EPIDEMIOLOGY

Age, Gender and Seasonal Patterns of Asthma in Emergency Departments of Southern Puerto Rico.

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We report findings derived from 55,547 emergency department records of asthmatic patients in the city of Ponce, Puerto Rico over a period of six years. The analysis of the data revealed that mean age of the asthmatic cases were 18.7 ± 17.8 years, with 45% percent of the patients in the 1–9 years age range, and proportionally decreasing with age. In children 1-9 years the percent of males was 1.5 times that of females, and in 10-19 year-old group, admissions to the emergency room for males and females was identical, and between 20-69 years of age, the female ratio ranged from 1.5-2.12. The data also demonstrated that there is a seasonal variation in the asthma attacks reaching its peak in December, and the lowest in June. In conclusion, in the city of Ponce, Puerto Rico, emergency department usage due to asthma attacks show a seasonal variation, and males are more affected by asthma at younger ages while females are more affected at older ages. These findings strongly suggest that emergency department usage due to asthma attacks is highly common and represents an important place where specialized health care delivery is needed. With the implementation of dedicated asthma centers, specialized health care delivery can be easily accomplished. In addition, our data supports the that asthma should be declared a public health problem and a reportable disease.

Key words: Asthma, Epidemiology, Emergency departments, Puerto Rico.

The characterization of the asthmatic population using emergency departments is very important because it allows identification of populations at high risk for asthma attacks. These patients require close monitoring as well as health education for proper management of their severe asthma (1). To achieve this goal, a regional characterization of the asthma epidemic is necessary. Among the numerous variables affecting asthma, age, gender, and seasonal variation should be carefully studied in order to establish adequate asthma management. Available information about the overall epidemiology of asthma in Puerto Rico indicates that the prevalence of asthma is extremely high, especially among children (2,3,4). In addition, these data suggest there is a seasonal variation in asthma attacks and that females might are more affected than males.

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The seasonal variation in asthma attacks has been documented in the United States, (5,6) and in other countries such as Canada, (7,8) and South Africa (9). In Finland Harju *et al* reported that asthma related hospitalizations showed a marked seasonal variation peaking in May with a 36% incidence above the baseline, and in fall and early winter with 41.3% incidence above the average during the month of October (10). The authors suggest that the variations in the asthma attacks were related to birch pollen and viral respiratory infections. Other researchers have been able to demonstrate that allergens and incidence of respiratory infections, in turn, have seasonal patterns that could affect asthma attack rates (11-15). Therefore, to study seasonal patterns of asthma is an important step to identify and assess the relevance of potential triggers of asthma exacerbations.

Gender differences in asthma attacks have also been reported. Lwebuga-Mukasa *et al*, (16) reported that asthma is most common cause for emergency room visits and hospitalization among all respiratory disorders in New York State, and males ages 0– 9 years were hospitalized due to asthma twice as often as females. In contrast, after 15 years of age, females had twice the admission rates than males.

Our objectives are to describe the epidemiology of asthma in Puerto Rico to better understand the possible reasons for the distribution of cases by age, gender and month of the year. For this purpose, we conducted a case-series study record review of asthma cases in four major hospitals in the city of Ponce, Puerto Rico.

Methods

A case series study of 55,547 emergency room visits was conducted in four major hospitals in the city of Ponce, Puerto Rico. All cases diagnosed as asthma or bronchial asthma by attending physicians of the participating hospitals from 1987 to 1992 were included in the study. The data were collected from medical records of emergency department (ED), and analyzed by using Stata (Stata Corporation, College Station, TX). Additional statistical tests were conducted using Cluster version 3.1 (17). After the data were reviewed for integrity and errors, the frequency distribution of all variables was carried out for further evaluation of potential errors. Frequency distributions of all variables were also used to study the distribution of cases by age, sex and month of the year. Cross-tabulation was used to study the distribution of gender by age and month of the year. The mean and the median age by gender and month of the year were also calculated. The ratio of proportions and its Cornfield's 95% confidence interval was used to assess the difference in proportions of females by age group (18). The Kruskal-Wallis test was used to assess the statistical significance of the mean age differences between genders and months of the year respectively. The Scan method for case data analysis for clustering was used to confirm and identify differences in the number of cases per month.

Results

Age distribution. The mean and median age of the asthmatic cases were 18.7±17.8 years and 11 years respectively. Forty five percent of the patients were in the 1–9 years age range. The 10-19 year old group comprised 17.6% of the series and the 20-29 years of age group 11.1 %. The remaining age groups did accounted for 26.3% of the series (Table 1 and Figure 1). The distribution of children 1-9 years of age showed a decline from 4213 cases (16.6%) in the age group from 1-2 years (Table 2) to 1832 (7.3%) at the 9-10 years. The proportion of cases below 10 year of age increased from 5.9% for the month of July to 13.2 % in December (Table 3). A similar increase was observed in all of the asthmatics above 10 years of age.

