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ORIGINAL ARTICLE

Association between Pollen Risk Indexes, Air Pollutants, and Allergic Diseases in Korea

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Abstract
Objectives: This study, different from the past researches, has been conducted in all age groups to understand the association between air pollutants, pollen risk indexes, and outpatients with allergic rhinitis (AR), asthma, and atopic dermatitis (AD).
Methods: Data on air pollutants, pollen risk indexes, and outpatients with each disease were collected from 2003 through 2011 to verify the association between them. All data are time-series materials that have been observed by time (day) and region, and are in a nonlinear shape. In particular, the total number of outpatients per day is a count data that had a Poisson distribution as the response variable. SAS 9.3 was used to make a statistical model, generalized additive model, with lag effects for the analysis.
Results: For allergic diseases during spring (April–May) and fall (September-October), a significant association was shown between the variables of air pollutants, pollens, and the number of outpatients. Especially, the estimates of NO_2 [AR (43.00967 ± 0.11284), asthma (52.01837 ± 0.06452), AD (52.01837 ± 0.06452), $p < 0.001$] in spring and SO_2 [AR (43.00967 ± 0.11284), asthma (52.01837 ± 0.06452), AD (52.01837 ± 0.06452), $p < 0.001$] in fall were highly significant and showed a positive association with all diseases.
Conclusion: Domestically and even internationally, various studies on the allergic diseases are being conducted. However, not many studies related to similar studies. In the need of creating grounds to back up these efforts, additional studies on allergic diseases, as well as researches utilizing pollen data, air pollution data, and claims data provided by the Health Insurance Corporation that has no problem in the representativeness of the data that have close relationships to the allergic disease will be needed.

1. Introduction

Global warming following climate change has been causing direct effects such as natural disasters including drought and flood, as well as indirect effects such as an increase in the number of air pollutants as well as expansion of allergens [1]. With the initiation of the Climate Change Regime enacted in the year 2015 in the Paris Convention on Climate Change, the importance of climate change has come to the fore once again [2].

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With the rise in the annual mean temperature, the blossoming season picked up its speed, resulting in an increase in both the amount of pollen being created and the number of people being exposed to them. Accordingly, the prevalence rates of allergic diseases, including allergic rhinitis (AR), asthma, atopic dermatitis (AD), and allergic conjunctivitis, are increasing [3,4].

It is very likely that if symptoms of AD develops at infancy, it may lead to AR and asthma during adulthood [5]; allergic disease may vary with people's growth processes.

One of the main reasons for the development of these allergic diseases is pollen, and according to a domestic study conducted in 2010−2011 involving respiratory allergic patients' skin, 34.14% showed a positive reaction to tree pollen and 28.65% to weed pollen [6]. Other studies including allergic skin tests have also been conducted domestically and internationally [7−9].

Air pollutants that have been formed due to climate change may deform epidermis, affecting the immune reaction, and by mixing with pollen, may increase the chances of allergic diseases such as asthma, AR, and allergic conjunctivitis [10−14]. Moreover, it is reported that they may lead to skin problems such as AD [15].

A lot of research works on allergic diseases and air pollution have been conducted. Out of these, several studies were conducted in children and adolescents, and the main finding was that there is a significant correlation between allergic diseases, such as AR and asthma, air pollutants, such as fine dust (PM_{10}) and sulfur dioxide (SO_2) [16−18].

Domestically, the Korean Academy of Pediatric Allergy and Respiratory Disease and the National Institute of Meteorological Sciences have made efforts to prevent these diseases, and succeeded in inventing a model for predicting pollen concentration in the atmosphere by utilizing meteorological elements such as precipitation and temperature. Moreover, regional forecast is provided by calculating the pollen risk index. Pollen observation is done throughout the year, from February to November, excluding January and December. By months, tree pollen is closely examined during March−May, whereas grass pollen is examined in May−September and weed pollen in August−October [19].

Most of the existing researches in infants and teenagers have analyzed the association by utilizing data on allergic diseases, weather, or air pollution. This study has been conducted for all age groups with an aim to understand the association between the number of outpatients with allergic diseases, air pollutants by pollen types, and pollen risk indexes by analyzing their interconnectivity, with the help of additional data on pollen risk index.

2. Materials and methods

2.1. Meteorological data

Korea's modern weather observation initiated in the year 1904 by observing the temperature, precipitation, and atmospheric pressure, and in the year 2000, Automated Synoptic Observation System was brought about, automating weather observation by improving aspects that required examining with the human eyes. The Meteorological Administration is operating the Regional Meteorological Office as well as the Meteorological Station, and is automatically observing 11 factors regionally, including atmospheric pressure, temperature, wind direction, wind speed, humidity, precipitation, likeliness of rainfall, insolation, sunshine duration, surface temperature, and grass temperature, as well as manually observing five factors, including visual range, cloud cover, cloud formation, evaporation loss, and earth temperature.

Meteorological data were provided by the Meteorological Administration, and meteorological factors observed by cities from the year 2003 to 2011 were processed and utilized.

2.2. National Health Insurance Service data

National Health Insurance Service data can largely be divided into the claims data related to the claims of the care facility, and medical expenses aid for the medical service recipients and its qualification data. Here, claims data are related to the care facility's claim on medical services, and have information on each claim's moment of treatment as well as respective disease information.

In order to proceed toward the analysis of climate change and the effects of allergens on allergic diseases, this study utilized National Health Insurance Service's health insurance claims data and qualification data, accumulated from the year 2003 through 2011, regarding several allergic diseases including AR (J30), asthma (J45), and AD (L20). For the variables, factors needed to process the data, such as personal ID, area of residence, start date of treatment, classification code, type of treatment, major/minor diseases, and the days of hospitalization, were used.

2.3. Air pollution data

For the air pollution data, the National Institute of Environmental Research is operating 233 Air Pollution Monitoring Networks (as of 2008) in 71 cities in order to figure out the mean air concentration level of air pollutants in the city areas. Twenty-seven networks are operated in Seoul, 17 in Busan, 11 in Daegu, 15 in Incheon, seven in Gwangju, seven in Daejeon, 14 in Ulsan, 64 in Gyeonggi, seven in Kangwon, seven in Chungbuk, seven in Chungnam, 10 in Jeonbuk, 12 in Jeonnam, 11 in Gyeongbuk, 15 in Gyeongnam, and three in Jeju. Measurement items in relation to the