



Puerto Rico Asthma Project  
Maternal, Child and Adolescent Health Division  
Auxiliary Secretariat of Family Health and Integrated Services  
Puerto Rico Department of Health  
in collaboration with the Puerto Rico Asthma Coalition



# EPIDEMIOLOGICAL PROFILE OF ASTHMA IN PUERTO RICO

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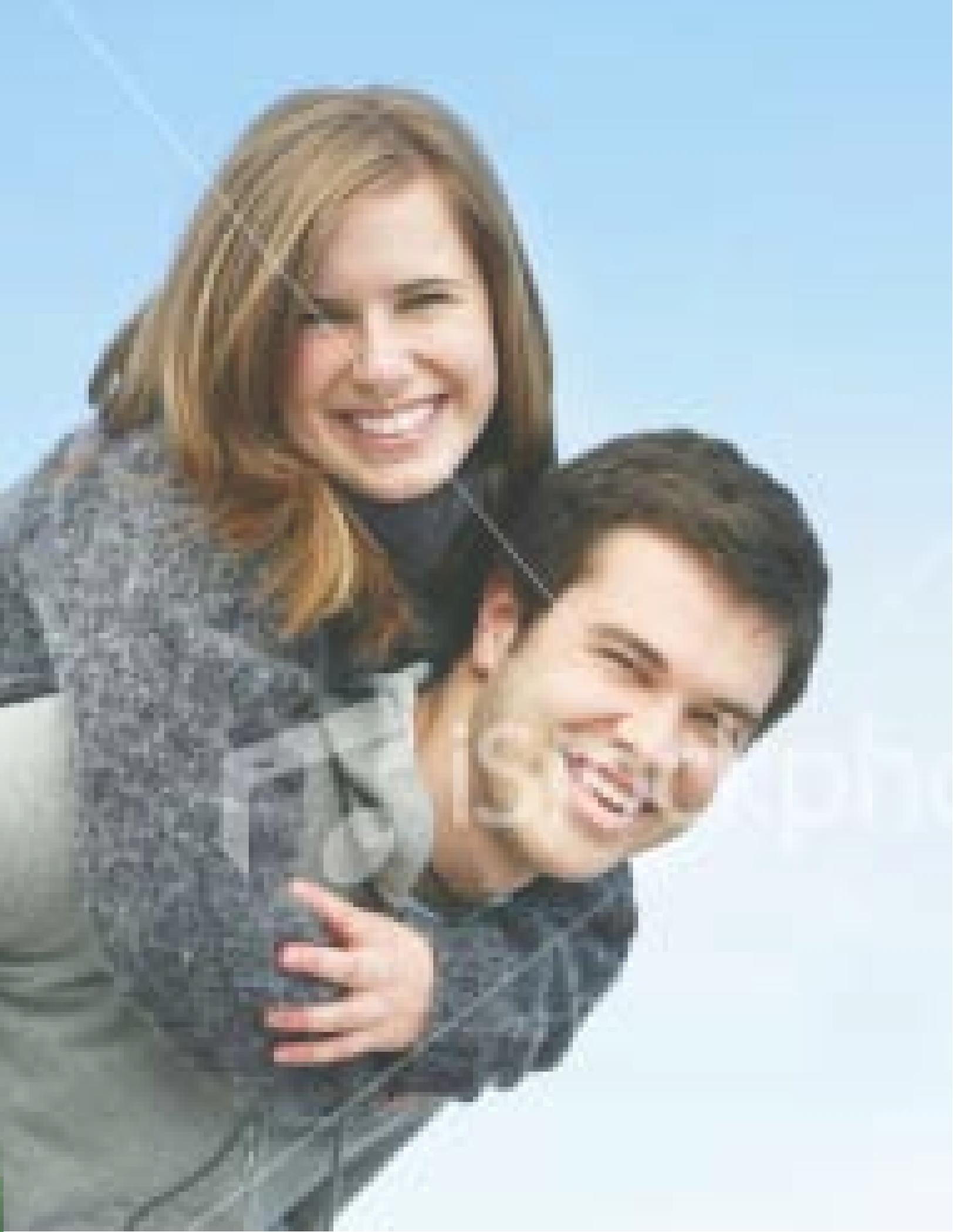
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## EXECUTIVE SUMMARY

Dear colleagues;

Asthma is an important health issue in Puerto Rico. Our population suffers from the highest asthma morbidity and mortality of all states and territories of the United States of America. To address this situation, the Puerto Rico Department of Health established an asthma project subsidized by the Centers for Disease Control and Prevention (CDC). Through this project, titled "Developing the Capacity to Address the Asthma Situation in Puerto Rico from a Public Health Perspective", the Department of Health developed an asthma surveillance system and a strategic plan for asthma control in Puerto Rico. The Puerto Rico Asthma Coalition, community based entities, government and private agencies have committed to be collaborators in meeting the project's objectives.

The following reports represents an epidemiological profile of the morbidity, mortality and use of health care services due to asthma in Puerto Rico. The information within this report will help guide the efforts of the Puerto Rico Asthma Control Strategic Plan. The utilization of this public health document is encouraged to better understand the burden of asthma in Puerto Rico and to develop research hypothesis for the planning of intervention strategies to reduce asthma morbidity and mortality on the island. An electronic version of the report is available at: [www.salud.gov.pr](http://www.salud.gov.pr). We thank the Puerto Rico Asthma Coalition and all collaborators for their effort in providing the data. We also thank the CDC for their funding and technical assistance.

Sincerely,

Rosa Pérez-Perdomo, MD, MPH, PhD  
Puerto Rico Secretary of Health



## Key Findings:

### MORBIDITY FROM 2000 TO 2002

- The asthma prevalence in Puerto Rico, according to the telephone survey known as the Puerto Rico Behavioral Risk Factor Surveillance Survey (PR-BRFSS), is greater than in any other state or participating territory.

#### Lifetime Prevalence:

Puerto Rico: 2000 (15.9%), 2001 (19.6%), 2002 (19.6%)

United States: 2000 (10.5%), 2001 (11.2%), 2002 (11.8%)

- The prevalence in females is significantly greater than in males.

#### Lifetime prevalence:

Females: 2000 (18.8%), 2001 (22.6%), 2002 (22.2%)

Males: 2000 (12.6%), 2001 (16.2%), 2002 (16.7%)

- Prevalence at the time of the survey:

Females: 2000 (9.4%), 2001 (12.2%), 2002 (14.0%)

Males: 2000 (5.4%), 2001 (6.5%), 2002 (8.8%)

- An increase in asthma prevalence was observed through time.

#### Lifetime prevalence:

2000 (15.9%), 2001 (19.6%), 2002 (19.6%)

#### Prevalence at the time of the survey:

2000 (7.5%), 2001 (9.5%), 2002 (11.5%)

## MORTALITY

- In Puerto Rico, the standardized asthma mortality rate by age is approximately 2.5 times higher than the reported in the United States:
  - Puerto Rico, 1998: 48.1 deaths per million inhabitants.
  - United States, 1998: 14 deaths per million inhabitants.
- Asthma mortality rate in the age group of 55 years and older was 15 deaths per 100,000 individuals from 1980 to 2000. This rate was consistently higher when compared to other age groups.
- There have been no significant changes in the mortality rate over the last 20 years.
- The risk of asthma mortality increases among those with lower education and older age.
- The asthma mortality rate for males and females from 1980 to 2000 is very close:
  - Males: 9.9 deaths per 10,000 males
  - Females: 10.4 deaths per 10,000 females

## HOSPITAL ADMISSIONS FROM 2000 TO 2003

- The annual asthma hospital admissions rate did not change significantly during the observed period.
- Twenty-seven hospital admissions of the 10,000 enrolled population of the selected insurance company were observed.
- The number of hospital admissions for females was approximately twice that of males during the four years surveyed:

Asthma hospital admissions rate by gender, selected Health Insurance Company, 2000-2003

<i>Year</i>	<i>Female rate per 10,000</i>	<i>United States</i>
<i>2000</i>	<i>31</i>	<i>21</i>
<i>2001</i>	<i>34</i>	<i>23</i>
<i>2002</i>	<i>32</i>	<i>23</i>
<i>2003</i>	<i>31</i>	<i>22</i>

Source: Selected Health Insurance Company

- Hospitalization rates are higher among younger males as compared to younger females, but the trend shifted as they grew older.
- The age group of 0-4 years accounted for the highest rate of hospitalizations during the whole study period and was consistent for the private and health care reform population.
- The hospital admissions seasonal rate trend was similar for the four years surveyed. A descending trend was observed from January to July, and it drastically increased to its maximum in the month of October.

## EMERGENCY ROOM VISITS (ERV) FROM 2000 TO 2003

- The emergency room visit (ERV) claim rate was slightly higher for females than for males. The estimated risk of ERV claims for females was 1.3 more as compared to males.
- Overall, children 0-14 years of age had higher ERV claims than any other age group.
- July (summer season) was the month with the lowest ERV claims during the whole year, 287 ERV claims per 10,000 persons enrolled.
- October (fall season) was the month with the highest ERV claims, 442 ERV claims per 10,000 persons enrolled.
- Health Care Reform population had an average of three times higher ERV claims than the private insured population.
- Health Care Reform children from 0 to 4 years old had approximately 7.5 times higher ERV claims than those of the private insured population.

## ASTHMA DRUG CLAIMS FROM 2000 TO 2003

- The total of asthma drug claims from year 2000 to 2003 was 918,093 claims.
- No statistical differences were found between gender:  $p=0.0997$ .
- Patients younger than 18 years old account for 32.7% among all drug claims.
- Sub-analysis of inhaled corticosteroids claims rate for patients from 0 to 9 years old showed an increase, while showing a decrease for patients from 10-19 years old.
- Overall, inhaled corticosteroids utilization decreased, although an increase in the frequency of its use was observed in the population younger than 9 years old.
- Current guidelines place inhaled corticosteroids or long acting beta agonists as the preferred drugs for asthma treatment, but the utilization rate was greater for xanthines and leukotriene receptor antagonists which are "alternative treatment options".
- Inhaled short acting beta agonists utilization is expected to be high since every person with asthma should have it available for the management of exacerbations.

# I. INTRODUCTION

Asthma is a chronic inflammatory disorder of the airways characterized by variable airflow obstructions in which prominent clinical manifestations include wheezing, coughing, dyspnea, and chest tightness, reversibility to bronchodilators and corticosteroids, increased airway responsiveness to a variety of stimuli, and evidence of inflammation in which eosinophils, mast cells, and lymphocytes together with a multitude of cytokines have important roles (Sears 1997).

It has been recognized that asthma has become an environmental public health problem of great importance (Picard et al. 2002; Ford et al. 2003). The increasing trend in asthma morbidity and mortality rates, especially in developed countries, has alarmed public health authorities around the world (Mannino et al. 1998). Puerto Rico, which is a densely populated island in the Caribbean, has suffered high asthma mortality rates for over 20 years as well as high lifetime asthma prevalence rates. The causes for this public health problem in Puerto Rico are unknown, and only a few studies have been conducted to investigate this problem (Montealegre et al. 2002, Pérez et al. 1999). As a multifactorial disease, the causes of asthma, its incidence, prevalence, mortality and the episodes of asthma attacks are difficult to study effectively.

The implementation of a surveillance system to follow a disease through time is just one of many strategies to understand the pattern, distribution and determinants of this disease. The qualities of a surveillance system reside in the methodology of systematically collecting, analyzing, interpreting and disseminating the outcomes of a specific health problem and environmental events involved, if applicable, for the planning, implementation and evaluation of public health practices (Teutsch 2000). The implementation of a surveillance system will contribute to address the following issues: (1) measure the burden of a disease, including changes in related factors and the identification of new or emerging health concerns; (2) guide immediate action for the intervention of cases; (3) monitor trends of the disease in time and place, including the identification of epidemics; (4) study the natural history of the disease; (5) guide the planning, implementation, and evaluation of programs; (6) evaluate and develop public policy; (7) detect the impact of changes in health practices; (8) prioritize the allocation of health resources; and (9) provide the basis for epidemiological research.

Another important contribution of the development of a surveillance system is the ability to develop an Early Warning System (EWS) (Hay 2000). "Early warning for epidemics refers to risk formulation or modeled projections of potential outbreaks based on systematically collected information from the monitored site(s) to allow appropriate and timely actions for mitigation and response. There are three components for an EWS: (1) routine surveillance of the targeted disease; (2) modeling the disease risk based on historical surveillance and contemporary environmental data; and (3) forecasting future risk through the use of predictive models and continued epidemiological and environmental surveillance".

We intend to implement an Asthma Surveillance System in Puerto Rico to identify groups at risk by selected socio-demographic variables, morbidity, mortality, occupational asthma and utilization of health services due to asthma. In this surveillance report we specifically address the analysis of hospital admissions, Emergency Room Visits (ERV) and drug use due to asthma in a selected health insurance company for years 2000 to 2003.

## II. STUDY POPULATION

Three different types of case definitions were defined to study the prevalence, mortality and utilization of health care services due to asthma in Puerto Rico. Furthermore, three different populations selected from different data bases were studied. Asthma prevalence data was obtained via the PR-BRFSS survey. A validation process of all the questions to culturally adapt them is conducted every year (CDC 2006a). The asthma mortality data was obtained through the Vital Statistics Office at the Puerto Rico Department of Health (PRDOH), and the utilization of health services information (ERV, hospitalizations and drug use due to asthma), was obtained from the largest health insurance company (HIC) in Puerto Rico.

### **2.1. Prevalence case definition (PR-BRFSS)**

The Behavioral Risk Factor Surveillance System (BRFSS) asthma core consists of two base questions used to determine the lifetime asthma prevalence and the prevalence at the time of the survey.

Lifetime prevalence refers to the affirmative response to the following question:

*Have you ever been told by a doctor, nurse or health professional that you have asthma?*

Prevalence at the time of the survey refers to the affirmative response to the following questions:

*Have you ever been told by a doctor, nurse or health professional that you have asthma? Do you still have asthma?*

The lifetime prevalence intends to obtain all those individuals who in some time in their life have been diagnosed with this condition. On the other hand, the prevalence at the time of the survey is any individual

who at the time of the survey answered that he/she was having asthma symptoms which were diagnosed by a doctor, nurse or other health professional.

### **2.2. Mortality case definition**

The Vital Statistics Office at the PRDOH provided information on asthma mortality for the period of 1980 to 2000. This office obtains its information from the Puerto Rico Demographic Registry (PRDR). The PRDR, established in 1885, has the legal responsibility to safeguard vital documents (births, deaths, marriages and divorces) for the population of Puerto Rico.

To survey asthma mortality, we define a mortality case as any non-institutionalized person whose death certificate or record lists asthma as the primary diagnosis of death from 1980 to 2000 in Puerto Rico. This definition is known as a probable case.

The following International Diagnostic Codes (ICD) were used to select the asthma cases from the death certificates:

ICD-9 Code: 493.0-493.9 (1980-1998)

ICD-10-CM Codes: J45, J46. (1999-present)

Although we used the probable asthma case definition, surveillance case definitions for asthma mortality are classified into three categories (CDC 2003a):

1. Confirmed: there is no confirmed case classification for mortality data. Health departments are encouraged to evaluate the accuracy of this data.
2. Probable: death certificates/records listing the

asthma diagnostic code (ICD-9): 493.0-493.9; ICD-10-CM Codes: J45, J46 as the primary diagnosis.

3. Possible: death certificates/records listing the asthma diagnostic code (ICD-9 Code: 493.0-493.9; ICD-10-CM Codes: J45, J46 as a contributing cause of death.

### **2.3. Utilization of health care services**

Data from the largest Health Insurance Company (HIC) was obtained to study the utilization of health care services. This company provided a baseline data from year 2000 to 2003. It serves two different types of populations, the commercial sector and the Health Care Reform (HCR). The HCR population is considered as 200% below the US poverty level (Annex 6, US poverty level table).

The HCR began in Puerto Rico during 1993. It was a government initiative to integrate the health services for the medically indigent population into the private sector. One of the goals of the HCR is to improve the access to health services in the medically indigent population. The Puerto Rico Health Insurance Administration (PRHIA) was created upon the approval of Law 72 of September 7, 1993. The PRHIA is responsible for establishing contracts of comprehensive health services coverage for the medically indigent population in the market of private health insurance companies. The HCR is financed through the payment of a fixed capitation to the primary care physicians (PCPs) who assume the responsibility of the integral care of the patients subscribed under their services. The PCP must provide preventive services to guarantee the diagnosis and follow up of conditions (Ramírez & Crespo 2001).

In 1998, 30.1% of Puerto Ricans carried the health care plan provided by the HCR. According to the Puerto

Rico - Behavioral Risk Factor Surveillance Survey (PR-BRFSS), people with the HCR insurance plan had the highest proportion of individuals with an annual income between \$10,000 to \$14,000 and less. It was also identified that people with a lower educational level are more likely to have this type of health insurance. In year 2000 it was estimated that 1.8 million out of 3.8 million Puerto Ricans were covered under the HCR health insurance (information not published). Statistics on the proportion of Puerto Ricans insured by a private health care plan are not available, but it is likely to be represented by individuals that work for employers that provide an insurance package or by middle income and wealthy families. The proportion of the Puerto Rican population with no health care coverage was reported to be 9.0% according to year 2000 PR-BRFSS (CDC 2006b).

The following case definition was used to study health services utilization due to asthma: any non-institutionalized actively insured person within the selected HIC with a claim of an emergency room visit, hospitalization, or visit to a physician office during part of or the whole study period from year 2000 to 2003, following the criteria presented in Table 1.

Table 1. Criteria for selecting asthma claims from the HIC databases.

Type of Visit	Qualifying ICD-9-CM Diagnosis Code	Qualifying CPT	Qualifying UB-92
Hospitalization (insurance company's method to identify hospitalization plus CPT and UB92 codes)	493.XX, as primary diagnosis	99221-99223, 99231-99233, 99238, 99239, 99251-99255, 99261-99263, 99291, 99292	10X-16X, 20X-22X, 987
Emergency room visit (insurance company's method to identify emergency department visit plus CPT and UB92 codes)	493.XX, as primary diagnosis	99281-99285, 99288	45X, 981
Outpatient clinic visit	493.XX, as primary diagnosis.	99201-99205, 99211-99215, 99217-99220, 99241-99245, 99271-99275.	456, 510, 515-517, 520, 521, 523, 526, 76X, 770, 779, 982, 983, 988.
Drug use claims	Asthma Related NDC	_____	_____

ICD: International Classification of Diseases 9th Revision- Clinical Modification, CPT: Current Procedural Terminology, UB-92: Uniform Bill-92, NDC: National Drug Code

These criteria follow the International Classification of Diseases code 9th revision (ICD-9-R), the Current Procedural Terminology (CPT) and the UB-92. They were selected to expand the definition beyond using only ICD codes in order to minimize the loss of cases due to claims not fully completed by physicians. In addition, it attempts to capture possible misclassifications due to the absence of a standard definition of asthma and a common diagnosis via signs and symptoms of this condition. The HIC provided the data using a data dictionary with instructions on how to format the required information. The purpose of the data dictionary is to standardize the future information collected from year to year and from different HICs. In order to have a denominator or information on the background of the population, an aggregate database of the enrolled population during the selected period was provided. The information was aggregated per month, gender, age group, and municipality of residence.

### III: FINDINGS AND DISCUSSION

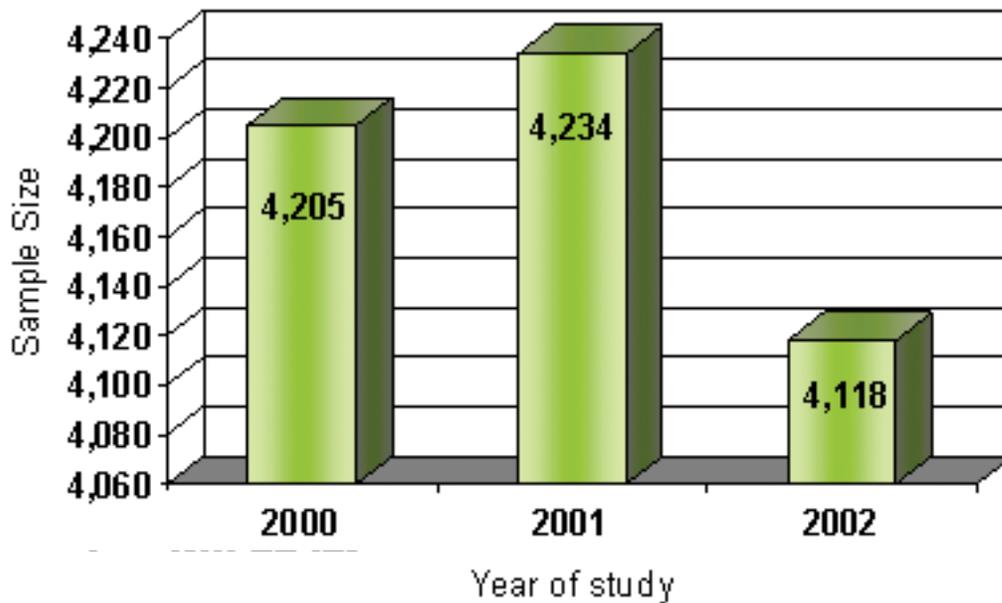
This chapter presents and discusses the findings of the health indicators related to asthma studied (prevalence, mortality, hospital admission, emergency room visit and drug use due to asthma).

#### 3.1. Prevalence

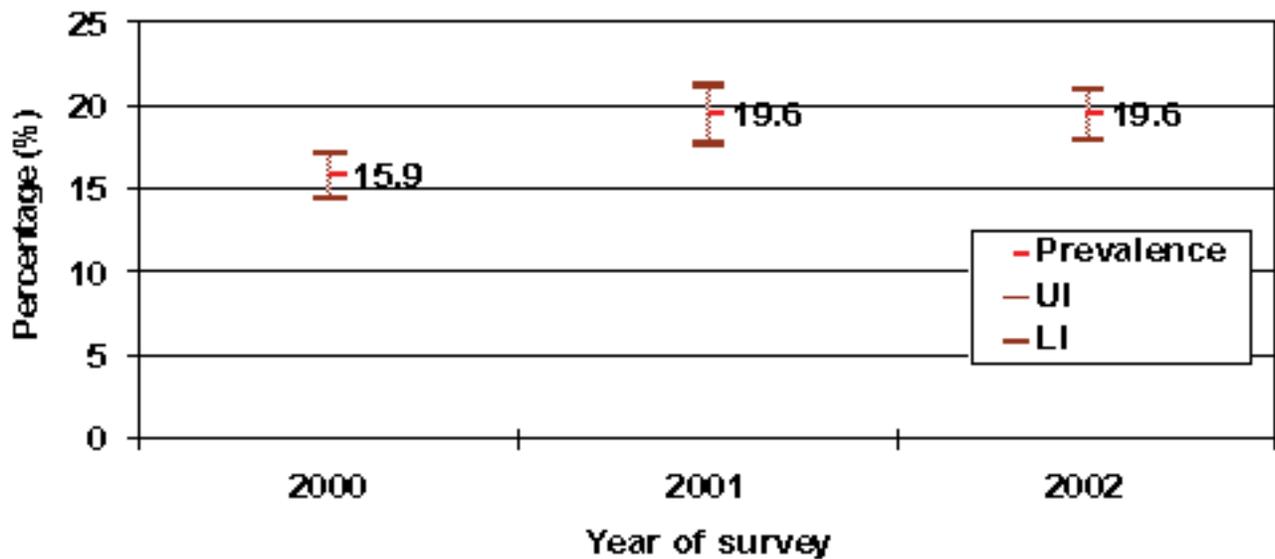
##### 3.1.1. Lifetime asthma prevalence in adults (PR-BRFSS 2000-2002)

The sample population which participated in the survey is representative of the population in Puerto Rico. The numbers of persons surveyed were 4,205, 4,234 and 4,118 for years 2000, 2001 and 2002 respectively (Figure 1).