Gender. Table 1 and Figure 2 show a female/male odds ratio of 2 or more ($p<0.0001$) for the entire series except in the 1-19 year group (Table 1). The female-male ratio of the entire case-series showed no major differences by month of the year (Table 4). Females showed an older age average (22.5±18.3 years) as compared to the males (14.9±16.17 years) for a mean difference of 7.6 years ($p< 0.0001$) (Table 4).

Table I. Emergency department asthmatic cases by age and gender. Ponce, Puerto Rico

Age in Years	Female		Male		Total		Female/Male	Ratio of Female Proportions
	N	%	N	%	N	%	Ratio	Odds Ratio (95% CI)1
1-9	9891	(35.0)	15177	(55.5)	25068	(45.1)	0.65	Reference group
10-19	4732	(16.7)	5021	(18.3)	9753	(17.5)	0.94	
20-29	4081	(14.4)	2060	(7.5)	6141	(11.0)	1.98	3.03 (2.86-3.22)2
30-39	3380	(11.9)	1899	(6.9)	5279	(9.5)	1.77	2.73 (2.56-2.90)2
40-49	3371	(11.9)	1586	(5.8)	4957	(8.9)	2.12	3.26 (3.05-3.48)2
50-59	1772	(6.2)	903	(3.3)	2675	(4.8)	1.96	3.01 (2.76-3.27)2
60-69	1017	(3.6)	657	(2.4)	1674	(3.0)	1.54	2.37 (2.14-2.62)2
TOTAL	28,244	(50.8)	27,303	(41.1)	55,547			

1. Cornfield 95% Confidence Intervals for the ratio of female proportions
2. $p<0.0000$

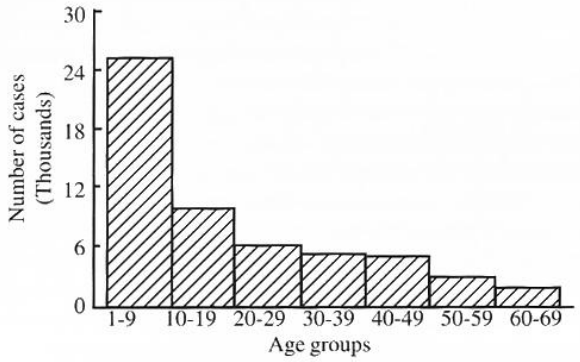

Figure 1. Frequency histogram of the asthma cases by age group.

Table 2. Emergency department cases from 1-9 years.

Age	N	% of age group 1-9 years	% of total ED cases
1	4213	16.8	7.8
2	3428	13.6	6.1
3	3142	12.5	5.6
4	2752	10.9	4.9
5	2871	11.4	5.1
6	2577	10.2	4.6
7	2193	8.7	3.9
8	2060	8.2	3.7
9	1832	7.3	3.3

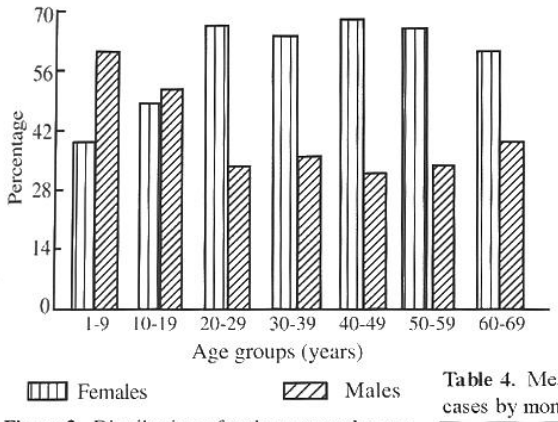

Figure 2. Distribution of asthma cases by age and gender. As shown, males (crosshatched bars) in the ages of 1-9 years require more frequent emergency room care due to asthma than females (solid bars). This trend in inverted as age progresses.

Seasonality of asthma attacks. December showed a statistically significant higher frequency of emergency department visits than other months (Table 4). The peak frequency of 12.3% was in December, and the lowest in June reaching 5.3% (Table 3 and Figure 3). The same pattern was found when analyzing the 1-9 years of age series (Table 3 and Figure 3). May, June and July showed higher mean and median age than November and December (Table 4).

Discussion

According to the U.S. Census Bureau in 1990, the city of Ponce, Puerto Rico had 188,722 inhabitants and this number can be considered the mid-period population for this study (19). Reporting the results of a large case-series study of asthma in emergency departments in Ponce illustrates the basic epidemiological distribution of asthma exacerbations by age, gender and month of the year. While is possible that emergency room care is used by a large proportion of

Table 3. Emergency department cases of selected age groups by months of the year. Ponce, Puerto Rico.

