

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; NACRS = 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) were *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

asthma attack visits were grouped into three categories: severe (CTAS 1 or 2), moderate (CTAS 3), and mild (CTAS 4 or 5). Separate autoregression models were built for each of 24 time series. The coefficient of determination, R^2_{autoreg} from the autoregression models was used as an estimate of the *strength of seasonality* [17]. Here, the strength of seasonality is not equivalent of the magnitude of seasonal fluctuations, rather it could be defined as a degree of predictability of seasonal fluctuations hence it is determined to a greater extent by consistency of fluctuations than by their relative dispersion. For further statistical details and discussion of the rationale of using autoregression coefficient R^2_{autoreg} as a measure of strength of seasonality see Moineddin et al. [17].

The fit of models was assessed through residual analysis including visual examination of a plot of residuals as well as autocorrelation and partial autocorrelation plots of residuals, and Fisher's Kappa and Barlett's Kolmogorov–Smirnov tests for white noise [13]. All statistical analysis was conducted using SAS V8.2 (Cary, NC). The study has been approved by McMaster University Research Ethics Board.

Results

During 3 years of study 99,054 ED visits due to asthma were made by 73,566 adult residents of Ontario. For the whole province, the average number of visits per day by people between 18 and 55 years was 90.4 (SD 24.8). Visits by female patients represented 62% (61,345) of all visits; visits by patients in the youngest age category (18–25 years) gave the largest proportion of the visits by age (29.6%); and the most visits were assigned the CTAS level 3 (49.1%) (Table 1). An examination of the distribution of number of visits by month and day of the week

Table 1. Distribution of ED visits for asthma by patient characteristics

Patient characteristics	Number of visits (Total = 99,054)	(%)
Gender		
Females	61,345	(61.93)
Males	37,709	(38.08)
Age group		
18 ≤ 25 years	29,329	(29.61)
26– ≤ 35 years	27,626	(27.89)
36– ≤ 45 years	25,011	(25.25)
46–55 years	17,088	(17.25)
CTAS level		
CTAS 1 (Resuscitation)	417	(0.48)
CTAS 2 (Emergent)	11,792	(11.91)
CTAS 3 (Urgent)	48,663	(49.13)
CTAS 4 (Less urgent)	29,985	(30.27)
CTAS 5 (Non-urgent)	8,134	(8.21)

revealed an increased number of visits in September, October and December, and on Sundays and Mondays (Table 2).

Monthly time series

The series of plots displaying monthly rates of visits by different patients categories were constructed to examine whether monthly pattern varied by patient characteristics. Although women have consistently higher rates of visits compare to men, the overall monthly patterns in men and women are similar (Figure 1). The same holds true when series were split by age groups and severity of asthma attack (Figures 2,3).

Daily time series

Daily series consisted of 1096 records of daily number of ED visits during 3 years period. A visual inspection of the daily series suggested the presence of both monthly and weekday fluctuations (Figure 4). Phillips–Perron unit-root test for trend rejected the hypothesis of presence of trend in series ($p = 0.001$). The test for white noise clearly rejected the hypothesis of series being a white noise in all patients' subgroups. Inspection of periodogram and spectral density estimates plotted against the period revealed prominent spike at the period of 7 days signifying the presence of strong weekly periodicity (data is not shown).

Table 3 presents the parameter estimates for the original series of patients. The results confirmed the

Table 2. Number of ED visits by month and day of the week

	Number of visits (Total = 99,054)	(%)
Month		
January	6,765	(6.8)
February	6,532	(6.6)
March	7,818	(7.9)
April	7,923	(8.0)
May	8,064	(8.1)
June	7,845	(7.9)
July	7,226	(7.3)
August	7,509	(7.6)
September	9,705	(9.8)
October	11,199	(11.3)
November	8,468	(8.6)
December	10,000	(10.1)
Day of the week		
Monday	15,483	(15.6)
Tuesday	13,748	(13.9)
Wednesday	13,508	(13.6)
Thursday	12,941	(13.1)
Friday	12,511	(12.6)
Saturday	14,082	(14.2)
Sunday	16,781	(16.9)