**Figure 1**  
Sample size  
Puerto Rico, BRFSS, (2000-2002)



**Figure 2**  
Lifetime asthma prevalence by year of survey  
Puerto Rico, BRFSS (2000-2002)



In Figure 2, the lifetime asthma prevalence for the year 2000 was 15.9%, and 19.6% for the subsequent years 2001-2002. This change represents a percentage increase of 23.27%. The estimate of the PR-BRFSS for the year 2000 of lifetime asthma prevalence in Puerto Rico can be interpreted as follows: 15 of every 100 persons surveyed reported being diagnosed with asthma at some point in their life by a doctor, nurse or other health professional.

**Figure 3**  
 Lifetime asthma prevalence by gender and year of survey  
 Puerto Rico, BRFSS (2000-2002)

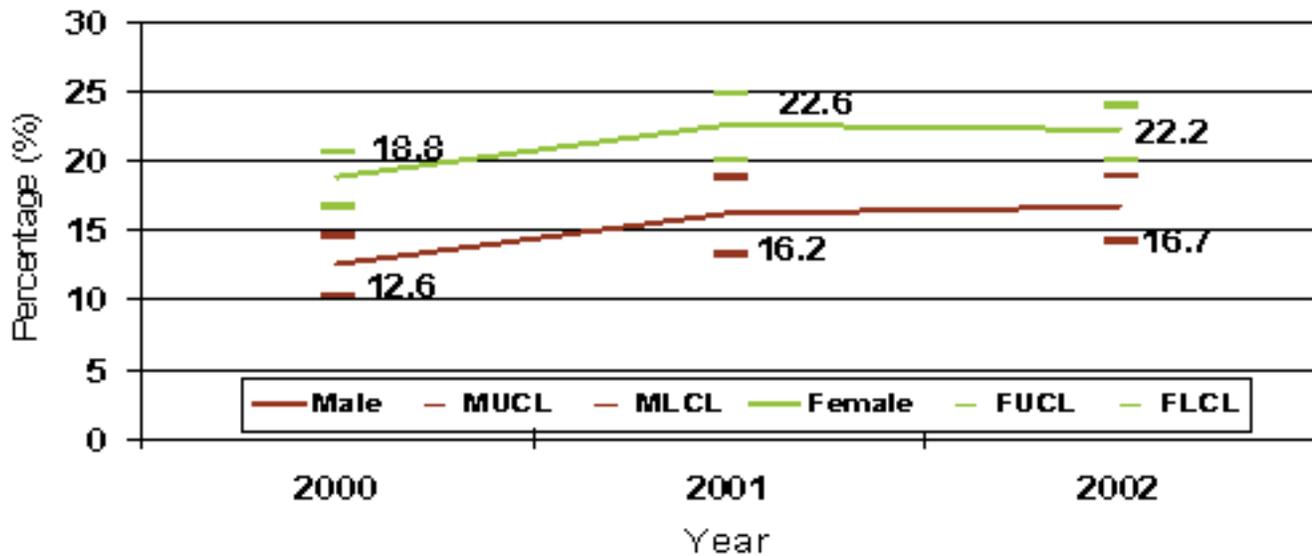


Figure 3, shows lifetime asthma prevalence statistically significant higher for females than for males, constantly maintained across the years. The percentage of males that reported having this condition at some point in their life fluctuated between 12.6% in year 2000 to 16.7% in year 2002. In females, this measurement fluctuated from 18.8% in year 2000 to 22.6% for year 2001.

**Figure 4**  
 Lifetime asthma prevalence by age group and year of survey  
 Puerto Rico, BRFSS (2000-2002)

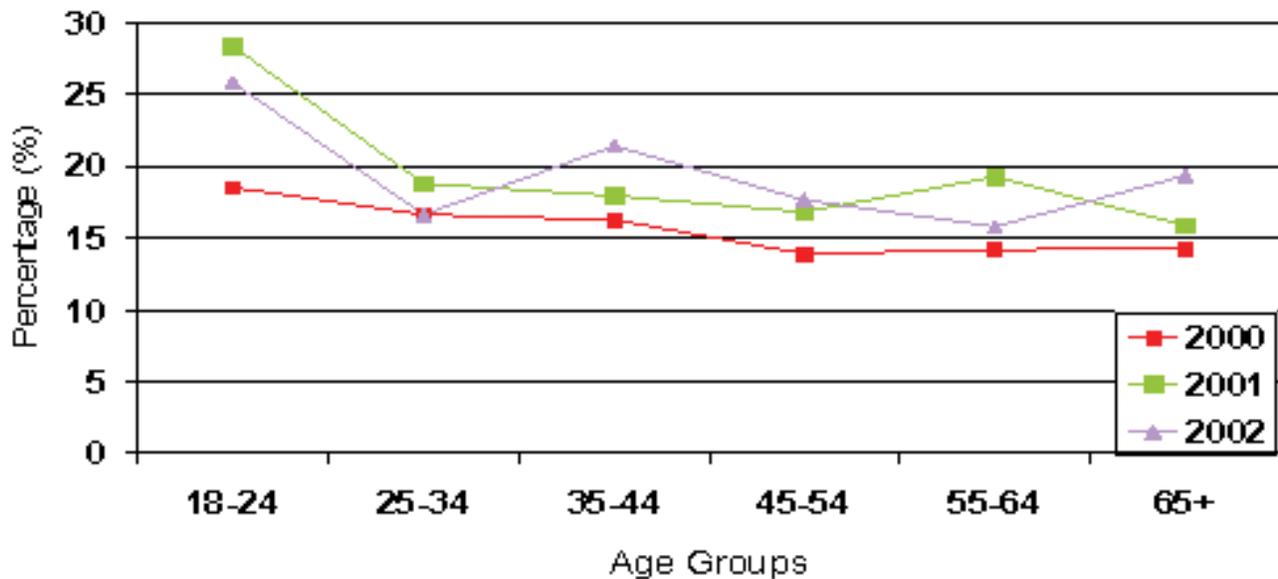
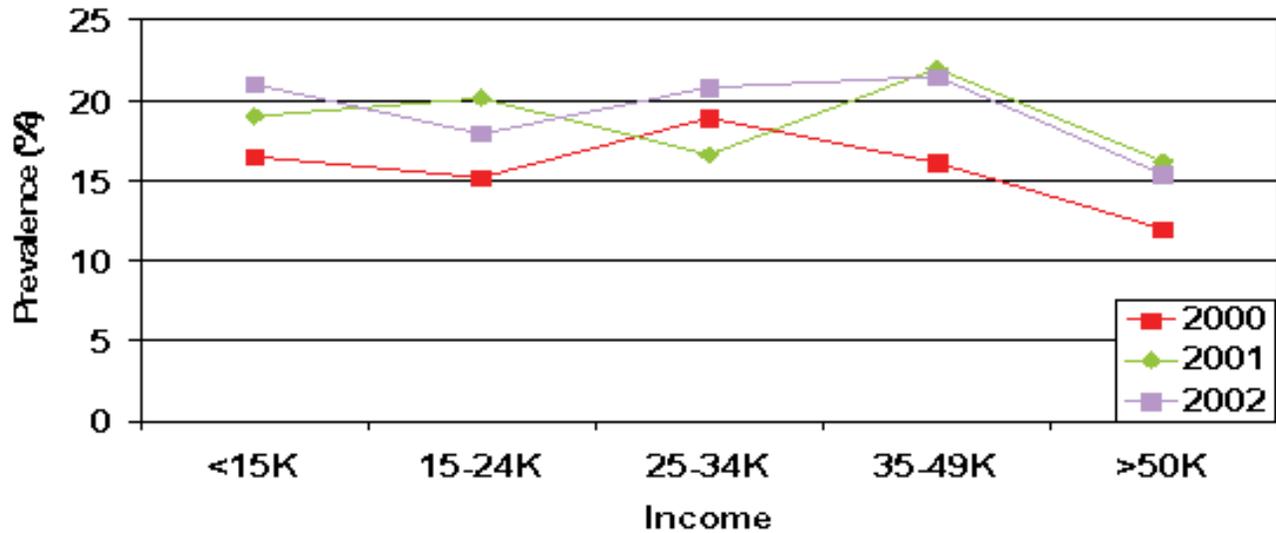


Figure 4 shows that the lifetime asthma prevalence, stratified by age group and survey year, decreased as it moves across age category. This pattern is more evident for the year 2000. Also, an increase in the lifetime prevalence was observed in all age groups surveyed for years 2001 and 2002 when compared to year 2000. In year 2001, the 18-24 age group reported the highest prevalence at 28.4%. In year 2000, the 65 and older age group showed the lowest prevalence. None of the differences observed was statistically significant.

**Figure 5**  
 Lifetime asthma prevalence by income and survey year  
 Puerto Rico, BRFSS (2000-2002)



The percentage of study participants with economic income of \$50,000 and higher per year showed the lowest lifetime asthma prevalence and persisted through the three years surveyed when stratified by economical income and year of survey. Even though no statistically significant differences between the groups were assessed, the lifetime asthma prevalence fluctuated between 16.5% for the group of less than \$15,000 and income per year in the 2000 survey and up to a 21% in the 2001 survey. In addition, in the 2001 and 2002 surveys the group with the highest prevalence was the one with income of \$35,000-\$49,000 per year (Figure 5).

**Figure 6**  
 Lifetime asthma prevalence by education and survey year  
 Puerto Rico, BRFSS (2000-2002)

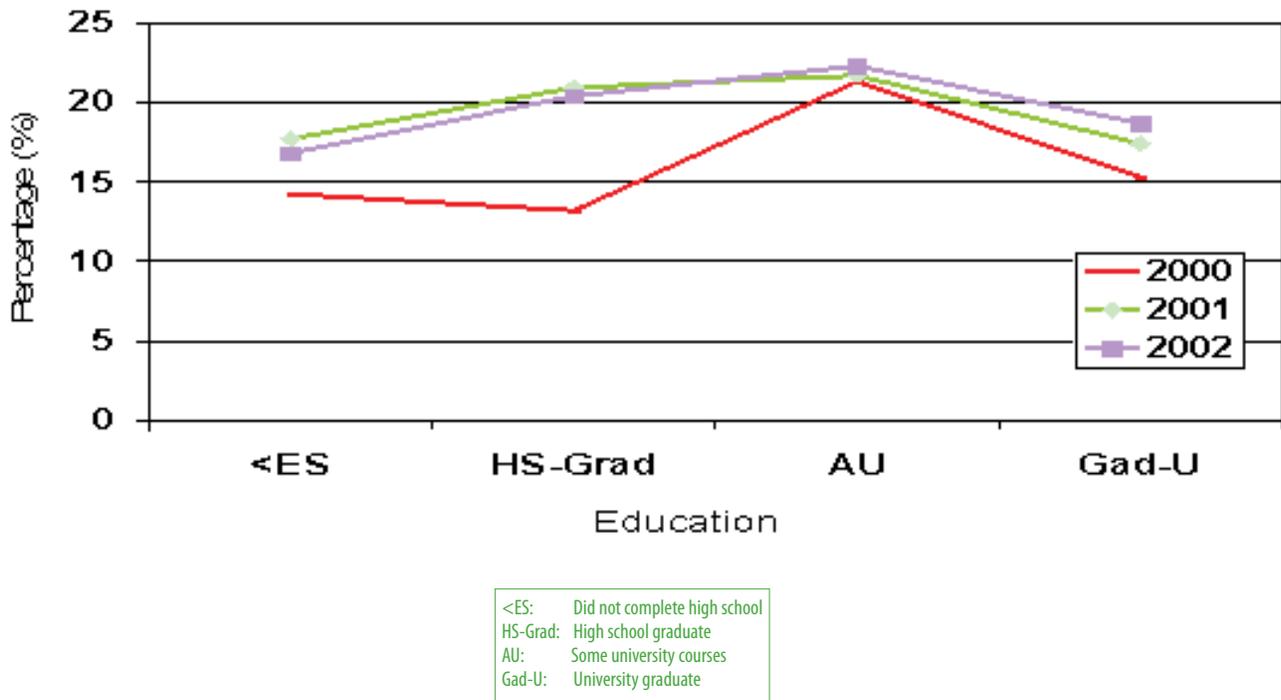
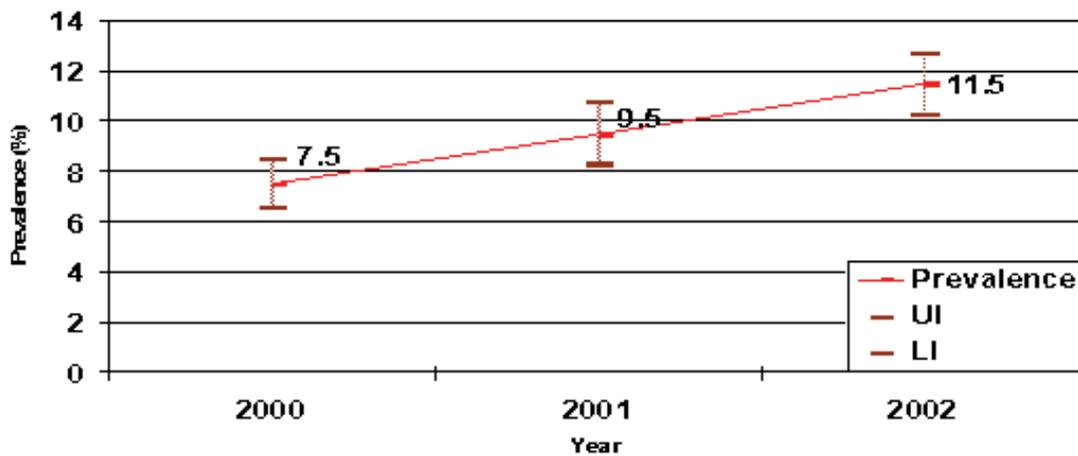


Figure 6 shows the lifetime asthma prevalence stratified by education and year of survey. Although the differences observed in this chart were not statistically significant, there is a tendency suggesting that at a higher education level, a higher report of lifetime asthma prevalence. The university graduates (Grad-U) break this tendency as the prevalence in this group is drastically reduced.

### 3.1.2. Asthma prevalence at the time of the survey (PR-BRFSS 2000-2002)

Asthma prevalence at the time of the survey collects the number of persons that during the telephone survey answered affirmatively to the following question: Do you still have asthma? The study participants reported asthma prevalence at the time of the survey of 7.5% in BRFSS-2000, 9.5% in BRFSS-2001 and 11.5% in BRFSS-2002. Figure 7 shows that the prevalence at the time of the survey reflects a linear increase and the difference is statistically significant when compared with years 2000 and 2002. From the total of persons that answered affirmatively to this question, 47.5% in BRFSS-2000, 48.6% in BRFSS-2001 and 58.9% in BRFSS-2002 responded in the affirmative to the question of lifetime asthma prevalence.

**Figure 7**  
Asthma prevalence at the time of the survey in  
Puerto Rico, BRFSS (2000-2002)



**Figure 8**

Asthma prevalence at the time of the survey by sex and survey year,  
Puerto Rico, BRFSS (2000-2002)

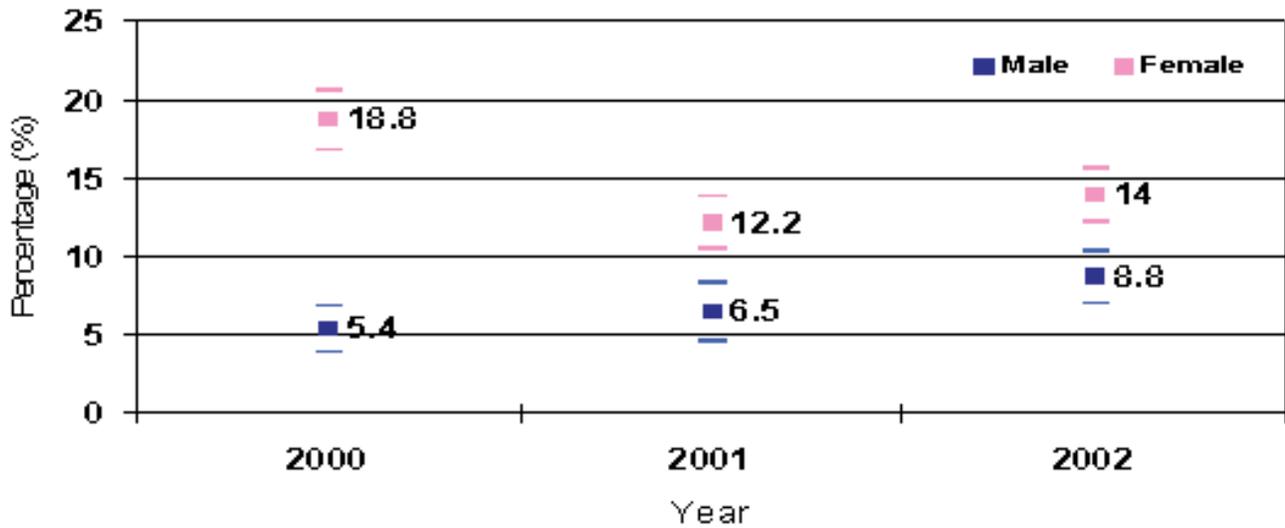
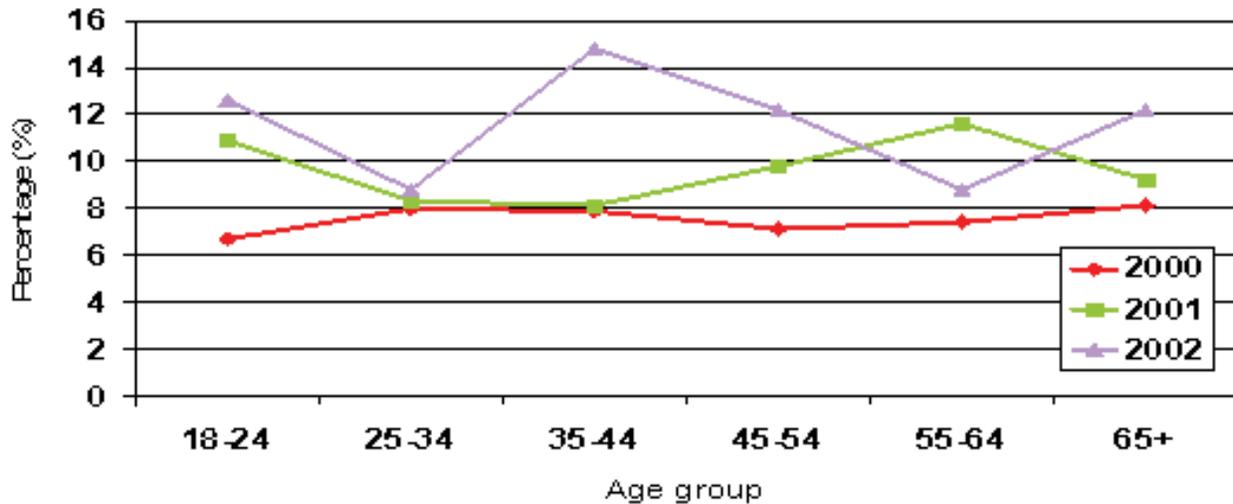


Figure 8 shows the asthma prevalence at the time of the survey stratified by sex and survey year. Females reported statistically significant higher asthma prevalence at the time of the survey than males. This observation was maintained throughout the survey years in a similar way as with the measurement of the lifetime asthma.

**Figure 9**

Asthma prevalence at the time of the survey by age group and year of survey, Puerto Rico, BRFSS (2000-2002)



The distribution of asthma prevalence at the time of the survey stratified by age group is shown in Figure 9. The compared age distribution between the three surveys is different; however, it is not evident that a specific age group has constantly the highest prevalence. Nevertheless, in 2002, the age category of 35-44 showed the highest prevalence at the time of the survey of all the period surveyed and a statistically significant difference when compared to the 25-34 and 45-54 age groups.

**Figure 10**

Asthma prevalence at the time of the survey by income and year of survey, Puerto Rico, BRFSS (2000-2002)

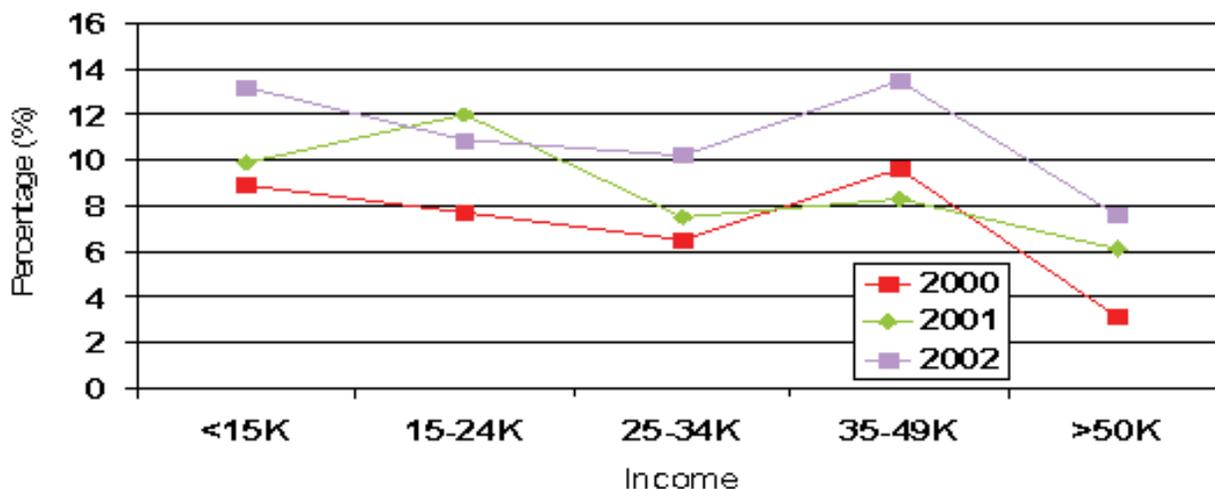
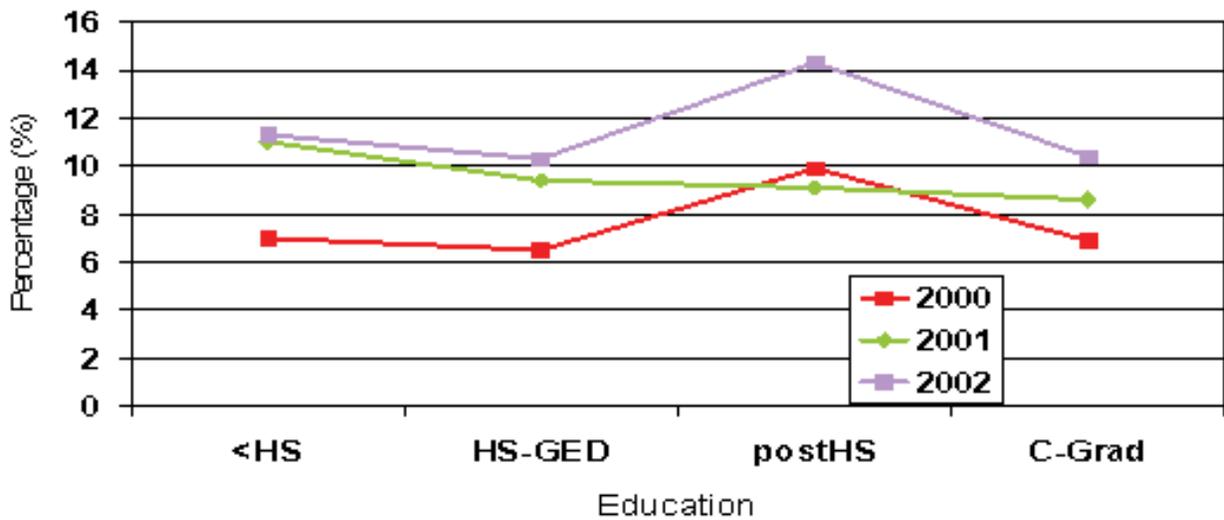


Figure 10 shows the asthma prevalence at the time of survey stratified by income. This chart shows a decreasing tendency in the asthma prevalence as income reported increases. A statistically significant difference was observed during year 2000 between income groups of less than \$15,000 and \$50,000 or more. However, in years 2000 and 2002 the group with the highest prevalence was the one with income of \$35,000-\$49,000.

