, in that the ORs for hay fever were 40% higher among those with higher socioeconomic status (Butland et al., 1997). A study to evaluate childhood allergic diseases in eight major cities in China indicated that higher parental socioeconomic status was a predictor of higher prevalence of allergic disease (Li et al., 2011). However, in a study of the association between socioeconomic status and allergen levels in a family cohort in Boston, United States, homes in areas of high poverty showed higher levels of cockroach allergens, and lower maternal education level was associated with higher dust mite allergen levels (Kitch et al., 2000). Thus, people with lower socioeconomic status had greater exposure to allergens. However, previous epidemiological investigations failed to explain why socioeconomic status played a factor in the prevalence of AR. Such differences in estimating and assessing the prevalence of self-reported AR may vary in relation to the symptoms of allergies or the awareness about allergies, so those with higher socioeconomic status may be more aware and prone to report such diseases (Sly, 1999).

Furthermore, this study showed that the prevalence of AR was significantly higher in females than males. Some previous epidemiological studies indicated that the prevalence of allergic diseases was higher in males before puberty, whereas females were likely to have higher prevalence rates after puberty (Chen, Mempel, Schober, Behrendt, & Ring, 2008; Cingi et al., 2009; Hwang et al., 2010; Olivieri et al., 2002). Several laboratory studies evaluating the impact of sex hormones on allergic diseases support these epidemiological observations (Chen et al.; Holt, Britten, & Sedgwick, 1987; Mitchell & Gershwin, 2007; Yamatomo et al., 2001). It was reported that testosterone suppresses phospholipase A2-specific IgE in CBA/J mice (Yamatomo et al.) and promotes allergic sensitization and IgE production in mice and rats (Holt et al.). The association between age-standardized prevalence of AR and residence after adjusting for age, education levels, and household income among Korean males and females from the first through fourth KNHANES. Note: AR — allergic rhinitis; KNHANES — Korea National Health and Nutrition Examination Survey. *Odds for AR in living an urban area was significantly higher than rural area (p < .05).
limitations in our study. Third, it is inevitable that information bias will have influenced these data compared with the actual prevalence because this study used self-reported survey results. However, the question was based on diagnosis by physicians rather than using subjective determinations of AR. Therefore, detailed questions minimized the limitations of the survey data.

Conclusion

This study showed that the prevalence of AR in Korea has increased markedly over the past decade, and revealed that living in an urban area is a susceptible factor for AR. Community health practice is a major part of nursing research. Nurses have started to play a considerable part in community health practice through public health centers. Those nurses who work for public health centers or policy making department in government as public servants should work towards reducing the relapse rates of chronic allergic disease as well as AR. The epidemiologic results may be used not only to assess patients with AR strategically but also to manage AR as an environmental assessment, in the form of residential advice. Furthermore, policy makers should carefully consider this result for AR management and prevention. Further evaluations of the inducing factors and mechanisms underlying the differences in AR between urban and rural areas are also needed.

Conflict of interest

The authors state that they have no competing financial interests to declare.

References