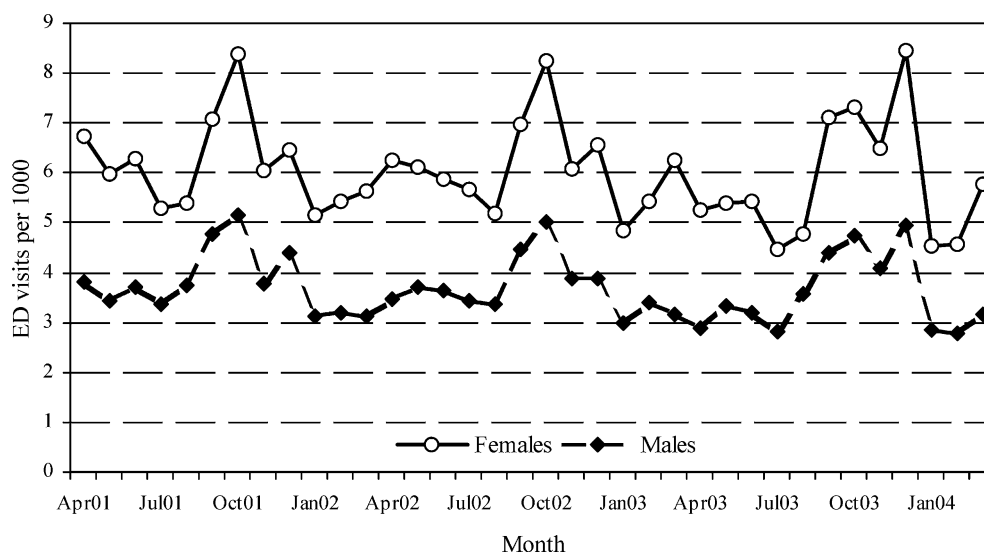


Figure 1. Asthma ED visit per 1 000 population by gender.

initial findings of an increased number of visits in September through December as well as on Sundays and Mondays. January and Fridays are associated with a decrease in number of visits. Parameter estimates of the remaining 23 models were smaller than those of the original series due to the smaller number of events in subgroups of patients compared to the whole sample, but otherwise they pointed to similar direction – autumnal, Sunday and Monday peaks. Table 4 shows percent changes in the number of visits from the baseline in series by patients' characteristics.

The R^2_{autoreg} coefficients for 24 series are shown in Table 5. The strength of seasonality is similar in men and women; it is the highest in young patients and tends to decrease with age. The age decline is less pronounced in women than in men. Moderate cases of asthma exhibit stronger seasonality than mild or severe cases. Models' residuals presented a white

noise and did not exhibit any additional seasonality. Autocorrelation and partial autocorrelation plots of residuals did not reveal any significant patterns.

Discussion

Our study confirmed the presence of distinctive monthly pattern in asthma exacerbation. It also found a strong day of the week pattern of ED visits by adult asthmatics, and quantitatively estimated the strength of seasonality in different patients' subgroups.

Monthly effect

The monthly pattern of visits was found to be fairly similar in all patient categories. Previous research

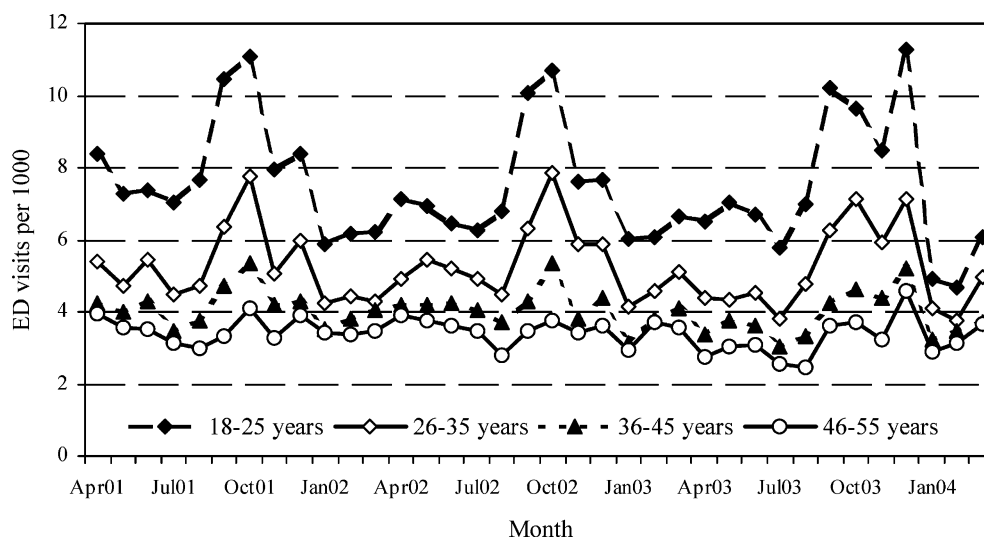


Figure 2. Asthma ED visit per 1 000 population by age.