**Figure 11**

Asthma prevalence at the time of the survey by education and year of survey,  
Puerto Rico, BRFSS (2000-2002)



<HS: Did not complete high school  
HS-GED: High school graduate  
postHS: Some university course  
C-Grad: University graduate

Figure 11 shows the asthma prevalence at the time of survey stratified by education level and year of survey. Although no differences were assessed between educational groups, it is important notice that the education level patterns are different in all three years surveyed.

### **3.1.3. PR-BRFSS findings discussion**

The estimates obtained from the Behavioral Risk Factor Surveillance Survey (BRFSS) in 2002, reported a higher lifetime prevalence of 19.5% and prevalence at the time of the survey of 11.5% for Puerto Rico when compared to the rest of the participants from the United States of North America and the district of Columbia, who showed an 11.8% for lifetime prevalence and a 7.5% for prevalence at the time of the survey. The observed differences in the prevalence indicators were statistically significant and consistently higher for Puerto Rico in contrast to the USA during a three year period, (BRFSS-2000, 2001, 2002). According to the BRFSS, the lifetime asthma prevalence for Puerto Rico was 15.9%, 19.6%, and 19.6%, and for the USA was 10.5%, 11.2% and 11.8% for years 2000, 2001 and 2002 respectively. In addition, the asthma prevalence at the time of the survey reported in the BRFSS for Puerto Rico was 7.5%, 9.5%, and 11.5%, and for the USA was 7.2%, 7.2% and 7.5% respectively for years 2000, 2001 and 2002. Other epidemiological studies, which have estimated the asthma prevalence in Puerto Rico, reported similar results as those obtained in the BRFSS: 14.5% (Pérez, 1999) and 17.5% (Bayona et al. 2002). Mannino et al. (2002) stated that for the time interval of 1980-1986 the asthma prevalence or episodes of asthma attacks in the USA increased among persons being diagnosed by a doctor with this condition. However, in this same study a decrease in this condition was observed from 1997 to 1999.

The differences in asthma prevalence found in Puerto Rico versus USA are not exclusive to the BRFSS survey. Various studies in which different racial and ethnic groups were compared have identified Hispanics and Afro-Americans as the groups with the highest morbidity and mortality related to asthma in the United States (Lara et al. 1999; Ledogar et al. 2000; Rhodes et al. 2005). Also, it has been reported that Puerto Ricans suffer the highest asthma mortality and morbidity compared to other Hispanic groups (Beckett et al. 1996; Carter-Pokras & Green 1993; Mendoza et al. 1991; Ledogar et al. 2000). Environmental risk factors such as temperature, humidity and other aero-allergens are not included in the BRFSS survey asthma core, but it is important to mention that the US Virgin Islands, with similar climate, geologic and geographic characteristics, reported lower lifetime asthma prevalence (9.4%, USVI-BRFSS, 2002) and asthma prevalence at the time of the survey (4.7% USVI-BRFSS, 2002) when compared to Puerto Rico.

The BRFSS results for Puerto Rico and the USA indicate that females reported a higher prevalence of asthma than males. This difference was statistically significant and was maintained through the three years of the survey. In addition, Pérez et al. (1999) findings in the population study were consistent with the BRFSS data when stratified by sex. However, Montealegre et al. (1996) observed a higher prevalence in males in his study sample which only represented the municipality of Ponce, Puerto Rico.

With regard to lifetime asthma prevalence stratified by age group, it was found that the age group of 18-24 years reported the highest asthma prevalence in the three-year study. However, it was observed that the prevalence measures at the time of the survey (current asthma prevalence) did not suggest a consistent tendency in the

three-year study, and the differences between age groups were not statistically significant. Although prevalence information for those younger than 18 years of age was not collected, other epidemiological studies reported a higher prevalence rate in this age group (Mannino et al. 2002; Montealegre et al. 1996; Silverman et al. 2003).

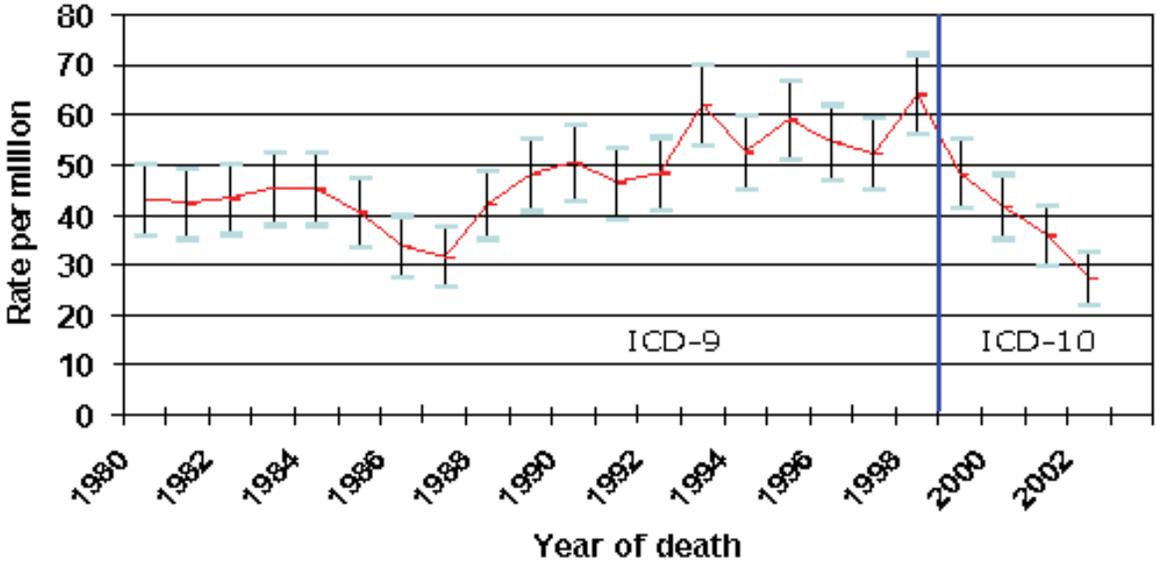
The PR-BRFSS is an instrument that helps obtain different perspectives of diverse health conditions and risk factors. This report must be analyzed taking into consideration all its advantages and limitations. The continual use of this survey should be a tool to assist health policies and initiatives to reduce adverse asthma outcomes, health related management costs and improve quality of life.

**3.2. Mortality Indicator**

**3.2.1. Asthma mortality findings**

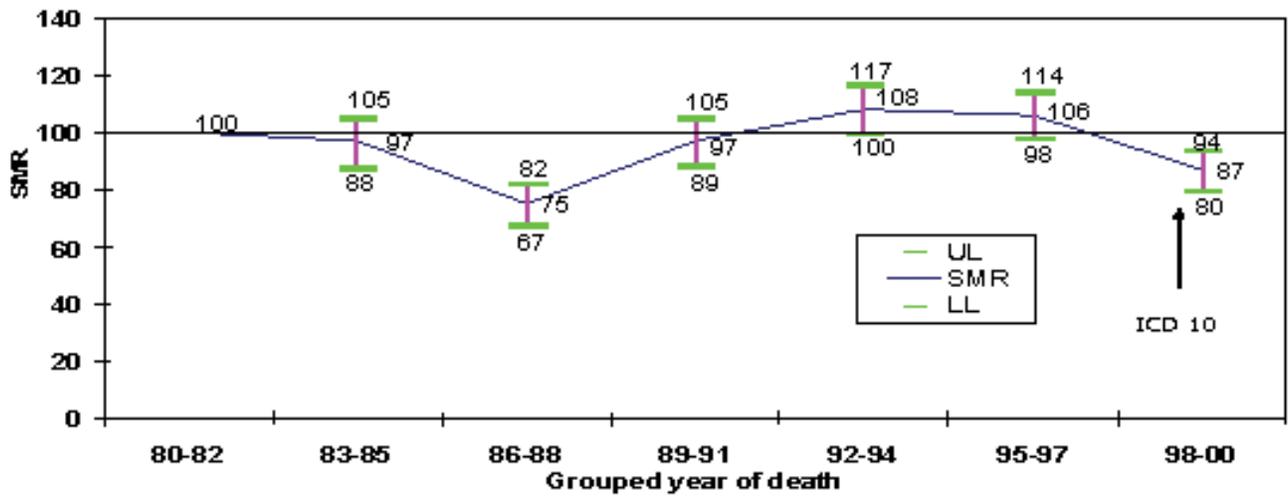
As shown in Figure 12, asthma mortality as the primary cause of death (probable cause) from 1980 to 1998 fluctuated between 31.64 (95%CI: 37.6-25.67) deaths per every million inhabitants in year 1987 to 64.17 (95%CI: 72.19-56.15) deaths per million residents for the year 1998. It is recommended the data from one classification to the other at the time of the analysis be separated because the ICD modifications could induce artificial changes in the time trend. For the period of 1999 to 2002, the asthma mortality fluctuated between 48.26 deaths per every million inhabitants in 1999 (95%CI: 53.21-41.30) to 27.46 deaths per every million inhabitants in 2002 (95%CI: 32.69-22.24).

**Figure 12**  
Asthma crude mortality rate, Puerto Rico,  
(1980-2002)



Source: Vital Statistics Office, Puerto Rico Department of Health

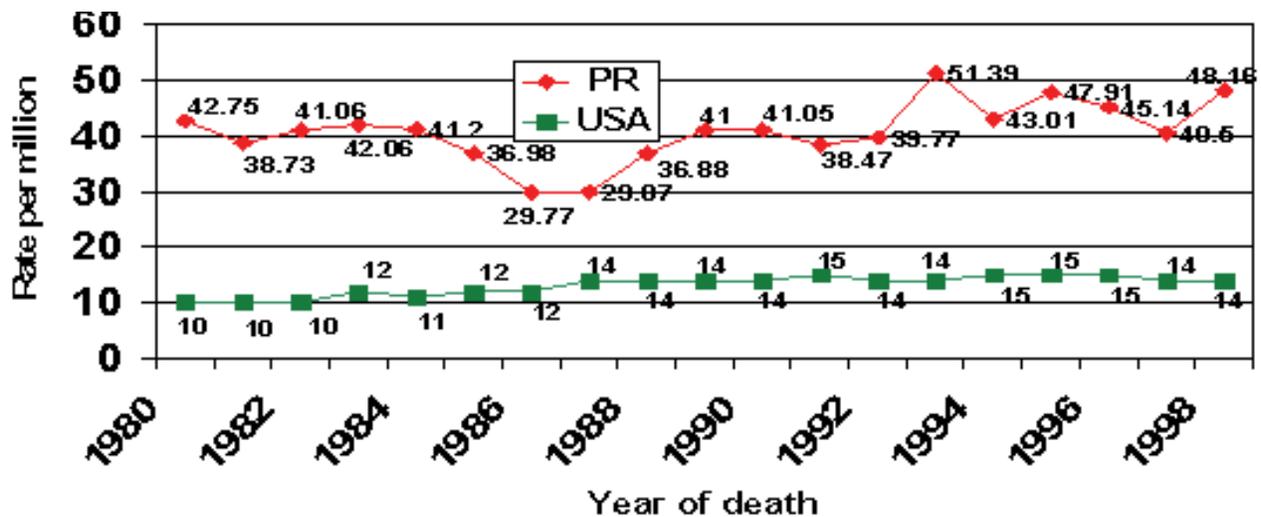
**Figure 13**  
 Asthma standardized mortality ratio,  
 Puerto Rico (1980-2000)  
 Standard population, Puerto Rico 1980-82



Source: Vital Statistics Office, Puerto Rico Department of Health

The fluctuation of asthma mortality through time was also evaluated by means of the standardized mortality rate (SMR). Figure 13 illustrates the SMRs calculated using the Puerto Rico asthma mortality ratio of 1980 to 1982 as the standard population. Although differences were observed between the trienniums, they were not statistically significant.

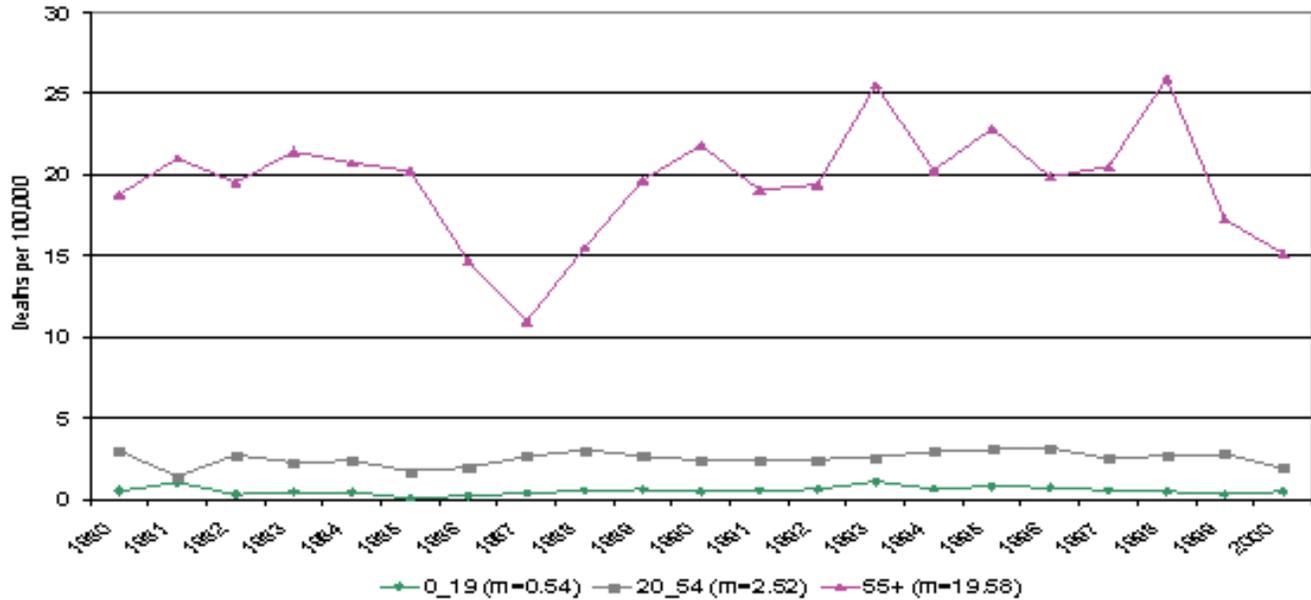
**Figure 14**  
 Age adjusted asthma mortality rate,  
 Puerto Rico & USA, (1980-1998)  
 Standard population USA (1940)



Source: Vital Statistics Office, Puerto Rico Department of Health  
 National Center for Health Statistics, Center for Diseases Control and Prevention

The asthma adjusted mortality rate by age was calculated using the direct method to compare the asthma mortality in Puerto Rico with the asthma mortality in the United States. The demographic distribution of the United States population for year 1940 was used as the standard population for this calculation as recommended by the Centers for Disease Control and Prevention (Anderson & Rosenberg 1998). Puerto Rico presented a fluctuation in its mortality rates trend; meanwhile, the US presented a stable mortality trend. In addition, it was observed that the Puerto Rico asthma mortality has been a statistically significant 2.5 times higher than in the United States for the 18 years studied (Figure 14).

**Figure 15**  
Asthma mortality by age category in Puerto Rico  
from 1980 to 2000



Source: Vital Statistics Office, Puerto Rico Department of Health

Figure 15 shows the crude asthma mortality rate between 1980 and 2000 stratified by age groups. In this figure, it was observed that the age group of 55 years and older presents a risk of dying of asthma nine (9) times higher than the age group of 20-54 years. Also, it was noted that the trend related to the age group of 55 years and older fluctuated through time. In the other two age groups, a smoother trend was observed when compared to the 55 years and older age group.

Table 2 Asthma mortality stratified by gender and education, Puerto Rico (1980-2000)

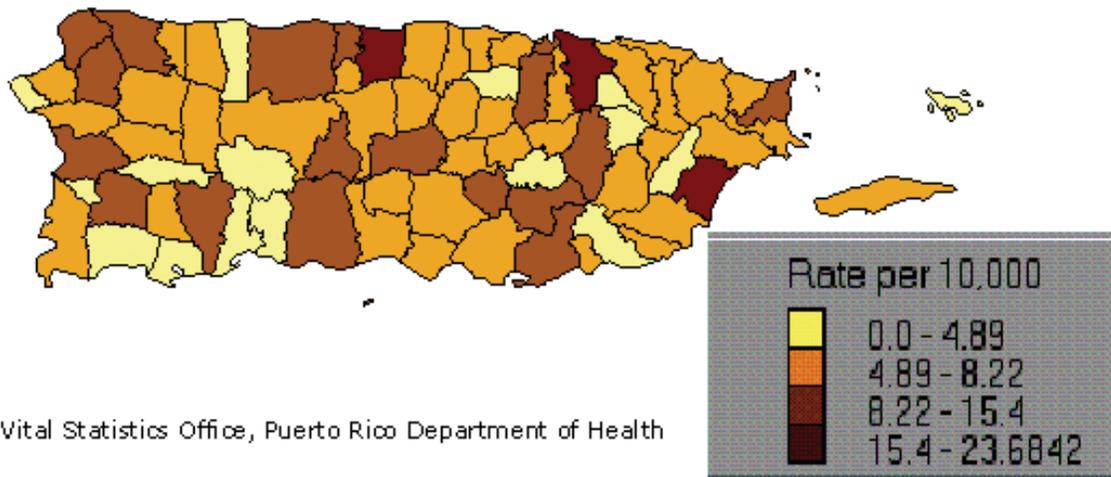
Gender (n=3,531)	Deaths	Mortality Rate by 10,000
Males	1676	9.9
Females	1855	10.4
Education (n=2,881)	Deaths	Mortality Rate by 10,000
Elementary*	1822	35.8
Secondary	739	28.4
College	320	13.52

\* Significant statistical difference (p<0.05)  
 Source: Vital Statistics Office, Puerto Rico Department of Health

The asthma mortality stratified by gender demonstrates that asthma mortality in males was 52.53% of the total deaths in the 1980 to 2000 period. No statistically significant difference was assessed in asthma mortality between males and females. The asthma mortality rate for males during this time period was 9.9 deaths per 10,000 persons. In females the mortality rate was 10.4 deaths per 10,000 persons. Regarding the educational level, asthma mortality was significantly higher in those with lower education or equal to elementary school (63.24%) when compared to those with higher education level. The asthma mortality rate in the group with lower education or equal to elementary school was 35.8 asthma deaths per 10,000 persons in the 1980-2000 period (Table 2).

Map 1

Asthma mortality rate by municipality of death (1980-2000)



Source: Vital Statistics Office, Puerto Rico Department of Health

Map 1 illustrates the geographical distribution of asthma mortality. The highest mortality rates were observed in the municipalities of Manatí and Humacao. These rates fluctuated between 15.41 and 25.67 asthma deaths per 100,000 persons in the study period.

### *3.2.2. Asthma mortality discussion*

In Puerto Rico, asthma as a probable cause of death, showed a fluctuant trend during the period from 1980 to 2002. Several factors could be related to this fluctuation, but no studies have been designed to evaluate the indicators associated to these changes. One of the reasons that might explain some variations in the time trend is the changes in the ICD codes from version nine (ICD-9) to ten (ICD-10). Ito et al. (2002) describe other factors that could be related to the observed fluctuations as: (1) changes in the disease recognition and concept; (2) changes in the diagnosis and detection techniques; (3) changes in the procedure to classify the cause of death; (4) changes in the classification code of the cause of death; (5) changes in the precision to classify the age at death; (6) errors in numbering the population; (7) changes in the population age distribution; (8) changes in survival due to changes in the fatality rate; and (9) changes in the incidence of the disease due to genetic or environmental factors. Also, it has been observed that the introduction of new medications has modified the asthma mortality pattern. Asthma mortality events, reported in the 1960's and at the end of the 1970's, were attributed to the excessive use of bronchodilators that contained isoproterenol and fenoterol (von Mutis 2002; Beasley 2002). The asthma mortality rate among Puerto Ricans living on the island (47.9 per million in 1995) is similar to the asthma mortality rate of Puerto Ricans living in the United States (40.9 asthma deaths per million from 1990-95) (Homa et al. 2000).

When calculating the standardized mortality rate (SMR) by the indirect method, no differences in risk of dying due to asthma in the trienniums of 1992-1994 and 1995-1997 were statistically significant when compared to the expected risk based on the mortality of the triennium 1980-1982. Nevertheless, the SMR's trend increased to worrisome levels and this observation is consistent with the asthma world epidemic (Eder et al. 2006, Beasley 2002). Although the tendency varies among countries, an increase in mortality and morbidity is observed, especially in developed countries (Beasley 2002). The adjusted mortality by age in Puerto Rico for the 1980-1998 period as compared to the United States showed that the Puerto Rican population has approximately a 2.5 times higher risk of dying of asthma. The findings are similar to previous studies showing that Puerto Ricans have higher asthma mortality and morbidity than other racial groups in the United States (Beckett et al. 1996; Carter-Pokras & Green 1993; Homa et al. 2000; Mendoza et al. 1991).

In terms of the socio-demographic analysis, the present epidemiological profile of asthma in Puerto Rico reveals that between 1980 and 1999, the age group of 55 years and older presented nine times higher risk of asthma mortality than the 0-19 age group. The New York Department of Health reported that persons 65 years and older had six times higher risk of asthma mortality compared to any other age group (Public Health Information Group 2005.). Also, Homa et al. (2000) found that the risk of asthma mortality in all ethnical races analyzed increased with age. In Japan, Israel and other countries the same pattern has been observed (Ito et al. 2002; Picard et al. 2002; von Mutius 2002). Even though a higher mortality rate in persons 65 years and older is expected as a consequence of the presence of co-morbid conditions such as obesity, respiratory or cardiovascular diseases, those estimates

condition such as Chronic Obstructive Pulmonary Disease (COPD) (Adams et al. 2006; Barua & O’Mahony 2005; Enright 2002). In addition, the older population might not have had appropriate access to medication in order to properly manage their condition and reduce the probability of having an asthma exacerbation or an airway remodeling (Barua & O’Mahony 2005). Regarding gender, Puerto Rican females maintained a higher risk of asthma mortality than males throughout all the analyzed period. This data differs from other countries that reported a higher death risk in males (Ito et al. 2002). In terms of educational level, a higher asthma mortality was observed in individuals who reported a lower education or elementary school. This finding could be related to the fact that older individuals who were born in the early 1900’s had fewer opportunities to study, and therefore the effect of education was observed and not that of age.

In relation to the risk of asthma mortality per geographic area, the results indicate that, of the 78 municipalities in Puerto Rico, Humacao and Manatí had the highest risk for asthma mortality. This could be due to the fact that these two municipalities are areas that serve asthma patients of nearby municipalities which do not have secondary care hospitals. A higher number of covariates related to health care services should be obtained to conduct a spatial ecological study and better understand the observed geographical patterns.

**3.3. Hospital Admissions Indicator**

**3.3.1. Hospital admission findings**

This section presents the results of hospital admission claims due to asthma for years 2000 to 2003

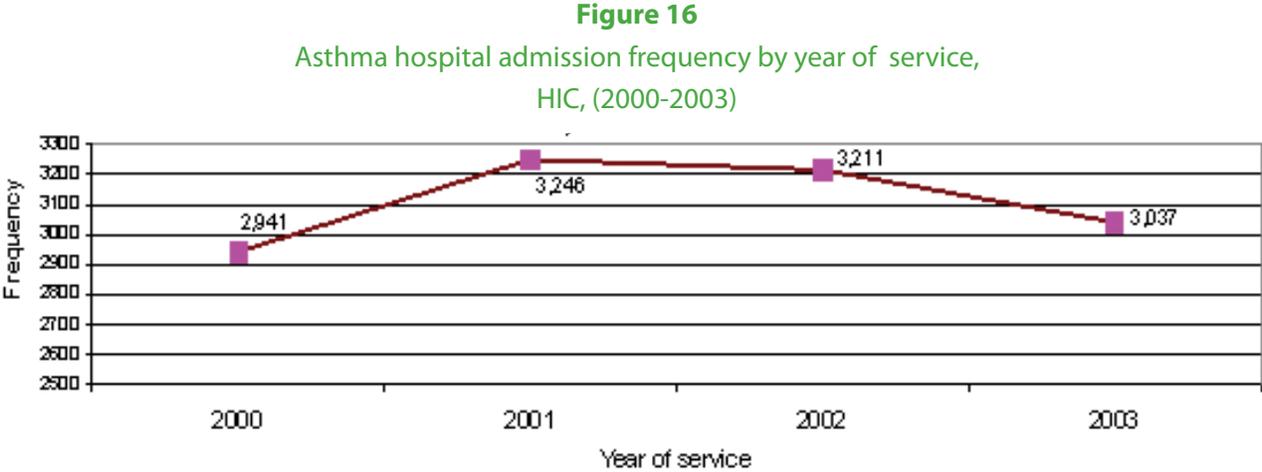


Figure 16 shows the frequency of hospital admission claims due to asthma for years 2000 to 2003. During this period of time, an average of 3,108 hospital admissions due to asthma was reported in the enrolled population of a selected Health Insurance Company (HIC). The total hospital admissions ranged from the lowest hospitalization rate in year 2000 (2,941) to the highest hospitalization rate in year 2001 (3,246). The graph takes the shape of an inverted U which indicates an increase in the tendency of claims followed by a decrease.

