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Assessing the cold temperature effect on hospital visit by allergic rhinitis in Seoul, Korea

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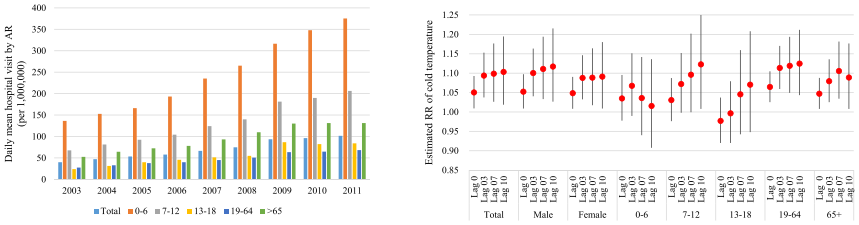
HIGHLIGHTS

- Studies for assessing cold temperature effect on AR are scarce.
- Cold temperature effect on hospital visit by AR was assessed.
- Hospital visit by AR has steadily increased especially for the elderly population.
- We found cold temperature effect on AR and the strongest effect found in autumn season.
- More studies should be conducted for better understanding of temperature effect on AR.

GRAPHICAL ABSTRACT



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ABSTRACT

The association between temperature and health outcome has been studied in worldwide. However, studies for mild diseases such as AR, with high prevalence and considerable economic burden, are lacking compared to other relatively severe respiratory diseases. We aimed to assess the trend of hospital visit by AR and estimate the cold temperature effect on hospital visit by allergic rhinitis in Seoul, Korea, 2003–2011.

We fitted generalized additive model with quasi-poisson distribution, controlling for humidity, long-term trend, day of week, national holiday, and influenza epidemic. We estimated the cumulative cold temperature effect (10%, −1.7 °C) referent to 7.9 °C for the considered lag periods using distributed lag non-linear model: vary from the day of hospital visit to 10 days before. Stratified analysis by season was also conducted. To adjust for possible confounding effect of air pollutants, we additionally adjusted for PM_{10}, O_3 and NO_2 respectively.

Hospital visit counts and rates per 1,000,000 show increasing trend especially in elderly population (over 65 years). Hospital visit rate is higher in children population (age < 13 years). Statistically significant cold temperature effects were found in the total (1.094(95%CI: 1.037, 1.153)), male (1.100 (95%CI: 1.010, 1.163)), female (1.088 (95%CI: 1.059, 1.170)) and adult (1.113 (95%CI: 1.059, 1.170)) population with consideration of 3-day lag period. In the stratified analysis by the season, the strongest effect was shown in the autumn (Sep–Nov) season. Confounding effects by air pollutants were not found.

In this study, we found significant increasing trend of hospital visit by AR. This study provides suggestive evidence of cold temperature effect on hospital visit by AR. To reduce the growing burden of AR, it is important to find possible related environmental risk factors. More studies should be conducted for better understanding of temperature effect on AR.

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1. Introduction

Allergic rhinitis (AR), as one of the allergic respiratory diseases, has been an issue in public health area in both developed and developing countries due to their high prevalence and economic burden. According to the "WAO White Book on Allergy 2010", about 10 to 30% of the adult population and as many as 40% of children are affected with AR. The World Health Organization have estimated that 400 million people in the world suffer from AR (Pawankar et al., 2011). Moreover, the prevalence of AR is still increasing (Pawankar et al., 2011).

In Korea, Seong et al. reported that prevalence of AR using nationwide survey increased in 2008 (25.07%) compared to 2005 (20.09%), and higher prevalence was observed in those younger than 10 years old (Seong et al., 2012). Another study that also used the nationwide study of Korean school children, estimated the prevalence to be 46.7% for ever having AR symptoms, to 42.2% for AR symptoms in the last 12 months and to 38.2% for doctor diagnosed AR (Y. Kim et al., 2015a). Rhee et al. investigated the prevalence of AR in the subjects aged ≥ 10 who participated in the Fifth Korean National Health and Nutritional Examination Survey in Korea (Rhee et al., 2014). The estimated prevalence of AR was 16.2% ± 1.0% (Rhee et al., 2014). According to the annual report of National Health Insurance statistics in 2014, about 6.3 million people visited hospital for AR and paid >390 billion Korean Won (1 dollar is 1100 Korean Won) in medical expenses (Kim and Son, 2014). Another study have estimated the total economic burden of AR in 2010 to be $273.92 million using National Health Insurance claims data (Kim et al., 2010).

AR is widely acknowledged as one of the major factor for asthma. Furthermore, higher prevalence (up to 95%) of AR in asthma patients and the theory of "one airway, one disease" (Grossman, 1997) may indicate the possibility of prevention or management of asthma or more severe respiratory diseases through a proper treatment or management of existing AR or respiratory symptoms. In that point of view, it is important to identify possible risk factors that can exacerbate current allergic respiratory symptoms.