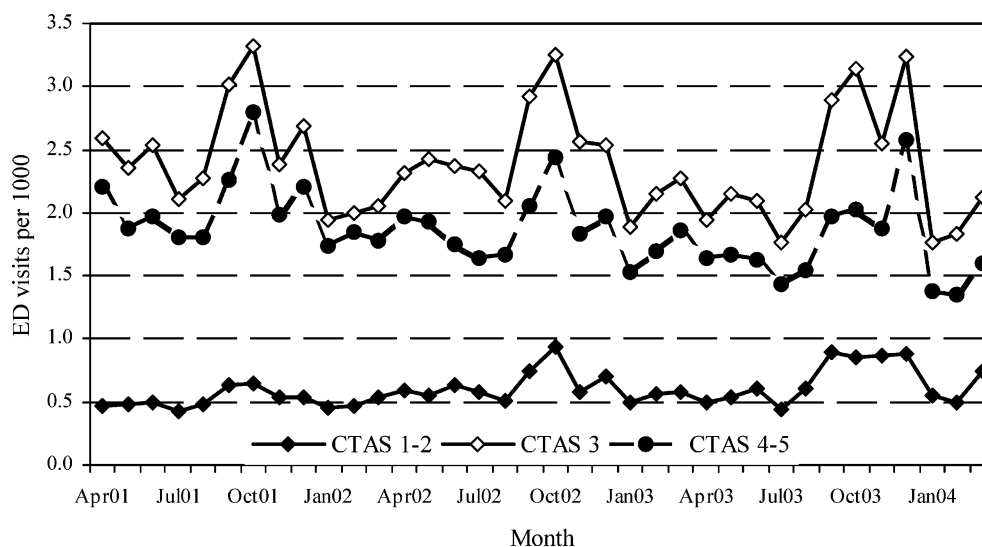


Figure 3. Asthma ED visit per 1 000 population by level of severity (CTAS).

attempted to link consistently observed autumnal peaks to various environmental factors ranging from the fall outbreaks of respiratory viral infections [18–22] to meteorological changes [23, 24]. However a consensus about the main determinant of fall peaks still has not been reached. Research in pediatric asthma tends to attribute fall exacerbations mainly to seasonal epidemics of viral airway infections. It has been shown that in children, up to 80–85% of asthma hospitalizations and ED visits are associated with viral infections (19,22). In adults, however, the link between asthma exacerbations and viral infections is not that well established. For example, the study by Sokhandan et al. [25] conducted among adult patients presented to the ED with severe exacerbation of asthma, failed to find any association between acute asthmatic episode and respiratory viral infections using available virologic diagnostic methods. The

authors suggested that “other precipitants of acute asthma requiring ED evaluation should be sought” [25, p. 1574]. In contrast, Atmar reported that 55% of asthmatic episodes in adult patients presented to the ED were associated with respiratory tract viral infections [26]. Discrepancies in the results of these studies could be explained by differences in the patient samples or variations in laboratory techniques used for diagnosing viral infections. Thus the role of respiratory viral infections in seasonality of adult asthma cannot be dismissed and is worthy of further investigation.

Cold air is another known precipitating factor of asthma exacerbation [27,28]. Yet annual peaks in asthma visits do not necessarily occur in coldest months of the year. In our study month of January was consistently associated with decreases in number of ED visits in all patients’ subgroups. In Ontario,