**Figure 17**  
Asthma hospital admission rate by year of service,  
HIC, (2000-2003)

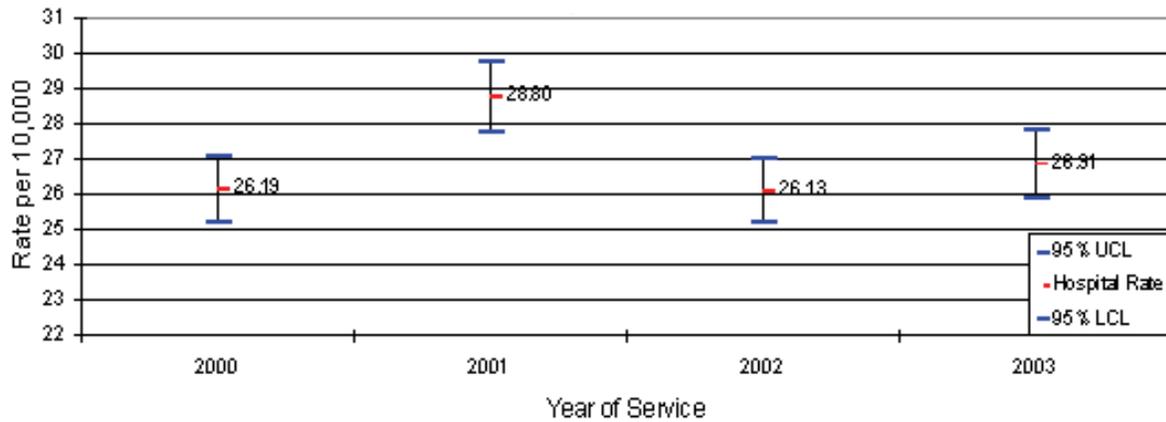
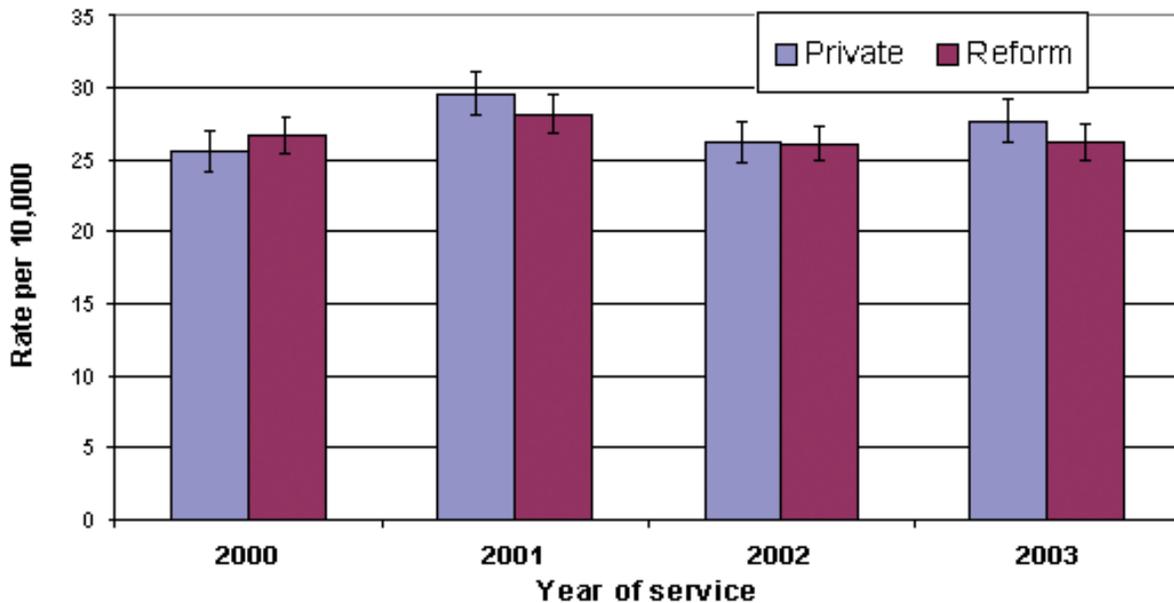


Figure 17 presents the hospital admission claims rate due to asthma per 10,000 enrolled for the years 2000 to 2003. It was observed that the hospital admissions rate ranged from the lowest, 26.13 claims per 100,000 enrolled in year 2002, to the highest, 28.80 claims per 100,000 enrolled in year 2001. The differences among the four rates were evaluated using the 95% confidence interval. A statistical difference was found in 2001 when compared with the other three years.

**Figure 18**  
Asthma hospital admission rate by type of coverage and year of service,  
HIC, (2000-2003)



The hospital admissions rate due to asthma stratified by year of service and type of coverage for years 2000 to 2003 is presented in Figure 18. No statistical difference was observed in the hospital admissions rate due to the asthma between the private sector and the Health Care Reform sector through the years surveyed.

**Figure 19**  
 Asthma hospital admission rate by sex and age group,  
 HIC, (2003)

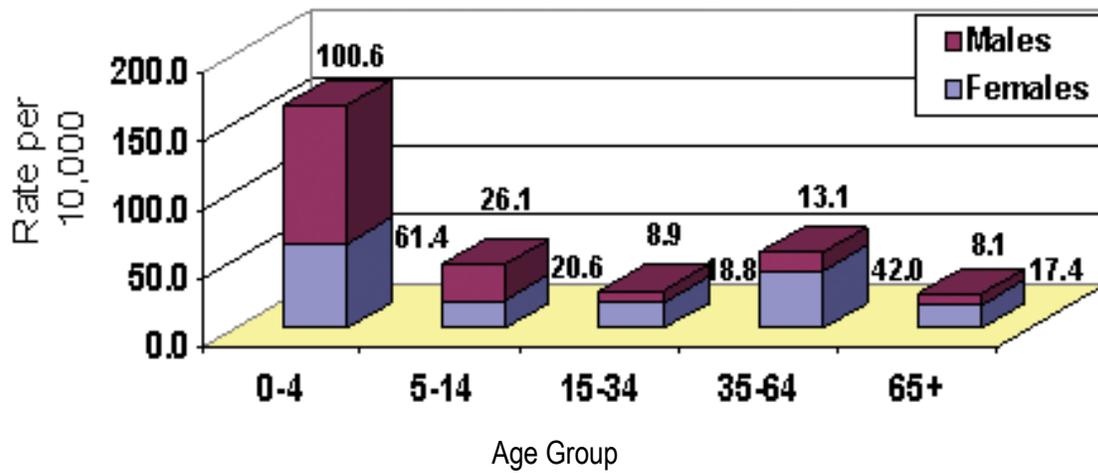


Figure 19 illustrates the asthma hospital admissions rate by sex and age group for the selected HIC for year 2003. This figure indicates that males had higher asthma hospitalization rates in the younger ages (14 years or less) than females. This observation shifted in females, having the highest rate as the population reached 15 years or older.

**Figure 20**  
Asthma hospital admission rate by type of coverage, sex and year of service, HIC, (2000-2003)

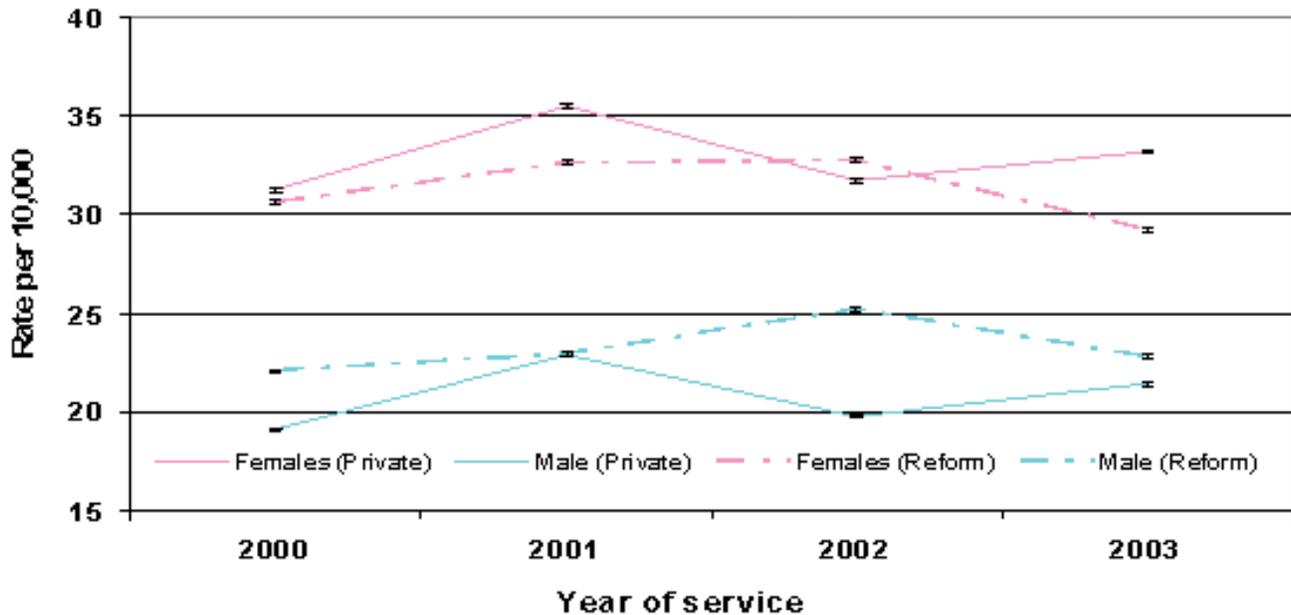


Figure 20 presents the hospital admissions rate due to asthma stratified by type of coverage, sex, and year of service. A statistically significant difference was found in females with both types of coverage (Private & Reform) with a higher rate of hospital admissions when compared to males. The female rates ranged from the highest, 35.47 hospital admission claims due to asthma per 10,000 enrolled in the private plan during 2001, to the lowest, 29.20 for those enrolled in the Health Care Reform plan in 2003. Except for year 2002, females from the private insurer had higher hospital admission rates due to asthma than females from the Health Care Reform coverage. The risk of being hospitalized due asthma for females enrolled in the private insurance in year 2003 was 13% (RR=1.13) higher than females in the Health Care Reform. When comparing females with males enrolled in the private health insurance, females had an average of 1.55 times more risk of being hospitalized due to asthma than males. Also, in 2003 the private insured females had approximately 55% more hospital admission claim rates due to asthma when compared with males. Females enrolled in the Health Care Reform insurance had an average of approximately 1.28 times more risk (28 %) of being hospitalized for asthma related conditions than males with the same type of coverage.

**Figure 21**  
Asthma hospital admission rate by age group and year of service,  
HIC, (2000-2003)

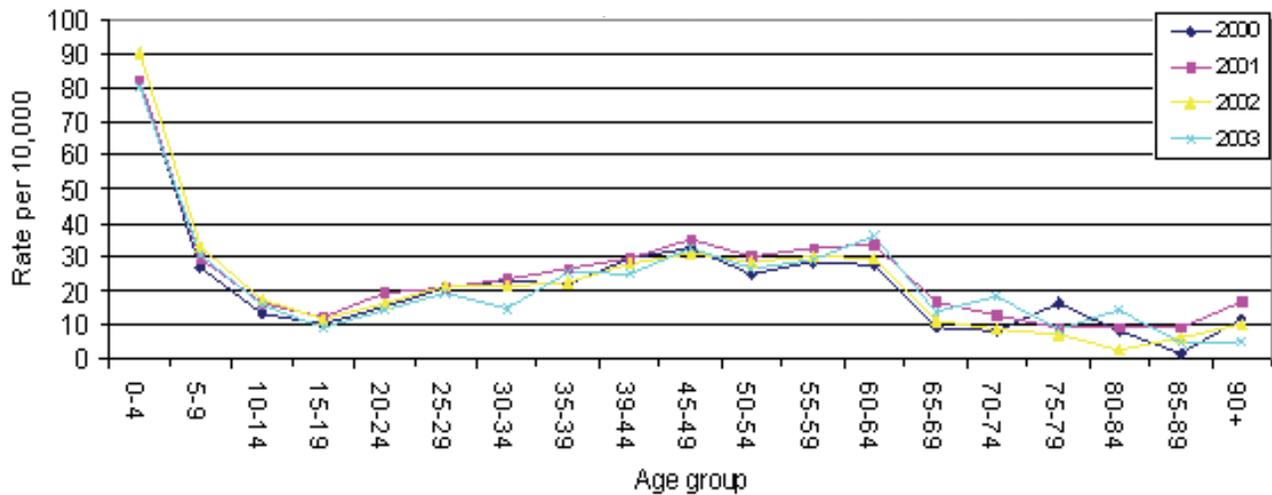


Figure 21 presents the hospital admissions rate due to asthma stratified by age group and the years of service for years 2000 to 2003. A statistically significant higher rate was detected in the 0-4 year group when compared to all age groups. The highest peak was observed in 2002 with 90.19 asthma hospital admission claims per 10,000 enrollees. Also, an inverted J shape tendency was observed up to the age group of 25-29 followed by an increasing pattern from the age group of 60-64 years with a shift that decreased in the age group of 65-69 years. These findings were constant in all the years studied.

**Figure 22**  
 Asthma hospital admission rate by age group and year of service,  
 HIC, (2000-2003)

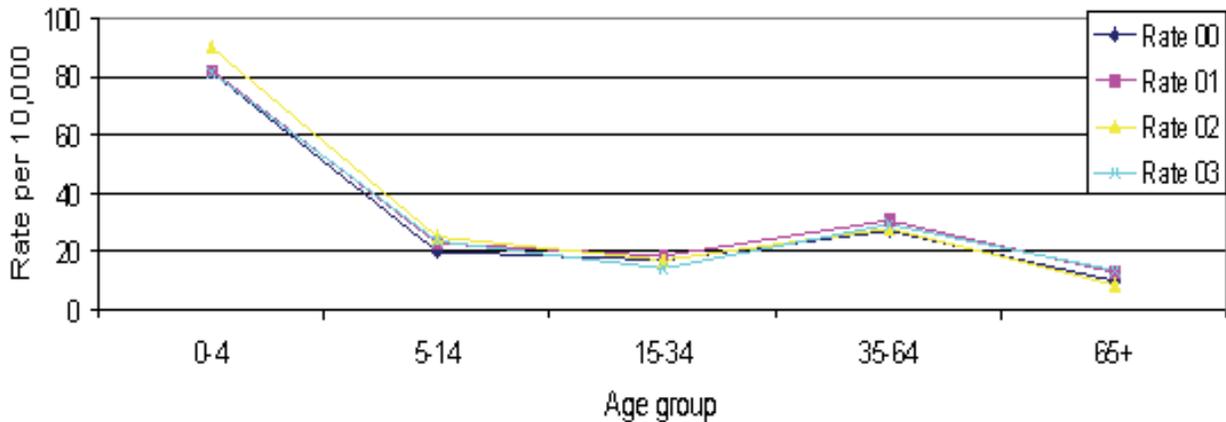


Figure 22 shows the hospital admissions rate due to asthma stratified by year of service and age group. This graph was developed to smooth the data presented in Figure 21. As mentioned before, the age group of 0-4 years had a statistically significant highest admission rate due to asthma when compared to the other age groups. The age group of 35-64 years presented the second highest rate in hospital admissions reported.

**Figure 23**  
 Asthma hospital admission rate by age group, year of service,  
 type of coverage and type of service,  
 HIC, (2000-2003)

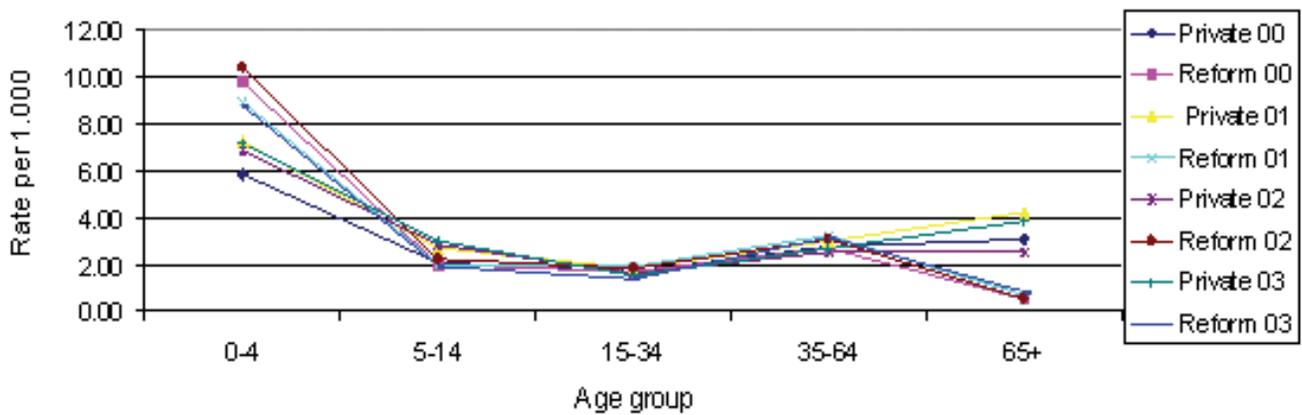


Figure 23 presents the hospital admissions rate due to asthma stratified by year of service, type of coverage and age group. The data shows evidence of a similar pattern across the four years of services (2000-2003) for both health coverages (private and Health Care Reform). The age groups of 0-4 years and 65+ years presented a broad variability in asthma hospitalization rates when the information was compared against the type of coverage and year of service.

**Figure 24**

Frequency fo asthma hospital admission claims by month and year of service, HIC, (2000-2003)



The number of hospital admission claims per month and year of service is showed in Figure 24. The highest number of hospital admission claims (frequency = 375) due to asthma within the study period was observed in October of year 2001. Each year, the month of July reflects the lowest point in the trend. All four years presented a similar individual trend.

**Figure 25**

Asthma hospital admission rate by month and year of service,  
HIC, (2000-2003)

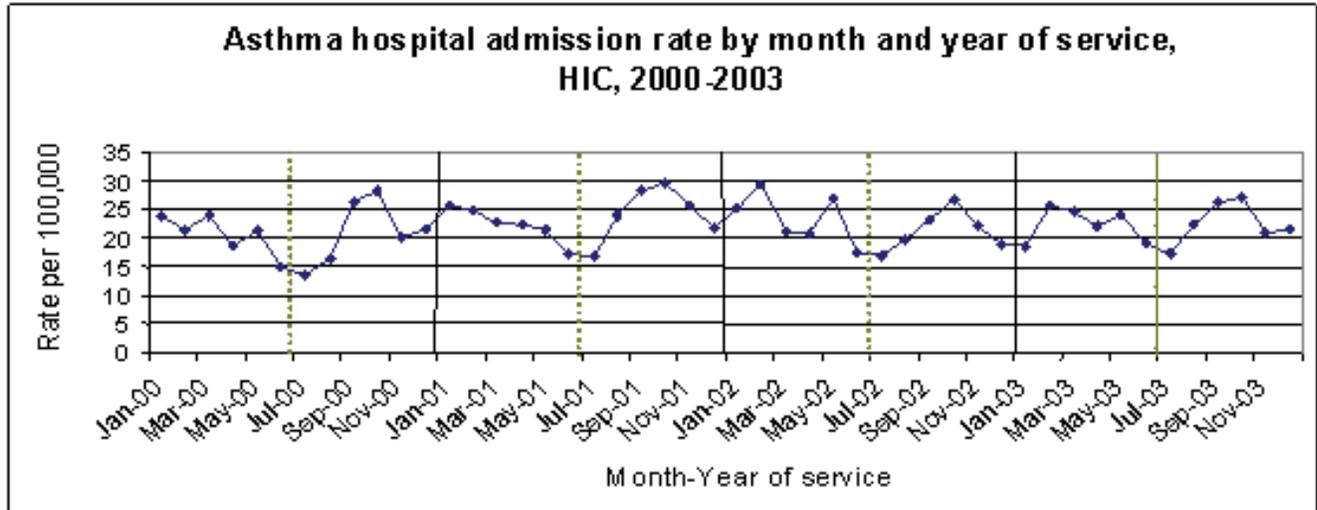


Figure 25 presents the hospital admission claims rate per month and year of service. The highest rate was detected for October 2001 (30 hospital admission claims due to asthma per 100,000 enrolled). The same pattern was observed in all the years within the surveillance period in which the month of October reflected the highest rate. In contrast, the lowest rate was presented constantly for the month of July. The lowest point found in the surveillance period was in July 2000, with 13 hospital admission claims due to asthma per 100,000 enrolled. The monthly trend had a decreasing tendency that occurred from January to July, and then in August it increased reaching the highest point in October. The following months of November and December had fewer claims than the month of October. A polynomial regression line was incorporated to evaluate the overall time series, were a stable trend was describe ( $R^2 = 0.0787$ ).

**Figure 26**  
 Asthma hospital admission rate by month, year of service and service type,  
 HIC, (2000-2003)



Figure 26 presents the hospital admission rate per month, year of service, and type of coverage. This figure revealed that the pattern between the two types of health insurances followed a similar time trend across the surveillance period. No evidence of differences in rates between the private and reform populations were observed through time.

**Figure 27**  
 Asthma hospital admission claims frequency by month of service,  
 HIC, (2000-2003)

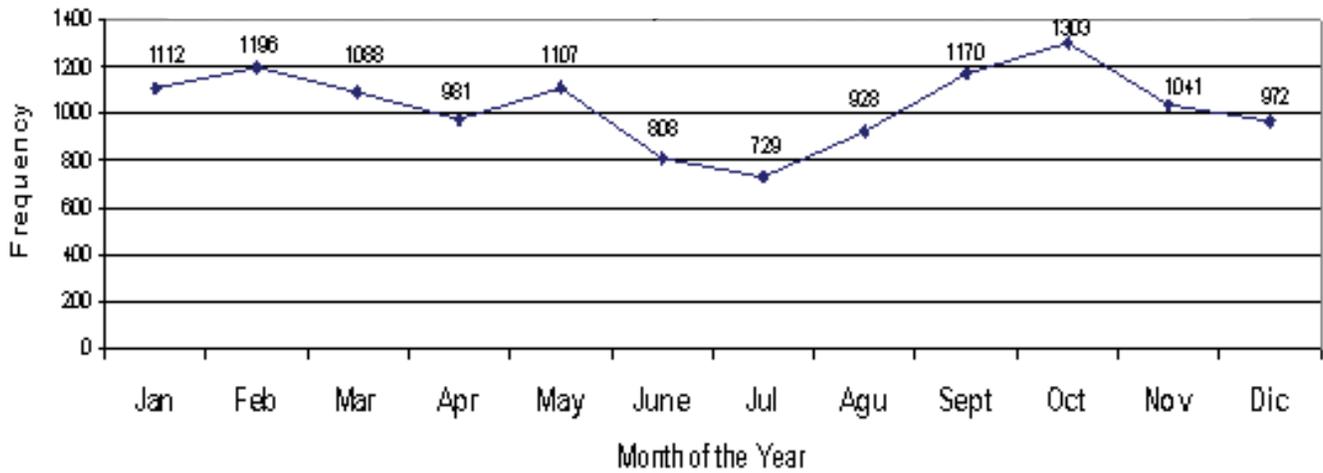


Figure 27 displays the aggregated number of hospital admission claims due to asthma grouped by month of service. There was an average of 1,036 hospital admissions per month during the four surveyed years. October represents the month with the highest number of accumulated claims with 1,303 claims and July was the month with the lowest accumulated claims with 729 claims.

