PULMONARY DISEASES

Effect of gender, age, and severity of asthma attack on patterns of emergency department visits due to asthma by month and day of the week

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Abstract. Objective: To examine the pattern and strength of seasonal fluctuations in emergency department (ED) visits due to asthma, by month and day of the week, by the patient’s age, gender, and severity of asthma attack. Methods: Time series analysis of ED visits was conducted among patients with asthma aged from 18 to 55 years who visited Ontario EDs between April 1, 2001 and March 31, 2004. Autoregressive regression models with months and days of the week as predictors were fitted for (1) all patients; (2) females and males separately; (3) each combination of gender and age group, and (4) each combination of gender and level of severity. The strength of seasonality in each group of patients was estimated from the \( R^2 \)-statistic derived from autoregression models. Results: For all patient groups, the highest number of ED visits occurred in October and December, and on Sundays and Mondays. Month of January and Fridays were associated with a decreased number of visits. The strength of seasonality was similar in men and women (\( R^2 = 0.52 \)), was the highest in young patients and decreased with age, in men more rapidly than in women. Severe cases of asthma attacks exhibited weaker seasonality (\( R^2 = 0.30 \)) compared to mild (\( R^2 = 0.45 \)) or moderate (\( R^2 = 0.53 \)) cases. Conclusion: The strength of seasonal patterns of asthma ED visits is influenced by age and the severity of attack, and to a lesser extent, gender. Understanding the significance of seasonal precipitants of asthma in different patients subgroups could lead to better management strategies.

Key words: Asthma, Day of the week, Emergency department, Month, Strength of seasonality

Abbreviations: CI = confidence interval; CIHI = Canadian Institute For Health Information; CTAS = Canadian Triage Acuity Score; ED = emergency department; IgE = immunoglobulin E; NAC-RS = National Ambulatory Care Reporting System

Introduction

It has been long recognized that the course of asthma is often correlated with seasonal changes. Studies conducted in different populations of patients in Canada [1,2], the United States [3], England and Wales [4,5], and Finland [6] have consistently reported an autumn increase in asthma hospitalizations. Remarkably, even in New Zealand, similar fall peaks (April–June) in asthma hospitalizations were observed [7]. Fewer studies of asthma emergency department (ED) visits have confirmed the autumnal increase in the frequency of acute asthmatic episodes requiring emergency care [8,9]. The seasonality of asthma has also been investigated in relation to patient characteristics, primarily age and gender. The available evidence suggests that monthly fluctuations in hospitalizations and ED visits are most pronounced in male children before puberty, and that they tend to decrease with age [2, 5, 9].

Environmental precipitants of asthma include not only various climatic and weather conditions but also a range of stress factors related to work and social situations. Consequently while some triggers of asthma follow an annual cycle by month, others may have a weekly cycle by day of the week. Therefore, variations in the frequency of asthma attacks by day of the week may also offer clues to precipitating factors. Two studies that have examined the patterns of asthma ED visits by day of the week [8,10] but without adjusting for monthly effects, suggest that while in colder climates (New York City and Vancouver) some increases in ED visits on weekends compared to weekdays do occur, in warmer climate...
(New Orleans) no weekly pattern of visits is evident. However, the combined effect of months and day of the week on rate of asthma exacerbations have not been investigated.

The objective of this study is to investigate the effects of both month and day of the week on frequency of asthma ED visits by adult patients in Ontario, Canada’s largest province. In addition to gender and age, this study examines seasonality by severity of patients’ condition. It is expected, for example, that if severe cases of asthma are triggered by wider spectrum of precipitating factors compared to mild cases, then it would result in more diluted patterns of seasonality.

Methods

Data source

The principal data source used for the study is the National Ambulatory Care Reporting system (NACRS) managed by the Canadian Institute for Health Information (CIHI). It contains records on ambulatory visits, including both emergency and non-emergency visits and has information on patients’ demographic characteristics, procedural and some administrative data. Because this database was established in the year 2000, only three full years of data were available for the study: from the April 1st, 2001 to March 31st, 2004.

By April 2002 the diagnostic coding system in Ontario had undergone a transition from the ninth revision of the International Classification of Disease (ICD–9) to the tenth revision with Canadian enhancement (ICD–10-CA). For this reason the study data included a mixed diagnostic coding system: ICD–9 in the first year of data and ICD–10-CA in the last 2 years of data. The variables used for this study include patient’s date of visit, patient’s gender, age, and triage level. Triage level in NACRS is recorded according to Canadian Triage Acuity Score (CTAS). CTAS provides a measure of the patients’ priority for treatment and is considered to be an indirect estimator of the severity of patients’ symptoms on arrival in the ED. The urgency or need for ED treatment decreases as scores increase with the CTAS system. The CTAS levels used in NACRS are: 1 – resuscitation required; 2 – emergent care required; 3 – urgent care required; 4 – semi-urgent care required; and, 5 – non-urgent care required [11].

Study population

Only records from Ontario EDs were used in the study. There are approximately 180 EDs (number slightly varies from year to year) across Ontario located in both urban and rural areas, and affiliated with teaching and non-teaching hospitals. Total ED volumes of those EDs range from 800 to 80,000 emergency visits per year. The study population includes ED visits that met the following criteria: (1) emergency visits; (2) patients had principle diagnosis of asthma or status asthmaticus – “493” in ICD–9, or “J45.0”–“J45.9” in ICD–10 systems; (3) patient’s age at visit was from 18 to 55 years. Records on individuals older than 55 years were excluded to reduce the likelihood of including patients with chronic obstructive pulmonary disease.

Analytical strategy

Time series methods were employed as a principle analytical strategy. Three years of records were aggregated into monthly and daily series. The monthly series were used for calculation of monthly rates of ED visits and visualization of monthly pattern. Population estimates obtained from Statistics Canada population files [12] were used in the denominator for calculating rates. Monthly fractions of population estimates were derived using the fraction of number of days in a certain month by total number of days in a year.

The main part of the analysis was conducted using daily time series that contain information on both date parameters: month and day of the week. Daily time series were tested for white noise and periodicity pattern using spectral analysis methods [13,14]. The presence of trends was tested by Phillips–Perron unit-root test [15]. The generalized Durbin–Watson test [16] was used for detecting autoregression up to the eighth order. The inspection of autocorrelation and partial autocorrelation plots revealed the presence of strong autoregressive pattern of order 1 and 7 in time series. Therefore the subsequent model building employed autoregressive regression of order one and seven (AR(1,7)). The model regressed the daily number of visits on 17 dummy variables representing 11 months and 6 days of week. The month of June was used as a reference group for the rest of months, and Wednesday as a reference group for the rest of days of the week. Estimates and statistical significance of the dummy variables indicated monthly and weekday seasonality of visits.

For investigating seasonality by patient characteristics 24 series of the same length were constructed for 24 samples of patients. The original series consisting of all patients will be further referred to as the “original series.” The remaining 23 smaller series were constructed separately (1) for female and male patients; (2) for four age groups; (3) for three levels of severity of asthma attacks; (4) for combinations of each gender and age group; and (5) for combinations of each gender and level of severity of asthma attack. Based on distribution of age in the study sample, patients were categorized by age into four age groups: 25 years and younger, from 26 to 35 years, from 36 to 45 years, and 46 years and over. By severity of