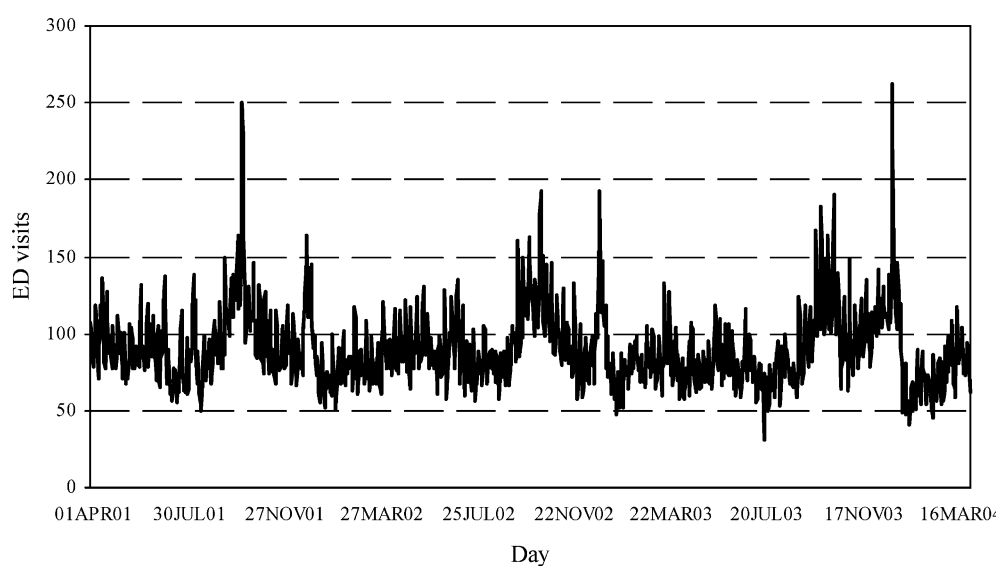


Figure 4. Daily series of asthma ED visits.

Table 3. Results of the autoregression model (1,7) for the original series of patients

Model Variable	Estimate	P-value	95% CI	% change from the intercept*
Intercept	79.8	< 0.0001	71.0–88.7	
January	–8.4	0.167	–20.4–3.5	–10.6
February	–4.5	0.464	16.6–7.6	–5.7
March	0.1	0.983	–11.8–12.1	0.2
April	2.2	0.708	–9.4–13.9	2.8
May	2.4	0.638	–7.8–12.7	3.1
July	–2.7	0.599	–13.0–7.5	–3.5
August	3.7	0.527	–7.8–15.3	4.7
September	17.7	0.004	5.8–29.6	22.1
October	27.9	< 0.0001	16.0–39.8	34.9
November	16.5	0.007	4.5–28.5	20.7
December	18.6	0.002	6.7–30.6	23.3
Sunday	20.8	< 0.0001	16.7–25.0	26.1
Monday	12.4	< 0.0001	8.6–16.3	15.5
Tuesday	1.5	0.344	–1.6–4.5	1.8
Thursday	–3.0	0.058	–6.0–0.1	–3.7
Friday	–5.7	0.004	–9.6 to –1.8	–7.1
Saturday	4.3	0.041	0.2–8.5	5.4

*Calculated as (variable estimate/intercept) × 100%.

January is typically as cold as, or colder than, December, when the number of asthma visits increased. In fact, December increases may more aptly support the theory of respiratory viral infections,

since a greater number of social interactions related to the holiday season might lead to a higher risk of contracting cold or viral infections. The effect of holiday stress may also play a role in December

Table 4. Percent change in number of visits from model-estimated intercept^a in selected months and days of the week

	January	September	October	November	December	Sunday	Monday	Friday
All patients								
Overall	–10.5	22.1	34.9	20.7	23.3	26.1	15.5	–7.1
Age ≤ 25	–14.2*	49.7	53.7	27.4	33.6	30.8	21.9	–8.3
Age 26 to < 35	–15.8	26.8	53.3	19.2	27.0	32.9	18.5	–6.5*
Age 36 to < 45	–17.8	9.1*	26.3	5.4*	15.0	19.0	9.2	–6.5
Age 46–55	–8.0*	3.2*	15.05	–1.4*	18.7	17.1	8.9	–5.3*
CTAS 1–2	–10.0*	32.8	43.0	18.0	24.9	25.0	23.2	–4.9*
CTAS 3	–17.2	25.9	39.4	19.6	21.6	29.6	17.0	–7.8
CTAS 4–5	–11.1*	19.2	35.4	13.9	27.6	21.3	10.6	–6.5
Females								
Overall	–13.4	21.9	36.0	16.0	25.5	19.5	12.2	–6.1
Age (25	–15.7	47.6	49.8	19.1	28.6	23.9	19.1	–8.3
Age 26 to < 35	–17.8	27.5	57.2	20.2	31.4	26.8	16.7	–5.0*
Age 36 to < 45	–21.0	9.4*	27.7	0.3*	15.7	14.6	5.8	–3.6*
Age 46–55	–8.1*	–4.3*	9.7*	–3.8*	17.2	9.5	5.0*	–6.8*
CTAS 1–2	–15.3*	26.2	33.5	10.8*	22.7	19.3	18.4	–4.7*
CTAS 3	–15.1	23.0	41.1	16.5	24.2	21.0	11.6	–8.6
CTAS 4–5	–15.9	19.0	33.5	7.1*	24.9	17.0	10.4	–2.9*
Males								
Overall	–12.5*	28.5	42.5	18.3	22.5	36.7	20.6	–8.3*
Age ≤ 25	–17.0*	59.0	65.9	30.2*	43.1	40.8	25.8	–7.9*
Age 26 to < 35	–14.5*	27.1	50.8	11.4	22.0	41.9	20.9	–8.5
Age 36 to < 45	–11.7*	9.5*	27.1	10.9*	13.9*	27.7	15.8	–12.1
Age 46–55	–8.8*	18.2	24.7	2.5*	21.5	33.1	17.3	–1.9*
CTAS 1–2	–3.1*	46.6	63.5	30.6	28.2	35.9	32.3	–5.3*
CTAS 3	–24.5	35.4	41.6	12.4*	19.6	44.3	26.2	–5.8*
CTAS 4–5	–5.8*	19.5	41.9	17.9	32.3	27.8	10.5	–11.8