**Figure 28**

Asthma hospital admission rate by month and year of service, HIC, (2000-2003)

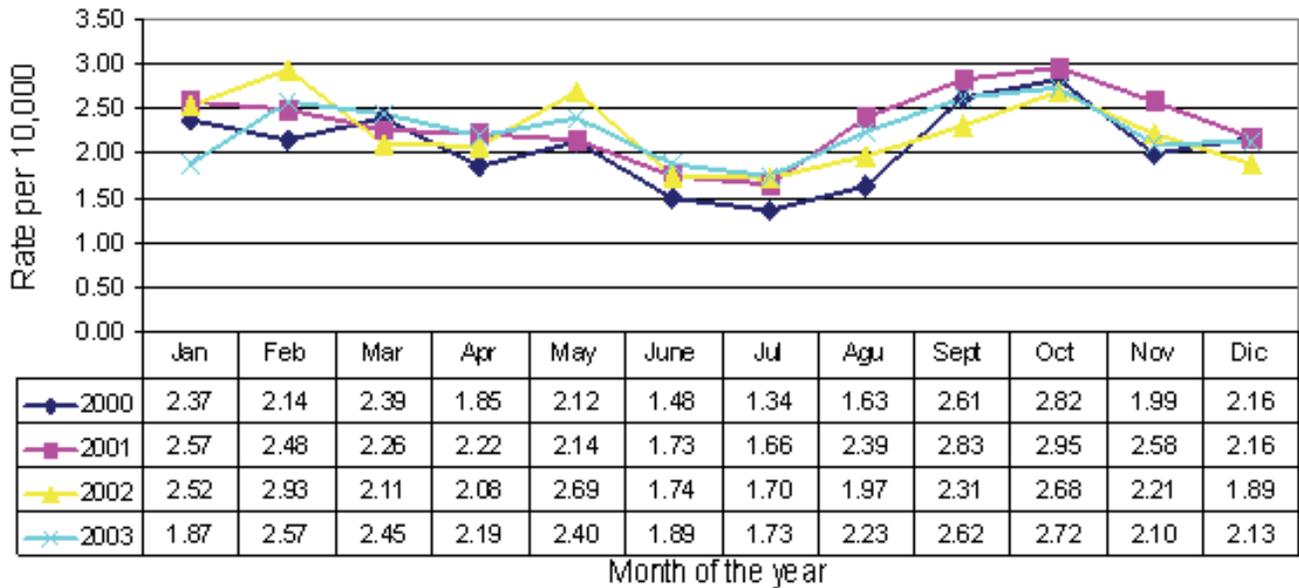
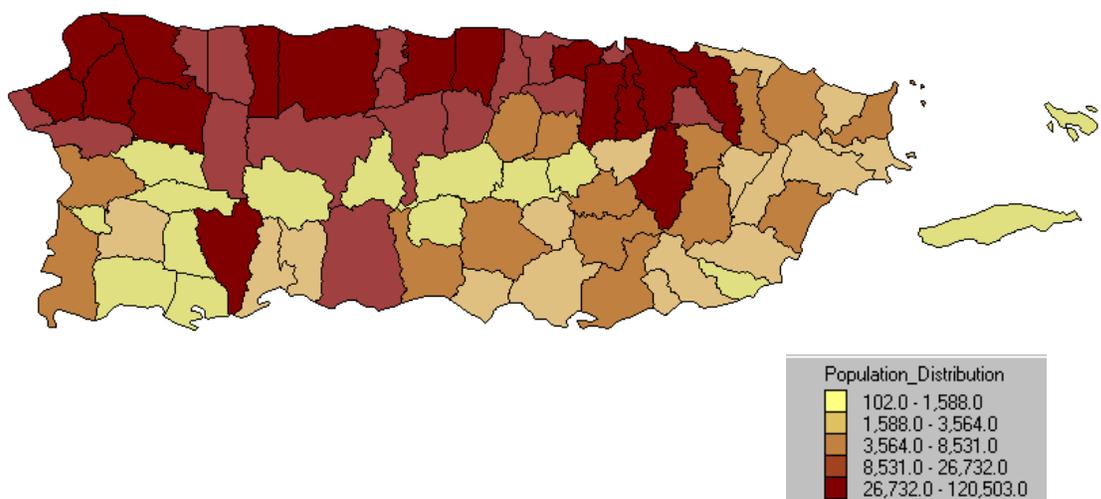


Figure 28 presents the hospital admission claims rate due to asthma by month and year of service. In this figure, once again it is evident that August, September and October are constantly the months with the highest rates regardless of the study year.

The asthma hospital admissions stratified by geographical location was evaluated using the Age-Sex Standardized Morbidity Ratio (SMR). The SMR result was smoothed using the Marshall Empirical Bayes model (Marshall 1991). The purpose of using the geographical modelling of the SMR was to produce a “clean” map to reduce variability and to control for known factors such as population variation (for example, sex and age distribution), and unknown factors such as random noise (Marshall 1991, Pascutto 2000, Lawson et al. 2001). The resulting maps provide, with a greater certainty, the locations to target and allocate the healthcare resources in the Puerto Rico municipalities. A proper geographical evaluation in Puerto Rico has not been previously conducted and the literature does not provide any comparison for this type of analysis.

## Map 2

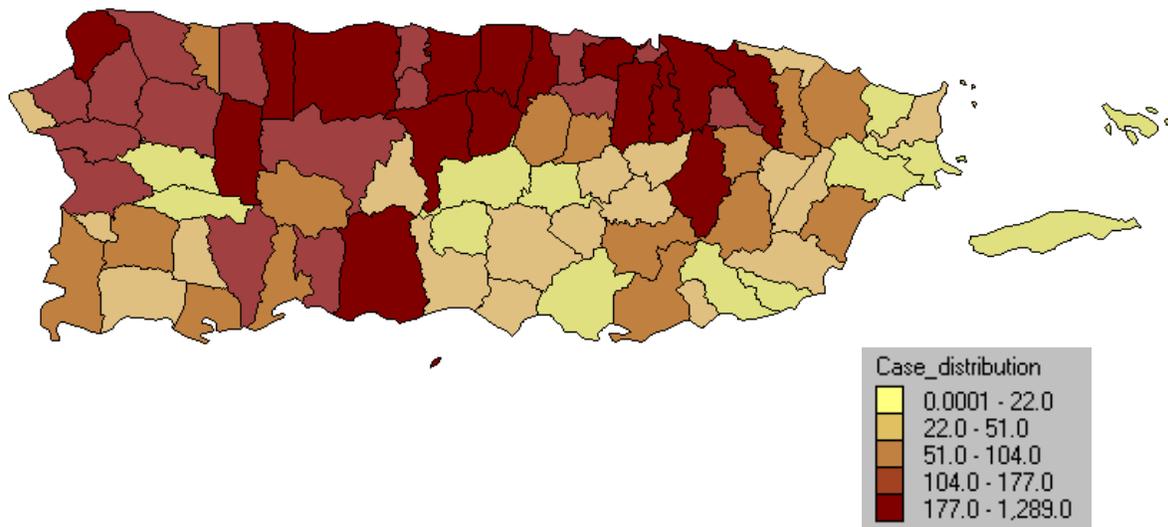
# Distribution of enrollees in a selected HIC by municipality (2001)



Map 2 presents the geographical distribution of enrollees in a selected HIC. A large proportion of the enrollees are within the municipalities of north coast of Puerto Rico. The eastern, central and southern municipalities have fewer people enrolled.

### Map 3

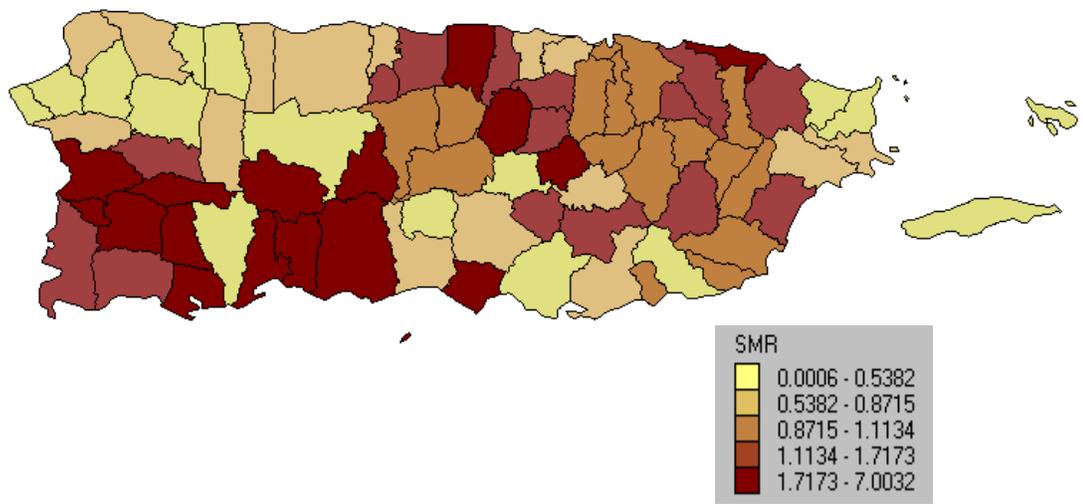
## Frequency of hospital admission claims due to asthma by municipality in a selected HIC, (2000-2003)



admission claims. As expected, the municipalities with the highest number of enrollees were the ones with the highest number of claims.

#### Map 4

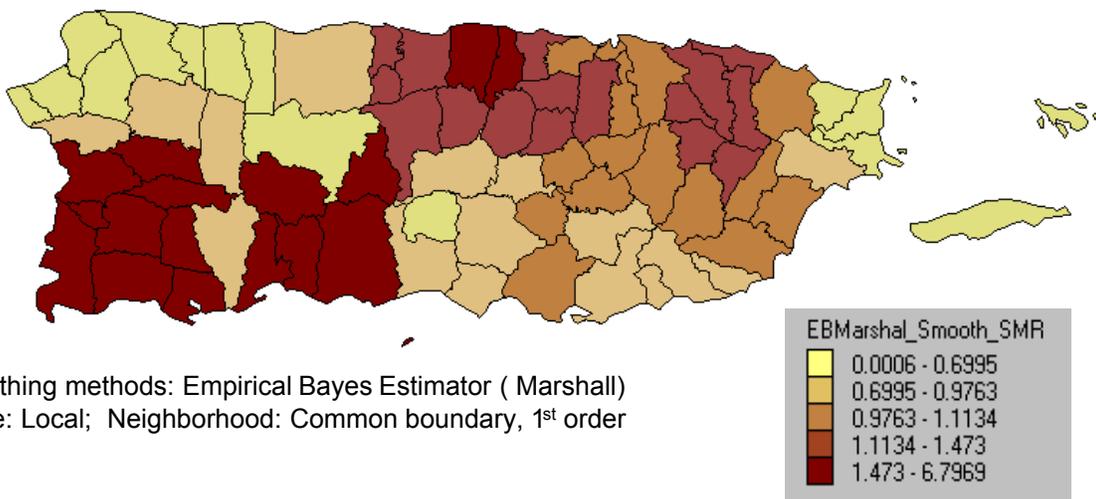
## Spatial age-sex adjusted SMR of asthma hospital admission claims in a selected HIC, (2000-2003)



Map 4 presents the spatial age-sex adjusted standardized morbidity ratio of asthma hospital admission claims during years 2000 to 2003. Ponce, Peñuelas, Guayanilla, Adjuntas, Guánica, Maricao, Corozal, Comerío, Vega Baja, Hormigueros, Mayaguez, Lajas, San German, Sabana Grande, and Maricao are the municipalities with a higher estimated relative risk than 1.7. The mentioned municipalities had 70% more risk than expected.

## Map 5

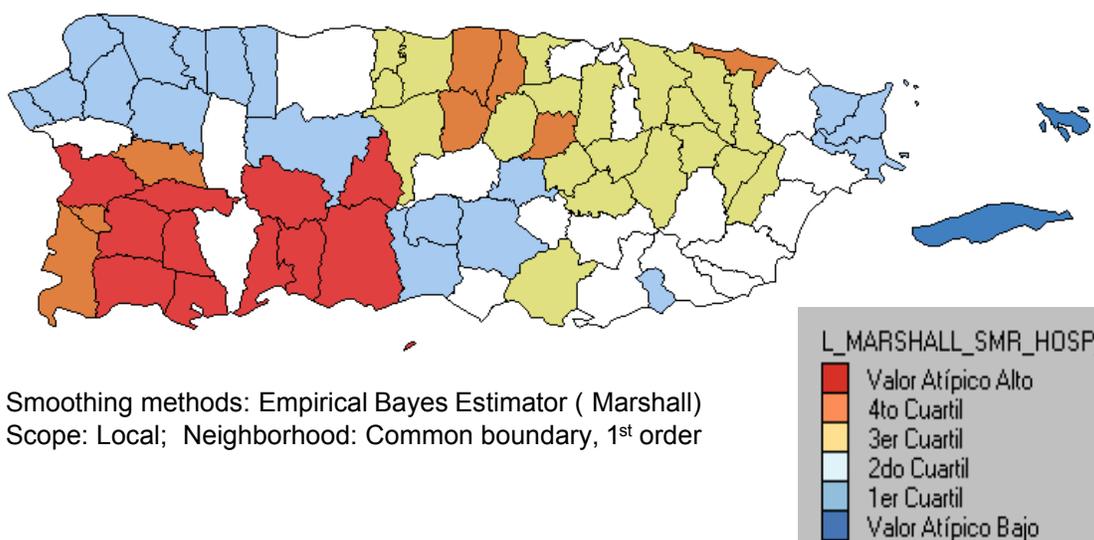
# Smoothed Spatial age-sex adjusted SMR of asthma hospitalization claims in a selected HIC, (2000-2003)



Map 5 presents the smoothed spatial age-sex adjusted standardized morbidity ratio of asthma hospital admission claims for years 2000 to 2003. The statistical technique employed smooth the map presented in Map 4. This new view of asthma hospital admission claims shows a geographical distribution minimizing the over-dispersion. Municipalities with higher relative risk are located in the southwestern region of Puerto Rico. In addition, Vega Baja and Vega Alta are municipalities from the northern region which also have a higher relative risk of hospital admission.

Map 6

## Outliers of the smoothed age-sex SMR of asthma hospital admission claims in a selected HIC, (2000-2003)



Map 6 presents the selected municipalities with outlier values of the smoothed age-sex adjusted standardized morbidity rate of asthma hospital admission claims during years 2000 to 2003. This map reflects the selected municipalities with the priority for interventions to reduce asthma hospital admissions. These municipalities are: Peñuelas, Guayanilla, Adjuntas, Guánica, Maricao, Mayaguez, Lajas, San Germán, and Sabana Grande.

### **3.3.2. Hospital admissions discussion**

In Puerto Rico no significant changes were assessed in asthma hospital admission rates from 2000 to 2003. An average of 27 hospital admissions per 10,000 enrolled in a selected insurance company was observed during the four years surveyed. Information regarding the US population was provided by the US National Center for Health Statistics (NCHS) through their National Hospital Discharge Survey (NHDS), which reported 17 asthma hospitalizations per 10,000 non institutional citizens for year 2000 (CDC 2003b). Also, the asthma hospitalization rate in white Americans was 11 hospitalizations per 10,000, and in African Americans was 36 per 10,000 non institutional citizens for year 2000. NHDS did not collect additional ethnic data for hospitalization.

The information from the NHDS is an average estimate of asthma hospital discharges from 1999 to 2003. The NHDS collects the data from a sample of inpatient records acquired from the national sample of short stay, non-federal hospitals in the United States. Because patients with multiple discharges during a year may be sampled more than once, estimates are for discharges, not for patients. For asthma discharges, the codes for the first-listed diagnoses are ICD-9CM: 493.0 through 493.9. The first-listed diagnoses are usually the main reason for hospitalization and is the principal diagnosis on the face sheet or discharge summary of the medical record (<http://209.217.72.34/HDAA/TableViewer/summary.aspx>). The NHDS is similar to the procedure used in this investigation with patients of a selected HIC in Puerto Rico.

Asthma hospital admissions rate stratified by type of coverage revealed that the rate for the health care reform coverage in year 2003 (26 per 10,000) was not statistically different from the rate of the private coverage in the same year (28 per 10,000). A trait of our population surveyed is that the study participants enrolled in the private insurance were distributed throughout Puerto Rico, and the ones enrolled in the health care reform represented 21% of the population of all municipalities.

With regards to hospital admissions stratified by gender, females had approximately two times more hospital admission rates than males during the four years surveyed. The observed difference between females and males was similar for both types of coverage. For year 2004, the asthma hospital discharge rate by gender in the United States revealed that females had a higher hospitalization rate (19.1 per 10,000) than males (14.5 per 10,000) (CDC, 2006b). These findings are consistent with the gender distribution observed in Puerto Rico. Similar results were found by Pérez, et al. (1999) in their study. As seen earlier, the higher asthma in females in the United States and Puerto Rico suggests a possible explanation for the high hospitalization rate observed in this group (Schatz, 2003). This difference in gender is worth further investigating. The information gathered in this study should help to determine the allocation of healthcare resources such as health education and promotion to the female population. As previously mentioned, no differences were assessed in asthma mortality when stratified by gender regardless of the higher asthma prevalence found in females. More studies should focus on the elevated use of the healthcare resources by females. We suggest further analysis to observe if this pattern could explain why a higher risk for asthma mortality was not observed in males. Furthermore, the hospitalization rates were higher in younger males than younger females, but the pattern shifted as they grew older.

in terms of asthma hospital admissions stratified by age, the 0-4 year age group accounts for the highest hospitalization rates during the four years studied. This rate remains constant for the private insurance company and healthcare reform population. NHDS data presents similar results where hospitalization rates were higher among the 0-4 years age group. In contrast, Perez et al. (1999) found a higher hospitalization rate in the age group of 45-64 years for 1996-1997.

Regarding the temporal trends evaluated from January 2000 to December 2003, the point with the highest number of asthma hospitalizations was October 2001 with 375 hospital admissions. Meanwhile, July 2000 showed the lowest number of asthma hospital admissions with 150. The hospital admissions rate trend is practically the same for the four years surveyed in which a descending trend is observed from January to July and an increase occurs to its maximum in October. The months of November and December had lower hospital admission rates than October. In another study, Gergen et al. (2002) found that asthma symptoms and healthcare utilization patterns of childhood asthma had the lowest point during summer from June through August, with a peak during autumn beginning in the month of September. The trend observed by Gergen et al. (2002) is similar to the trend observed in this epidemiological profile, although a slight shift was identified in October. In our surveillance data, an increasing trend is observed in August, when school begins after summer vacation in Puerto Rico. Then the trend reaches its peak point in October. A possible explanation for this time trend, which needs further analysis, could be that asthma exacerbations are influenced by viral infections transmitted in schools and work places, but has been documented as environmental fluctuations which trigger seasonal variations in asthma (Fleming et al. 2000; Silverman et al. 2003). Some environmental factors that could trigger asthma are fungus, pollen and viral infections, which vary depending on seasonal conditions (Newson et al. 2000). Considering Bayona et al. (2002), the correct management of respiratory infection in asthmatic patients may reduce hospitalization up to 86.3 percent.

After conducting the spatial analysis, it was determined that there are several municipalities within the southwestern region of Puerto Rico that need attention to reduce their reported hospital admissions. The municipalities of Peñuelas, Guayanilla, Adjuntas, Guánica, Maricao, Mayaguez, Lajas, San German, and Sabana Grande, are identified as a priority requiring interventions dedicated to reduce asthma hospital admissions.

The previous results allow us to consider the importance of continuing the efforts of monitoring the parameters associated to asthma throughout time in the Puerto Rican population.

### **3.4. Emergency Room Visits Indicator**

#### **3.4.1. Emergency room visit findings**

**Figure 29**  
Asthma ERV claim frequency by year of service,  
HIC, (2000-2003)

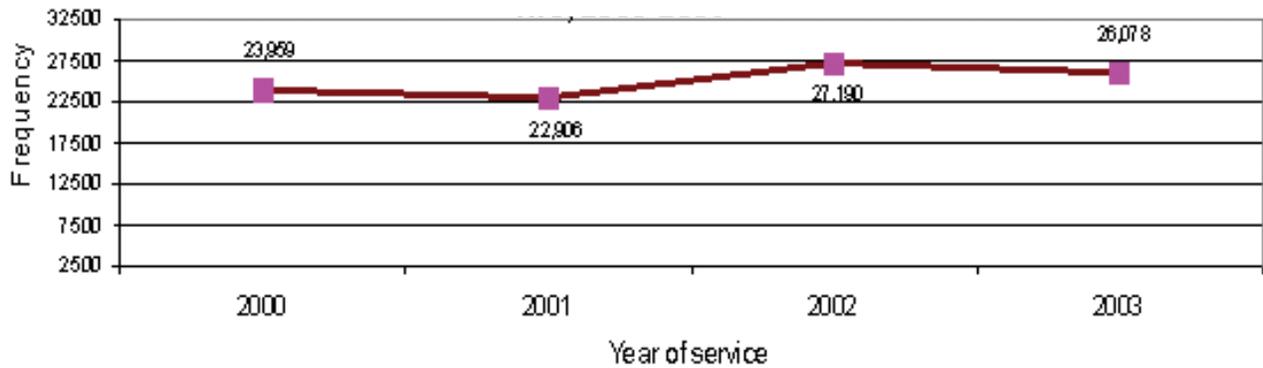


Figure 29 presents the emergency room visit claims frequency due to asthma from 2000 to 2003. The ERV claims fluctuated from a low of 22,906 in year 2001 to a high of 27,190 in year 2002.

**Figure 30**  
Asthma ERV rate by year of service,  
HIC, (2000-2003)

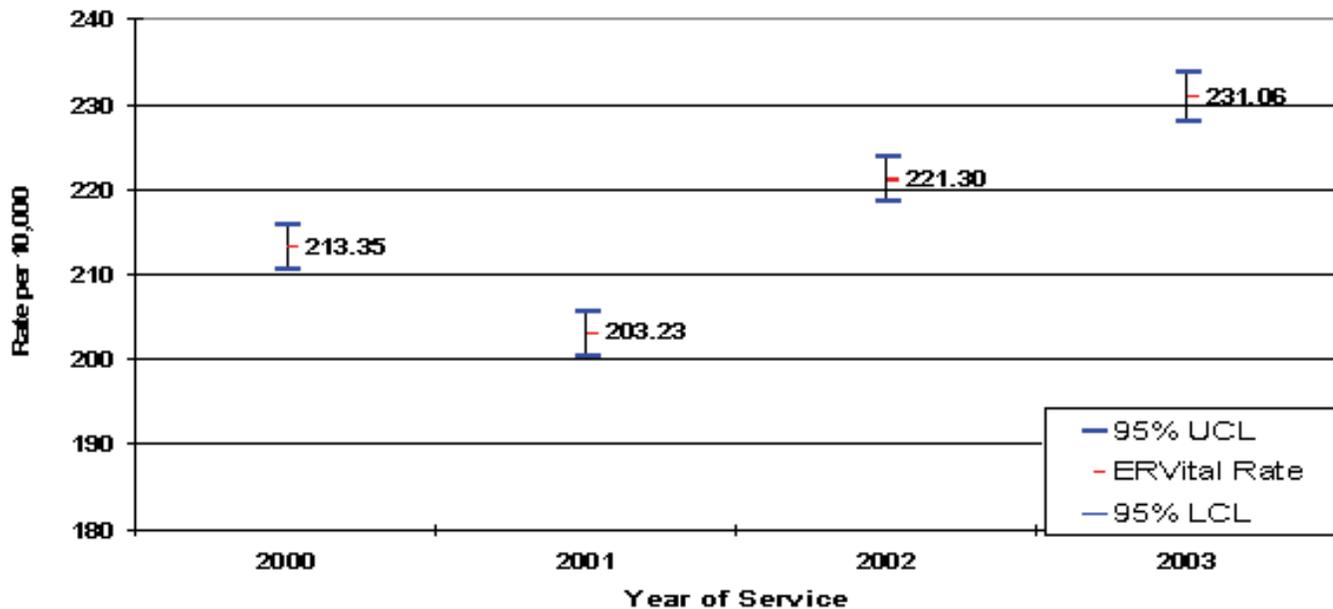


Figure 30, presents the emergency room visit claims rate by year of service due to asthma per 10,000 from year 2000 to 2003. The lowest rate occurred in year 2001 with 203 ERV claims per 10,000 enrollees while the highest rate occurred in the year 2003 with 231 ERV claims per 10,000 enrollees. The differences among the four rates were evaluated using the 95% confidence interval. A statistical significant trend was detected from 2001 to 2003.