To identify possible risk factors on AR, many studies across various disciplines were conducted. These studies mainly focused on indoor allergens such as residential chemical emissions, moisture/mold endotoxin, combustion products or genetic factors (Mendell, 2007; Dold et al., 1992; Mendell et al., 2011; Jaakkola et al., 2013). The association between temperature and health outcome has been widely studied across the worldwide and in light of climate change (Guo et al., 2014; Hajat and Haines, 2002; Miao et al., 2017). IPCC have projected that global warming will continue with increases in the frequency and intensity of extreme whether events. Studies investigation the association between temperature and health outcome are becoming more important now than ever. There are some clinical, epidemiological and biological evidences that suggest cold air can affect to respiratory symptoms (Koskela, 2007; Graudenz et al., 2007). Most of studies investigating cold temperature effects on respiratory diseases focused on general respiratory diseases (J00 – J99), categories with similar diseases group (upper or lower respiratory diseases) (Carreras et al., 2015; Mäkinen et al., 2009) or severe diseases such as COPD or asthma (Fitzgerald et al., 2014; Zhang et al., 2014). However, despite evidences of possible mechanisms of cold temperature effect on allergic respiratory diseases, studies related to temperature effect on AR are scarce (Lee et al., 2003).

In this study, we aimed to look into the trend of hospital visit by AR for the period of 2003 to 2011 and to estimate the effect of cold temperature on hospital visit by AR with consideration for various lag structures in Seoul, Korea.

2. Material and methods

2.1. Study population

In this study, we targeted people who reside in Seoul. Seoul is the capital city of the Republic of Korea, and located at the center of the Korean Peninsula, with an area coverage of 605 km^2.

The Korean population is subjected to National Health Insurance Service operated by National Health Insurance Service (NHIS). According to the "Statistics in Health Insurance 2015", the national insurance service system covers 97% of the Korean population and the other 3% are covered by the medical security system. Using this system, NHIS gathers hospital visit or hospitalization records through health insurance claim data and generates a massive national health insurance database.

Daily mean count of hospital visit by allergic rhinitis was extracted from the national health insurance database for the period of 2003 to 2011. To include all possible AR patients, we set the inclusion criteria to include those who were diagnosed with AR (ICD-10, J30) as primary or secondary cause. In general, hospital visit in tertiary medical institutions such as university hospitals are mostly scheduled visit, and since such visit might have different association with cold temperature, we excluded these visits in the calculation of daily mean count. To account for follow-up visits, we also excluded visits that occurred within a 30-day interval from the previous visit. Sex and age-specific (0–6, 7–12, 13–18, 19–64, 65+ years) hospital visit count was also calculated. The classification of children and adolescent (0–6, 7–12, 13–18 years) was made with consideration of Korean education system; individuals in the same age group might have higher chances of having similar exposure patterns.

2.2. Meteorological and air pollutants data

Hourly measured daily temperature and humidity in Seoul were obtained from the Meteorological Administration in the period of 2003 to 2011. Automated Synoptic Observing System (ASOS) is an equipment for measuring weather conditions, and this equipment was installed at the Jong-ro district, Seoul, in 1995. ASOS automatically measure temperature, humidity, and other weather conditions by every hour or by every 3 h. We calculated the daily mean temperature and humidity using hourly measured data.

Hourly measured ambient concentration of particles with diameter of 10 μm or less (also known as PM_{10}), ozone (O_3) and nitrogen dioxide (NO_2) were obtained from the National Institute of Environmental Research for the same period. Daily average value of PM_{10} and NO_2 and maximum of 8-hour moving average within a day of O_3 was used as daily representative value.

2.3. Statistical analysis

To identify the monotonic trend of hospital visit by AR, we used Mann-Kendall test that commonly used non-parametric trend test to detect monotonic trend. Because the Mann-Kendall test is robust against serial dependency, seasonality, and departure from normality, we adopted this test to identify monotonic increase trend of hospital visit count by AR (Hirsch and Slack, 1984).

To estimate the cold temperature effect on hospital visit by AR, generalized additive model (GAM) with Quasi-Poisson distribution was used with consideration for long-term seasonal trend, humidity, day of week, national holiday, and influenza epidemic (Bhaskaran et al., 2013; Bell et al., 2004).

For the preliminarily analysis, we analyzed the association between daily mean temperature and hospital visit by AR. The results indicate that the estimated relative risk (RR) of temperature showed increasing trend followed by decreasing trend for both an increase and decrease of temperature with referent to 7.9 °C (Supplementary Fig. A). Therefore, to estimate the cold temperature effect in the main analyses, we estimated the cumulative relative risks (RRs) of 10th percentile (−1.073 °C) of mean temperature referent to 7.9 °C with considered lag periods.

According to the studies estimating the ambient temperature effect on morbidity, delayed effects were taken into account from the date of the hospital visit to the visit for a period of up to one month (Ye et al., 2012). AR symptoms that are triggered by cold air can