^aCalculated as (variable estimate/intercept) × 100%.

*Variable estimate has a *p*-value > 0.05.

Table 5. Value of R^2 coefficient from autoregression models for series by patient subgroups

	Females	Males	Both
Overall	0.53	0.52	0.63
Age			
Age ≤ 25	0.37	0.41	0.52
Age 26 to <35	0.37	0.32	0.49
Age 36 to <45	0.21	0.16	0.29
Age 46–55	0.15	0.13	0.22
Severity			
CTAS 1–2	0.19	0.21	0.30
CTAS 3	0.43	0.40	0.54
CTAS 4–5	0.31	0.30	0.45

peaks. Rather than the general effect of cold weather, the first onset of cold after summer could be a stronger precipitant of exacerbations. Studies that applied a synoptic climatological approach tried to link fluctuations in asthma hospital admissions to specific types of air masses [23, 24]. Jamason et al. [24] suggested that a certain type of air mass representing the first or second influx of cold weather into a region during the fall contributes to autumnal increase in frequency of asthma exacerbations. Additionally, the first onset of cold leads to the start of indoor heating for the first time after summer, and is often accompanied by a release of dust, mites and mold spores that have been accumulating in heating system since the previous spring [24].

In spite of a substantial body of research suggesting a link between increased levels of air pollutants and outdoor allergens, and asthma, these factors alone cannot explain the monthly variation witnessed in this study. Although concentration of air pollutants is indeed subject to some seasonal fluctuation, the peak season is different across pollutants [29, 30]. It has been suggested that independently of the atmospheric concentration of pollutants, high temperatures may potentiate their effects on asthmatics [31, 32]. Warm seasons are also known to be associated with higher concentration of aeroallergens. However, the results of our study indicate that number of ED visits is the lowest during summer months. Thus, it is unlikely that the air pollutants and aeroallergens significantly contribute to the observed seasonality. It is plausible, though, that changes in air content are responsible for short-term fluctuations that may be masked by more pronounced monthly pattern.

Given the complex pathogenesis of asthma the observed monthly pattern perhaps should be better explained by a combination of several factors rather than a single factor. Acting simultaneously, several triggers of asthma factors interact and often boost each other. For example, it has been shown that presence of allergy is a risk factor for enhanced lower airway effects during respiratory viral infections [33], while opposite is also true – respiratory viruses could

augment immediate and late allergic responses in the airways of allergic individuals [34].

Day of the week effect

We found that the highest number of emergency visits in adults asthmatics occurred on Sundays and Mondays. Two previous studies on this topic have reported weekend but not Monday increases in asthma hospitalizations [10] and ED visits [8]. Perhaps differences in the study population could explain this slight discrepancy with our findings. For example, the inclusion of children may dilute the Monday increase, which might be more an “adult” phenomenon.

The increased number of visits on Sundays might be easily explained by the limited access to day clinics and family physicians services on weekends. Therefore more patients with asthma requiring medical assistance go to emergency rooms on Sundays compared to other days of the week. Two other factors related to weekends may play a role. First, during weekends, patients are more likely to be engaged in strenuous physical leisure-time activities that might provoke asthma attacks. Second, patients also tend to spend more time outdoors on weekends and get more exposed to some outdoor triggers of asthma.

Monday peaks in asthma emergency visits are perhaps more intriguing. The “Monday phenomenon” has been systematically found for cardiac arrest and myocardial infarction [35–38], but has never been documented in relation to asthma. Research in cardiovascular conditions tends to attribute the Monday effect to higher level of stress and consequently increased catecholamine activity. Stress is a known trigger of asthma as well. It has been reported that stressful situations that are unavoidable and demand a passive coping response particularly tend to increase respiratory resistance in asthma [39]. This type of passive stress is also the one that is likely to be associated with Mondays and may contribute to Monday increase in frequency of asthma attacks.