**Figure 31**  
 Asthma ERV rate by type of coverage and year of service,  
 HIC, (2000-2003)

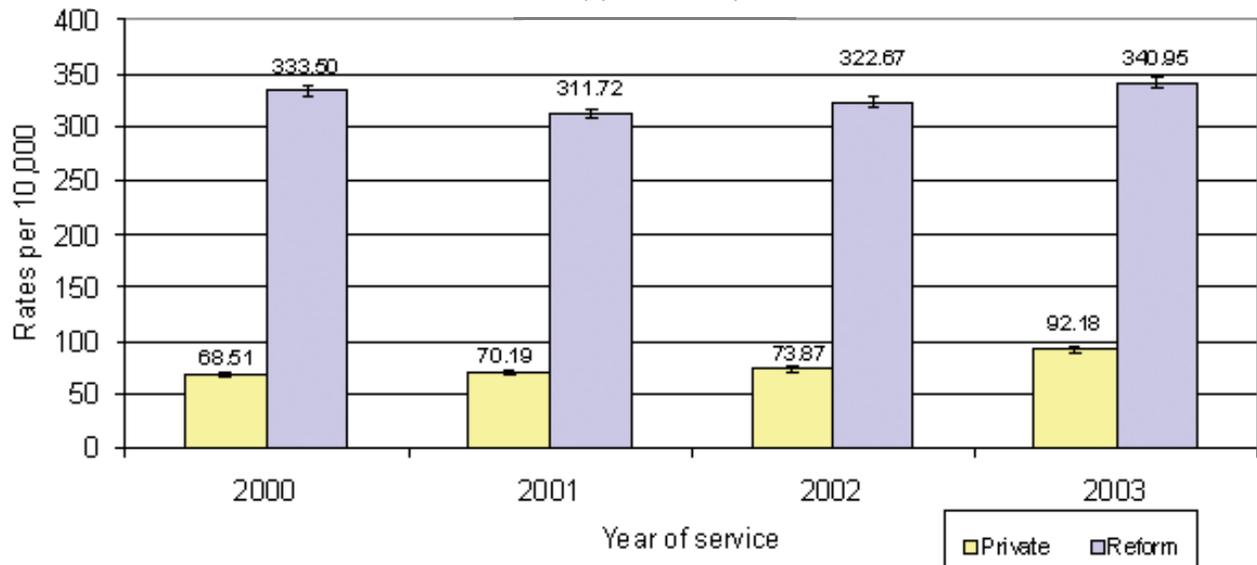


Figure 31 presents the asthma emergency room visit (ERV) claims rate by type of coverage and year of service in the selected health insurance company for years 2000 to 2003. The health care reform population had a statistically significant difference of approximately six times more ERV rate than the private population. The ERV trend has been increasing since year 2001 in both groups.

**Figure 32**  
 Asthma ERV rate by type of coverage, sex and year of service,  
 HIC, (2000-2003)

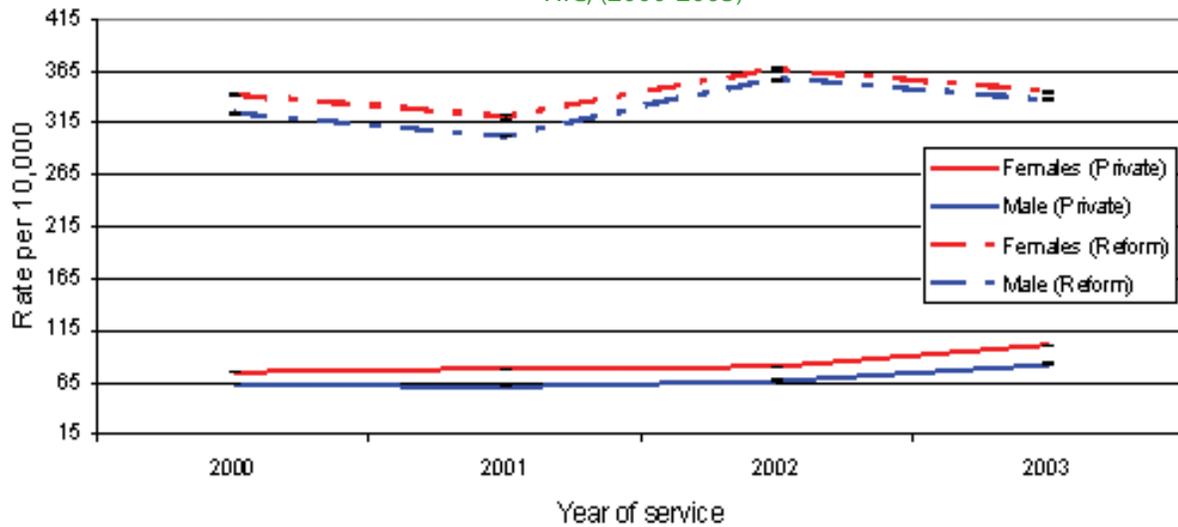


Figure 32 presents the asthma emergency room visit (ERV) claims rate by type of coverage, sex and year of service from 2000 to 2003. Females from both coverage populations had a significantly higher ERV rate than their male counterpart. This figure reflects again that the health care reform population had a higher ERV claims rate than the private population during the four-year surveillance period.

**Figure 33**  
 Asthma ERV rate by age group and year of service,  
 HIC, 2000-2003

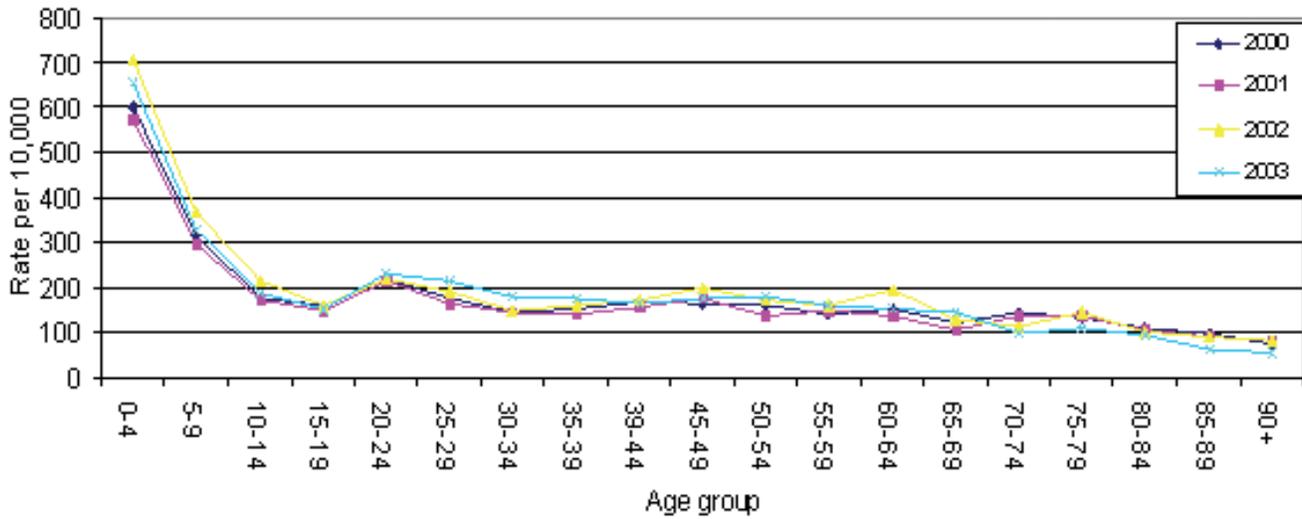


Figure 33 shows the emergency room visit claims rate due to asthma by age group and year of service from 2000 to 2003. A statistically significant higher rate in the 0-4 age group was identified when compared with all the other age groups, being 2002 the year with the highest rate with 700 ERV per 10,000 enrollees. The age-group trend was constant during the four year of surveillance. A decreased trend was observed from the 0-4 age group up to the 15-19 age groups. There was a slight increase in the 20-24 age group followed by a continued decreasing trend up to the 90+ age group. The majority of the ERV claims during the four year of surveillance were observed in the 0-4 through 15-19 age groups.

**Figure 34**  
Asthma ERV rate by group, year of service & type of service,  
HIC, (2000-2003)

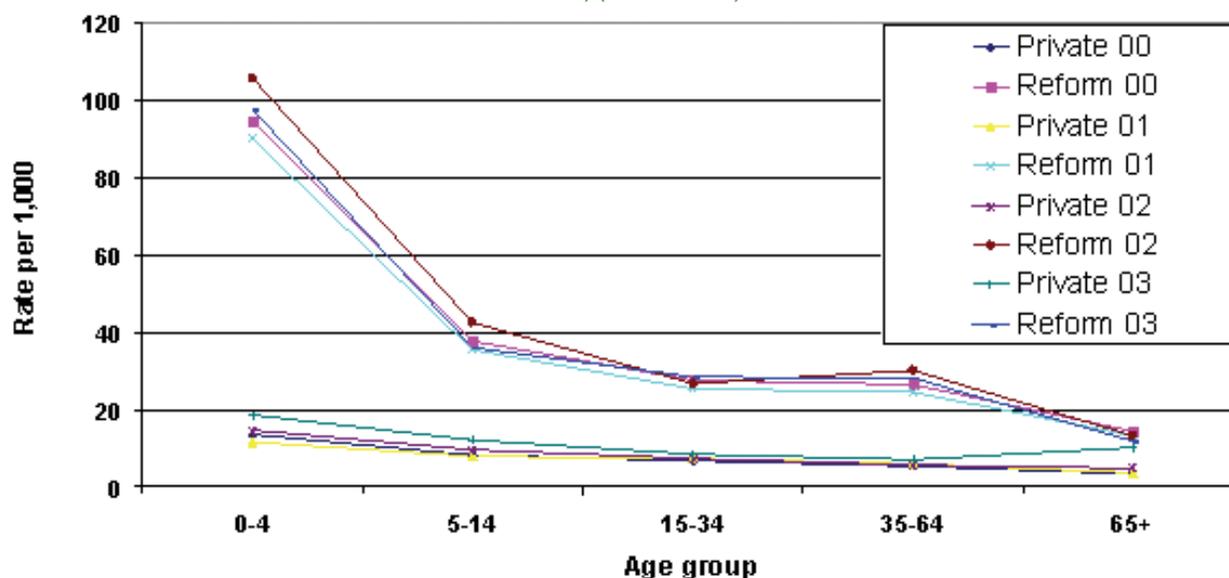


Figure 34 presents the asthma emergency room visit (ERV) claims rate by age group, type of coverage and year of service from 2000 to 2003. All age groups in the health care reform coverage had a higher rate of ERV claims than the population with private coverage. In 2002, the 0-4 age group from the health care reform coverage presented the highest rate of ERV claims (106 ERV claims per 1,000 enrollees). During the four year surveillance period, the 0-4 age group from the health care reform coverage had approximately 7.3 times more ERV claims than the 0-4 year age group from the private coverage.

**Figure 35**  
 Asthma frequency ERV claims by month and year of service,  
 HIC, 2000-2003



Figure 35 shows the asthma emergency room visit (ERV) claims frequency by month and year of service from 2000 to 2003. An average of 2,089 ERV claims per month was observed during the study period. The highest number of ERV claims was observed during the month of February 2002 with 2,640 claims, while July 2000 was the month with the lowest ERV claims with 1,290 claims.

**Figure 36**  
Asthma ERV rate by month and year of service,  
HIC, 2000-2003



Figure 36 presents the asthma emergency room visit claims rate by month and year of service from 2000 to 2003. The highest ERV rate was observed in October 2002 with 226 ERV claims due to asthma per 100,000 enrollees. The lowest rate of ERV during the surveillance period was during July 2000 with 115 ERV claims per 100,000 enrollees. A similar trend was observed throughout the four year surveillance period, with a descending trend from January to July followed by an increasing trend after July. The month of October constantly had the highest rate, while the month of July was consistently the month with the lowest asthma ERV rate during the studied period. A slight increase trend was observed in the asthma ERV rate, as a polynomial regression line was incorporated to evaluate the overall trend. The regression trend line had a moderate fit to the data ( $R^2 = 0.2784$ ).

**Figure 37**

Asthma ERV rate by month and year of service and type of service,  
HIC, 2000-2003

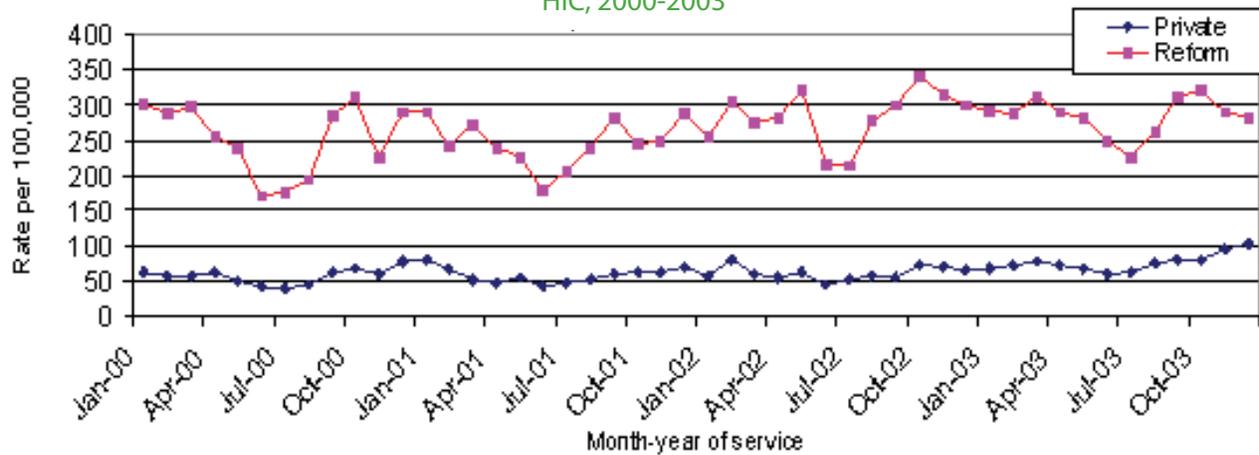


Figure 37 presents the asthma emergency room visits rate by month, year of service and type of coverage from 2000 to 2003. The health care reform trend had a sharp fluctuation during the four years surveillance period. The trend follows the pattern showed earlier in Figure 36, where the lowest ERV claims were observed during the summer months and the highest ERV claims were observed during the fall season. The trend within the population with private coverage does not present a sharp fluctuation as observed in the population with health care reform coverage, but it follows the same pattern described above. The population with health care reform coverage had consistently higher ERV claims due to asthma than the population with private coverage during the whole surveillance period.

**Figure 38**  
Asthma ERV rate by month of the year,  
HIC, 2000-2003

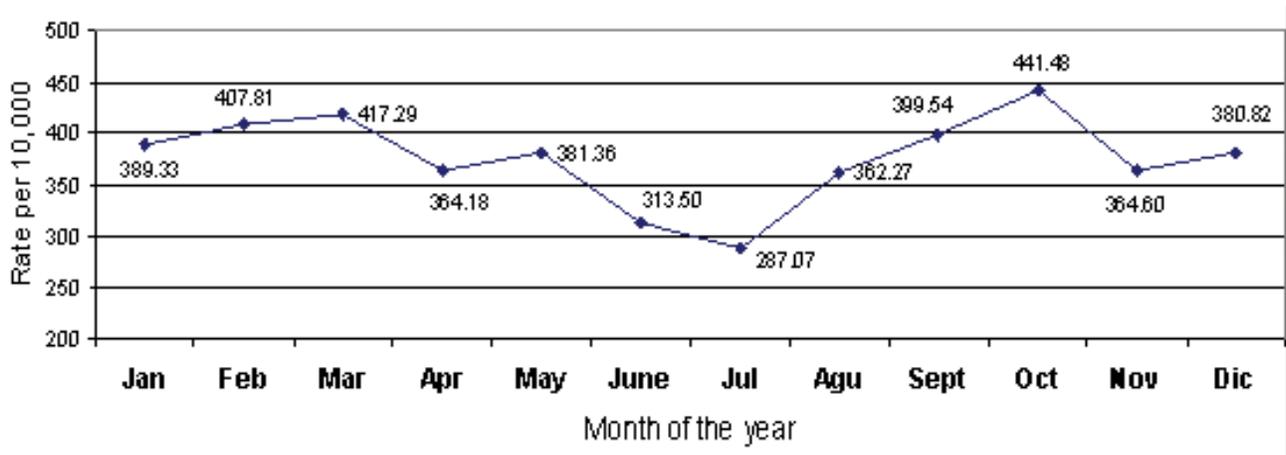


Figure 38 presents the aggregated asthma emergency room visits rate (ERV) by month from 2000 to 2003. This figure corroborates the trend previously showed that fewer ERV claims were reported during the summer months than any other season, specifically the month of July had 287 ERV claims per 10,000 enrollees. Whereas, October was the month with the highest ERV claims with 442 ERV claims per 10,000 enrollees.

**Figure 39**  
Asthma ERV rate by month and year of service,  
HIC, 2000-2003

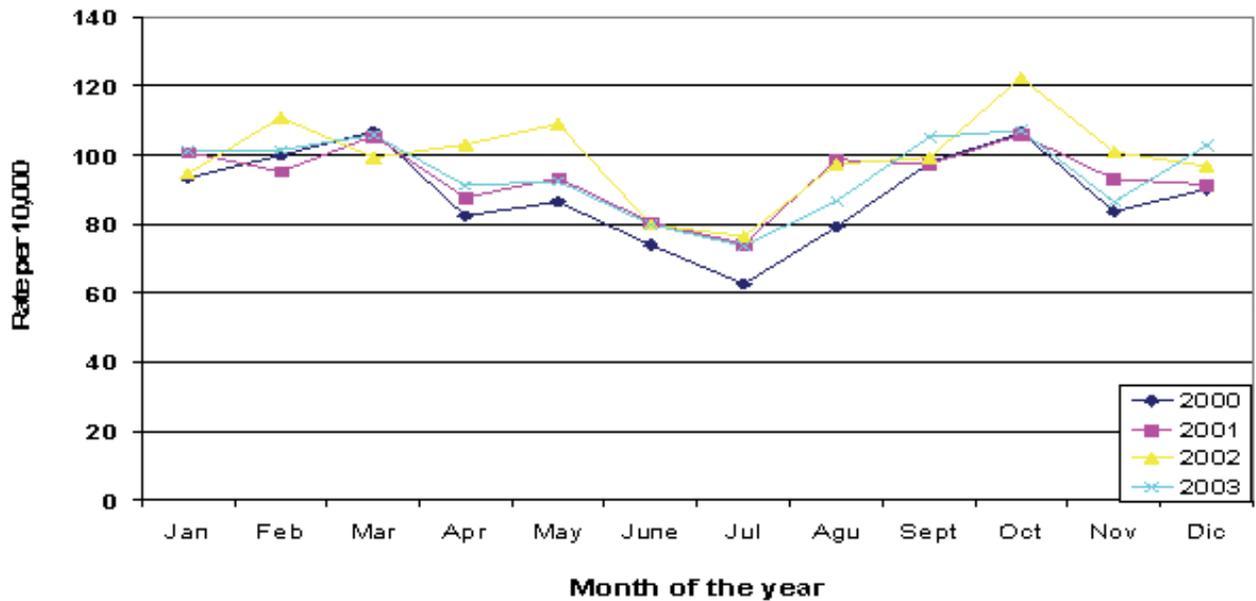
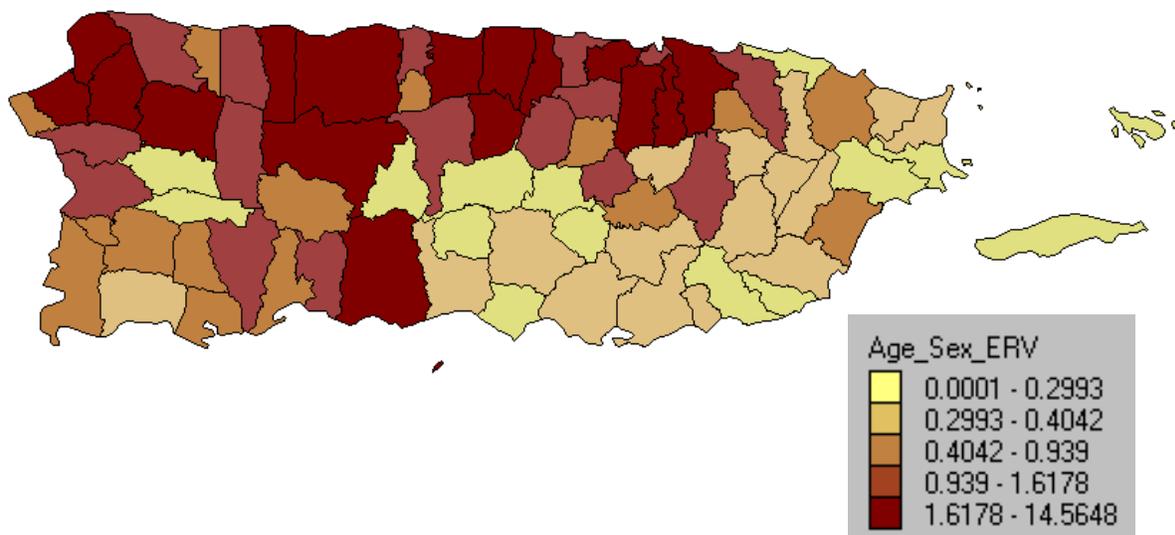


Figure 39 presents the asthma emergency room visit (ERV) rate by month and year of service from 2000 to 2003. The distribution followed the same seasonal trend observed and explained in figures 37 and 38, when all four years of surveillance period were stratified by month. The month with the lowest ERV claims recorded was July, 2000 with 63 ERV per 10,000 enrolled in the HIC, while the month with the highest ERV claims was October, 2002 with a total of 123 ERV claims per 10,000 enrolled.