Months	<10 Years of Age		>10 Years of Age		Total	
	N	%	N	%	No.	(%)
January	2207	(8.2)	2511	(8.7)	4718	(8.4)
February	2393	(8.9)	2466	(8.5)	4859	(8.7)
March	1992	(7.4)	2445	(8.5)	4437	(7.9)
April	1749	(6.5)	1973	(6.8)	3722	(6.7)
May	1641	(6.1)	1994	(6.9)	3635	(6.5)
June	1367	(5.1)	1835	(6.3)	3202	(5.7)
July	1586	(5.9)	2294	(7.9)	3880	(6.9)
August	2020	(7.5)	2289	(7.9)	4309	(7.7)
September	2463	(9.1)	2496	(8.6)	4959	(8.9)
October	2709	(10.0)	2390	(8.3)	5099	(9.1)
November	3143	(11.7)	2718	(9.4)	5861	(10.5)
December	3557	(13.2)	3309	(11.5)	6866	(12.3)
Total	26827	(48.30)	28720	(51.70)	55547	(100)

Table 4. Mean, median and gender distribution of emergency department asthmatic cases by month of the year.

Variable	Total		Age		Gender				Female/Male Ratio
					Female		Male		
	N	%	N	%	N	%	N	%	
Month									
January	4718	(8.4)	19.8	12	2268	(8.3)	2450	(8.6)	0.9
February	4849	(8.7)	18.6	11	2436	(8.9)	2423	(8.6)	1.0
March	4437	(7.9)	19.7	12	2171	(7.9)	2266	(8.0)	0.9
April	3722	(6.7)	19.2	12	1832	(6.7)	1890	(6.6)	0.9
May	3635	(6.5)	20.0	12	1830	(6.7)	1805	(6.4)	1.0
June	3202	(5.7)	20.9	14	1585	(5.8)	1617	(5.7)	0.9
July	3880	(7.0)	18.7	15	1795	(6.5)	2085	(7.3)	0.8
August	4309	(7.7)	19.5	12	2229	(8.1)	2080	(7.3)	1.0
September	4959	(8.9)	18.0	11	2389	(8.7)	2570	(9.1)	0.9
October	5099	(9.1)	17.3	10	2549	(9.3)	2550	(9.0)	0.9
November	5861	(10.5)	17.0	9	2850	(10.4)	3011	(10.6)	0.9
December	6866	(12.3)	17.0	10	3369	(13.3)	3497	(12.3)	0.9
Gender									
Female	27303	(49.1)	22.5*	18					
Male	28244	(50.8)	14.9	8					
Total	55547				27303	(49.1)	28244	(50.8)	0.9

*>0.0001 *Kruskal Wallis Test)

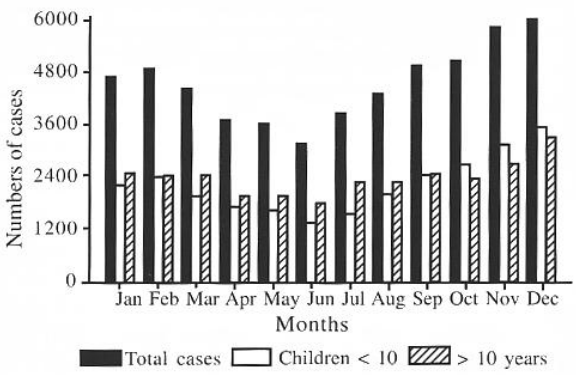

Figure 3. Histogram of the asthma attacks by month and age, the seasonal pattern can be observed. The largest case load is during the months of November, December, January and February. Solid bars represent the total case load, the light solid bars are those patients with less than 10 years of age. The cross-hatched bars are patients older than 10 years of age.

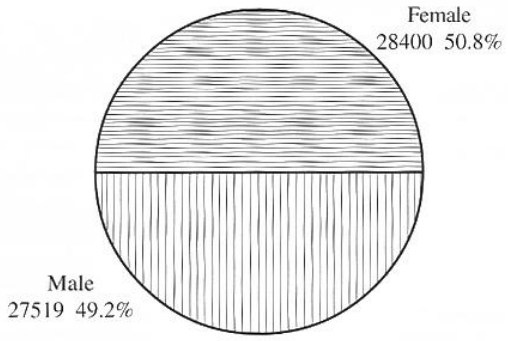

Figure 4. Pie chart illustrating the gender distribution of the asthmatic population.

patients with asthma as their primary care facility, the use of the emergency room denotes a degree of disease severity.

The use of the emergency department was found to be most common in asthmatics below 10 years of age who accounted for 45. 1% of the total cases. This was followed by a decreasing prevalence according with age. These data denotes an increased risk for severe asthma in children and adolescents. Causes for this high prevalence of ER usage at this early age are not clearly defined. In a recent review on allergen exposure and asthma by Pearce *et al*, points out to the fact that available evidence does not indicate that allergen exposure is a major risk factor for the primary causation of asthma in children (20). One theory is that the high percent of cases below ten years is due to a high incidence of respiratory infections that are frequently found in infants (21-24).