There is some evidence, however, that Monday increase in ED visits is not limited to certain conditions rather it is a universal phenomenon in emergency medicine. For example, the most recent US report on ED services use showed Mondays peaks in number of ED visits for all conditions combined [40]. It may be that the limited access to medical care on weekends and patients’ hope that the condition will spontaneously improve over the weekend due to rest, could lead to deterioration in patients’ conditions over the weekend and as a result they are likely to rush to the ED on Mondays. Thus the Monday increase in asthma visits similar to the Sunday peaks may to a greater extent reflect the “health care system effect” rather than effect of specific precipitants. It suggests that the observed daily variation could have more social and administrative rather than clinical relevance.

Overall seasonality

Values of R^2 coefficients from autoregression models demonstrated that a substantial portion of the variation in the number of daily ED visits could be explained by month and day of the week. The coefficient was the highest (0.63) for the original series of all patients, thereby indicating the existence of strong seasonality at the population level. The value of the coefficient decreased in smaller samples of patients. In spite of the significantly higher number of visits in women the strength of seasonality is similar between genders. Thus, although women account for majority of ED visits [41–43] and hospitalizations for asthma [2, 44–47], it seems unlikely that overall they are more susceptible than men to those external precipitants of asthma that are seasonal in nature. Decreases in the R^2 coefficient as age increases confirms the previous findings of the inverse correlation between seasonality and age in asthma. Interestingly, it also correlates with laboratory findings of decline in immunoglobulin E (IgE) production and prevalence of atopy with age [48,49]. The observed decline in seasonality with age is more rapid in men than in women. This could be explained by a gender-specific effect of age on the level of total and specific IgE. It has been reported that in men both total and specific IgE levels decrease with age, while in women only total IgE level decreases with age [48]. Finally, the strength of seasonality differs by the severity of asthma attack: it is the highest in moderate cases of asthma attacks, and it is the lowest in patients with severe attacks. Severe asthma attacks are usually indicators of severe asthma. Since severe asthma is likely to be triggered by wider range of precipitants present in different seasons, its course may exhibit less seasonality.

Several limitations of our study should be mentioned. First, identification of cases based on administrative records cannot exclude a certain degree of misclassification when diagnosis of asthma is erroneously assigned in cases of other respiratory conditions, or non-asthma cases are included. This misclassification tends to occur at the extremes of age: in cases of bronchiolitis in infants and COPD in older patients. Both of these age groups were not represented in our sample, which minimizes the chances of misclassification. Second, the level of severity of asthma attack was assessed indirectly through CTAS score. It has been shown, however, that the CTAS score is a valid estimator of severity and is assigned fairly consistently across EDs in Canada [50, 51]. Third, the study included only patients seen in ED, while patients who visited day clinics, family physician offices, or had asthma attacks in any other locations were missed. There is no reason to believe that missed cases of acute asthma might exhibit a different seasonal pattern. For example, it has been reported that there is a high correlation in temporal patterns between hospital

admissions and general practice episodes [5] with peaks in the fall.

While in the past, research on the seasonality of asthma was mainly based on inpatient hospitalization records, this study utilized data on ED visits. Patients who are hospitalized usually represent the most severe cases of asthma. ED records on the other hand, contain information on a much broader spectrum of patients presenting with mild to severe asthma. Therefore data on ED utilization could be better suited for studies of seasonality compared to hospitalization records. Unlike previous studies we limited the sample to adult patients. It has been consistently shown that the course and seasonality of asthma is very different in children and adults [2, 5, 7], which merits its separate investigation. Lastly, the analytical approach employed by this study made it possible to isolate the effect of each month and day of the week adjusting for the remaining months and days of the week. In addition to the effect of gender and age this study investigated seasonality in relation to severity of asthma attacks, which has not been done previously.

Conclusion

This study found the existence of both monthly and weekday patterns in asthma exacerbations in adults requiring emergency care. These patterns are quite similar in different patients subgroups by gender, age and severity of asthma. The strength of seasonal fluctuations seems to be influenced to a greater extent by age and the severity of asthma attacks than by gender, although gender does modify these effects slightly. Uncovering the mechanisms responsible for the found monthly and weekday patterns may provide better understanding of the precipitants of asthma and lead to improved management strategies.

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