### Map 7

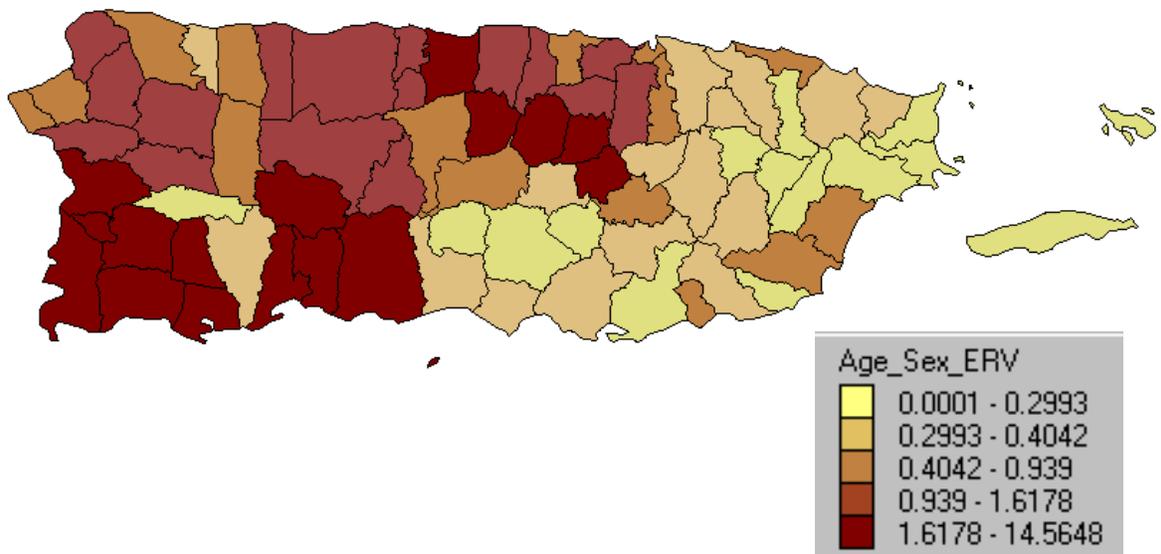
## Frequency of asthma ERV claims by municipality in a selected HIC, (2000-2003)



Map 7 presents the number of emergency room visit (ERV) claims due to asthma grouped by municipality during the surveillance period from 2000 to 2003. The northern coast municipalities of Puerto Rico and Ponce in the south had higher ERV claims when compared with other municipalities. The ERV claims frequency in the mentioned municipalities range from 2,276 to 12,196 during the surveyed period.

## Map 8

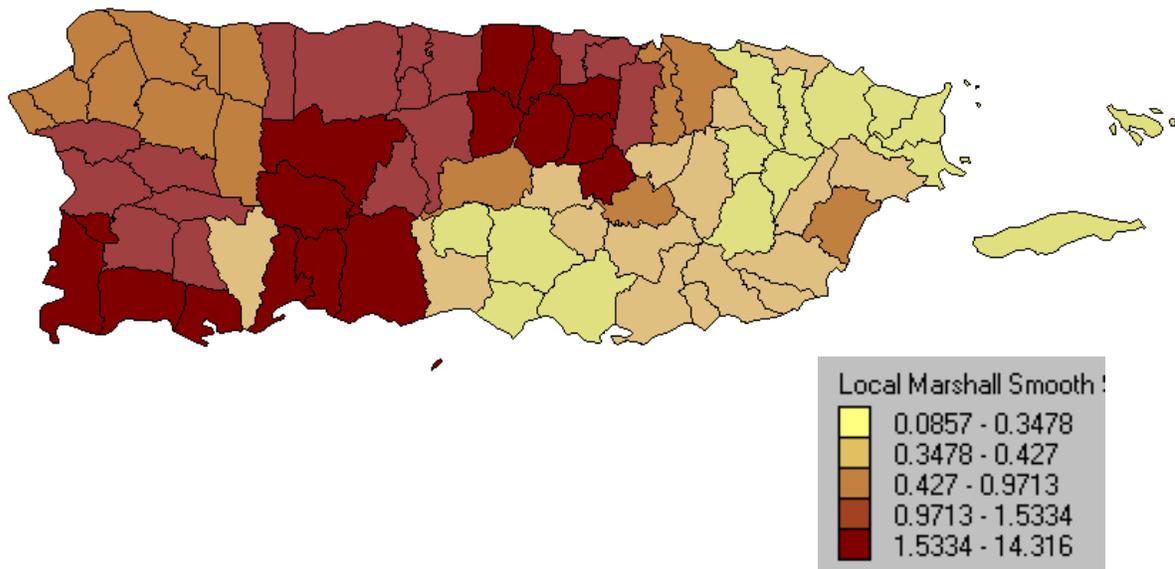
# Spatial age-sex adjusted SMR of asthma ERV in a selected HIC, (2000-2003)



Map 8 presents the spatial age-sex adjusted standardized morbidity ratio of the emergency room visit claims in the studied period from 2000 to 2003. The age-sex standardization was conducted as a control for the differences in ages and the sex distribution of the enrolled population across municipalities. The southwestern municipalities reflected an emergency room estimated relative risk (RR=1) higher than expected.

Map 9

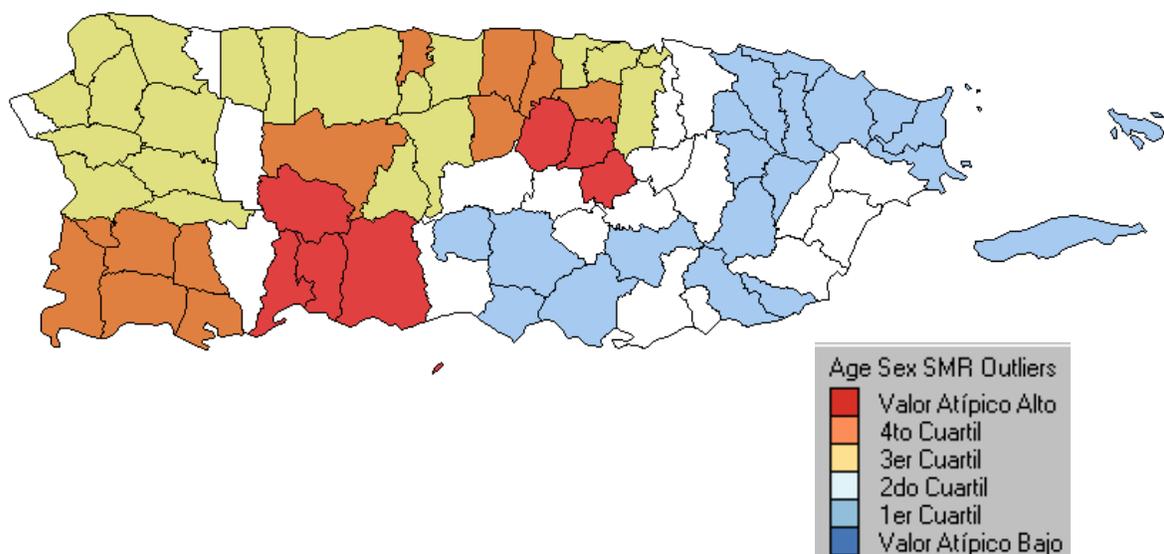
## Smoothed age-sex SMR of asthma ERV claims in a selected HIC, (2000-2003)



Map 9 shows the smoothed age-sex standardized morbidity ratio (SMR) of asthma emergency room visit claims in the study period from 2000 to 2003. Smoothing techniques allow controlling for over-dispersion in the estimated values. Furthermore, the SMR variance was reduced. This map presents a smoothed pattern of the relative risk distribution compared to the one presented in Map 8. The south, southwestern, and north-central municipalities presented a relative risk higher than expected (RR=1).

Map 10

## Outliers of the smoothed age sex SMR of asthma ERV claims in a selected HIC, (2000-2003)



Map 10 presents the outlier values of the smoothed age-sex standardized morbidity rate of asthma emergency room visit claims during the study period from 2000 to 2003. This map will help determine priority areas. Based on this information, interventions to reduce the emergency room visits will be prioritized in the municipalities of Ponce, Peñuelas, Guayanilla, Adjuntas, Comerío, Naranjito and Corozal.

### 3.4.2. Emergency room visits discussion

In Puerto Rico the average emergency room visit (ERV) claims due to asthma during the four year study period (2000-2003) was 25,033 ERV claims per year. The total number of study participants with one or more ERV claims due to asthma were: 17,501, 16,699, 19,205, and 20,300, for 2000, 2001, 2002 and 2003 respectively. The ERV rates fluctuated from the lowest, 203 ERV claims per 10,000 enrolled in year 2001, to the highest of 231 ERV claims per 10,000 enrolled in year 2003. ERV information regarding US population was provided by the National Center for Health Statistics (NCHS), through their National Hospital Ambulatory Medical Care Survey – NHAMCS (CDC, Web Page). In contrast, they reported for year 2003, 73.3 visits per 10,000 non-institutionalized citizens. The NHAMC recorded the lowest rate of 56.8 in year 1992 to the highest of 75.1 emergency department visits per 10,000 non-institutionalized citizens in 2003. After calculating the non-standardized risk estimate, it was observed that the population surveyed in Puerto Rico reported approximately three times higher ERV claims than the NHAMCS populations.

A higher morbidity and use of health care resources among Puerto Ricans in the main land has been observed in the Genetics of Asthma in Latino American (GALA) study (González et al. 2005), where all measures of asthma morbidity except for admissions to an intensive care unit were significantly higher among the Puerto Rican subjects regardless of the asthma severity. Estimates in the utilization of health services for asthma treatment presented a different perspective in emergency room visit claims rate with a range of 11% to 56% (Pérez et al. 1999; Montealegre et al. 2002). Our results showed that females had a statistically significant higher use of ERV than males during the four years of surveillance. Also, data from emergency room departments in Ponce presented a higher use of these services in females than in males (Montealegre et al. 1996), and Pérez et al. (1999) reported higher ERV claims in females. In addition, Pérez et al. (1999) observed a higher use of emergency room visits in the 18-44 age group (13.3%) and in the 0-17 age group (11%), in contrast with this study where the 0-4 and 5-9 age groups had constantly higher claims than any other age group.

Regarding time trends, Mannino et al. (2002) reported an increased emergency room visits rate for asthma in the United States from 1995 to 1998. Also, an increased ERV pattern was observed during the surveillance period from 2001 to 2003 in Puerto Rico. In terms of the seasonal variation, the lowest rate of ERV claims was identified during the month of July (summer) and the highest rate during the month of October (fall). Both observations were constantly maintained through the four-year surveillance period. In Puerto Rico the school summer recess is between mid May to mid August. Seasonal patterns of asthma clinical episodes were observed in a group of 3,000 volunteers conveniently selected in a shopping mall located in the southern region of Puerto Rico. The winter months (November, December and January) were reported to have approximately 3.8 times more exacerbations when compared to the rest of the year (Montealegre et al. 1996). A similar tendency was observed in the emergency room data collected from hospitals located in the city of Ponce (Montealegre et al. 2002), where December was the month with the highest prevalence (12.3%) and June the one with the lowest prevalence (5.3%). Other studies by Silverman et al. (2003) and Gergen et al. (2002), who studied the relationship between ages and seasonal asthma periodicity in patients, observed a higher number of ERV during the fall and fewer during the summer season.

As to seasonality and environmental factors, a popular belief is that the Sahara Desert Storm Dust that arrives to the Puerto Rican archipelago every year during the months of May to August causes an increase in ERV and hospital admission rates. The observed data suggests that if the Sahara Desert Storm Dust induces any effect on the asthma patients, the ERV claims due to asthma do not exceed the expected numbers. The seasonal trends described leads to the hypothesis that infectious respiratory diseases or exposure to an inhospitable environment in schools and/or the working place could induce asthma exacerbations severe enough to attend the emergency room.

With regards to health coverage, the health care reform population significantly accounted for a higher ERV claims rate due to asthma than the private insured population. There are no specific explanations related to this particular issue, but several indicators arise as possible reasons that could lead to the observed differences between health care coverage. It is suggested to explore with further investigation if the health care reform population suffers more exacerbations as a consequence of the capitation system which may affect the accessibility to the correct drug prescription and preventive treatment approaches for proper asthma management, and if this population may be frequently exposed to environmental factors as part of their living conditions. Our findings suggest that females and children from 0 to 14 years of age pose the biggest burden due to the incorrect use of ERV services utilization.

Geographical analysis suggested that the municipalities of Ponce, Peñuelas, Guayanilla, Adjuntas, Comerio, Naranjito, Corozal are those with the highest priority for interventions to the reduce emergency room visits claims. These municipalities which are within the south, southwestern, and north-central regions of Puerto Rico presented a higher relative risk than expected ( $RR > 2.36$ ).

### 3.5. Asthma Drug Claims

#### 3.5.1. Asthma drug claim findings

**Table 3:** Top 7 drug claim rate due to asthma and 95 confident limits

Asthma related drug claim rate (Rate per 10,000)								
Category	2000	95%IC	2001	95%IC	2002	95%IC	2003	95%IC
<b>SABAI</b>	725.33	720-730	719.79	715-725	792.58	788-798	478.23	474-782
<b>Xanthines</b>	518.61	514-523	411.65	408-415	399.94	396-404	144.20	142-146
<b>SABAO</b>	351.53	348-355	260.00	257-263	257.41	254-260	97.72	96-100
<b>LRA</b>	209.94	207-213	299.88	297-303	337.99	335-341	348.46	345-352
<b>ICS</b>	234.71	232-238	239.28	236-242	220.90	218-224	200.52	198-203
<b>ICS-LABA</b>	0.00	N/A	14.68	14-15	81.37	80-83	109.58	108-112
<b>LABAI</b>	56.31	55-58	55.09	54-56	36.04	35-37	22.96	22-24

Table 3 shows the asthma related drug claims rate per 10,000 with 95% confidence interval for years 2000 to 2003 in a selected HIC for the following drugs: inhaled short-acting beta agonists (SABAI), xanthines, oral short-acting beta agonists (SABAO), leukotriene receptor antagonist (LRA), inhaled corticosteroids (ICS), inhaled corticosteroids-long acting beta agonists (ICS-LABA), and inhaled long-acting beta agonists (LABAI). SABAI prescription rates were the highest through all the study period. Inhaled corticosteroids, which are the preferred treatment to maintain long term control of asthma, have one of the lowest rates of prescription during the observed period. Xanthines and leukotriene receptor antagonists, which are alternative treatments to maintain long term control of asthma, had higher utilization rates than inhaled corticosteroids.

Figure 40 (a)

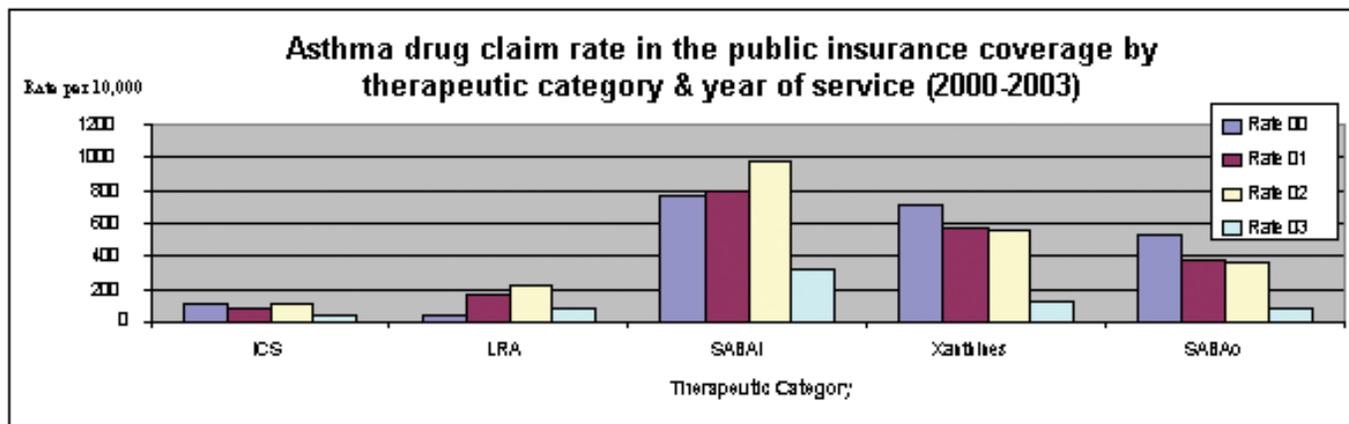
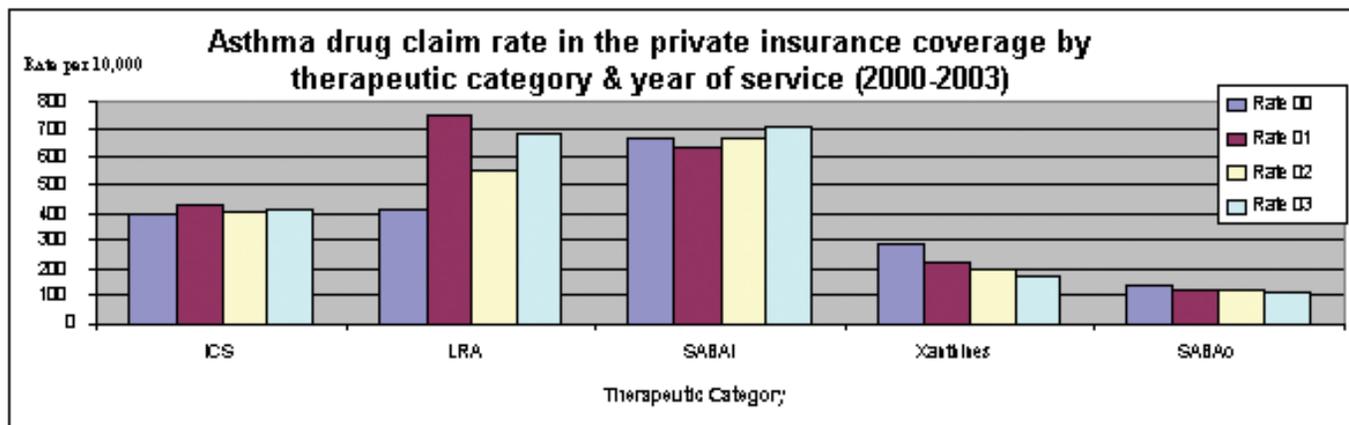


Figure 40 (b)

Figure 40 (a) shows the drug claims rate by year of service and therapeutic category type for the private insurance coverage, and Figure 41 (b) shows the drug claims rate for the same therapeutic category and year of service for the Health Care Reform insurance plan (public). For both insurances, ICS had the lowest utilization rate during the surveillance period. The utilization rate of ICS was significantly lower for the Health Care Reform plan (106, 86, 105, 33 from 2000 to 2003 respectively) than for the private insurance company (390, 427, 406, 410 from 2000 to 2003 respectively). The drug utilization of LRA was significantly higher for private coverage than for health care reform. In addition, lower drug utilization was detected for SABAi and for xanthines in the private coverage when compared to the Health Care Reform. For the private insurance company, the utilization rate of ICS was lower than the utilization rate of LRA, but higher than the utilization rate for xanthines. For the Health Care Reform plan, the utilization rate of inhaled corticosteroids was lower than the utilization rate of xanthines or LRA. The data obtained from the Health Insurance Company related to the Health Reform asthma drug claims use was incomplete, so a drop in utilization could be attributed for 2003.

**Figure 41**

Drug claim rate by therapeutic category, type of coverage and year of service in a selected HIC (2000-2003)

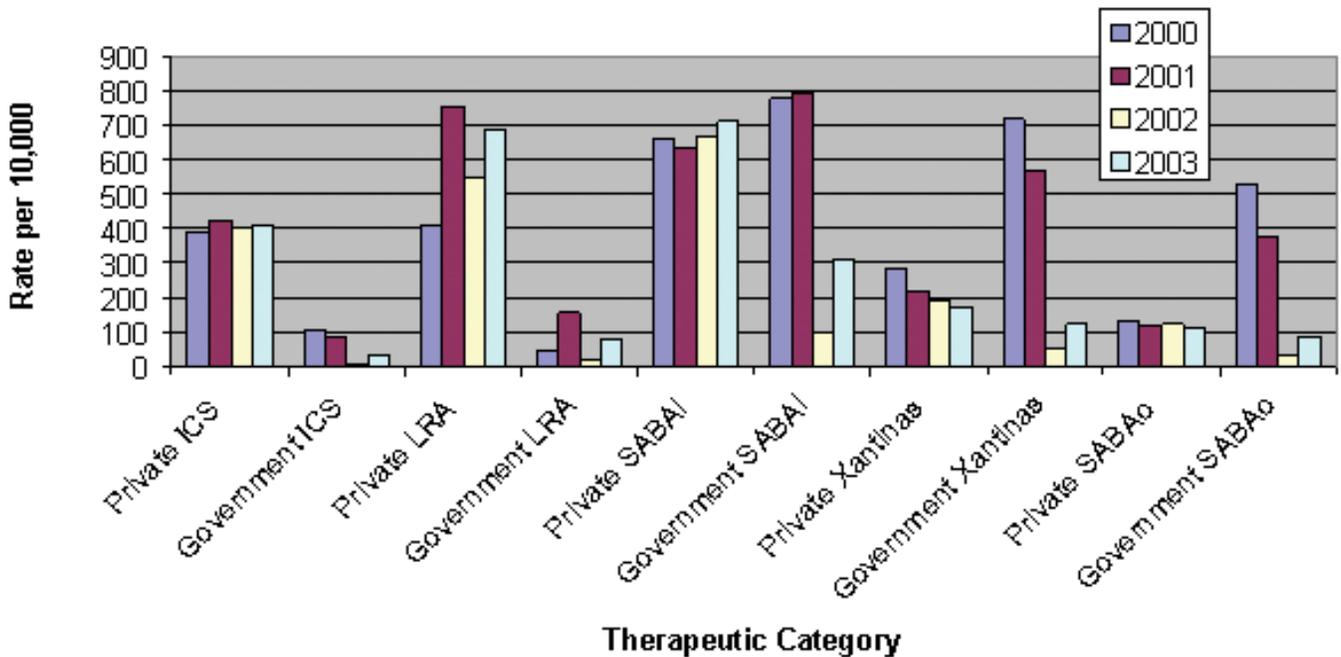
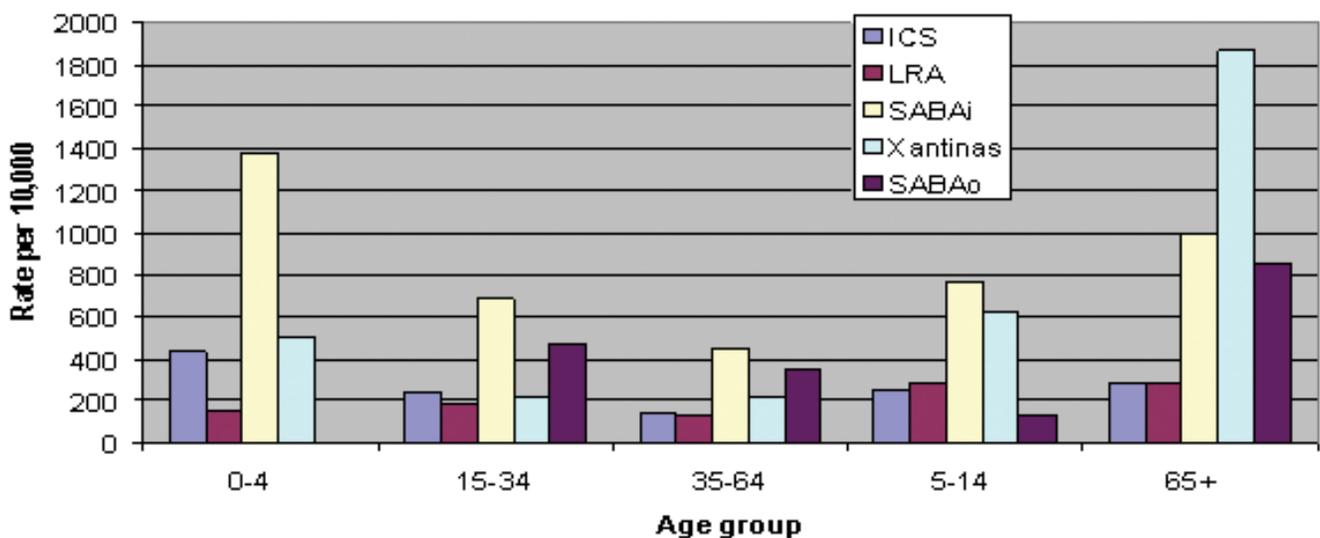


Figure 41 shows the asthma drug claims rate by gender, therapeutic category and year of service. Females showed higher utilization rate per 10,000 enrollees consistently across the periods studied. The rates of drug utilization maintained a constant pattern through the years in males and females, specifically the lowest rates for ICS and the highest rates for SABAI.