The gender distribution in the asthma cases clearly demonstrates than females are more affected than males. As illustrated in Figure 1, in children 1-9 years the percent of males was nearly 1.5 that of females. In the 10- to 19-year-old group, admissions to the emergency room for males and females was identical, and between 20-69 years of age, the female ratio ranged from 1.5-2.12 (Table 2). Our results are comparable to those reported by Skobeloff *et al,* (25) and Lwebuga *et al.* (26). As pointed out by Skobeloff *et al,* (25) gender disparity in asthma could be influenced by hormonal or biochemical differences related to sex. No differences were found on the female-male ratio by month of the year.

Asthma attacks in our study population showed a clear seasonal pattern reaching its peak in December, and low in June. This suggests that different risk factors may be involved as triggers for asthma attacks. Although our study can not identify causes for this pattern, there are several possible causes that should be investigated. First, an important trigger could be temperature oscillations. Although Puerto Rico does not have clear seasonal changes and temperatures do not vary significantly throughout the year, it is possible that minimal temperature changes are sufficient to facilitate the establishment of respiratory infections which in turn will trigger asthma attacks. Available data from other regions indicate that asthma attacks are more frequent in the winter months (27-29). Second, exposition to outdoor pollutants may show seasonal patterns. Asthma exacerbations have been associated to of indoor and outdoor allergenic pollutants such as mites and pollens (30-31). Third, there may be changes in daily activities from outdoor to indoor environments with prolonged contact with allergens such as domestic mites in infested sofas, mattresses, and pillows. Fourth, it is possible that changes in levels of other indoor triggers such as endotoxin may increase in November and December. The tropical environment of Puerto Rico may stimulate continuous production of flowers and pollen. In conclusion, asthma attacks in Puerto Rico share with many other reports in the literature, the following characteristics: 1) a seasonal pattern with the highest ER usage in December and the lowest in June, 2) close to one half of the cases were patients under 10 years of age, and 3) males are more affected than females at younger ages while females predominated at older ages.

To decrease the use of emergency department usage, we propose the following: first, to stimulate city and state governments to establish public policy for asthma, and most importantly, to declare asthma a public health problem and a reportable disease. Second, to implement dedicated asthma centers in all major hospitals. It has been reported that dedicated asthma center can significantly reduce the

average cost of care of those treated in these units (32-33). In addition, these specialized units can manage asthma according to the National Guidelines for asthma treatment, and educate patients and parents in the proper use of the asthma medication. Third, enhanced education programs aimed to health care professional including pediatricians and emergency department personnel in which the most recent asthma management and treatment modalities would be focused. The educational program should also be extended to future mothers, in which their risk factors for asthma would be identified and to promote preventive measures for asthma exacerbations in their future offsprings. Fourth, to promote the use of anti-inflammatory medication in schools by health professionals, parents or guardians. Fifth, to address parental attitudinal issues towards their appraisal of their children's severity and management of the asthma attacks. Future studies on asthma in Puerto Rico should be focused to the understanding the relationship between the degree of asthma severity, interaction of the indoor environmental factors and its seasonal patterns.

Resumen

Este reporte muestra los hallazgos obtenidos en 55,547 expedientes de pacientes asmáticos que visitaron las salas de emergencia de la ciudad de Ponce, Puerto Rico, en un período de seis años. El análisis de los datos reveló que la edad promedio de los pacientes asmáticos fue de 18.7± 17.8 años y 45% entre las edades de 1 a 9 años de edad, disminuyendo en proporción con la edad. En niños de 1 a 9 años, el porciento del sexo masculino fue 1.5 veces mayor que el femenino, mientras que en el grupo de 10-19 años fue idéntico. Entre las edades de 20 a 69 años, la proporción de femeninas varió entre 1.5 – 2.12 años. Los datos demostraron también que hay una variación estacional en los ataques de asma, alcanzando su pico en diciembre y su descenso en junio. En conclusión, en la ciudad de Ponce, Puerto Rico, el uso de las salas de emergencia por ataques de asma, muestran una variación estacional. Los varones son más afectados por asma en edades más tempranas, mientras que las féminas se ven más afectadas en su etapa de adulta. Estos hallazgos demuestran que las visitas a la sala de emergencia por ataques de asma son comunes y que dichas salas de emergencia representan un lugar importante donde es necesario se ofrezca un cuidado especializado. Con la implementación de centros dedicados al manejo del asma se puede alcanzar con mayor facilidad un tratamiento de salud especializado. Además, nuestros datos apoyan el hecho de que el asma se debe declarar un problema de salud pública y que sea una enfermedad reportable.

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