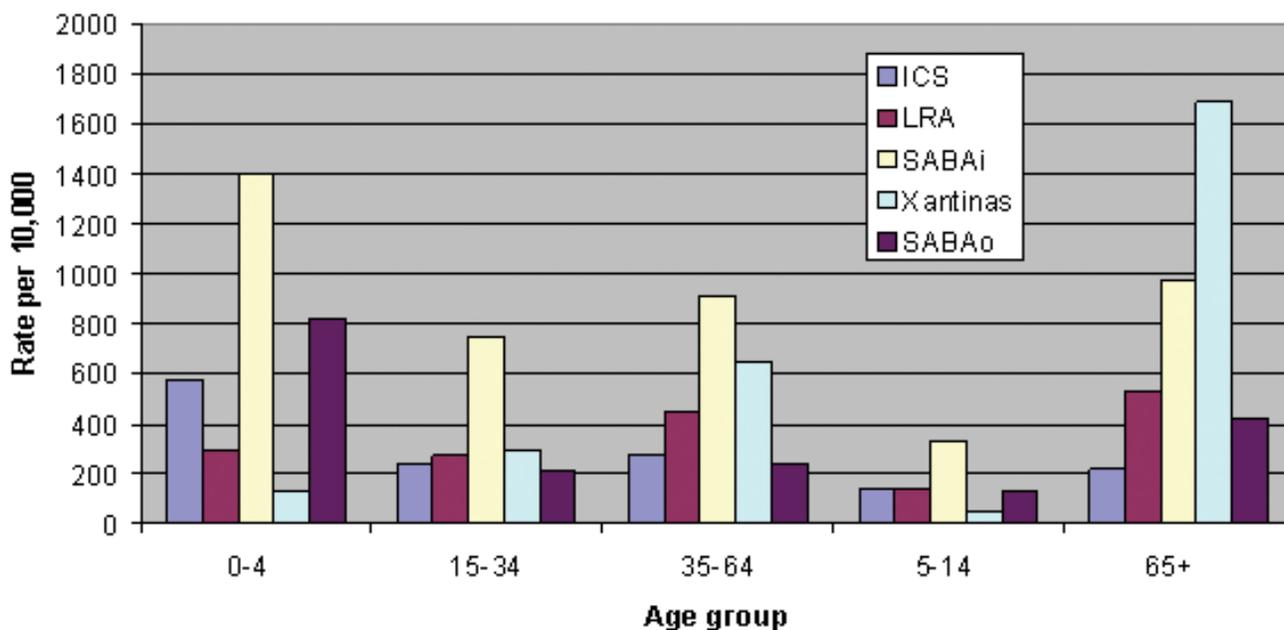
**Figure 42 (a)**

Asthma drug claim rate by therapeutic category and age group in a selected HIC (2000)



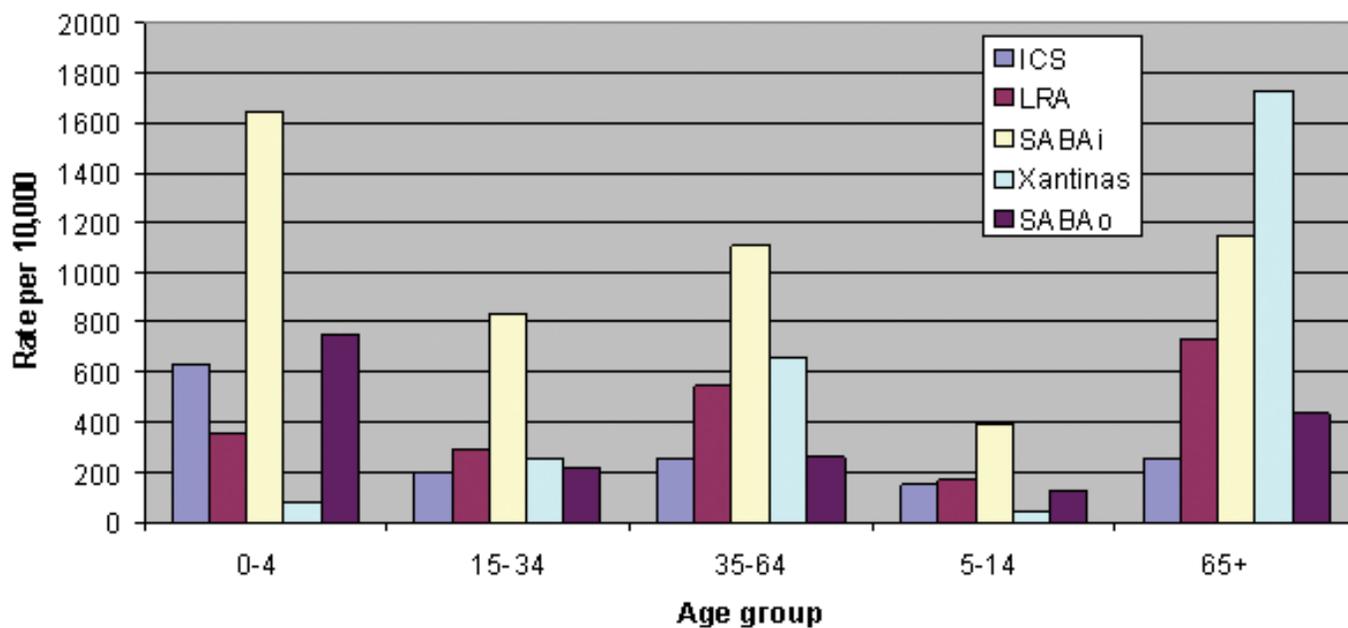
**Figure 42 (b)**

Asthma drug claim rate by therapeutic category and age group in a selected HIC (2001)



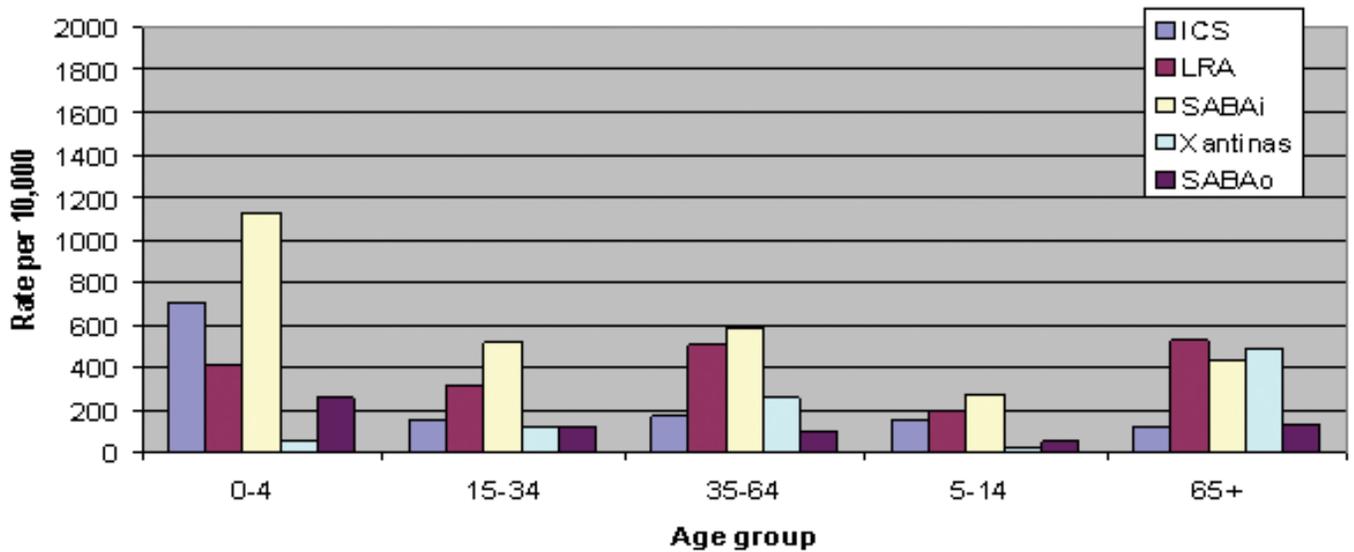
**Figure 42 (c)**

Asthma drug claim rate by therapeutic category and age group in a selected HIC (2002)



**Figure 42 (d)**

Asthma drug claim rate by therapeutic category and age group in a selected HIC (2003)



Figures 42 (a) to 42 (d) show the asthma drug claim rate stratified by age group and year of service. In Figure 42 (a), the drug claim rate of SABAI for year 2000 had higher utilization rate than ICS, LRA, xanthines or SABAO for the following age groups: 0-4, 5-14, 15-34 and 35-64. In patients over 65 years old, xanthines showed greater claim rate than the other drugs. Patients in the 0-4 age groups showed no claim rate for SABAO. Figure 42 (b) shows in 2001, that SABAI had higher claim rate than ICS, LRA, xanthines or oral short-acting beta agonist for the following age groups: 0-4, 5-14, 15-34 and 35-64. In patients over 65 years old, xanthines showed greater claim rate than the other drugs. Patients in the 5-14 age groups showed the lowest utilization rate for all the drugs. Patients in the 5-14 age groups showed the lowest utilization rate for all the drugs studied. Figure 42 (c) shows that in 2002, SABAI had higher claim rate than ICS, LRA, xanthines or SABAO for the following age groups: 0-4, 5-14, 15-34 and 35-64. In patients over 65 years old, xanthines showed greater claim rate for all drugs evaluated. Patients in the 5-14 age groups showed the lowest claim rate for all the drugs evaluated. Figure 42 (d) shows that in 2003, SABAI had higher claim rate than ICS, LRA, xanthines or SABAO for the following age groups: 0-4, 5-14, 15-34 and 35-64. In patients over 65 years old, LRA showed greater claim rate than the other drugs. Patients in the 5-14 age groups showed the lowest claim rate for all the drugs evaluated.

### ***3.5.2. Asthma drug claims discussion***

In Puerto Rico the asthma drug claims pattern differs from those suggested by the two principal guidelines developed for asthma control. In the United States, the National Heart, Lung and Blood Institute (NHLBI) with its National Asthma Education and Prevention Program (NAEPP) convened their expert panel and issued the Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma in 1997 (NIH 1997). Then in 2002, they issued an Update on Selected Topics on those guidelines. The Global Initiative for Asthma (GINA) is a similar initiative generated by the World Health Organization and the National Institutes of Health (NIH, 2002b). Their 1995 guidelines recommended goals for the management of asthma and were updated in 2002 similar to the NAEPP guidelines.

The present study analyzed a total of 918,093 asthma drug claims. When analyzing the drug claims rate per 10,000 enrollees, the following five therapeutic categories presented the highest utilization through the four years of study: inhaled short-acting beta agonists (SABAI), xanthines, oral short-acting beta agonists (SABAO), leukotriene receptor antagonists (LRA) and inhaled corticosteroids (ICS). The high rate of SABAI and SABAO prescription could be observed since it is recommended that all patients, regardless of their asthma severity classification, should have an effective rescue drug when treating acute exacerbation for immediate control (Barnes 2006). This observation is consistent with other studies where high use of quick relief bronchodilators or SABAI were reported (Rabe et al. 2004, Rodriguez & Fidalgo 2006). The high rate of xanthines claims was maintained through the study period, even though this therapeutic category is not considered appropriate for asthma control in the NAEPP and GINA guidelines. The prescription rates of LRA and ICS are similar regardless of the guidelines classification of the LRA as an alternative treatment on an equal footing of xanthines. It is worrisome that ICS, the most recommended and effective drug for asthma control and treatment, presented such a lower prescription rate in Puerto Rico when the use of this therapy is clearly recommended by NAEPP and GINA guidelines and studies report an increase in prescription (Schatz & Camargo 2002; Allen-Ramey et al. 2003).

In terms of drug claims stratified by type of health care coverage, the use of SABAI was significantly higher in the Health Care Reform (government health coverage) than in the private coverage. The SABAI claim rate shows that this is the top category in asthma drug treatment. The comparison of the sabai claims rate between government and private coverage showed a constantly higher rate in the government plan during 2000, 2001 and 2002. When the utilization rate by therapeutic category and year of prescription is compared between the private insurance plan and the government health plan, it shows that the utilization rate for ICS and LRA in the government plan is statistically lower than the claim rate for the private insurance. The trend in utilization of ICS can be associated to multiple factors. Allen-Ramey et al. (2003) studied ICS prescribing trends between 1994 and 1998 within a selected group of physicians. They found that allergy and lung specialists prescribed ICS in a larger proportion than generalists (family practice, internal medicine, pediatricians, and pediatric emergency departments). In this study, the claims of xanthines, a less effective bronchodilator, were higher in the Health Care Reform than in private insurance company. Even though a drop in the claim rate of xanthines for both sectors was recorded during the surveyed years from 2000 to 2003, the high rate could be due to the inexpensiveness of this drug and to the fact

that it is available in oral formulations. For SABAO, the claim rate is constantly higher for the government insurance than for the private insurance during 2000, 2001 and 2002. The claim rate for the private sector shows stability for SABAO drug use.

Regarding drug claims stratified by gender, every drug category was significantly higher for females than for males. Similar patterns were maintained for asthma treatment through the study period where SABAI and xanthines was the most prescribed drug for both genders.

Data was analyzed for the following age groups: 0-4, 5-14, 15-34, 35-64, and 65 or more during study period from 2000 to 2003. SABAI had a higher claim rate than inhaled corticosteroids, leukotriene receptor antagonist, xanthines or oral short-acting beta agonists in those age groups, except in patients over 65 years old where xanthines showed the highest claim rate than the other drugs during 2000-2002. It is of concern that xanthines, drugs that at high concentrations are associated with tachycardia, cardiac arrhythmia, tremor, neuromuscular irritability and seizures, are so commonly prescribed in this susceptible age group.

The observations and findings from this epidemiological profile suggest that physicians should reinforce their adherence to the NAEPP and GINA prescription guidelines of current standard care practices in the management of asthma. Efforts should be made to educate health practitioners and asthma patients as a way to reduce the severity of asthma in Puerto Rico.



## IV. CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

### 4.1. *Conclusions*

This study shows that asthma is a disease of great impact in the Puerto Rican community. Approximately 19% of the Puerto Rican population has had this condition at one point in their lives. Puerto Ricans have higher lifetime and current asthma prevalence than any other 53 participants of the BRFSS. The asthma mortality rate in Puerto Rico is in average 2.5 times higher than the mortality in the United States. Although not-standardized, the data suggests that the population surveyed in Puerto Rico had higher hospital admissions claim rates and ERV claim rates than the United States' population. Therefore, it is expected that the use of health care services impose a burden to the economy of asthma patients and to the country due to the high rate of health care utilization (Baliss 2005).

Overall, females had higher lifetime asthma prevalence, higher asthma prevalence at the time of the survey, higher hospital admissions, emergency room visits and higher asthma drug claim rates than males. The mortality indicator did not present any differences when stratified by sex even though males at younger age groups (less than 15 years) have higher hospital admission claims and emergency room visit claim rates than females. The estimated risk in the year 2003 showed that females had 1.3 more ERV claims than the males. The hospital admission claims rate estimate was similar where females had 1.4 more hospital admission claims rate than males. Hence, females as well the younger males should be one of the primary goals of intervention for assessing the asthma burden on the island.

The younger group in the BRFSS sample, from 18 – 24 years old, was constantly the one with the highest prevalence in the three years surveyed. A similar pattern was observed in hospital admissions and ERV claim rates where the younger age groups (less than 15 years old) accounted for the highest rate in use of these services. Moreover, the 55 years of age or older group had nine times more risk of asthma mortality than the younger age group of 19 to 54 years of age.

When the lifetime asthma prevalence and asthma prevalence at the time of the survey were compared by year of surveillance, both prevalence measures showed an increase from years 2000 to 2003. For hospital admissions, a time series by month and year was analyzed revealing a smooth global trend with no indication of a significant increase or decrease during 2000 to 2003. Moreover, the ERV time series showed a tendency to increase starting in October of 2001. Both indicators showed a similar seasonal trend where October was the month with the highest hospital admission and ERV claims rate compared to any other month of the year. The back-to-school timing and new viral infections lead the hypothesis for this trend. The seasonality observed suggests to the health authorities in Puerto Rico that the asthma prevention month celebrated during May should be shifted to the months of August and September as a way to reduce the high rates of hospital admissions and ERV reported.

The Health Care Reform population had an average of 3 times more ERVs than the private insured population; specifically the children from 0 to 4 years old had approximately 7.5 times more ERVs than the ones with private coverage. Overall, the children 0-14 years of age had the highest ERV claims than any other age group. The type

of coverage in the hospital admission analysis did not have a significant difference. Clearly, the data from the study underlines the need to prioritize the prevention of asthma ERV for children by the public health representatives.

Geographical analysis showed that the municipalities with highest precedence for interventions directed to reduce hospital admission rates are: Peñuelas, Guayanilla, Adjuntas, Guánica, Maricao, Mayaguez, Lajas, San German, Sabana Grande and Maricao. On the other hand, geographical analysis of ERV claims showed that Ponce, Peñuelas, Guayanilla, Adjuntas, Comerio, Naranjito and Corozal are the municipalities with the highest priority for interventions to reduce the emergency room visit claims. The spatial analysis conducted for both ERV and hospital admission claims determined that the Southwestern municipalities presented a higher estimated relative risk than expected. Ecological studies must be conducted to enhance our understanding of the observed patterns of hospital admissions and ERV.

Analysis of drug claims rate showed that asthma management should be reevaluated. Current guidelines place inhaled corticosteroids or long acting beta agonists as preferred drug treatments (NIH 2002), but drug claim rates showed greater claims for xanthines and leukotriene receptor antagonists which are placed as alternative treatments. Results support the need to reinforce education to health professionals on how to understand the guidelines and optimize asthma management (Kaliner 2005). The utilization rate patterns observed for each insurer, private and government, clearly showed that both have to make efforts to manage asthma patients according to current guidelines. But in the government, an especial effort should be made to uncover the reasons for having consistently lower utilization of ICS and LRA than the private insurer. The government should analyze how the Health Care Reform system is working and evaluate the effects of the administrative and funding structure of the program in driving physicians to the utilization to SABAI, SABAO and xanthines, which are not preferred treatment options for long-term management of asthma patients.

In terms of treatment, patients should understand the role of short-acting beta agonists as drugs to be used as “rescue” medications which are designed to manage an asthma attack. On the other hand, they should be aware that long-acting beta agonists should not be used instead of short-acting beta agonists for the management of acute attacks. Physicians need to involve patients and/or caregivers in their own care (Long 2005), especially children, who should have knowledge on how to monitor their asthma using the peak flow meters to measure the amount of airflow from the lungs in order to determine the status of the condition. Another factor to be considered is the physician’s specialty, because it may have a direct impact in the drug claim trend. As suggested by Kaliner (2005), patient care will be put to better use by involving an asthma specialist earlier in the process. This is important since the private health insurance is an open system where the patient can choose the health care provider. On the other hand, the government’s system is a closed one in which the patient has to visit a primary physician who decides if the patient needs to be referred to a specialist.

The reasons for the high asthma mortality and morbidity in Puerto Rico are unknown and several explanations are possible. It is understood that some factors that could affect the mortality pattern are changes in the disease recognition and concept, changes in the diagnosis and detection techniques, changes in the procedure to classify

the death cause, changes in the classification code of death cause, changes in the precision to classify the age at death, errors in numbering the population, changes in the population age distribution, changes in survival due to changes in the fatality rate, and changes in the disease incidence due to genetic or environmental factors (Brachman 1997; Buehler 1998). In terms of morbidity, cultural differences could influence the way a population answers a self-reporting questionnaire such as the BRFSS questionnaire. Hypothesis for evaluating the relationship between environmental risk factors and specific genetic factors in this population should be considered as possible explanations for the high mortality and morbidity identified in the Puerto Rican population (Perez et al. 2003; Homa et al. 1999).

The high use of health care services suggests that physicians may not be following the National Asthma Education and Prevention (NAEPP) guidelines or may not be giving the patient the proper written asthma management plan (Ohar 2005). Also, asthma devices and peak flow meters are not covered by most insurance plans, and there is still a lack of awareness of asthma, lack of self-efficacy and adherence to treatment among patients and their caregivers to manage and control the condition. Another important matter is the need of patient education and multiple interventions in the areas of: (1) self-reported asthma severity, making them conscious about reporting any symptoms, even those that they consider mild; (2) adherence to treatment; (3) proper use of medication delivery devices; and (4) treatment goals (Kelly 2005).

This Puerto Rico asthma profile provides a thorough representation of the asthma burden in the island never conducted before. This is probably the most comprehensive epidemiological profile conducted for any disease in Puerto Rico. The obtained results allow for the consideration of further analysis and investigations in the asthma health care field. Furthermore, the results provide important information to guide public health authorities to create and improve strategic planning for target groups and to allocate resources designated to address the asthma burden in specific populations. The Puerto Rico Asthma Strategic Plan elaborated with the Puerto Rico Asthma Coalition will use the results of this study to target their designed interventions.

This profile sets the infrastructure for an ongoing and standard asthma surveillance system. The maintenance of this infrastructure will allow the Puerto Rico Health Department to measure changes in asthma related factors such as the identification of new or emerging health concerns, the monitoring of trends of the disease by time and place, and the study of the natural history of the disease to develop public policy and to provide the basis for epidemiological research. These efforts will guide the planning, implementation, and evaluation of health related interventions structured in the Puerto Rico Asthma Control Strategic Plan. Upon this scenario, the health agencies, private institutions and non-profit organizations are encouraged to continue supporting the initiatives to reduce the burden that this condition represents to the Puerto Rican population.

#### **4.2. Limitations**

The present surveillance data has several limitations that must be considered when analyzing the information provided in this report. The mortality case definition used was asthma as the probable cause of death. As mentioned

before, it is difficult to be certain that a death caused by asthma is not misclassified with other pulmonary diseases. The asthma case definition in any asthma study or surveillance is complex due to a lack of a precise and standard surveillance definition. This limitation is applicable to all asthma indicators and studies, not only for mortality.

Another limitation is that for the selected HIC, although is the largest in Puerto Rico, the results cannot necessarily be generalized to all the Puerto Rican population. The selected HIC Health Care Reform enrollee population covers 21% of all the municipalities in Puerto Rico, making complex the interpretation of the study data. Furthermore, inferences regarding hospital admission, ERV and asthma drug claims are applicable only to the population within this particular HIC.

The methods used in this study are different from other studies describing the Puerto Rican population and other countries. Therefore, comparisons should be conducted cautiously. The lack of published information regarding hospital admission rates or health care utilization in other countries limits the possibilities to compare patterns observed in this study.

### **4.3. Recommendations**

Based on the findings of this epidemiological profile, several recommendations are proposed, which if implemented, will help to enhance the understanding of the asthma situation in Puerto Rico. A validation study of asthma diagnoses should be conducted to explore the probability that physicians are using a different pattern of diagnosis from those used in the United States and other countries. It is also important to observe if there is a misdiagnosis with the Chronic Obstructive Pulmonary Disease or other pulmonary conditions. In addition, a validation study of the death certificates by asthma should be designed and performed to allow for the identification of the probability of classification errors in the certification process of deaths caused by asthma. Asthma is a condition that needs to be managed with a multi-professional approach. Furthermore, it is important to study if the current governmental healthcare system has somehow influenced the way asthma is treated and if there is any difference with the past health system. The Puerto Rico Asthma Surveillance System should be improved by including information from other health insurance companies to increase the quality of our estimates of the insured population. The additional data will provide a larger database with accurate assessments and patterns for geographical analysis locations that were not included in this report. Ecological spatial analysis should be conducted to include possible risk factors in the spatial model to obtain possible explanations of the observed spatial distribution on hospital admissions, ERVs and mortality. Health care resources and intervention activities planned to reduce hospital admissions and ERVs due to asthma, such as the ones established in the Puerto Rico Asthma Control Strategic Plan, must be targeted to females and children from the private and health reform insurance populations. Nevertheless, the health care reform population is the priority for both health indicators. Interventions to reduce asthma mortality should be targeted to the population of 55 years of age and older. In depth investigations related to the patterns of mortality, morbidity and the use of health care services in Puerto Rico are encouraged. Meanwhile, it is important to reinforce partnerships among agencies that serve people with asthma. These efforts will allow for continuous education among the population and the health care professionals on proper asthma management and control, and encourage health systems changes in order to reduce the asthma burden in Puerto Rico.



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